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Monetary Policy and the Relative Price of Durable Goods

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Abstract

In a SVAR model of the US, the response of the relative price of durables to a monetary contraction is either flat or mildly positive. It significantly falls only if narrowly defined as the ratio between new-house and nondurables prices. These findings are rationalized via the estimation of a two-sector New-Keynesian (NK) models. Durables prices are estimated to be as sticky as nondurables, leading to a flat relative price response to a monetary shock. Conversely, house prices are estimated to be almost flexible. Such results survive several robustness checks and a three-sector extension of the NK model. These findings have implications for building two-sector NK models with durable and nondurable goods, and for the conduct of monetary policy.

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1 Introduction

Whether monetary policy innovations create distortions in allocations across durable and nondurable goods boils down to the extent to which such shocks change their relative price. The importance of the response of the relative price of durables to monetary policy has been explored in a small number of theoretical contributions, but surprisingly largely neglected in the empirical literature.[1]

In the context of optimal policy, Erceg and Levin (2006) show that the relative price of durables affects both the user cost and the demand of durable goods. A stable relative price of durables keeps output close to potential in both sectors and its role for the conduct of monetary policy is therefore non-negligible.[2] Petrella and Santoro (2011), in an economy with input-output structure, show that the relative price of services affects sectoral marginal costs and creates a channel through which the comovement between consumption of the two goods is attained. They claim that their results can be generalized to any sticky price model with two sectors. In fact, in a similar model featuring durable and nondurable goods, Sudo (2012) demonstrates that if the change in the relative price is small, the substitution effect between durables and nondurables is likewise small and the two goods comove in response to a monetary policy shock.

The comovement between durables and nondurables in response to monetary policy has indeed been a popular topic in the literature and has been documented in a number of papers employing recursive Structural Vector-Autoregressive (SVAR) models (see Bernanke and Gertler, 1995; Erceg and Levin, 2006; Monacelli, 2009; Sterk and Tenreyro, 2014; Di Pace and Hertweck, 2016, among others). Barsky et al. (2003) confirm this empirical result using Romer dates. However, Barsky et al. (2003, 2007, BHK henceforth) were the first to notice that a two-sector New-Keynesian (NK) model fails to replicate such a comovement, hence the so-called comovement puzzle. Consequently, several extensions of the baseline model have been explored in order to solve it.[3]

[1] One exception is Reis and Watson (2010) who estimate a dynamic factor model to argue that relative price movements are a main determinant of aggregate inflation.

[2] In a similar model Aoki (2001) reaches the same conclusion.

[3] Carlstrom and Fuerst (2010), DiCecio (2009) and Iacoviello and Neri (2010) introduce nominal wage stickiness; Monacelli (2009), Sterk (2010), Chen and Liao (2014) and Tsai (2016) evaluate the role of credit frictions; Bouakez et al. (2011) and Sudo (2012) study an economy with input-output interactions; Kim and Katayama (2013) assume non-separable preferences; finally, Di Pace and Hertweck (2016) introduce search and matching frictions. For an extensive literature review see Cantelmo and Melina (2015).

The crucial assumption that prevents the baseline model from generating the comovement concerns sectoral price stickiness. In fact, BHK assume that prices of durable goods are flexible whereas prices of nondurables are sticky. This assumption is made for two reasons. First, durables prices such as houses are largely negotiated and most homes are priced for the first time when they are sold. Second, they appeal to microeconometric studies, such as Bils and Klenow (2004), documenting that durables are more flexible than nondurables. On these grounds, although durables price stickiness turn out to play a key role in the comovement issue (see Sterk, 2010), BHK and most of the subsequent papers assume that durables prices are completely flexible. In contrast, more recently, Nakamura and Steinsson (2008), Boivin et al. (2009), Klenow and Malin (2010) and Petrella and Santoro (2012) report microeconometric evidence of stickiness in many categories of durables other than houses (investment in housing represents about 23% of aggregate durables in US NIPA tables in the post-war period).

The assumption about sectoral price stickiness is closely related to the response of the relative price of durables to a monetary policy shock. In fact, when durables prices are assumed to be flexible, while nondurables prices are sticky, the relative price of durables necessarily falls following a monetary policy tightening, implying that monetary policy creates a distortion in sectoral allocations.

Quite surprisingly, little empirical analysis has focused specifically on this issue.[4] Table 1 reports unconditional correlations between lags of changes in the federal funds rate (FFR) and changes in key macroeconomics variables over the main sample considered in the paper. The durables sector is defined as the sum of durable goods and residential investment and we report both the relative price of durables and the relative price of houses.[5] As expected, changes in the FFR are negatively associated with changes in real GDP, durables, houses and nondurables with some lags. As regards

[4]With different objectives in mind, Boivin et al. (2009) estimate a dynamic factor model to show that the price setting behavior of firms changes according to the nature of the shock hitting the economy. Sectoral prices appear to be sticky in response to aggregate shocks such as monetary policy innovations but flexible in response to sector-specific shocks. Makowiak et al. (2009) largely confirm these results and compare a Calvo model with sticky information and rational inattention models to reproduce them. They argue in favor of the latter as the former two models need implausible calibrations to match the distribution of sectoral prices responses to aggregate and sector-specific shocks. However, Beck et al. (2016) challenge these empirical results thus reducing the importance of sector-specific shocks. They conclude that multi-sector, multi-country models are needed be consistent with their empirical findings but a rational inattention model proves to be a good approximation to them.

[5]Section 2.1 discusses the choice of the sample and the definitions of durable and housing sectors employed.

	GDP	Durables	Houses	Nondurables	Inflation	Rel. Price Durables	Rel. Price Houses
FFR (-1)	0.0801	-0.3282*	-0.2534*	-0.3020*	0.1675*	0.0804	-0.0985
FFR (-4)	-0.1806*	-0.2865*	-0.3081*	-0.2411*	0.2230*	0.1110	-0.0049
FFR (-8)	-0.1810*	-0.0727	-0.0903	-0.0803	0.1392	0.0438	-0.0497
FFR (-12)	0.0318	-0.0533	0.1198	0.0634	-0.0070	0.0599	-0.0596

Note: GDP, durables, houses and nondurables are first differences in log real per-capita variables. Inflation is the first difference in the log of the GDP deflator. The relative prices are the first difference of the ratios of the relevant price indices. More data details are available in the Appendix. Frequency: quarterly. Sample: 1969Q2-2007Q4. * denotes significance at a 5 percent level.

Table 1: Correlations between lags of changes in the Federal funds rate (FFR) and changes in selected macroeconomic variables

inflation, it takes up to three years to detect a negative (though insignificant) correlation. Changes in the relative price of durables seem to be uncorrelated with changes in the FFR, this being in accordance with overall price stickiness not being dramatically different across the two sectors. The relative price of houses exhibits negative but insignificant correlation.

