A Tale of Three Prices: Monetary Policy and Autonomous Consumption in the US

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June 14, 2021

Preliminary Draft. Please do not cite or circulate.

Abstract

The paper empirically assesses the role of real estate prices, housing rent, consumer prices, and monetary policy in an amended version of the Sraffian Supermultiplier Model. To do this, six different Structural VAR models are estimated on US quarterly data for the period 1970-2020. The estimations suggest that the own interest rate (Sraffa, 1932; Teixeira, 2015) produces more persistent and statistically significant effects on autonomous consumption and on output than the real interest rate. The implication of these results is twofold. First, these findings confirm the hypothesis that monetary policy transmission passes through autonomous consumption, in particular via changes in house prices. Second, the persistence of the effect of autonomous consumption on output reaffirms its long run implications that goes beyond the business cycle, in line with the recent literature on autonomous demand-led growth. Furthermore, after the inclusion of rents and the overall price level, a positive monetary policy shock leads to an increase in rents, while housing prices decrease and the overall price level increases, giving a possible explanation of the Gibson's Paradox. This contradictory movement in rent prices explains part of the price puzzle since shelter has a significant impact as one of the main components of the Consumer Price Index (Dias and Duarte, 2019). These latter results open a path for the discussion of the linkages between monetary policy and distribution, since recent expansionary monetary policy did not fail to translate into worsening house affordability leading to a decrease in home-ownership (particularly affecting lower-income households). In this sense, it is evident that autonomous consumption has to move in step rather than detached from income distribution, making the case for income and redistribution policies.

Keywords: Monetary Policy; House Prices; Rent; Supermultiplier; Autonomous demand; SVAR; US.
JEL Codes: C32; E11; E12; E31; E32; E43; E52; R21.

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1 Introduction

In the epicenter of the ground breaking financial shock, the housing market gradually attracted greater attention in the academia and otherwise. Nevertheless, even before the policy tools of the FED and 'the science behind its arts' ended up on shaky grounds, a great amount of research has been produced within the mainstream to incorporate the role of housing in the transmission of monetary policy. As argued by Bernanke and Gertler (1995), finding a direct channel between monetary policy and output would require going "inside the black box", where no evidence is found in what concerns the interest rate-investment nexus.

From a post-Keynesian perspective, the transmission channels of monetary policy grounded in the downward sloping IS curve have been challenged before its birth early in the days of heated debate among Cambridge UK/US around the "capital controversy". In fact, a whole theoretical body grounded in the works of Sraffa (1960); Garegnani (1970) and Garegnani (1978) have challenged the theoretical consistency of a downward-sloping investment demand curve through the possibility of re-switching of techniques, arriving to the conclusion that investment only reacts to shifts in "final demand". Accordingly, the linkage between interest rate and output can be attributed to the semi-autonomous components of demand (in particular autonomous consumption) that affect, in turn, investment. In fact, these linkages are in the very heart of the endogenous money theory, according to which money supply is credit-led and demand-determined.

Along these lines, the present contribution seeks to empirically assess the role of real estate prices, housing rent, consumer prices, and monetary policy in an amended version of the Sraffian Supermultiplier Model. To do this, six different Structural VAR models are estimated on US quarterly data for the period 1970-2020. By using SVAR models, it is possible to identify exogenous autonomous consumption, price and monetary policy shocks. To do this, a recursive identification strategy is employed, based on a standard Cholesky decomposition, which is commonly used in the literature to isolate monetary policy shocks (e.g., Bernanke and Blinder 1992).[1] The novelties of this investigation are manifold : (i) confirm the hypotheses that monetary policy transmission passes through autonomous consumption, in particular via changes in house prices; (ii) verify the persistency of the effect of autonomous consumption on output to reaffirm its long run implications that goes beyond the business cycle as found by Leamer (2007); (iii) assess the dynamics of three prices (housing prices, rent prices and overall consumer price index measured by the CPI) inspired by Dias and Duarte (2019).

The remainder of this paper is organized as follows. Section (2) reviews the literature on the Sraffian Supermultiplier Model and the empirical literature on monetary theory and policy instruments focusing on the role played by housing prices and dwellings. In particular, Subsection (2.1) briefly assesses the distinctions between the post-Keynesian monetary theory and its competing schools, drawing particular attention to monetary policy tools and its transmission mechanisms. Then, the theoretical and empirical literature on the role of housing prices and dwellings in the transmission of monetary policy is briefly reviewed, highlighting the perspective from the Sraffian Supermultiplier (Serrano, 1995) framework presenting an amended version of the model (2.2). In Section (3), both data and methods employed are presented. In Section (4), the empirical findings of all estimated models are displayed and discussed. Section (5) concludes and draws some policy implications.

[1] For a detailed review on SVAR models and on the recursive identification strategy, the interested reader might refer to Ramey (2016) and Kilian and Lütkepohl (2017).

2 Monetary Theory and Policy Instruments: The Role of Housing Prices and Dwellings

This section presents the distinctions between the post-Keynesian (PK, henceforth) monetary theory and its competing schools, drawing particular attention to monetary policy tools and its transmission mechanisms (2.1). Then, the theoretical and empirical literature on the role of housing prices and dwellings in the transmission of monetary policy is briefly reviewed, highlighting the perspective from the Sraffian Supermultiplier Model (SSM, henceforth) presenting an amended version of the model (2.2).

2.1 Monetary Theory and Policy Instruments

As argued by Lavoie (2014), the PK school presents some distinctive features as regards its take on money, credit, interest rate determination as well as on macroeconomic implications of monetary theory. Important contributions from PKs on endogenous money theory date back to the late 1950s and early 1960s as pointed out by Lavoie (1992), that has made available to a wider audience two articles from the French economist Jacques le Bourva (1959; 1962). These two contributions provide "almost all the elements that have been put forth by [...] post-Keynesian proponents [of the theory of endogenous money]" (Lavoie, 1992, p.437). In fact, one or two decades later, Kaldor (1970; 1981; 1982), Davidson and Weintraub (1973), Eichner (1986), Moore (1988) and Wray et al. (1990) formalized the foundations of endogenous money by picking up elements that were already present in the works of Le Bourva in French. [2]

Therefore, the first distinctive feature among PK scholars as regards monetary theory is undoubtedly the endogeneity of money. In particular, money-supply is demand-determined and credit-driven, depending on creditworthy demand for bank credit. While mainstream monetary theories (see Table 1) tend to assume that the causality runs from deposits that allows creation of credit through the bank multiplier, for PKs the causality runs in the opposite direction, i.e. bank deposits are created in the occasion of bank credit concession. Accordingly, bank reserves are endogenous and credit-demand-determined, being a fraction of the amount of bank deposits. In other words, it is the asset side that determines the liability side in banks' balance sheets.[3]

[2]Many Cambridge-based PKs have also adhered to the endogenous money hypothesis, see Robinson (1956); Kahn and Kahn (1972); Cramp (1971); Godley and Cripps (1983) among many others. Indeed, Basil Moore himself suffered great influence from PKs at Cambridge in the occasion of his sabbatical year there, which played an instrumental role in his engagement with the endogenous money approach to monetary theory. For a chronological in depth review of the evolution of Basil Moore's shift from seeing endogenous money as a choice of central banks to the idea that central banks have no choice but to let money be endogenous see Rochon (2020).

[3]The concept of credit-driven money supply is also supported by several 'orthodox dissenters' (Lavoie, 2014), namely New Consensus authors, New Paradigm Keynesians, neo-Austrians, and Real-business cycle scholars. Nevertheless, in these cases the 'accommodation principle' is a special case, and not the general case of endogenous money as in the PK framework. This is consistent with what Rochon (1999) has called 'credit-led but supply determined', in other words the causality is still read from liabilities to assets.

Table (1) Horizontalist post-Keynesians and the Mainstream

Theoretical Paradigm	**Neo-Keynesians / Neoclassical Synthesis**	**Monetarism**	**New-Classical**	**Real Business Cycle**	**New Consensus / New-Keynesians**	**Horizontalists post-Keynesians**
Monetary Policy Tool	Monetary Aggregates	Monetary Aggregates	Monetary Aggregates	Monetary Aggregates	Short-term Interest Rate	Short-term Interest Rate
The Role of Monetary Policy	Short-run Real Effect	Short-run Real Effect	Nominal Effect	Nominal Effect	Short-run Real Effect	Long-run Real Effect
Neutrality of Money	Neutral in the long run	Neutral in the long run	Neutral	Super-Neutral	Neutral in the long run	Non-Neutral
Money Supply	Exogenously Determined	Exogenously Determined	Exogenously Determined	Endogenously Determined	Endogenously Determined	Endogenously Determined
Reserve Mechanism at Work	Multiplier	Multiplier	Multiplier	Multiplier	Multiplier	Divisor
Monetary Causality	Deposits allow credit	Deposits allow credit	Deposits allow credit	Deposits allow credit	Deposits allow credit	Credit makes deposits
Macroeconomic Causality	Investment determines Savings	Saving determines Investment	Saving determines Investment	Saving determines Investment	Saving determines Investment	Investment determines Savings
Inflation	-	Monetary Phenomenon	Monetary Phenomenon	Monetary Phenomenon	Monetary Policy Phenomenon	-

As regards the views on interest rates, the distinctions between PKs and the mainstream are manifold. First, according to the PK framework, the monetary authority is able to control interest rates setting the base rate which is not influenced by market forces, whereas, in the mainstream, banks can only lend their deposits and the rate of interest is set equilibrating supply and demand for credit. Lastly, but surely not least, in PK monetary theory, the interest rate does not emerge naturally from market laws, but has an intrinsic relation with distribution.[4]

In practice, modern monetary policy framework uses an inflation target, controlled by the monetary authorities that no longer aim at controlling the supply of monetary aggregates. However, this has not always been the case.[5] At the present stage, in the US, the base rate is targeted as the overnight rate (Federal Funds Rate), which is the main instrument of the FED when it comes to controlling the spectrum of interest rates. Indeed, the tight control of short-rates (especially in the case of private sector issued securities) may deviate from the target set by the central bank, particularly in turbulent times. In this sense, liquidity preference may affect the differentials relative to the base rate, but certainly does not affect the central bank's determination of the latter as a discretionary policy tool in the hands of the monetary authority (Lavoie, 2014).

This shift in policy instrument has been mostly the result of the failure of money supply targeting, as highlighted by Carlin and Soskice (2014) in reference to the British experience during the mandate of Margaret Thatcher. Even though there has been a broad consensus in the mainstream literature after the publication of Friedman and Schwartz (1963) in what concerns the influences of monetary policy in the real economy (short-run effects), the monetarist framework lost strength in the beginning of the 1990s giving space to the New Consensus Model (NCM). This shift was much related to a dispute in what concerns the transmission channels of monetary policy. In fact, as highlighted by Carlin and Soskice (2014) , the failure of monetary targeting in controlling inflation would depend on two basic conditions: i. the ability of the central bank in controlling the monetary aggregate of choice, and ii. the soundness of the relationship between inflation and the monetary aggregate; and both of the conditions would seem to be not met.

Accordingly, the NCM approach contributed to a shift towards a modern monetary policy framework, combining inflation targeting with the use of interest rate as the policy tool, the so called inflation targeting (IT, henceforth) regime. This framework is grounded on three equations New Keynesian model composed by an IS curve, a Phillips curve, and an interest rate-based monetary policy rule (Taylor Rule), the IS-PC-MR approach. Notwithstanding the mainstream adopted a Taylor rule, which is an interest rate rule, too little has changed. This is in fact is confirmed by Romer (2000), that argues that "[t]he main change is that it replaces [...] the money supply with [...] a simple interest rate rule". In this sense, as argued by (Lavoie, 2004, p.16), the NCM is still very much "old wine in new bottle".

In a nutshell, the NCM still carries the main implication of monetarism. First, while relying on a long-run vertical Phillips-curve, the NCM is perfectly in line with the idea of a NAIRU (non-inflationary inflation rate of unemployment), which can be summarized in the disappearance in the long-run of a

[4]Indeed a fertile branch of PK monetary theorists has developed an extensive literature dealing with the connections between monetary policy and both income and wealth distributions. For an extensive review see () among many others.

[5]In the US, for instance, since the early 1920s until the 1990s the reserve position doctrine prevailed (see Bindseil 2004 for an in depth chronological review). Accordingly, until 1990, monetary policy was mainly conducted via open market operations, that would somewhat target reserves, impacting, in turn, the monetary aggregates via the money multiplier.

trade-off between inflation and activity level. As in the monetarist view, money ends up being neutral in the long run. Second, in the short run, the real effects of monetary policy are outlined in the IS curve.[6] The success of inflation targeting will depend, in turn, on the transmission mechanisms of monetary policy that are grounded on the downward sloping Phillips-curve (in the short run) and on the sensitivity of investment to changes in the interest rate (the IS curve). In other words, changes in interest rate must have a predictable impact on output (IS curve), which, in turn, needs to have a predictable impact on prices and inflation (Phillips Curve). Accordingly, it is important both to identify the Phillips curve and the IS curve must be well-behaved. Both of the mechanisms can be found to have significant problems seen from a PK perspective. However, from now on, this investigation will focus on the mechanisms behind the transmission channels of monetary policy starting from the IS curve.

In fact, the cost of capital argument influencing investment has hardly found any empirical foundation, in the sense that it would appear to lag behind the reaction in the housing sector, and this is also in line with what New Keynesians find as well (see, for instance, Bernanke and Gertler, 1995). As argued by Sharpe and Suarez 2015, p.1: "[a] large body of empirical research offers mixed evidence, at best, for substantial interest-rate effects on investment".

From a PK perspective, authors from different strands have criticized the mechanisms of monetary policy transmission passing by the IS curve. If in fact, spending (and particularly business investments) is not sensitive to shifts in the interest rate, "very large reductions in the interest rate are necessary to offset the effects of even modest negative demand shocks" (Cynamon et al., 2013, p.9). This is justified by the fact that money is credit-led and demand determined; loose monetary policy might thus be as "pushing on string". The inverse also holds true, "unless interest rates are changed by drastic amounts (that may jeopardize the stability of the financial system)" (Kriesler and Lavoie, 2007, p.391). The effects of monetary policy might take a long time before appearing. What often emerges in the empirical literature that assesses the transmission of monetary policy is the so-called Gibson's paradox (positive correlation between the interest rate and the general level of prices). In this sense, when trying to decrease inflation through an increase in interest rates, what monetary authorities might get is actually a higher general price level.

PKs from a Sraffian background have also shown concern about the relationship between interest rate and investment:

> "neither economic theory nor the facts offer any compelling reason to think that investment is particularly interest-elastic. On the contrary, theory and facts both appear to refute the existence of any such elasticity."(Garegnani, 2015, p.113)

Indeed, the challenge of the theoretical consistency of a downward-sloping investment demand curve lies in the very ground of the Sraffian approach (Sraffa, 1960; Garegnani, 1970, 1978) to the "capital controversy". The very possibility of reswitching of techniques invalidades this negative relation. As argued by Garegnani (2015), this would imply that in the long run changes in the stock of productive capacity adjust to the level of "final demand".

If empirical studies hardly find any evidence of a sensitivity of investment to shifts in the interest rate, then the question that remains is what are the effects of monetary policy and its transmission

[6]The short run effects of monetary policy can also be challenged from a New Keynesian perspective if we take into account wage and price rigidities (Taylor, 1999).

mechanisms? Krugman (2018) points out to a similar track to the one found in Barbieri Góes and Deleidi (2021); Deleidi (2018), that interest rates affect the economy mainly "through their effect on the housing market and the international value of the dollar (which in turn affects the competitiveness of U.S. goods on world markets)". Krugman continues arguing that "[a]ny direct effect on business investment is so small that it's hard even to see it in the data" and concludes arguing that what actually drives investment is market demand. This is in great accordance with what PKs, particularly Sraffians, have long advocated. In fact, Garegnani (2015, p.122) pointed out that the homebuilding is one of the sectors most affected by interest rate shocks: "[w]e have in fact seen that the interest rate can have a noticeable effect only in areas like homebuilding". In the next sub-section, it is presented a brief review on the empirical an theoretical literature on the role of housing prices and dwellings on monetary policy policy transmission highlighting the perspective from the SSM framework.

2.2 The Role of Housing Prices and Dwellings: A Theoretical and Empirical Overview

This subsection presents a brief literature review of the transmission channels of monetary policy, particularly focusing on the role played by housing prices and residential investment. This analysis will be based in the Real Business Cycle and New Keynesian frameworks[7] first, and on the PK approach, then.

Since the turbulent events of 2007-2008, the effects and transmission of monetary policies have been contested. Furthermore, gradually greater attention is drawn to the role played by the real estate sector. This has become particularly relevant in a context of historically low interest rates constrained by a zero lower-bound, and booming housing prices in many advanced economies in the decade that followed the great recession (in particular in the US), which was accompanied by low growth. Despite the fact that mainstream literature and Central Bankers failed to prevent the turbulent events of the collapse of the US American housing market, a great amount of research has been produced within the mainstream to incorporate the role of housing in the transmission of monetary policy.

Productive investment and output have continually shown to present sluggish responses to monetary policy shocks as demonstrated by Bernanke and Gertler (1995). The authors find that other expenditure components such as consumer durables and housing respond much faster. Focusing on the credit channel, Bernanke and Gertler (1995) split their analysis in the balance sheet and bank lending channels. They use US monthly data (1965-1993) to estimate a VAR model testing the effect of interest rate shocks via changes in the Federal Funds Rate. The authors document a positive transitory one standard deviation shock in the federal funds rates leading to a decline in GDP within a 4 months lag and achieving its bottom 24 months after the shock, followed by a decline in prices for 12 months. After splitting GDP in final demand and inventory investment, they find that the later first builds up before starting to drop, whereas the former decreases quickly after the shock. Lastly, the authors show that residential investment is the variable that drops faster and more significantly after a negative monetary shock, followed by consumer durable and non-durables, and business fixed investment following with a greater lag than all other spending variables. The authors conclude that magnitude, timing, and composition of monetary policy shocks could be better understood only after a comprehensive

[7]From a mainstream perspective, the analysis will be focused on these two frameworks that incorporated the short run interest rate target as well as the endogenously determined (even though supply constrained) money supply in their approach. This is discussed more in-depth in the previous subsection.

analysis of the credit channel is in place, particularly in what concerns the external finance premium impacting bank lending (supply of loans laid out by financial institutions) and balance-sheet channels (interest-rates affecting borrowers' balance sheet and income statements).

Bernanke et al. (1999) picks up this line of research developing a DSGE model to investigate the external finance premium. According to the authors, endogenous changes in credit market are of key importance to explain changes in the responses to macroeconomic shocks. A fall in asset prices impacts negatively the balance sheet of firms and their net worth, impairing their ability to borrow (due to an increase in the external finance premium), which impacts negatively investment. In turn, the impact on the economic activity leads to a further decrease in asset prices enabling a vicious circle, what is described as the financial accelerator. In this sense, changes occurred in the credit market tend to ensure that a shock keeps the economy for longer time out of the equilibrium.

According to the line of reasoning of real business cycle theorists, forward looking individuals act conditioned by how they think their income will be like in the future. Hence, an increase or decrease in residential investment is interpreted as a consequence of perceptions on future income. If individuals expect an increase in the future, then they will buy houses, on the contrary, they would rather postpone acquisitions. Using US data from 1959 to 1992, Green (1997) performs Granger Causality tests to investigate whether non-residential and residential investment cause GDP. The author finds that only residential investment Granger causes GDP, whereas non-residential investment would be caused by GDP.[8] Besides, he argues that more than causing GDP, residential investment could be used as a good predictor of the former:

> "perhaps residential investment, like stock prices and interest rate, is a good predictor of GDP because it is a series that reflects forward looking behavior. Presumably households will not increase their expenditures on housing unless they expect to prosper in the future. Building a house is a natural mechanism for doing this. Thus, the series can do a good job of predicting GDP without necessarily causing GDP."(Green, 1997, p.267)

Along these lines Leamer (2007) argues that residential investment is the component of GDP that offers the earlier sign of recessions or booms and should be considered to play an important role in monetary policy design and transmission.

Bjørnland and Jacobsen (2010) use a SVAR to assess the role of housing prices in monetary policy transmission in Norway, Sweden and the UK (what the authors classify as small open economies). According to them, since housing is both a store of wealth and a (durable) consumption good, as increase (decrease) in house prices increases (decreases) the collateral of home-owners that are credit constrained as well as lead to an increase in housing construction. In this sense, housing prices affect growth and consumer prices through the supply channel, and, as argued by Green (1997), is a crucial variable for monetary policy design and transmission, since it leads the other variables, predicting changes in the income level. Mishkin (2007), for instance, extensively discusses 6 (3 direct and 3 indirect) channels through which interest rate affects the housing market. The first main direct channel

[8] Although confirming that housing leads and non-housing investment follows, the Granger-Test is seen with skepticism. The methodology was extensively criticized in the literature due to the fact that the Granger test finds 'predictive causality', which might be reflecting mere correlations, specially in the case of non-stationary series that are cointegrated. Lavoie (2012), for instance, expresses concerns about the usefulness of such test, also by making reference to Rowley and Jain (1986) that have called the Granger-Sims causality tests as 'soft econometrics', questioning the true validity of the casual relation between the variables.

(cost of capital) is summarized in Equation (1) below:

$$u_c = ph[(1-t)i - \pi_h^e + \delta] \tag{1}$$

where u_c is cost of capital, ph is the relative purchase price of housing capital, i is the mortgage rate, π_h^e is the expected rate of appreciation of housing prices, and δ the depreciation rate. It is clear that one important channel through which interest rates affect the economy is via expected house prices (second channel), that affect, in turn, the demand for housing investment. However, as highlighted by Mishkin (2007), house prices are not only influenced by the price of the building itself, but also by the value of the land where the property is located, which explains why housing prices fluctuate more. Land, in turn, can be greatly influenced by two other factors. The first factor is zoning (land use restrictions), that limits the supply of houses in specific areas. The second is the limited availability of land in specific areas (such as the center of big cities, that are often well served by public infrastructure). The third and last direct channel is housing supply which the author argues to be negatively influenced by short-term interest rates, since building companies are able to construct quickly.