Given the important policy and modeling implications, this topic deserves more careful investigation. In the paper we exploit both SVAR and Dynamic Stochastic General Equilibrium (DSGE) models, in order to assess the effects of a monetary policy shock on the relative price of durables and the relative house price. The monetary policy shock in SVAR models is identified through recursive, sign restrictions and narrative approaches. Across subsamples and methodologies, the response of the relative price of durables is either flat or mildly positive, but it never falls, contrary to what most DSGE models imply under the assumption of flexible durables prices. A significant fall is found only if the relative price is narrowly defined as the ratio between house prices and nondurables prices, this being consistent with flexible house prices. The estimation of DSGE models corroborates and helps rationalizing the SVAR results. We build a two-sector NK model in which durable goods are used by credit-constrained impatient households as collateral to borrow funds from patient households. The Bayesian estimation unveils that the degree of price stickiness in the sector comprising all durable goods (housing and non-housing) is not significantly different from the nondurables sector. Thus the credible set of impulse responses of the relative price to a monetary policy shock includes zero. In contrast, when durables comprise only housing, house prices are estimated to be almost flexible whereas nondurables prices are substantially stickier. Only in this case, a monetary policy tightening affects the relative price of durable goods, namely the relative house price.

These results on price stickiness survive also modifications affecting sectoral Phillips curves, i.e. if we allow for imperfect labor mobility across sectors, or if we introduce sectoral price indexation to past inflation, and they hold true also in a generalization to a three-sector model.

Our DSGE analysis is related to recent contributions in the literature. Our results on price stickiness are broadly in line with those of Bouakez et al. (2009) who estimate price stickiness in a six-sector model. In their framework, however, there is full symmetry in modeling the various types of goods, which fully depreciate within one period. In contrast, we capture two important features of durable goods that distinguish them from nondurables. First, they yield utility over time rather than being completely consumed in one use. Second, they serve as collateral for borrowing purposes. In a simpler two-sector model Barsky et al. (2016) show that different degrees of durability have implications also for optimal monetary policy. Normative monetary policy implications in a two-sector model are drawn also in Petrella et al. (2017) who focus on input-output interactions. These last two papers, however, do not estimate price stickiness parameters as we do. Iacoviello and Neri (2010) estimate a two-sector model where durables comprise only housing and house prices are assumed a priori to be fully flexible. In contrast, we consider both housing and non-housing durables and estimate all price stickiness parameters.

Our SVAR and DSGE results have two important implications for modeling and policy. The first is that, when building a two-sector New-Keynesian, model it is desirable to assume that prices of durable goods are somewhat sticky, unless the model's aim is to focus on the housing sector in isolation from other durables. A three-sector model is needed to fully capture the intrinsic differences between housing and non-housing durables, such as the type of goods that can be used as collateral and their different degree of durability. The second is that overall monetary policy innovations do not foster big distortions in sectoral allocations between durables and nondurables, this representing a desirable feature of the monetary policy conduct. Conversely, since monetary policy does affect the relative house price, it may potentially create allocative distortions between housing and non-housing goods.

The remainder of the paper is organized as follows. In Section 2 we perform the SVAR analysis. Section 3 presents the DSGE model, its extensions, and discusses the results of the Bayesian estimation. Section 4 concludes. An appendix complements the paper by providing details about the dataset, the theoretical model, and by reporting robustness checks.

2 Structural vector-autoregressive models

2.1 Methodology

As regards the estimation of the empirical model, we use quarterly, seasonally adjusted US data for the Federal funds rate, real GDP, real durable goods, real nondurable goods and services, the GDP deflator and the relative price of durables.[6] In order to thoroughly investigate the effects of a monetary policy shock on the relative price of durables, we employ two alternative definitions of durables sector. We first follow Erceg and Levin (2006), Monacelli (2009), Sterk and Tenreyro (2014) and Di Pace and Hertweck (2016) in defining durables as the sum of durable goods consumption and residential investments.[7] Then, we assume that durables comprise only houses. We label the former model *baseline* SVAR and the latter *housing* SVAR. Table 2 summarizes the various definitions of durables sector and relative prices used throughout the paper. Definitions I and II are used in the main analysis whereas III and IV serve for robustness checks. The algebraic details for the computation of all relative prices are reported in Appendix A.

The main analysis is performed over the sample 1969Q2-2007Q4. This choice is dictated by the availability of the narrative measure of monetary policy shocks constructed by Romer and Romer (2004, RR henceforth) and extended by Coibion et al. (2012) and Tenreyro and Thwaites (2016).

The vector of variables employed in the SVAR is the following:

$$x_t \equiv [GDP_t,\ D_t,\ C_t,\ P_t,\ Q_t,\ FFR_t]' \tag{1}$$

where GDP_t denotes gross domestic product; D_t and C_t represent consumption of

[6] A detailed description of the data can be found in Section A of the Appendix.

[7] Erceg and Levin (2006) slightly depart from the other studies by disaggregating GDP into an index of consumer durables and residential investment and an index of all other components of output.

	Definition	Description
I	Relative Price of Durables	Ratio of price deflator of durables and residential investment to price deflator of nondurables and services.
II	Relative House Price	Ratio of price deflator of new single and multifamily houses components of residential investment to price deflator of nondurables and services.
III	Relative Price of Durables and New Single Family Houses	Ratio of price deflator of durables and new single family houses components of residential investment to price deflator of nondurables and services.
IV	Relative Price of Durables and Broad Measure of Houses	Ratio of price deflator of durables and new single and multifamily houses components of residential investment to price deflator of nondurables and services.

Table 2: Definitions of Relative Prices

durable and nondurable goods, respectively; P_t is the GDP deflator; Q_t is the the relative price of durable goods; and FFR_t denotes the Federal funds rate. We take the natural logarithm of all variables except for the FFR, which is in levels.

For the sake of robustness, we take three different approaches to the identification of monetary policy shocks:[8]

i) *recursive (Cholesky) approach* in which we make the standard assumption that the monetary policy variable is ordered last, hence it has no contemporaneous effect on the other variables (see Bernanke and Mihov, 1998, among others);

ii) *sign restrictions* imposed on the impulse responses of the variables and derived from a DSGE model as in Canova (2002), Dedola and Neri (2007), Pappa (2009) and Bermperoglu et al. (2013), among others. Fry and Pagan (2011) critically review the sign restrictions approach arguing that if there is not enough information to discriminate among the various shocks, it may be problematic to correctly identify them. In principle, only if the researcher describes the sign pattern for each shock in the model it is possible to avoid this problem. In order to partially address this identification issue we proceed as follows. Following Peersman (2005), we first determine the sign pattern of two standard supply and demand shocks, and then we identify the monetary policy shock.[9]

Table 3 summarizes the set of sign restrictions imposed. A contractionary supply

[8]A detailed discussion of the methodologies is in Appendix B.

[9]Robust IRFs for the supply and demand shocks are completely standard and are available upon request.

Shock	GDP	D	C	P	Q	FFR
Supply	< 0	< 0	< 0	> 0	none	> 0
Demand	< 0	< 0	< 0	< 0	none	< 0
Monetary Policy	< 0	none	< 0	< 0	none	> 0

Table 3: Sign restrictions

shock curbs output, nondurable and durable consumption, while increasing inflation, which leads the central bank to raise the nominal interest rate. A negative demand shock reduces both all the mentioned real variables and inflation, thus leading the central bank to cut the interest rate. Conversely, the monetary policy shock is characterized by an increase in the nominal interest rate, which leads to a decrease in output, nondurable consumption and inflation. As discussed in Appendix E, notwithstanding the lack of a robust response, in order to correctly identify the monetary policy shock, we assume that the nominal interest rate is positive in the first quarter. We remain agnostic on the response of the relative price and consumption of durables as it is the main objective of our investigation. The different restrictions imposed on the responses of the GDP deflator and the interest rate ensure the orthogonality between the disturbances and the correct identification of the monetary policy shock.

iii) *recursive narrative approach*: we follow Romer and Romer (2004), Coibion (2012) and Cloyne and Hurtgen (2016) and re-estimate the recursive SVAR model by replacing the FFR with the monetary policy shock constructed by RR and extended by Coibion et al. (2012) and Tenreyro and Thwaites (2016).