The first indirect channel highlighted by Mishkin (2007) is the standard wealth effect from house prices, which affects the total wealth of households, stimulating, in turn, household consumption (life-cycle wealth effects). The second and third indirect channels is the balance sheet channel, which would impact consumer credit and credit for house purchases constraints on households due to shifts in home equity. In fact, most of the mainstream empirical literature focuses on these last two indirect channels related to the collateral effect of an increase in housing prices as described previuously (see Bernanke and Gertler (1995); Bjørnland and Jacobsen (2010).

After extensively discussing all the channels through which monetary policy affects the housing market, Mishkin (2007) concludes that we should not attribute a special role to the housing sector in monetary policy transmission advocating for a focus on inflation and employment. This is justifiable according to author by the amount of uncertainty related to the dynamics of house prices:

> "The uncertainty around housing-related monetary transmission mechanisms provides one further reason why monetary policy will continue to be an art, albeit one that makes use of science." (Mishkin, 2007, p.33)

In this investigation however, it is argued that avoiding to focus on the housing sector would be playing 'Hamlet without the prince (of Denmark)', in the sense that probably the whole *modus operandi* of monetary policy would be missing. As argued in the previous subsection, monetary policy acts through the so called autonomous components of demand[9] (in particular autonomous consumption)

[9]It ought to be noted that autonomous components of demand are theoretically defined by Serrano (1995) as those components that are neither financed by contractual incomes nor are able to create productive capacities. In particular, these components are related to discretionary or autonomous injection of purchasing power in the economy Cesaratto et al. (2003), and, in this sense, are very much in the core of the literature on endogenous credit-led and demand-determined money supply. In the empirical literature these expenditures include: (i) government expenditures, that are determined by policy decisions; (ii) exports, which depend on the level of foreign demand; (iii) autonomous consumption, that are financed in the credit market either via an endogenous money creation process or through accumulated wealth. In this contribution the terms autonomous and semi-autonomous components (Kalecki, 1968; Fiebiger and Lavoie, 2019) are used interchangeably, in the sense that despite arguing these components are independent from the current level of income, they should not be interpreted as 'manna from heaven'. Indeed, these variables may be affected by other macroeconomic variables. Monetary policy, for instance, can exert a certain degree of influence on the volume of credit borrowed by households (Pariboni, 2016; Deleidi, 2018; Deleidi and Mazzucato, 2019; Barbieri Góes and Deleidi, 2021), which is the focus of the present article.

channel. Moreover, rather than assuming that individuals react to changes in expectations about their future income and wealth smoothing consumption decisions, from a PK perspective, it is more plausible to assume that it is effective demand that plays a decisive role (both in the short as well as in the long run). Indeed, if the principle of effective demand is valid both in short and long run, the expenditure categories that do not create productive capacities and do not depend on the current level of income (the semi-autonomous components of demand) will determine the dynamics of the system (trend and cycle).[10]

Accordingly, this contribution seeks to draw on a recent growing literature that includes semi-autonomous demand components on macroeconomic models of different PK theoretical backgrounds.[11] In order to do so, an alternative approach to deal both with the transmission channels of monetary as well as with semi-autonomous demand components inspired by Teixeira (2015), which incorporates the concept of 'own-interest rate' based on Sraffa (1932) is introduced. A consumption equation based on the works of Pariboni (2016) and Teixeira (2015) can be represented as follows:

$$C_t = C_t^y + C_t^a \tag{2}$$

Total consumption (2) is defined as the sum of induced consumption out of disposable income (C_t^y) and autonomous consumption (C_t^a). As shown in Equation (3), the induced component (C_t^y) is dependent on the current level of income where c indicates the marginal propensity to consume ($0 \leq c \leq 1$).

$$C_t^y = cY_t \tag{3}$$

It is possible to split total autonomous consumption (Equation 4) into two main components, the first related to consumer credit and the second to housing dwellings. The first component is the sum of loans (consumer credit) minus the negative fraction of autonomous consumption related to consumer credit. More precisely, this negative fraction refers to the total of accumulated debt from consumer credit (D_t^L) multiplied by the propensity to consume (c) multiplied by the interest rate on loans for consumer credit (r) and by the percentage of principal repaid every period (ϕ). The second component can be decomposed into the sum of loans (real estate loans) minus the negative fraction. In the second component however, this negative fraction refers to the total mortgage debt (D_t^M) multiplied by the propensity to consume (c) multiplied by the interest rate on mortgages (r_m) and by the percentage of principal repaid every period(ψ).

$$TOTALC_t^a = Cc_t - c(r+\phi)D_t^L + RES_t - c(r_m+\psi)D_t^M \tag{4}$$

If the positive components are isolated as in Equation (5), we have that the total amount of new autonomous consumption can be described simply as the sum of credit-financed consumption (Cc_t) and residential investment (RES_t). Both components are a function of the so called 'own-interest rate' (FF_s), which is represented in Equation (6).

[10] For an empirical investigation on how residential investment in volumes not only drives the business-cycle, but also long-run growth in the US see Pérez-Montiel and Pariboni (2021).

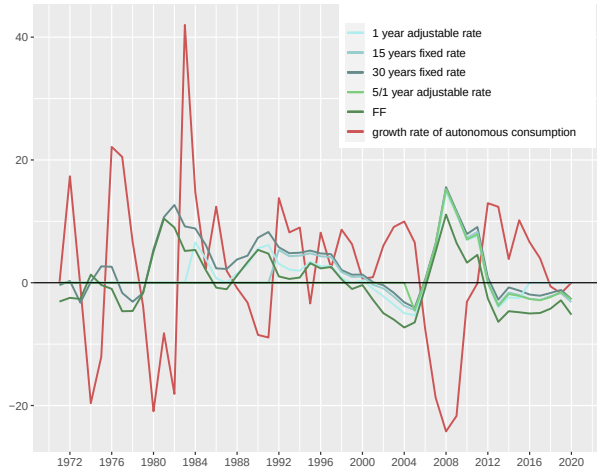
[11] The interested reader might refer to Allain (2015); Lavoie (2016); Fiebiger and Lavoie (2019); Palley (2019); Fazzari et al. (2020); Deleidi and Mazzucato (2019, 2020); Nomaler et al. (2020), among others.

$$C_t^a = Cc_t + RES_t = f(FF_s) = f(\overline{FF}, \pi_{residential}) \tag{5}$$

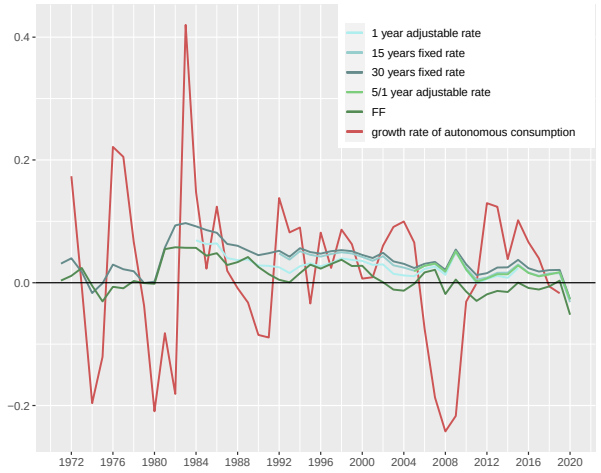
$$FF_s = \left(\frac{1 + \overline{FF}}{1 + \pi_{residential}} \right) - 1 \tag{6}$$

The own-interest rate of real estate (FF_s) is a function of the exogenously determined federal funds rate ($\overline{FF}$) and of profits from real estate ($\pi_{residential}$).[12] The key role of this rate is not only related to determination of the weight of debt-service on the income of real estate owners, but also to the fact that "the owners of an asset, or those who intend to buy it, take price changes into account to speculate and obtain capital gains, or to prevent capital losses, and thus try to avoid reductions in their net worth" (Teixeira, 2015, p.53, *author's translation*). Indeed, as illustrated in Figure (1), autonomous consumption reacts to changes in rate of interest adjusted using residential inflation (own rate of interest) and not due to changes in the real interest rate. Accordingly, the aim of this contribution is to exploit a point left open by Mishkin (2007), that is placing on the center of the analysis the movements in house prices (measured by the inflation rate in the real state sector).

Figure (1) Growth Rate of Autonomous Consumption and the Spectrum of Interest Rates



(a) Own Interest Rate and the Growth Rate of Autonomous Consumption



(b) Real Interest Rate and the Growth Rate of Autonomous Consumption

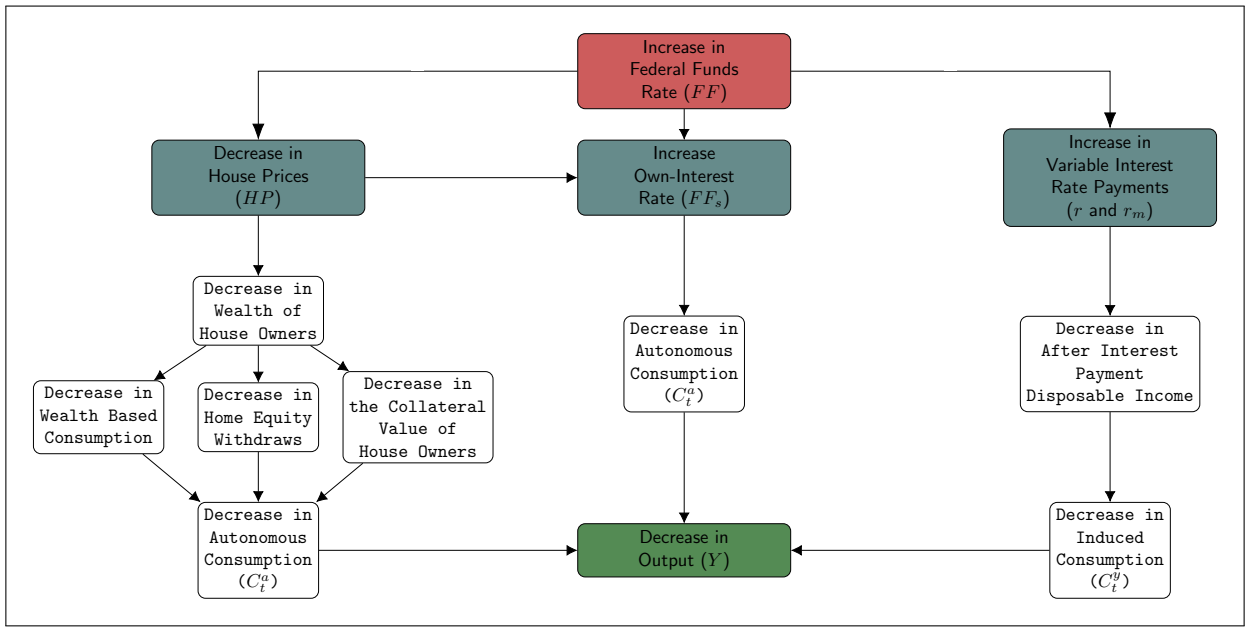
As argued by Leamer (2007), Teixeira (2015) and Fiebiger and Lavoie (2019), consumer durables follow movements in residential investment, therefore, the two variables are summed, as in Equation (5), to obtain autonomous consumption (C_t^a). This is especially true in the US American case, where households (particularly in the years of the Great Moderation) have used home equity withdraws (home equity extraction) to finance consumer credit. Furthermore, the symbiotic development of house prices and consumer credit is also related to other implication of the balance sheet credit-channel mentioned by Mishkin (2007) in the sense that higher house prices increase collateral of home owners, increasing, in turn, the supply of credit. Nevertheless, following the PK horizontalist approach to monetary theory,

[12] The Federal Funds rate is used as the base rate. Mortgages are usually taken based on the 30-years fixed rate, however, as presented in subsection 2.1 all interest rates -in normal times- are a spectrum of the base rate. Hence, to avoid considering different rates, the base rate is taken as a benchmark. This is illustrated in Figure (1).

it is possible to argue that, in normal times, the supply of credit is demand-determined and credit-driven, in the sense that credit supply tends to follow demand, improving credit supply is not sufficient to create demand for credit ('pushing on a string').

Figure (2) illustrates the channels through which interest rate shocks might affect residential investment, consumer credit, and output.

Figure (2) Monetary policy: Effects and Transmission Mechanisms



Source: authors' representation

First, an increase in the base rate leads to a decrease in after interest payment disposable income, which in turn produces a decrease in induced consumption, and thus a decrease in output. This first channel is the so called cash-flow channel, which affects directly the amount of cash that households have to spend, this channel can be understood from the negative fraction of the autonomous consumption equation.[13] Second, an increase in the base rate leads to an increase in the own-interest rate (FF_s), even if house prices keep constant, decreasing in turn the demand for housing dwellings, consumer credit, and output. Third, this upward movement in the base rate can lead to a decrease in house prices,[14] that would lead to a further increase in the own-interest rate, engendering, in turn, an even stronger decrease in dwellings and consumer credit, and, hence, in output. The second and third channels are related to the so called credit demand channel, since increases in the own-interest rate (increase in the base rate and decrease in house prices) leads to a decrease in the demand of loans for house purchase and consumer credit. Fourth, increases in the base rate leading to lower house prices decrease the wealth of house owners, decreasing the collateral value of (credit-constrained borrowers),

[13] From the cash-flow channel many PKs have derived income distributive effects, that impacts the overall multiplier and hence output. This concatenation can be explained by the fact interest rate (as an income) is very unequally distributed and interest receivers are usually households with high income and wealth, that, according to the Keynesian tradition have a smaller propensity to consume.

[14] This is not equivalent of arguing that movements in the base rate are sufficient to impact house prices. In fact, whereas a decrease can be assumed when interest rates increase, a boom in housing prices cannot be taken for granted in a scenario of low interest rates. As argued by many PKs scholar, low interest rate are a necessary but not sufficient condition for booming housing prices, key factors could be financial institutions and regulation (see, among others,).

leading to a decrease in credit supply (the so called credit supply channel). This decrease in wealth is also related to a contraction in wealth-based consumption.[15]

With the exception of recent PK attempts, particularly embedded in the SSM framework (Deleidi, 2018; Deleidi and Mazzucato, 2019; Barbieri Góes and Deleidi, 2021), the centrality of (semi-autonomous) demand in the transmission of monetary policy (without relying on rational-expectations) considering the role played by housing prices has not been successfully approached. Therefore, this contribution seeks to build on this literature empirically assessing the role of autonomous consumption and housing prices in the transmission of monetary policy.

3 Data and Methodology

3.1 Data

In order to estimate the SVAR models and assess the transmission channels of monetary policy, this contributions relies on time-series quarterly data (1970q1-2020q1) for the US provided by the Federal Reserve Bank of St, Louis, the OECD, and the Bureau of Economic Analysis. In particular, the dataset is build using the Federal Funds rate (FF), the Federal Funds rate in real terms deflated using the CPI (FF_{real}), own interest rate using housing price inflation (FF_s), housing prices index (HP), rent prices index ($RENT$), consumer price index (CPI), housing prices to consumer prices ratio (HP_{ratio}), the sum of private residential investment and the flow of total consumer credit owned and securitized (autonomous consumption - CA), and GDP (Y). Autonomous consumption and GDP are deflated using their corresponding deflators. Price indexes, autonomous consumption and GDP are used in log-levels. All considered variables are seasonally adjusted. Considered variables are summarized in Table (2) and Appendix (A).

Table (2) Variables, description and acronyms

Acronyms	Variables
FF	Federal Funds Rate
FF$_{real}$	Federal Funds Rate deflated using the CPI
FF$_s$	own rate of interest
HP	Housing Prices
RENT	Rent Prices
CPI	Consumer Price Index
HP$_{ratio}$	Housing Prices Ratio (HP/CPI)
RENT$_{ratio}$	Rent Prices Ratio ($RENT/CPI$)
CA	Autonomous Consumption (Private Residential Investment plus Consumer Credit)
Y	GDP

3.2 Methodology

To detect the transmission channels of monetary policy and assess the key role played by house prices, this contribution relies on SVAR models. Before estimating a SVAR model, a reduced-form VAR is estimated (Equation 7):

[15] This last channel is very debated both among PKs as well as in the mainstream since empirical tests related to the estimation of a marginal propensity to consume out of wealth hardly find any statistically significant coefficients.

$$y_t = c + \sum A_i y_{t-p} + u_t \tag{7}$$

where y_t is the $kx1$ vector of considered variables, c is the constant term, A_i is the kxk matrix of reduced-form coefficients and u_t is a $kx1$ vector composed by the error terms. The optimal lag length of the VAR is selected by minimizing the Akaike's Information Criterion (AIC).[16] Since $A_i = {B_0}^{-1}B_i$, and $u_t = {B_0}^{-1}\omega_t$[17] we can obtain the structural model (SVAR) in Equation (8):

$$B_0 y_t = c + \sum B_i y_{t-p} + \omega_t \tag{8}$$

where B_0 is the kxk non-singular matrix of contemporaneous relationships between the k variables in y_t, B_i is the kxk matrix of autoregressive slope coefficients, and ω_t is the $kx1$ structural innovation vector.

Therefore, to obtain a structural model in (8) an identification strategy needs to be imposed to the reduced-form VAR in Equation (7). The identification of the structural model requires to impose restrictions on the matrix B_0, usually retrieved from the economic theory (Kilian and Lütkepohl, 2017). Accordingly, we set five different models using a recursive[18] identification based on the Cholesky decomposition[19] as summarized in the systems of Equations (9, 10, 11, 12, 13, and 14) referring to Models 1, 2, 3, 4, 5, and 6 respectively.

$$B_0 y_t = \begin{bmatrix} - & 0 & 0 \\ - & - & 0 \\ - & - & - \end{bmatrix} \begin{bmatrix} FF_s \\ CA \\ Y \end{bmatrix} \tag{9}$$

$$B_0 y_t = \begin{bmatrix} - & 0 & 0 \\ - & - & 0 \\ - & - & - \end{bmatrix} \begin{bmatrix} FF_{real} \\ CA \\ Y \end{bmatrix} \tag{10}$$

$$B_0 y_t = \begin{bmatrix} - & 0 & 0 & 0 \\ - & - & 0 & 0 \\ - & - & - & 0 \\ - & - & - & - \end{bmatrix} \begin{bmatrix} FF \\ HP_{ratio} \\ CA \\ Y \end{bmatrix} \tag{11}$$

$$B_0 y_t = \begin{bmatrix} - & 0 & 0 & 0 & 0 \\ - & - & 0 & 0 & 0 \\ - & - & - & 0 & 0 \\ - & - & - & - & 0 \\ - & - & - & - & - \end{bmatrix} \begin{bmatrix} FF \\ HP \\ CPI \\ CA \\ Y \end{bmatrix} \tag{12}$$

[16] Lag-length criteria available upon request.

[17] As explained by Kilian and Lütkepohl 2017, p.108, the reduced-form innovations can be interpreted as "weighted averages of the mutually uncorrelated structural innovations (ω_t), with the elements of ${B_0}^{-1}$ serving as the weights".

[18] As argued by (Kilian and Lütkepohl, 2017, p.216), "[i]t is important to keep in mind that the orthogonalization of the reduced form residuals by applying a Cholesky decomposition is appropriate only if the recursive structure embodied [...] can be justified on economic grounds".

[19] In the restriction matrix '-' indicates an unrestricted parameter and ' 0' represents a zero restriction.

$$B_0 y_t = \begin{bmatrix} - & 0 & 0 & 0 & 0 \\ - & - & 0 & 0 & 0 \\ - & - & - & 0 & 0 \\ - & - & - & - & 0 \\ - & - & - & - & - \end{bmatrix} \begin{bmatrix} FF \\ HP_{ratio} \\ RENT_{ratio} \\ CA \\ Y \end{bmatrix} \tag{13}$$

$$B_0 y_t = \begin{bmatrix} - & 0 & 0 & 0 & 0 & 0 \\ - & - & 0 & 0 & 0 & 0 \\ - & - & - & 0 & 0 & 0 \\ - & - & - & - & 0 & 0 \\ - & - & - & - & - & 0 \\ - & - & - & - & - & - \end{bmatrix} \begin{bmatrix} FF \\ HP \\ RENT \\ CPI \\ CA \\ Y \end{bmatrix} \tag{14}$$

Following the PK endogenous monetary theory presented in Section (2), the first equation of the models assumes that the Federal Funds rate is exogenously set by the central bank, implying that monetary policy can affect output and its components within the quarterly observation, while output may affect monetary policy with a delay. Subsequently, it is assumed that autonomous consumption (CA) contemporaneously affects the output level (Y), while output may influence CA with a delay. When considering separately housing, rent and consumer prices indexes, it is assumed that prices are affected by the base rate contemporaneously but only affect the base rate with a lag.[20] Moreover, it is assumed that house prices affect rent contemporaneously, and that both rent and house prices affect the CPI contemporaneously since housing is considered within the CPI. Finally, following the transmission channels of monetary policy discussed within the amended version of the autonomous consumption equation in the SSM, CA is assumed to follow movements in the interest rate and in house prices, determining contemporaneously higher or lower GDP levels while not depending on the current level of the latter.

Once the SVAR is estimated, impulse responses functions (IRFs) are computed in order to assess the effect of monetary policy shocks on prices, autonomous consumption, and output. IRFs are reported with a 90 per cent confidence interval calculated through a 500 runs moving block bootstrap with respect to a 40-quarters time horizon. Finally, the forecast error variance decompositions (FEVDs) are computed to illustrate how much of the forecast error variance of each of the variables can be explained by shocks to the other variables.