In the macro-fiscal literature, Mertens and Ravn (2013) and Mertens and Ravn (2014) challenge the use of narrative measures to identify fiscal shocks in SVAR models on the ground that such measures do not represent truly exogenous fiscal shocks. They therefore build on Stock and Watson (2012) and use narrative measures as external instruments for the identification of the structural shocks in the SVAR model (Proxy SVAR henceforth).[10] However, as noted by Cloyne and Hurtgen (2016), while fiscal narrative measures are directly derived from historical sources, thus representing

[10]Such an approach has also been employed to identify monetary policy shocks by Kliem and Kriwoluzky (2013) and Gertler and Karadi (2015). The former try to reconcile the monetary policy shock identified with the standard recursive approach with the RR measure since the two result in non-negligible discrepancies. They use the RR measure as external instrument in the Proxy SVAR but conclude that the correlation between the two resulting monetary shocks remains rather low. The latter adopt the Proxy SVAR approach to circumvent the timing issue posed by the presence of financial variables in the VAR model.

potential noisy proxies for the structural shocks, the monetary policy measure derived by RR is the result of a first-stage regression which yields a direct measure of the structural shock rather than a proxy. It is therefore reasonable to use such a measure directly in the VAR model rather than as an external instrument. In any case, for the sake of robustness, Figure C.14 in Appendix C.5 reports the impulse responses obtained with a Proxy SVAR model using the RR measure as external instrument to identify the structural shock linked to the monetary policy variable, i.e. the federal funds rate.[11] The relative prices exhibit the same sign patter to those reported in the main analysis.[12]

2.2 Results

The estimated impulse responses are presented in Figure 1. Rows refer to the variables of the model whereas columns refer to the three different identification approaches. The shock is a one standard deviation increase in the monetary policy measure. Solid lines depict the responses for the baseline SVAR model, and the shaded areas are the corresponding one-standard-deviation confidence bands. Dashed lines show the responses for the housing SVAR model, with dotted lines representing the corresponding one-standard-deviation confidence bands.[13] The impulse responses show that results are broadly robust across models and identification approaches, with the exception of the relative price. There is evidence for the comovement between durables and nondurables, and the responses of durables are always larger than those of nondurables, a finding that is consistent with the empirical literature.[14]

Turning to the dynamic behavior of the relative price, the estimated responses to a monetary policy tightening are highly dependent on the definition of the durables sector adopted. If durables account for both consumption goods and residential investment, the response of the relative price is either flat or mildly positive, this being at

[11] In doing so, we employ a similar approach to Gertler and Karadi (2015) with the difference that they use a narrative measure derived form a high-frequency approach that applies to their model including financial and real variables.

[12] Note that the Proxy SVAR approach does not impose any timing restriction hence the impact responses are not zero by construction as implied by the recursive identification.

[13] One-standard-deviation confidence bands in the recursive approaches are computed by Monte Carlo methods based on 2000 draws. In the sign restrictions approach we construct a distribution of impulse responses and we report the median together with the 16th and the 84th percentiles in order to report a comparable confidence band.

[14] See Bernanke and Gertler (1995), Erceg and Levin (2006), Monacelli (2009), Sterk and Tenreyro (2014) and Di Pace and Hertweck (2016), who estimate similar SVAR models.

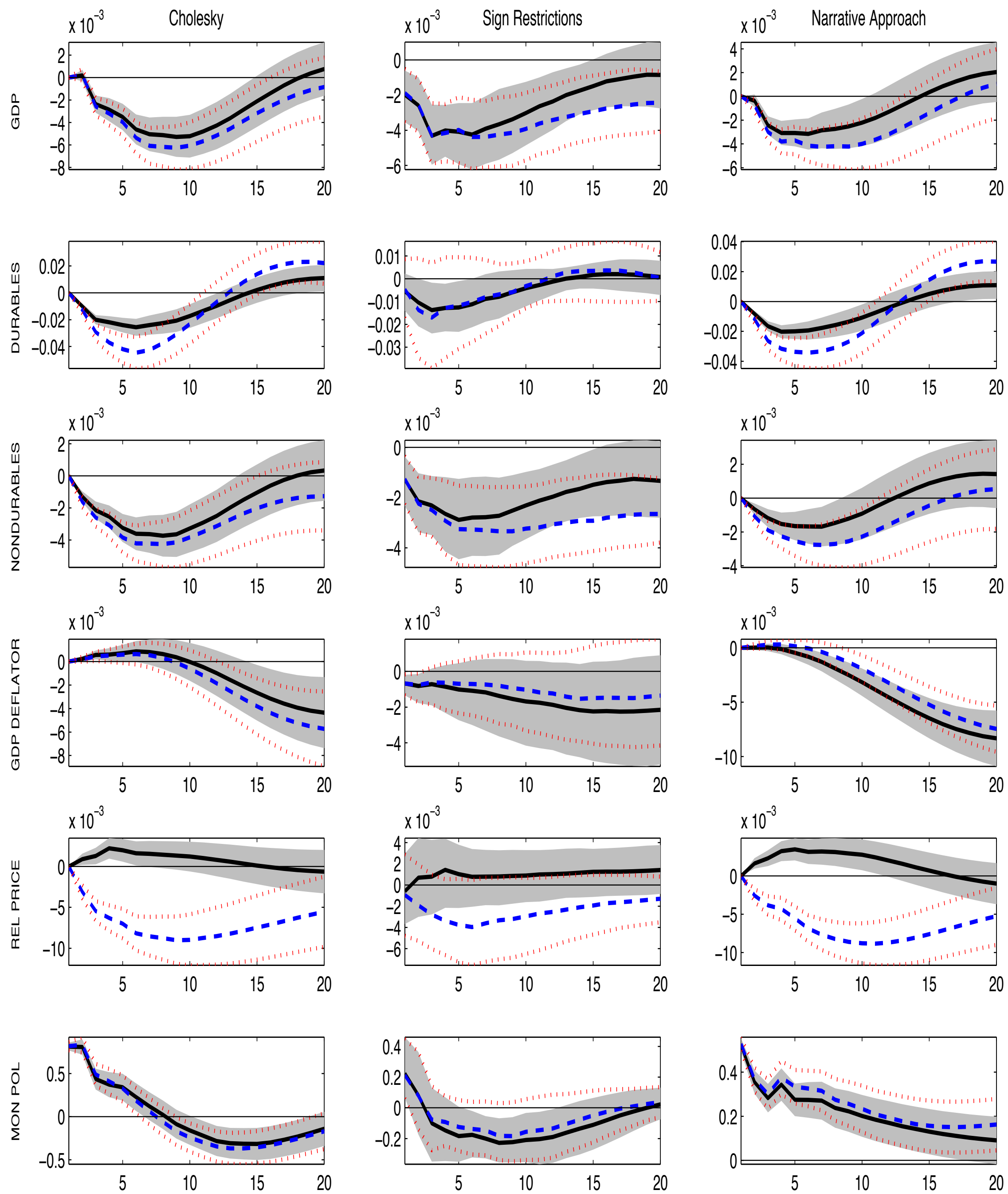


Figure 1: SVAR impulse responses to a one standard deviation increase in the monetary policy measure. Sample: 1969Q2-2007Q4 (bold lines refer to the model with all durable goods; dashed lines refer to the model with only houses; shaded areas and dotted lines represent one-standard-deviation confidence bands)