4 Empirical Findings

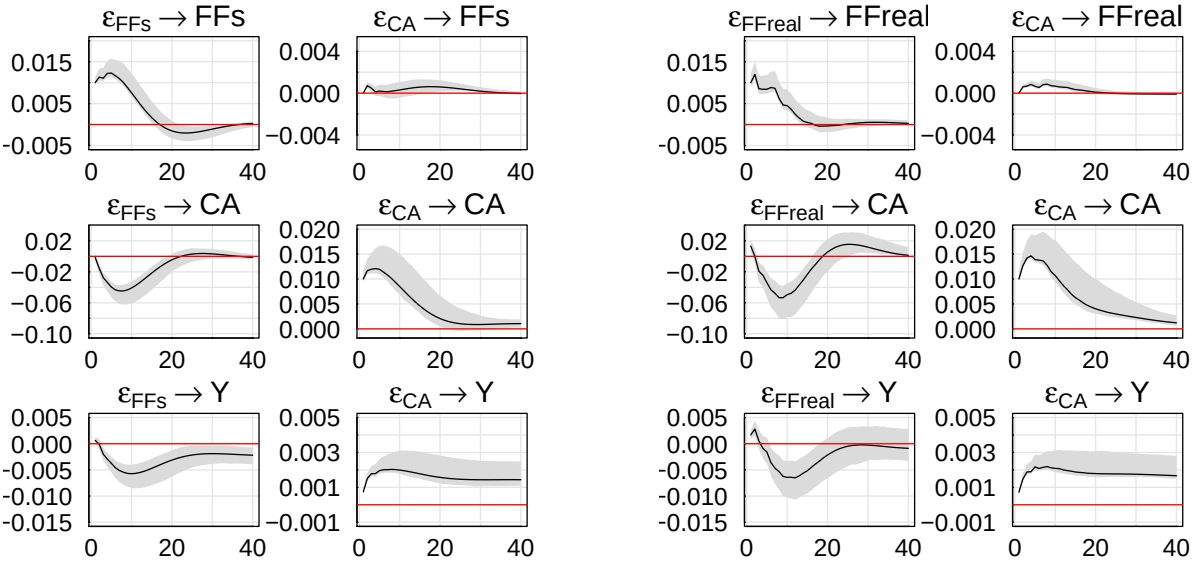
In this Section the empirical findings of Models 1, 2, 3, 4, 5, and 6 are presented. In particular, the results of IRFs and FEVDs are analysed. Figures (3, 5, 7, 9, and 11) display elasticities of prices, autonomous consumption and output to 1% changes on the shocked variables, whereas Figures (4, 6,

[20] As additional robustness check, all models have been estimated inverting the order of the variables in the identification matrix placing the Federal Funds rate at last following Perotti (2005) and the empirical literature on the transmission of monetary policy (Castelnuovo and Surico, 2010; Bjørnland and Jacobsen, 2010). The results of all six models letting interest rate react contemporaneously to output, autonomous consumption, and prices are very much in line with the estimations obtained using identification strategies reported in (9; 10; 11; 12; 12; 13; and 14), can be found in Appendix (B).

8, 10, and 12) show the contributions from each individual shock as a portion of the total variability of each variable throughout time.

Starting by Figure (3), it is possible to argue that the estimations of the IRFs suggest that the own interest rate (Figure 13a) produces more persistent and statistically significant effects on autonomous consumption and on output than the real interest rate (Figure 13b). In fact, when analysing the contribution of each shock to the variabilities of autonomous consumption and output (Figure 4), it is clear that a shock in own-interest rate (Figure 4a) explains a great share of the variability of autonomous demand and output compared to the structural shock in real interest rate (Figure 4b).

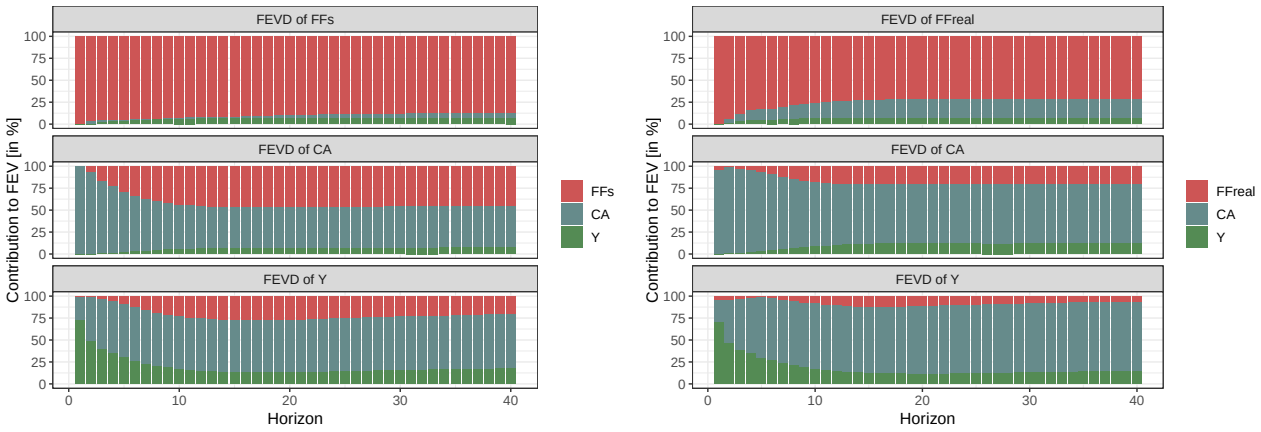
Figure (3) **Impulse Response Functions (IRFs), Models 1 and 2:** Figures display elasticities of FF_s, FF_{real}, CA, and Y to monetary policy (ε_{FF_s} and $\varepsilon_{FF_{real}}$) and autonomous consumption shocks (ε_{CA}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).



(a) Model 1 (FF_s, CA, Y)

(b) Model 2 (FF_{real}, CA, Y)

Figure (4) **FEVD Models 1 and 2:** Quarters on x-axis and Contribution to forecast error variance in % on y-axis.



(a) FFs

(b) $FFreal$

In order to verify the separate effects of interest rate and prices on autonomous consumption and

output, a successive step would be to consider different variables for prices, relative prices and the base interest. Figure (5), for instance, shows the IRFs of model 3 that includes FF (the Federal Funds rate in nominal terms), HP_{ratio} (which is the ratio between house prices and CPI), autonomous consumption (CA), and output (Y). A positive 1% shock in the base rate (FF) leads to a negative transitory movement in the house price to CPI ratio (HP_{ratio}), that leads to a negative movement in autonomous consumption (CA) and output (Y) until the shock in FF is reabsorbed. The analysis of the FEVDs (Figure 6) shows that the variability of autonomous consumption (CA) is mostly explained by shocks in the base rate (FF) and in the relative house prices-to-CPI ratio(HP_{ratio}).

Figure (5) **Impulse Response Functions (IRFs), Model 3 (FF, HP_{ratio}, CA, Y):** Figures display elasticities of FF, HP_{ratio}, CA, and Y to monetary policy (ε_{FF}), housing prices to CPI ratio ($\varepsilon_{HP_{ratio}}$), and autonomous consumption shocks (ε_{CA}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).

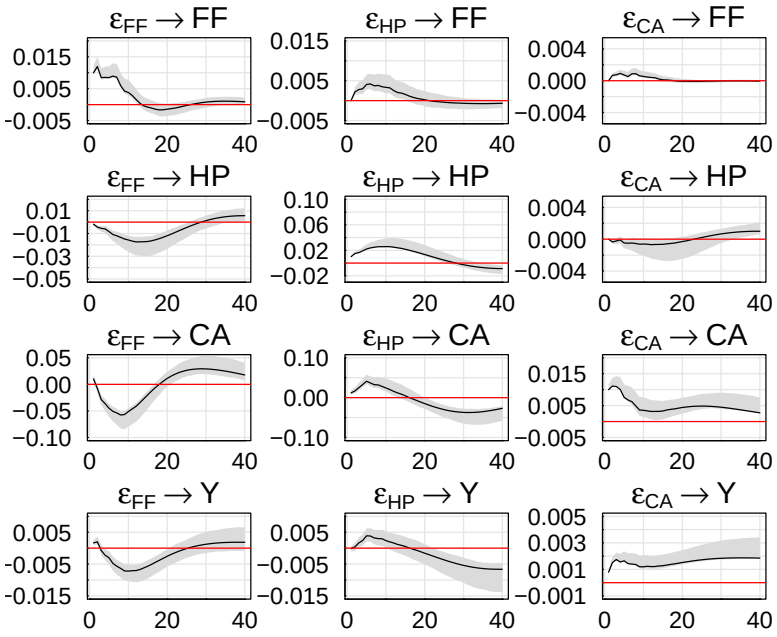
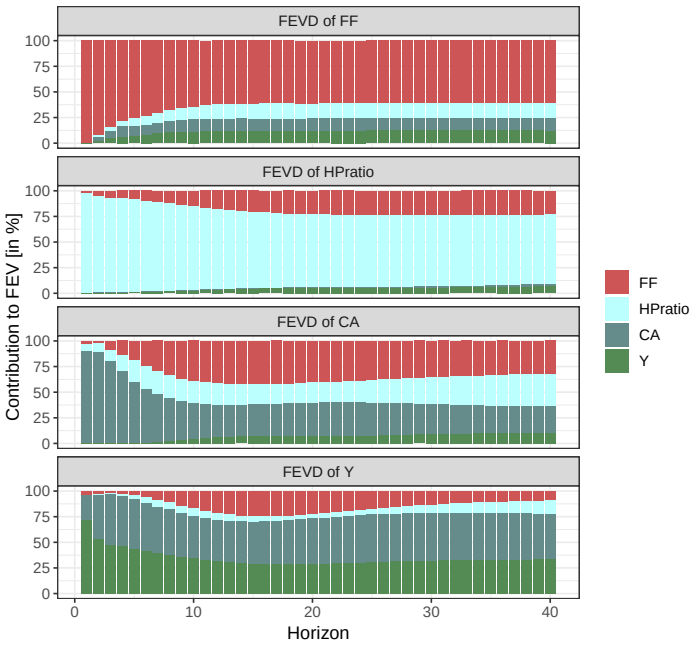


Figure (6) **FEVD Model 3 (FF, HP_{ratio}, CA, Y):** Quarters on x-axis and Contribution to forecast error variance in % on y-axis.



In order to assess the individual effects of housing prices (HP) and CPI separately, another model is estimated including both variables. Analysing the IRFs (Figure 7), a contrationary monetary shock (increase in the FF) leads to a temporary slight decrease in housing prices (HP), a temporary significant increase in the CPI, a temporary decrease in autonomous consumption (CA) and in output (Y). Accordingly, it is possible to argue that while the monetary authority increases interest rates to control inflation what they might actually get is an increase in the overall level of prices (CPI) which is accompanied by drop in autonomous consumption and output passing through the housing market. This counter-intuitive effect of a contractionary monetary polciy is commonly find in the empirical literature that investigates the effects of monetary policy (Gibson's Paradox). In fact, when analysing the results of the FEVDs (Figure 8) we get that the variable that has its variability most dependent on shocks in the interest rate is exactly autonomous consumption.

Figure (7) **Impulse Response Functions (IRFs), Model 4 (FF, HP, CPI, CA, Y):** Figures display elasticities of FF, HP, CPI, CA, and Y to monetary policy (ε_{FF}), housing prices (ε_{HP}), consumer prices (ε_{CPI}), and autonomous consumption shocks (ε_{CA}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).