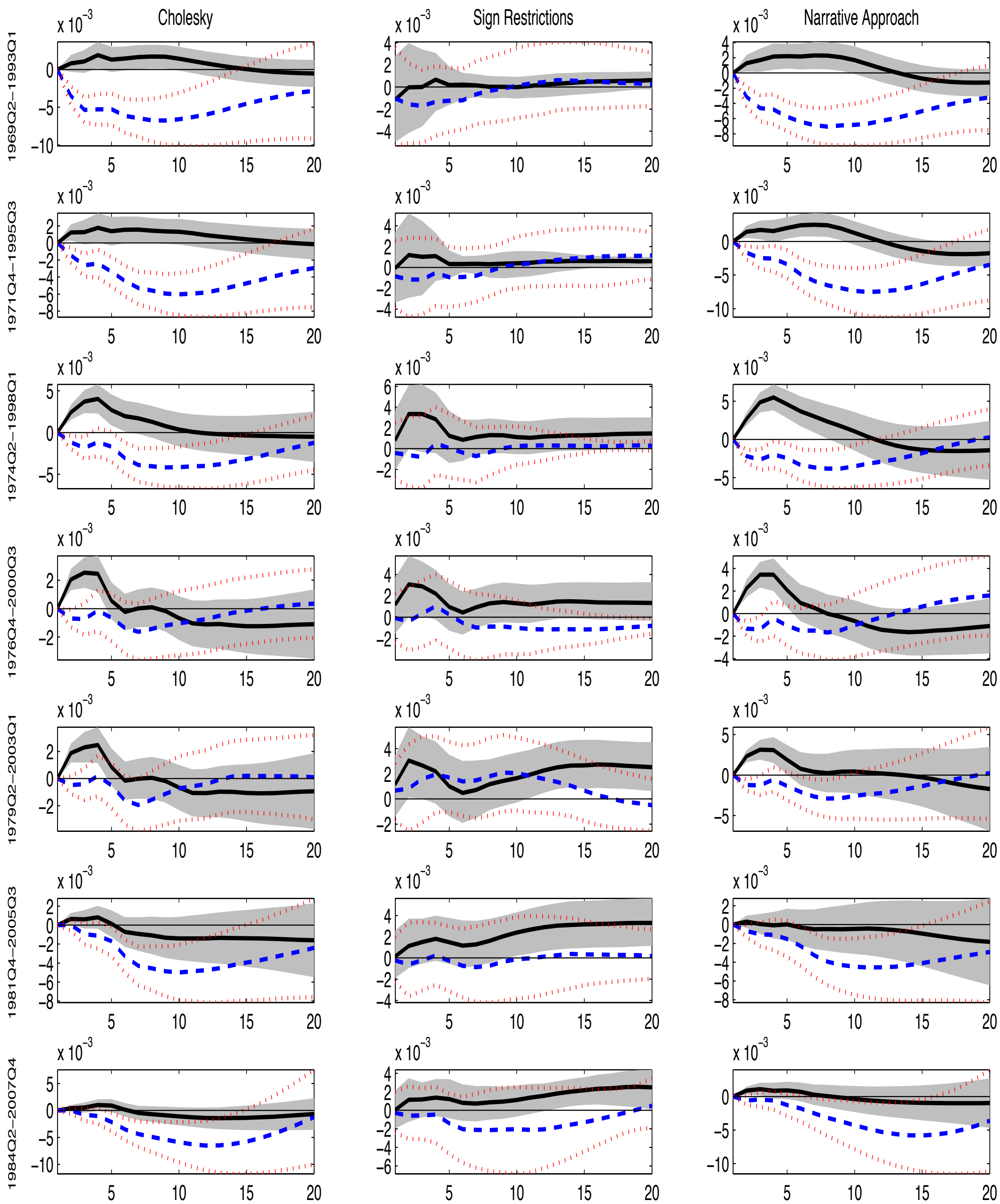


Figure 2: SVAR responses of the relative price to a one standard deviation increase in the monetary policy measure. Rows denote samples, columns denote identification methods (bold lines refer to the model with all durable goods; dashed lines refer to the model with only houses; shaded areas and dotted lines represent one-standard-deviation confidence bands)

odds with the assumption of flexible durable prices adopted in most of the theoretical literature. Conversely, a model in which the durables sector coincides exclusively with the housing sector, the relative price falls consistently with the notion of flexible new house prices. These results are confirmed by the responses of the relative price across seven subsamples.[15] In Figure 2 rows plot the relative price responses for each subsample, whereas columns represent the three identification approaches. The relative price of durables never falls in the baseline SVAR model whereas it significantly decreases in the housing SVAR model, thus confirming the previous results across subsamples and identifications of the monetary policy shock. To sum up, this empirical evidence suggests that the definition of the durables sector is crucial. If durable goods are defined to include both non-housing goods and residential investment, these display dynamics consistent with a non-negligible degree of price stickiness. Conversely, durable goods defined to include only the housing sector exhibit a behavior compatible with flexible prices.

These results survive several robustness checks reported in Appendix C: (i) inclusion of a linear time-trend (C.1); (ii) alternative definitions of durables as described in Table 2 (C.2); (iii) subsample analysis (C.3); (iv) sign restrictions imposed for two, four and six quarters (C.4); (v) the Proxy SVAR approach (C.5); (vi) a three-sector SVAR model in which durables and housing are treated separately in the same model (C.6). It is noticeable from Section C.2 that when any measure of house prices is bundled with non-house durables prices, the relative price never falls in response to a monetary policy tightening.

3 New-Keynesian model

To rationalize the SVAR estimates, we analyze a two-sector New-Keynesian model in which households consume both durable and nondurable goods. Following Monacelli (2009), Sterk (2010) and Iacoviello and Neri (2010) we assume that impatient households obtain loans from patient ones using their durables stock as collateral, with the amount they can borrow tied to the value of the collateral, thus allowing for a further transmission mechanism of monetary policy beyond the standard interest-rate channel.[16] The economy is characterized by several frictions, the importance of which is

[15]The size of each subsample is 24 years. See Appendix C.3 for details.

[16]This important transmission mechanism is not considered in related studies, such as Bouakez et al. (2009) and Kim and Katayama (2013). Furthermore, Walentin (2014) estimates the model of

empirically assessed. These are price and wage stickiness, investment adjustment costs in durable goods (IAC, henceforth) and habit formation in consumption of nondurable goods. Finally, the monetary authority sets the nominal interest rate according to a Taylor-type interest rate rule.

3.1 Households

The economy is populated by a continuum of two groups of infinitely-lived households (patient and impatient) each indexed by $i \in [0,1]$ in which consumers derive utility from consumption of durable and nondurable goods and get disutility from supplying labor. Impatient households have a lower discount factor than patient ones ($\beta' < \beta$) that is why they borrow in equilibrium. Throughout the paper, variables and parameters with a $'$ refer to impatient households.

3.1.1 Patient households

Patient household's lifetime utility is represented by

$$E_0 \sum_{t=0}^{\infty} e_t^B \beta^t U\left(X_{i,t}, N_{i,t}\right), \tag{2}$$

where e_t^B is a preference shock, $X_{i,t} = Z_{i,t}^{1-\alpha} D_{i,t}^{\alpha}$ is a Cobb-Douglas consumption aggregator between nondurable ($Z_{i,t}$) and durable goods ($D_{i,t}$) with $\alpha \in [0,1]$ representing the share of durable consumption on total expenditure, and $N_{i,t}$ being the household's labor supply. We assume that nondurable consumption is subject to external habit formation so that

$$Z_{i,t} = C_{i,t} - \zeta S_{t-1}, \tag{3}$$

$$S_t = \rho_c S_{t-1} + (1-\rho_c) C_t, \tag{4}$$

where $C_{i,t}$ is the level of the household's nondurable consumption; S_t, $\zeta \in (0,1)$ and $\rho_c \in (0,1)$ are the stock, the degree and the persistence of external habit formation, respectively, while C_t represents average consumption across households. Each household monopolistically supplies labor to satisfy the following demand function:

Iacoviello and Neri (2010) on the Swedish economy to investigate how macroprudential policies (i.e. changes in the LTV ratio) further alter the effects of monetary policy shocks.

$$N_{i,t} = \left(\frac{w_{i,t}}{w_t}\right)^{-e_t^W \eta} N_t, \tag{5}$$

where $w_{i,t}$ is the real wage of each household whereas w_t is the average real wage in the economy. Parameter η is the intratemporal elasticity of substitution between labor services and e_t^W is a wage markup shock. Finally, firms on average demand a quantity N_t of labor services. Nominal wages are subject to quadratic costs of adjustment à la Rotemberg (1982): $\frac{\vartheta^W}{2}\left(\frac{w_{i,t}}{w_{i,t-1}}\Pi_t^C - \Pi^C\right)^2 w_t N_t$, where ϑ^W is the parameter governing the degree of wage stickiness, Π_t^C is the gross rate of inflation in the non-durable sector, and Π^C is its steady-state level. The stock of durables evolves according to law of motion

$$D_{i,t+1} = (1-\delta) D_{i,t} + e_t^I I_{i,t}^D \left[1 - S\left(\frac{I_{i,t}^D}{I_{i,t-1}^D}\right)\right], \tag{6}$$

where δ is the depreciation rate of durables, $I_{i,t}^D$ is investment in durable goods that is subject to adjustment costs and e_t^I represents an investment-specific shock. The adjustment costs function $S(\cdot)$ satisfies $S(1) = S'(1) = 0$ and $S''(1) > 0$. In addition, each household purchases nominal bonds $B_{i,t}$, receives profits $\Omega_{i,t}$ from firms and pays a lump-sum tax T_t so that the period-by-period real budget constraint reads as follows:

$$C_{i,t} + Q_t I_{i,t}^D + \frac{\vartheta^W}{2}\left(\frac{w_{i,t}}{w_{i,t-1}}\Pi_t^C - \Pi^C\right)^2 w_t N_t + \frac{R_t B_{i,t-1}}{\Pi_t^C} = \frac{B_{i,t}}{P_t^C} + \frac{W_{i,t}}{P_t^C} N_{i,t} + \Omega_{i,t} - T_t, \tag{7}$$

where $Q_t \equiv \frac{P_{D,t}}{P_{C,t}}$ is the relative price of durables, R_t is the gross nominal interest rate and $W_{i,t}$ is the nominal wage. Households choose $Z_{i,t}, B_{i,t}, D_{i,t+1}, I_{i,t}^D, w_{i,t}$ to maximize (2) subject to (3), (4), (5), (6) and (7). At the symmetric equilibrium, the patient household's optimality conditions are:

$$\begin{aligned}
1 &= E_t\left[\Lambda_{t,t+1}\frac{R_t}{\Pi_{t+1}^C}\right], && (8)\\
Q_t \psi_t &= \frac{U_{D,t}}{U_{Z,t}} + (1-\delta) E_t\left[\Lambda_{t,t+1} Q_{t+1}\psi_{t+1}\right], && (9)\\
1 &= \psi_t e_t^I \left[1 - S\left(\frac{I_t^D}{I_{t-1}^D}\right) - S'\left(\frac{I_t^D}{I_{t-1}^D}\right)\frac{I_t^D}{I_{t-1}^D}\right] + \\
&\quad + E_t\left\{\Lambda_{t,t+1}\psi_{t+1}\frac{Q_{t+1}}{Q_t} e_{t+1}^I \left[S'\left(\frac{I_{t+1}^D}{I_t^D}\right)\left(\frac{I_{t+1}^D}{I_t^D}\right)^2\right]\right\}, && (10)
\end{aligned}$$

$$
\begin{aligned}
0 &= \left[1-e_t^W\eta\right]+\frac{e_t^W\eta}{\mu_t}-\vartheta^W\left(\Pi_t^W-\Pi^C\right)\Pi_t^W+ \\
&+E_t\left[\Lambda_{t,t+1}\vartheta^W\left(\Pi_t^W-\Pi^C\right)\Pi_{t+1}^W\frac{w_{t+1}N_{t+1}}{w_tN_t}\right]. \qquad (11)
\end{aligned}
$$

Equation (8) is a standard Euler equation with $\Lambda_{t,t+1}\equiv\beta\frac{U_{Z,t+1}}{U_{Z,t}}\frac{e_{t+1}^B}{e_t^B}$ representing the stochastic discount factor and $U_{Z,t}$ denoting the marginal utility of habit-adjusted consumption of nondurable goods. Equation (9) represents the asset price of durables, where $U_{D,t}$ is the marginal utility of durables consumption and ψ_t is the Lagrange multiplier attached to constraint (6). Equation (10) is the optimality condition with respect to investment in durable goods. Finally, equation (11) is the wage setting equation in which $\mu_t\equiv\frac{w_t}{MRS_t}$ is the wage markup, $MRS_t\equiv-\frac{U_{N,t}}{U_{Z,t}}$ is the marginal rate of substitution between consumption and leisure, $U_{N,t}$ is the marginal disutility of work and $\Pi_t^W=\frac{w_t}{w_{t-1}}\Pi_t^C$ is the gross wage inflation rate.

3.1.2 Impatient households

Impatient households solve a maximization problem analogous to patient households, with the additional assumption that the former are limited in the amount they can borrow from the latter by the value of their durables stock according to the following borrowing constraint:

$$
B'_{i,t}\leq mE_t\left(\frac{Q_{t+1}D'_{i,t}\Pi_{t+1}^C}{R_t}\right), \qquad (12)
$$

where m represents the loan-to-value (LTV) ratio.[17] At the symmetric equilibrium, the impatient household's optimality conditions are:

$$
\begin{aligned}
\lambda'_t &= e_t^B U_{Z',t}, \qquad (13)\\
\lambda'_t &= \beta' E_t\left[\lambda'_{t+1}\frac{R_t}{\Pi_{t+1}^C}\right]+\lambda_t^{BC}R_t, \qquad (14)\\
Q_t\psi'_t &= \frac{U_{D',t}}{U_{Z't}}+\beta'\left(1-\delta\right)E_t\left[\frac{\lambda'_{t+1}}{\lambda'_t}\psi'_{t+1}Q_{t+1}\right]+\frac{\lambda_t^{BC}}{U_{Z't}}mE_t\left[Q_{t+1}\Pi_{t+1}^C\right], \qquad (15)
\end{aligned}
$$

[17] As noted by Iacoviello and Neri (2010), patient households are subject to a similar constraint that never binds due to $\beta'<\beta$.