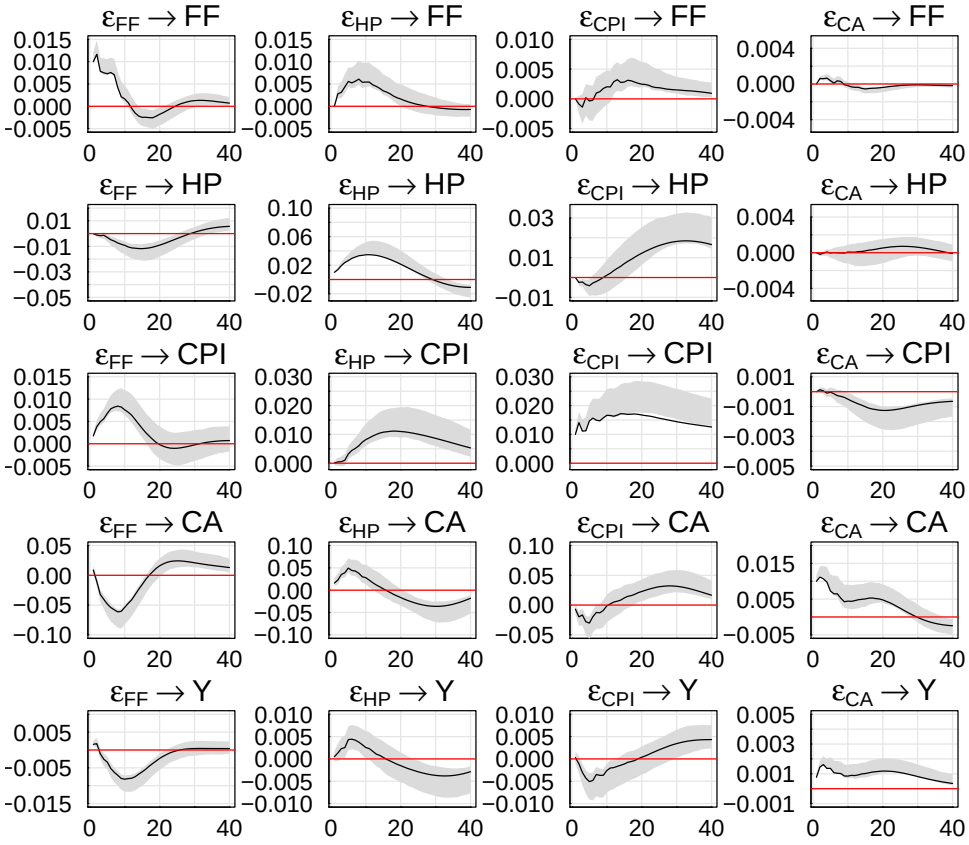
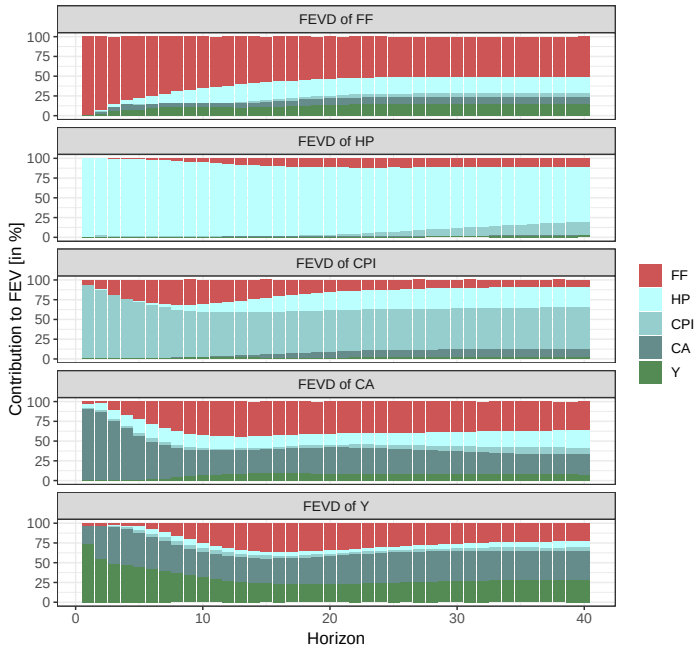


Figure (8) **FEVD Model 4 (FF, HP, CPI,CA, Y):** Quarters on x-axis and Contribution to forecast error variance in % on y-axis.



Following Dias and Duarte (2019), housing rent prices are included in the analysis in order to

investigate the validity of the Gibson's Paradox found in the previous exercise. Estimating the IRFs of Model 5 (Figure 9) its possible to see that an increase in the base rate leads to a temporary decrease in housing prices to CPI ratio (HP_{ratio}) that is accompanied by an increase in the rent-to-CPI ratio ($RENT_{ratio}$) and temporary decrease in autonomous consumption and output that turn out positive after the 20th quarter. Analysing the FEVDs (Figure 10), it is interesting to see that the variability of rent to CPI ratio ($RENT_{ratio}$) is much influenced by shocks in house prices to CPI ratio (HP_{ratio}), whereas it is not much influenced by shocks in the interest rate.

Figure (9) **Impulse Response Functions (IRFs), Model 5 (FF, HP_{ratio}, $RENT_{ratio}$, CA, Y):** Figures display elasticities of FF, HP_{ratio}, $RENT_{ratio}$, CA, and Y to monetary policy (ε_{FF}), housing prices to CPI ratio ($\varepsilon_{HP_{ratio}}$), rent prices to CPI ratio ($\varepsilon_{RENT_{ratio}}$), and autonomous consumption shocks (ε_{CA}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).

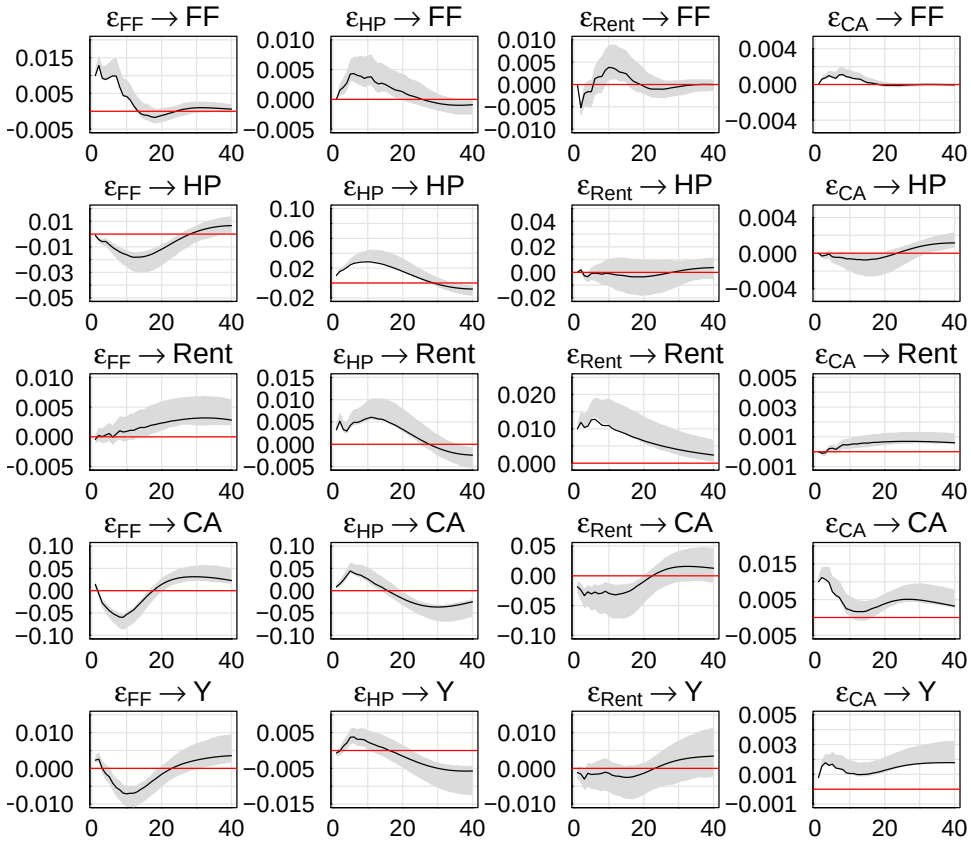
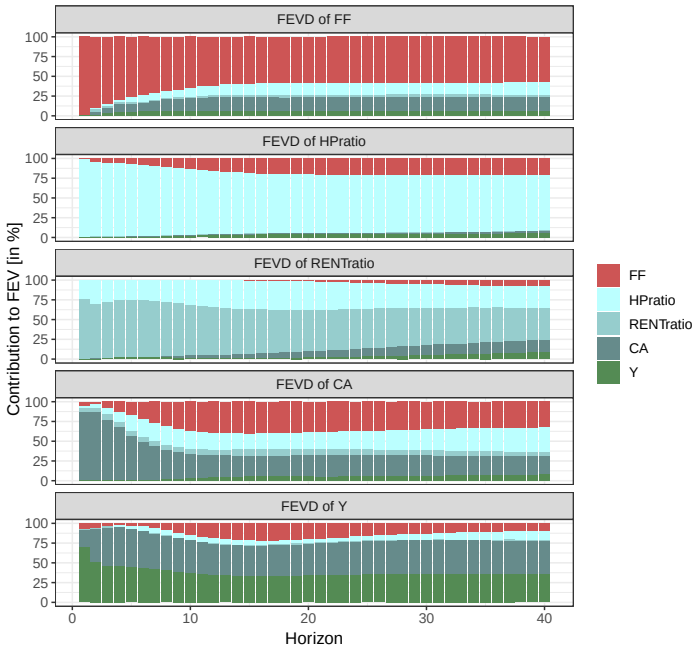


Figure (10) **FEVD Model 5 (FF, HP_{ratio}, $RENT_{ratio}$,CA, Y):** Quarters on x-axis and Contribution to forecast error variance in % on y-axis.



In fact, when analysing the three price indexes separately, the concatenation is clearer. Calculating the IRFs of model 6 (Figure 11), a positive shock in the base rate (FF) engenders a slightly negative response in house prices (HP), a significant positive response in rent prices with a very similar response in the consumer price index (CPI) accompained by a decrease in autonomous consumption (CA) and output (Y). Analysing the FEVDs (in Figure 12), it is possible to argue that whereas the variability of rent prices is much influenced by shocks in the interest rate, by itself, but also by housing prices and the overall price index, the variability of housing prices is basically not influenced by shocks in rent and very little influenced by shocks in the interest rate and in the CPI. In this sense, these results are very much in line with the arguments presented by Dias and Duarte (2019), contrary to the movements in residential investment, housing rents have shown to increase due to a contrationary monetary policy shock. These movements according to Dias and Duarte (2019) might be explained by a decrease in the home ownership rate and in rental vacancies which is a result of a decrease in residential investment (in this empirical test the biggest fraction of autonomous consumption).

Figure (11) **Impulse Response Functions (IRFs), Model 6 (FF, HP, $RENT$, CPI, CA, Y):** Figures display elasticities of FF, HP, $RENT$,CPI, CA, and Y to monetary policy (ε_{FF}), housing prices (ε_{HP}), rent prices (ε_{RENT}),consumer prices (ε_{CPI}), and autonomous consumption shocks (ε_{CA}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).

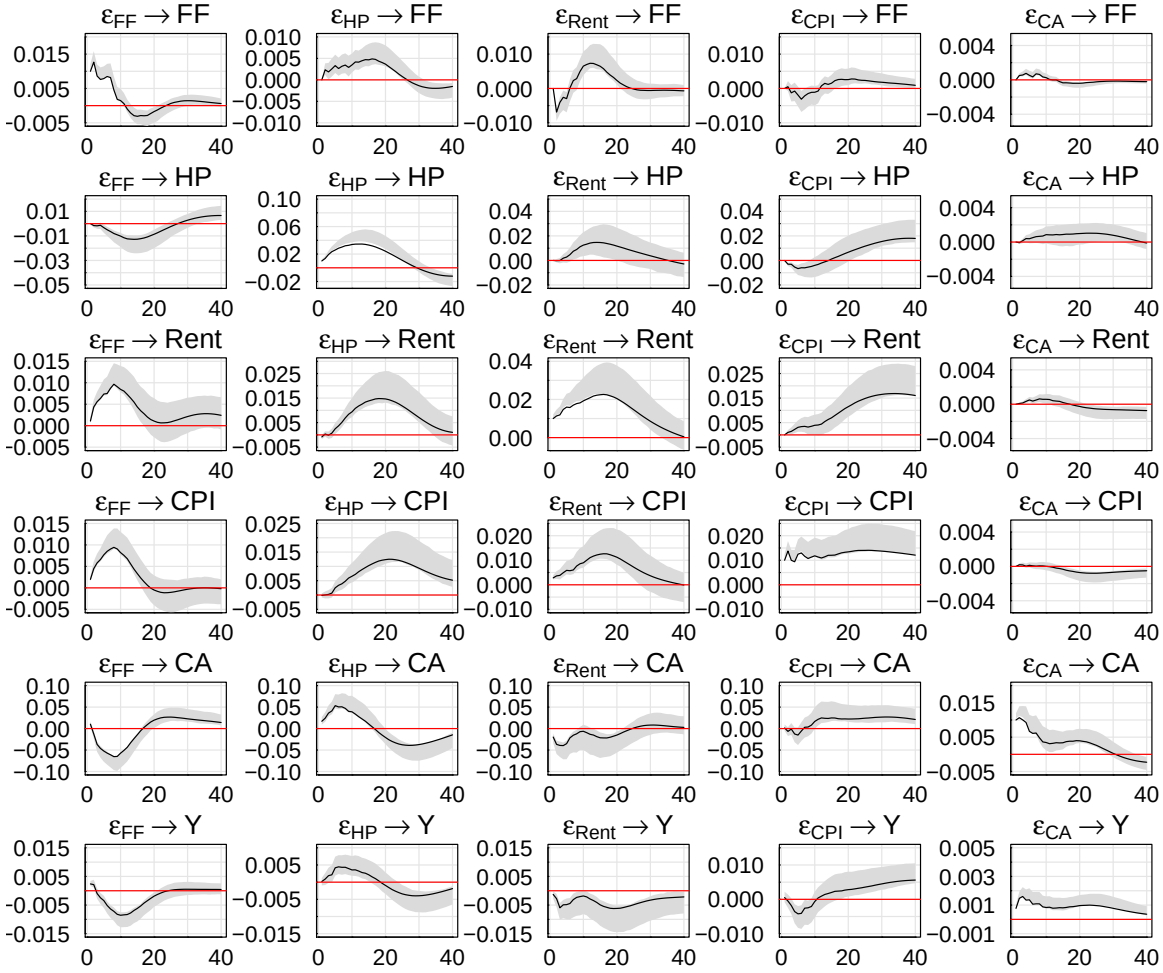
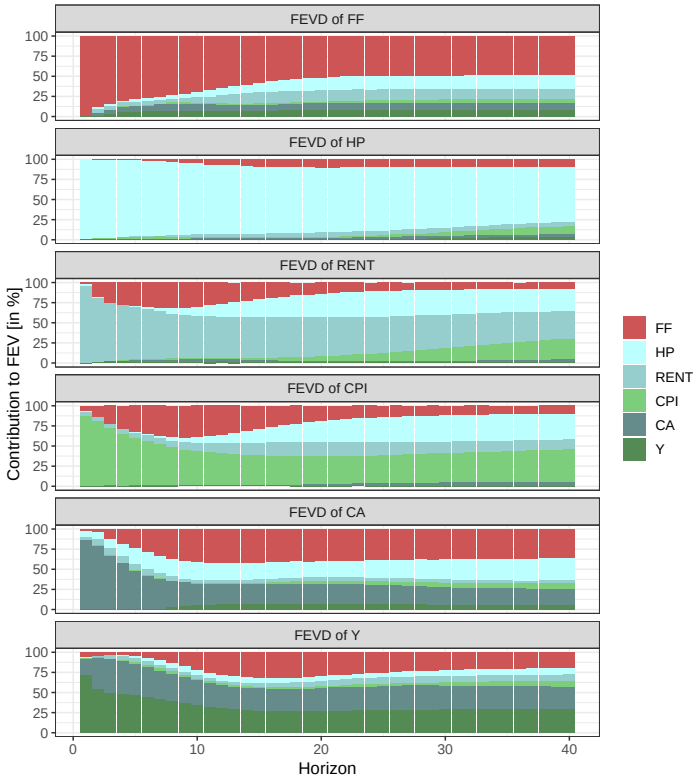


Figure (12) **FEVD Model 6 (FF, HP, $RENT$, CPI,CA, Y):** Quarters on x-axis and Contribution to forecast error variance in % on y-axis.



5 Concluding remarks

In this paper, the literature on monetary theory and monetary policy instruments has been revised, drawing particular attention to the role played by housing prices and dwellings. Then, an amended version of the SSM has been presented to incorporate the role of monetary policy and housing prices within the model. Once the theoretical model is presented, the role of real estate prices, housing rent prices, consumer prices, and monetary policy have been empirically assessed using 6 different SVAR models specifications. The estimations have suggested that the own interest rate (Sraffa, 1932; Teixeira, 2015) produces more persistent and statistically significant effects on autonomous consumption and on output than the real interest rate. These finding have confirmed the hypothesis that monetary policy transmission passes through autonomous consumption channel, in particular, via changes in house prices. Moreover, the persistency of autonomous consumption shocks restate the role played by semi-autonomous demand components beyond the business cycle, in line with Pérez-Montiel and Pariboni (2021).

Lastly when analysing separately the three price indexes considered, it is possible to observe the emergence of a price puzzle. That is, a positive shock in the base rate engenders an increase in the overall consumer price index measured by the CPI. In this sense, one could argue that a contractionary monetary policy shock has the opposite effects of its target (lower the inflation rate). However, this is explained by the fact that whereas a positive interest rate shock increases the CPI, it also tends to decrease house prices, contributing to an increase in the own interest rate, which impacts, in turn, autonomous consumption, and thus, output. In fact, rent prices increases after a positive monetary policy shock explaining at least part of the price puzzle, since shelter impacts the CPI itself.

These later implication are of particular interest. Even in a context of contractionary monetary policy, rent prices tend to go up as a consequence of an eventual decrease in home-ownership and private residential investment. Whereas, rent prices also go up when there is a positive shock in house prices. In this sense, dynamics of autonomous consumption replacing income could not fail to translate into worsening home affordability, particularly in big cities. This last issue opens the scope for further research and cooperation between different areas of economic studies such as the study of wealth and income distribution, economic geography and inclusive growth in a macro-framework, which is a direct implication of the, by now, widely acknowledged fact that monetary policy works (direct or indirectly) through income and wealth distribution.

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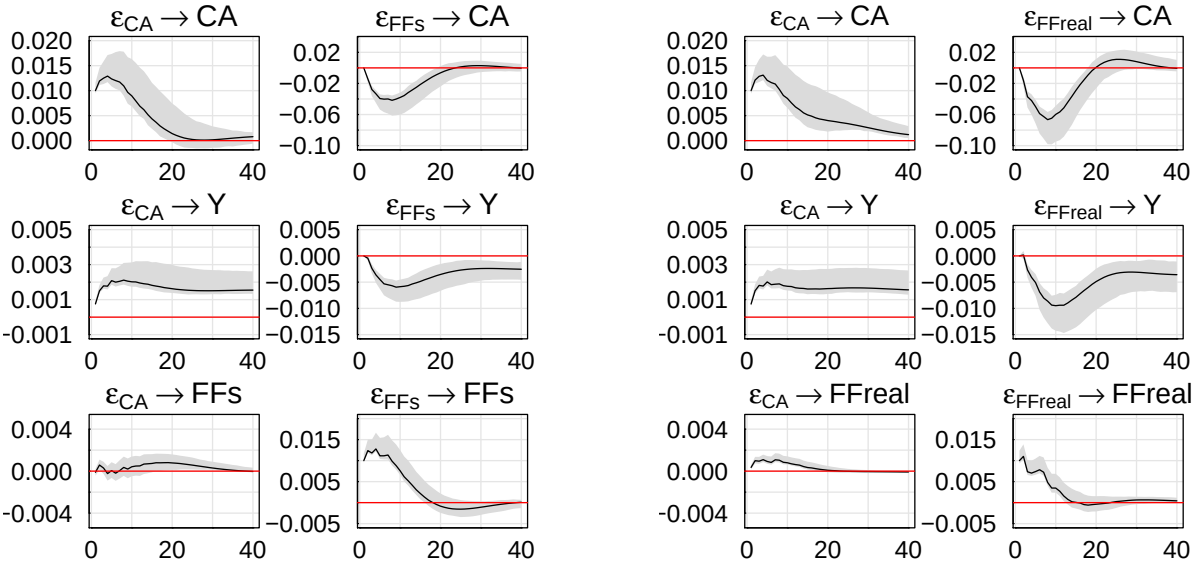
A Appendix: Data sources

- FF: Effective Federal Funds Rate, Quarterly Data, Federal Reserve Economic Data, Federal Reserve Bank of St. Louis. Available at: https://bit.ly/2VbSDcv
- CA: Autonomous Consumption (the sum of Private Residential Investment and Consumer Credit)
  - Res: Gross Private Residential Domestic Investment in Billions of Dollars, Seasonally Adjusted, Quarterly Data, Bureau of Economic Analysis, NIPA Table 1.1.5. Available at: https://bit.ly/34DlOsj
    Deflated using the Implicit Price Deflator for Gross Private Residential Domestic Investment, Seasonally Adjusted, Quarterly Data, Bureau of Economic Analysis, NIPA Table 1.1.9. Available at: https://bit.ly/2z6230N
  - CC: Flow of Total Consumer Credit Owned and Securitized in Billions of Dollars, Seasonally Adjusted, Quarterly Data, Federal Reserve Economic Data, Federal Reserve Bank of St. Louis. Available at: https://bit.ly/31xxNHw
    Deflated using the Implicit Price Deflator for Personal Consumption Expenditures, Seasonally Adjusted, Quarterly Data, Bureau of Economic Analysis, NIPA Table 1.1.9. Available at: https://bit.ly/2z6230N
- GDP: Gross Domestic Product in Billions of Dollars, Seasonally Adjusted, Quarterly Data, Bureau of Economic Analysis, NIPA Table 1.1.5; Available at: https://bit.ly/34DlOsj
  Deflated using the Implicit Price Deflator for Gross Domestic Product, Seasonally Adjusted, Quarterly Data, Bureau of Economic Analysis, NIPA Table 1.1.9.; Available at: https://bit.ly/2z6230N
- HP: Nominal house price index covering the sales of newly-built and existing dwellings, Quarterly Data, OECD, Housing prices (indicator); Available at: https://bit.ly/3ybk3Re
- RENT: Housing rent price index, Quarterly Data, OECD, Inflation (CPI); Available at:https://bit.ly/3hu92ox
- CPI:Consumer Price Index, Quarterly Data, OECD, Housing prices (indicator); Available at:https://bit.ly/3uLlALW

B Appendix: Taylor Rule

Figure (13) **Impulse Response Functions (IRFs), Models 1 and 2 Taylor Rule:** Figures display elasticities of CA, Y ,FF_s, and FF_{real}, to autonomous consumption (ε_{CA}) and monetary policy shocks (ε_{FF_s} and $\varepsilon_{FF_{real}}$). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).