$$
\begin{aligned}
1 &= \psi_t' e_t^I \left[1 - S\left(\frac{I_t^{D'}}{I_{t-1}^{D'}}\right) - S'\left(\frac{I_t^{D'}}{I_{t-1}^{D'}}\right)\frac{I_t^{D'}}{I_{t-1}^{D'}}\right] + \\
&+ \beta' E_t \left\{ \frac{\lambda_{t+1}' Q_{t+1}}{\lambda_t' Q_t} \psi_{t+1}' e_{t+1}^I \left[S'\left(\frac{I_{t+1}^{D'}}{I_t^{D'}}\right)\left(\frac{I_{t+1}^{D'}}{I_t^{D'}}\right)^2\right]\right\}, \qquad (16) \\
0 &= \left[1 - e_t^W \eta\right] + \frac{e_t^W \eta}{\mu_t'} - \vartheta^W \left(\Pi_t^{W'} - \Pi^C\right)\Pi_t^{W'} + \\
&+ \beta' E_t \left[\frac{\lambda_{t+1}'}{\lambda_t'} \vartheta^W \left(\Pi_{t+1}^{W'} - \Pi^C\right)\Pi_{t+1}^{W'} \frac{w_{t+1}' N_{t+1}'}{w_t' N_t'}\right]. \qquad (17)
\end{aligned}
$$

Variables λ_t' and λ_t^{BC} are the Lagrangian multipliers attached to the budget and borrowing constraints, respectively. Notice that (14) is a modified version of the typical Euler equation due to the presence of the borrowing constraint. Equations (15) and (16) show the optimal decisions about the stock and flow of durables whereas (17) is the wage equation. Here, $\Pi_t^{W'} = \frac{w_t'}{w_{t-1}'}\Pi_t^C$ is the gross wage inflation rate of impatient households.

3.2 Firms

Firms face quadratic costs of changing prices as in Rotemberg (1982): $\frac{\vartheta_j}{2}\left(\frac{P_{\omega,t}^j}{P_{\omega,t-1}^j} - 1\right)^2 Y_t^j$, where ϑ_j is the parameter of sectoral price stickiness. Each firm produces differentiated goods according to a constant returns to scale production function,

$$
Y_{\omega,t}^j = e_t^A \left(N_{\omega,t}^j\right)^{\tilde{\psi}} \left(N_{\omega,t}'^j\right)^{1-\tilde{\psi}}, \qquad (18)
$$

where $\omega \in [0,1]$ and $j = C, D$ are indices for firms and sectors respectively, $\tilde{\psi} \in [0,1]$ denotes the share of the patient household and e_t^A is a labor augmenting shock.[18] Firms

[18] We follow Iacoviello and Neri (2010) and assume a Cobb-Douglas production function. Conversely, Monacelli (2009) and Sterk (2010) assume perfect substitutability between labor inputs and use a linear production function. We opted for the former because, given the different saving choices across the two households, they will bargain different wages. The income share of the two households is different and governed by parameter $\tilde{\psi}$. Assuming that workers are perfect substitutes would lead to the same income share across households, thus neglecting the different saving motive across them. It must be said that Iacoviello and Neri (2010) argue that estimating a model in which hours are perfect substitutes doesn't materially affect their results.

maximize the present discounted value of profits,

$$E_t \left\{ \sum_{t=0}^{\infty} \Lambda_{t,t+1} \left[\frac{P^j_{\omega,t}}{P^j_t} Y^j_{\omega,t} - \frac{W_{\omega,t}}{P^j_t} N^j_{\omega,t} - \frac{W'_{\omega,t}}{P^j_t} N'^j_{\omega,t} - \frac{\vartheta_j}{2} \left(\frac{P^j_{\omega,t}}{P^j_{\omega,t-1}} - 1 \right)^2 Y^j_t \right] \right\}, \quad (19)$$

subject to production function (18) and a standard Dixit-Stiglitz demand equation $Y^j_{\omega,t} = \left(\frac{P^j_{\omega,t}}{P^j_t} \right)^{-e^j_t \epsilon_j} Y^j_t$, where ϵ_j and e^j_t are the sectoral intratemporal elasticities of substitution across goods and the sectoral price markup shocks, respectively. At the symmetric equilibrium, the price setting equations for the two sectors read as

$$\begin{aligned} \left(1 - e^C_t \epsilon_c\right) + e^C_t \epsilon_c MC^C_t &= \vartheta_c \left(\Pi^C_t - 1\right) \Pi^C_t - \\ &\quad -\vartheta_c E_t \left[\Lambda_{t,t+1} \frac{Y^C_{t+1}}{Y^C_t} \left(\Pi^C_{t+1} - 1\right) \Pi^C_{t+1} \right], \quad (20) \\ \left(1 - e^D_t \epsilon_d\right) + e^D_t \epsilon_d MC^D_t &= \vartheta_d \left(\Pi^D_t - 1\right) \Pi^D_t - \\ &\quad -\vartheta_d E_t \left[\Lambda_{t,t+1} \frac{Q_{t+1}}{Q_t} \frac{Y^D_{t+1}}{Y^D_t} \left(\Pi^D_{t+1} - 1\right) \Pi^D_{t+1} \right]. \quad (21) \end{aligned}$$

If $\vartheta_j = 0$ prices are flexible and are set as constant markups over the marginal costs.

3.3 Fiscal and monetary policy

Every period, a lump-sum tax equates government spending so that the government budget is balanced. Government spending e^G_t follows an exogenous process and, as in Erceg and Levin (2006), we assume that the government purchases only nondurable goods and services. Monetary policy is set according to the following Taylor rule:

$$\log\left(\frac{R_t}{R}\right) = \rho_r \log\left(\frac{R_{t-1}}{R}\right) + (1-\rho_r)\left[\rho_\pi \log\left(\frac{\tilde{\Pi}_t}{\tilde{\Pi}}\right) + \rho_y \log\left(\frac{Y_t}{Y}\right)\right] + e^R_t, \quad (22)$$

where ρ_r is the interest rate smoothing parameter, ρ_π and ρ_y are the monetary policy responses to the deviations of the inflation aggregator and output from their respective steady states, and e^R_t represents the exogenous innovation to the monetary policy rule. $\widetilde{\Pi}_t \equiv \left(\Pi^C_t\right)^{1-\tau} \left(\Pi^D_t\right)^{\tau}$ is an aggregator of the gross rates of inflation in the two sectors with $\tau \in [0,1]$ representing the weight of durables. Different monetary policy rules have been used in two-sector NK models with no difference in their main implications.[19]

3.4 Market clearing conditions and exogenous processes

In equilibrium all markets clear and the model is closed by the following identities:

$$\begin{aligned}
Y_t &= Y_t^C + Q_t Y_t^D + \frac{\vartheta^W}{2}\left(\Pi_t^W - \Pi^C\right)^2 w_t N_t + \frac{\vartheta^W}{2}\left(\Pi_t^{W'} - \Pi^C\right)^2 w_t' N_t', && (23)\\
Y_t^C &= C_t + C_t' + G_t + \frac{\vartheta_c}{2}\left(\Pi_t^C - \Pi^C\right)^2 Y_t^C, && (24)\\
Y_t^D &= \left[D_t - (1-\delta) D_{t-1}\right] + \left[D_t' - (1-\delta) D_{t-1}'\right] + \frac{\vartheta_d}{2}\left(\Pi_t^D - \Pi^D\right)^2 Y_t^D, && (25)\\
0 &= B_t + B_t', && (26)\\
N_t &= N_t^C + N_t^D, && (27)\\
N_t' &= N_t'^C + N_t'^D. && (28)
\end{aligned}$$