(a) Model 1 (CA, Y, FF_s)

(b) Model 2 (CA, Y, FF_{real})

Figure (14) **Impulse Response Functions (IRFs), Model 3 Taylor Rule (HP_{ratio}, CA, Y, FF):** Figures display elasticities of HP_{ratio}, CA, Y, and FF to housing prices to CPI ratio ($\varepsilon_{HP_{ratio}}$), autonomous consumption (ε_{CA}), and monetary policy shocks (ε_{FF}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).

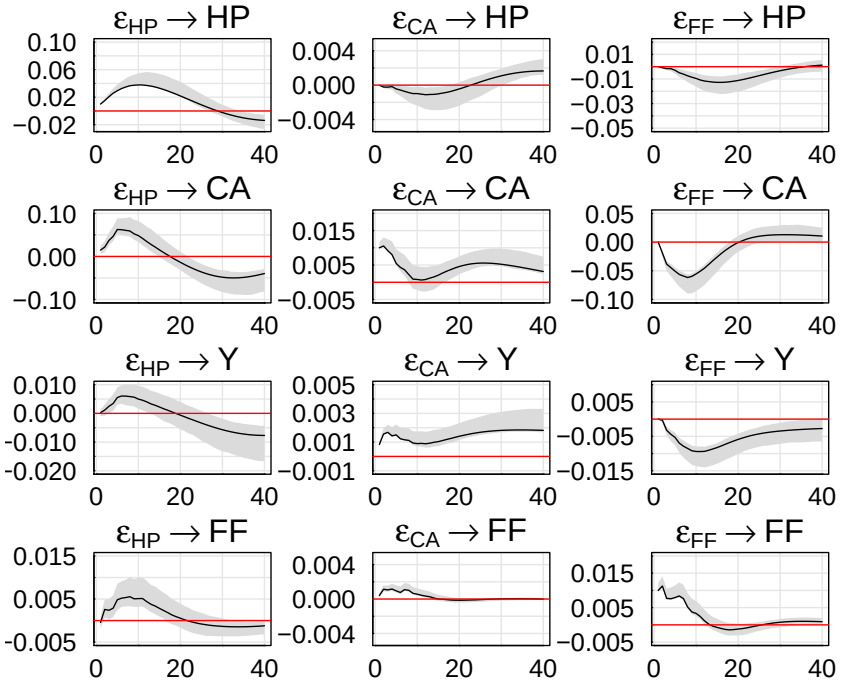


Figure (15) **Impulse Response Functions (IRFs), Model 4 Taylor Rule (HP, CPI, CA, Y, FF):** Figures display elasticities of HP, CPI, CA, Y, and FF to housing prices (ε_{HP}), consumer prices (ε_{CPI}), autonomous consumption (ε_{CA}), and monetary policy shocks (ε_{FF}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).

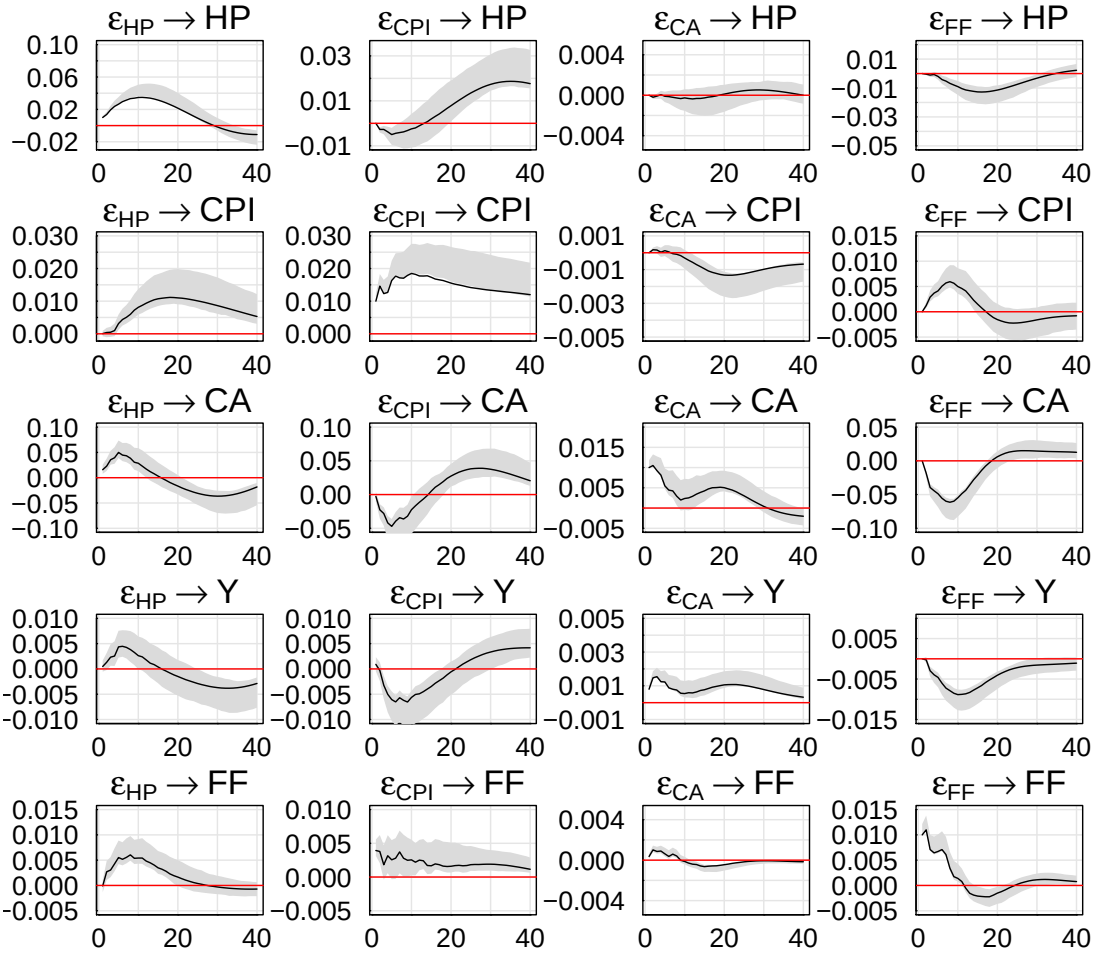


Figure (16) **Impulse Response Functions (IRFs), Model 5 Taylor Rule (HP_{ratio}, $RENT_{ratio}$, CA, Y, FF):** Figures display elasticities of HP_{ratio}, $RENT_{ratio}$, CA, Y, and FF to housing prices to CPI ratio ($\varepsilon_{HP_{ratio}}$), rent prices to CPI ratio ($\varepsilon_{RENT_{ratio}}$), autonomous consumption (ε_{CA}), and monetary policy shocks (ε_{FF}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).

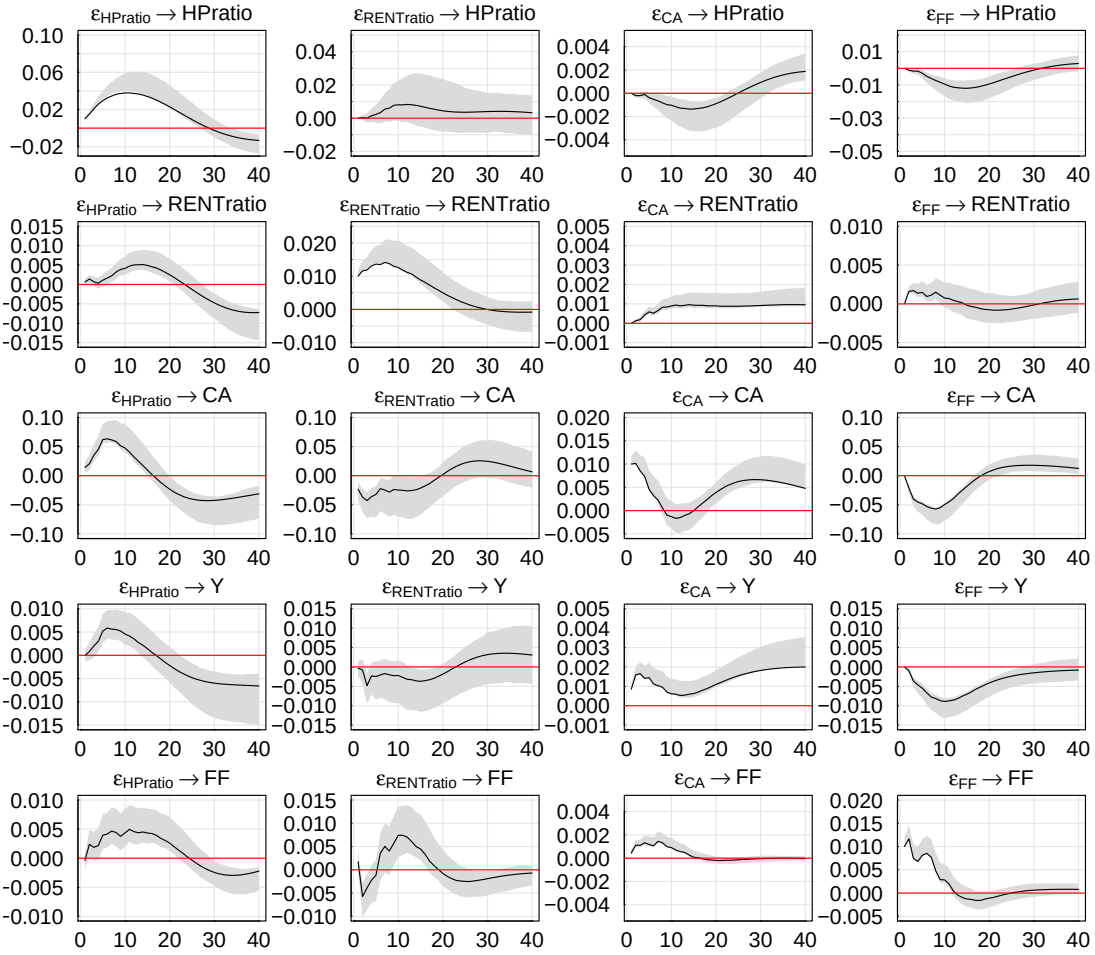


Figure (17) **Impulse Response Functions (IRFs), Model 6 Taylor Rule (HP, $RENT$, CPI, CA, Y, FF):** Figures display elasticities of HP, $RENT$,CPI, CA, Y, and FF to housing prices (ε_{HP}), rent prices (ε_{RENT}),consumer prices (ε_{CPI}), autonomous consumption (ε_{CA}), and monetary policy shocks (ε_{FF}). Quarters on x-axis. Shaded gray area denotes 90% confidence bands calculated through m.b. bootstrapping (500 runs).