As in Smets and Wouters (2007), the wage markup and the price markup shocks follow ARMA(1,1) processes:

$$\log\left(\frac{\varkappa_t}{\bar{\varkappa}}\right) = \rho_\varkappa \log\left(\frac{\varkappa_{t-1}}{\bar{\varkappa}}\right) + \epsilon_t^\varkappa - \theta_i \epsilon_{t-1}^\varkappa, \tag{29}$$

with $\varkappa = \left[e^W, e^C, e^D\right]$, $i = [W, C, D]$, whereas all other shocks follow an AR(1) process:

$$\log\left(\frac{\kappa_t}{\bar{\kappa}}\right) = \rho_\kappa \log\left(\frac{\kappa_{t-1}}{\bar{\kappa}}\right) + \epsilon_t^\kappa, \tag{30}$$

where $\kappa = \left[e^B, e^I, e^R, e^A, e^G\right]$ is a vector of exogenous variables, $\rho_\varkappa$ and ρ_κ are the autoregressive parameters, θ_i are the moving average parameters, $\epsilon_t^\varkappa$ and ϵ_t^κ are i.i.d shocks with zero mean and standard deviations $\sigma_\varkappa$ and σ_κ.[20]

3.5 Functional forms

The utility function is additively separable and logarithmic in the consumption aggregator: $U(X_t, N_t) = \log(X_t) - \nu \frac{N_t^{1+\varphi}}{1+\varphi}$, where ν is a scaling parameter for hours worked and φ is the inverse of the Frisch elasticity of labor supply. Following Christiano et al. (2005), we assume quadratic adjustment costs in durables investment:

[19] See Cantelmo and Melina (2015) for more details.

[20] The systems of equations describing the full symmetric equilibrium and the steady state are presented in Sections D.1 and D.2 of the Appendix.

$S\left(\frac{I_t^D}{I_{t-1}^D}\right) = \frac{\phi}{2}\left(\frac{I_t^D}{I_{t-1}^D} - 1\right)^2$, with $\phi > 0$ representing the degree of adjustment costs. The same functional forms are assumed for the impatient households, with the preference and investment adjustment cost parameters specific to them.

3.6 Bayesian estimation

The model is estimated with Bayesian methods. The Kalman filter is used to evaluate the likelihood function, which combined with the prior distribution of the parameters yields the posterior distribution. Then, the Monte-Carlo-Markov-Chain Metropolis-Hastings (MCMC-MH) algorithm with two parallel chains of 150,000 draws each is used to generate a sample from the posterior distribution in order to perform inference. We estimate the model over the sample 1969Q2-2007Q4, the same as in the SVAR analysis. We use eight observables: GDP, investment in durable goods, consumption of nondurable goods, real wage, hours worked, inflation in the nondurables sector, inflation in the durables sector and the nominal interest rate, using US data. Similarly to the SVAR analysis, we first define the durables sector as the sum of durable goods and residential investments and label this model as the *baseline* DSGE. Then, we estimate the model by assuming that durables comprise only houses and we will refer to it as the *housing* DSGE. This model becomes then very close to Iacoviello and Neri (2010) who, however do not estimate the price stickiness parameter in the housing sector and assume that prices are flexible.[21] The following measurement equations link the data to the endogenous variables of the model:

$$\Delta Y_t^o = \gamma + \hat{Y}_t - \hat{Y}_{t-1}, \tag{31}$$

$$\Delta I_{D,t}^o = \gamma + \hat{I}_{D,t}^* - \hat{I}_{D,t-1}^*, \tag{32}$$

$$\Delta C_t^o = \gamma + \hat{C}_t^* - \hat{C}_{t-1}^*, \tag{33}$$

$$\Delta W_t^o = \gamma + \hat{W}_t^* - \hat{W}_{t-1}^*, \tag{34}$$

$$N_t^o = \hat{N}_t^*, \tag{35}$$

$$\Pi_{C,t}^o = \bar{\pi}_C + \hat{\Pi}_t^C, \tag{36}$$

$$\Pi_{D,t}^o = \bar{\pi}_D + \hat{\Pi}_t^D, \tag{37}$$

$$R_t^o = \bar{r} + \hat{R}_t. \tag{38}$$

[21] Another difference between our model and Iacoviello and Neri (2010) is that we assume perfect labor mobility across sectors.

Variables with a ˆ are in log-deviations from their own steady state while * denotes that the variable has been aggregated between the patient and impatient households (i.e. $x_t^* = x_t + x_t'$).[22] γ is the common quarterly trend growth rate of GDP, investment of durables, consumption of nondurables and the real wage; $\bar{\pi}_C$ and $\bar{\pi}_D$ are the average quarterly inflation rates in nondurable and durable sectors respectively; $\bar{r}$ is the average quarterly Federal funds rate. Hours worked are demeaned so no constant is required in the corresponding measurement equation (35).

3.6.1 Calibration and priors

The structural parameters and steady state values presented in Table 4 are calibrated at a quarterly frequency. As in Iacoviello and Neri (2010), the discount factors β and β' are 0.99 and 0.97, respectively. Following Monacelli (2009), the depreciation rate of durable goods δ is calibrated at 0.010 amounting to an annual depreciation of 4%, and the durables share of total expenditure α is set at 0.20. The sectoral elasticities of substitution across different varieties ϵ_c and ϵ_d equal 6 in order to target a steady-state gross mark-up of 1.20. The elasticity of substitution in the labor market η is set equal to 21 as in Zubairy (2014), implying a 5% steady-state gross wage mark-up. The preference parameters ν and ν' are set to target steady-state hours of work of 0.33 for both households. The government-output ratio g_y is calibrated at 0.20, in line with the data. Finally, we follow Iacoviello and Neri (2010) and set the loan-to-value ratio m to 0.85 and the share of patient households $\tilde{\psi}$ at their estimated value 0.79.[23]

Table 5 summarizes the prior and posterior distributions of the parameters and the shocks. The choice of priors correspond to a large extent to those in previous studies of the US economy. We set the prior mean of the inverse Frisch elasticities φ and φ' to 0.5, in line with Smets and Wouters (2007, SW henceforth) who estimate a Frisch elasticity of 1.92. We also follow SW in setting the prior means of the habit parameter, ζ and ζ', to 0.7, the interest rate smoothing parameter, ρ_r, to 0.80 and in assuming a stronger response of the central bank to inflation than output. As far as the the constants in the measurement equations are concerned, we set the prior means equal to the average values in the dataset. In general, we use the Beta (B) distribution for all parameters bounded between 0 and 1. We use the Inverse Gamma (IG) distribution for the standard deviation of the shocks for which we set a loose prior with 2 degrees

[22]The aggregation for the real wage is borrowed from Iacoviello and Neri (2010).

[23]This calibration is also consistent with the findings in Jappelli (1990), who estimates an income share of 80% for savers in the U.S economy.

Parameter		Value
Discount factor patient households	β	0.99
Discount factor impatient households	β'	0.97
Durables depreciation rate	δ	0.010
Durables share of total expenditure	α	0.20
Elasticity of substitution nondurable goods	ϵ_c	6
Elasticity of substitution durable goods	ϵ_d	6
Elasticity of substitution in labor	η	21
Preference parameters	ν, ν'	set to target $N = N' = 0.33$
Loan-to-value ratio	m	0.85
Share of patient households	$\tilde{\psi}$	0.79
Government share of output	g_y	0.20

Table 4: Calibrated parameters

of freedom. Kim and Katayama (2013) are the only authors who jointly estimate the price and wage stickiness parameters whereas all the other studies calibrate them such that prices of nondurable goods are sticky whereas prices of durable goods are flexible. However, they define Calvo parameters for prices and a Rotemberg parameter for wages. Our model features Rotemberg parameters for both prices and wages and we choose a Gamma (G) distribution, given that these are non-negative. One of our main interests is to assess whether the durables price stickiness parameter is close to zero, or whether it tends towards values closer to those estimated for the nondurables sector. This is crucial in order to assess whether the response of the relative price of durables is significantly different from zero or not. To this aim, we assign a prior whereby durables prices are as sticky as nondurables prices and both degrees of price stickiness are low (corresponding to firms resetting prices around 2.3 quarters on average in a Calvo world).[24] Then, we let the data decide whether and to what extent these should depart from one another.

3.6.2 Estimation results

Table 5 also reports the posterior mean with 90% probability intervals in square brackets of the baseline and the housing DSGE models. The posterior means suggest that various frictions are supported by the data in both models.[25] Impatient households

[24]We follow Woodford (2003) and Monacelli (2009) to convert the Rotemberg to Calvo parameters and obtain the average price duration.

[25]In Appendix H we perform likelihood comparisons and a number of robustness checks and show that the frictions considered are important when the theoretical model is brought to the data. In

Parameter		Distr.	Prior Mean	Sd/df	Posterior Mean Baseline DSGE	Posterior Mean Housing DSGE
Structural						
Inv. Frisch elasticity patients	φ	N	0.50	0.10	0.5504 [0.4010;0.6986]	0.6448 [0.4933;0.7942]
Inv. Frisch elasticity impatients	φ'	N	0.50	0.10	0.6468 [0.4952;0.8028]	0.6860 [0.5300;0.8431]
Habits patients	ζ	B	0.70	0.10	0.6505 [0.5979;0.7036]	0.6615 [0.6188;0.6965]
Habits. impatients	ζ'	B	0.70	0.10	0.9336 [0.9240;0.9442]	0.9404 [0.9338;0.9465]
Habit persist. patients	ρ_c	B	0.70	0.10	0.5068 [0.3964;0.6206]	0.6399 [0.5412;0.7436]
Habit persist. impatients	ρ_c'	B	0.70	0.10	0.2195 [0.1564;0.2809]	0.3221 [0.2366;0.4142]
Price stickiness nondurables	ϑ_c	G	15.0	5.00	23.38 [15.82;30.61]	26.06 [18.56;33.99]
Price stickiness durables	ϑ_d	G	15.0	5.00	24.45 [16.09;33.26]	1.79 [1.13;2.43]
Wage stickiness	ϑ^W	G	100.0	10.00	152.39 [136.15;169.71]	168.06 [158.30;177.30]
IAC durables patients	ϕ	N	1.5	0.50	3.4738 [2.8002;4.1114]	3.7908 [3.2240;4.4022]
IAC durables impatients	ϕ'	N	1.5	0.50	1.9112 [1.2022;2.5902]	1.7710 [1.0228;2.4684]
Share of durables inflation	τ	B	0.20	0.10	0.1440 [0.0519;0.2299]	0.0516 [0.0367;0.0672]
Inflation -Taylor rule	ρ_π	N	1.50	0.20	1.4042 [1.2298;1.5702]	1.7285 [1.5062;1.9437]
Output -Taylor rule	ρ_y	G	0.10	0.05	0.0175 [0.0056;0.0291]	0.0221 [0.0059;0.0368]
Interest rate smoothing	ρ_r	B	0.80	0.10	0.7088 [0.6657;0.7545]	0.7681 [0.7314;0.8054]
Averages						
Trend growth rate	γ	N	0.49	0.10	0.4017 [0.3678;0.4343]	0.4054 [0.3752;0.4356]
Inflation rate nondurables	$\bar{\pi}_C$	G	1.05	0.10	1.0135 [0.9120;1.1146]	1.0427 [0.9348;1.1438]
Inflation rate durables	$\bar{\pi}_D$	G	0.37	0.10	0.4324 [0.3200;0.5495]	0.3462 [0.2180;0.4767]
Interest rate	$\bar{r}$	G	1.65	0.10	1.6140 [1.4898;1.7467]	1.6404 [1.4980;1.7754]
Exogenous processes						
Technology	ρ_{e^A}	B	0.50	0.20	0.9775 [0.9574;0.9970]	0.9555 [0.9223;0.9903]
	σ_{e^A}	IG	0.10	2.0	0.6933 [0.6196;0.7607]	0.7483 [0.6678;0.8308]
Monetary Policy	ρ_{e^R}	B	0.50	0.20	0.1019 [0.0258;0.1774]	0.0777 [0.0173;0.1320]
	σ_{e^R}	IG	0.10	2.0	0.2880 [0.2566;0.3180]	0.2803 [0.2503;0.3109]
Investment Durables	ρ_{e^I}	B	0.50	0.20	0.4915 [0.3072;0.6710]	0.9205 [0.8872;0.9543]
	σ_{e^I}	IG	0.10	2.0	6.1724 [4.0832;8.2543]	6.1915 [5.4443;6.9462]
Preference	ρ_{e^B}	B	0.50	0.20	0.7465 [0.6805;0.8167]	0.8641 [0.8198;0.9103]
	σ_{e^B}	IG	0.10	2.0	1.8512 [1.5433;2.1479]	2.1900 [1.7840;2.5739]
Price mark-up nondurables	ρ_{e^C}	B	0.50	0.20	0.9053 [0.8544;0.9595]	0.9098 [0.8490;0.9728]
	θ_C	B	0.50	0.20	0.5643 [0.4506;0.6733]	0.6449 [0.5262;0.7698]
	σ_{e^C}	IG	0.10	2.0	2.0840 [1.6533;2.4938]	2.2972 [1.7984;2.7678]
Price mark-up durables	ρ_{e^D}	B	0.50	0.20	0.9869 [0.9768;0.9976]	0.9888 [0.9778;0.9994]
	θ_D	B	0.50	0.20	0.7037 [0.6025;0.8045]	0.8903 [0.8561;0.9265]
	σ_{e^D}	IG	0.10	2.0	4.3290 [3.0803;5.5682]	24.451 [20.311;28.074]
Wage mark-up	ρ_{e^W}	B	0.50	0.20	0.9481 [0.9210;0.9761]	0.9557 [0.9346;0.9791]
	θ_W	B	0.50	0.20	0.5544 [0.4511;0.6632]	0.5661 [0.4608;0.6780]
	σ_{e^W}	IG	0.10	2.0	5.2236 [4.3012;6.1217]	5.5840 [4.6366;6.5235]
Government spending	ρ_{e^G}	B	0.50	0.20	0.9658 [0.9458;0.9879]	0.9565 [0.9283;0.9857]
	σ_{e^G}	IG	0.10	2.0	3.5099 [3.1807;3.8336]	3.3376 [3.0351;3.6504]

Table 5: Prior and posterior distributions of estimated parameters (90% confidence bands in square brackets)

display a higher degree of habits in nondurables consumption ($\zeta < \zeta'$), as found by Iacoviello and Neri (2010) but with a lower persistence ($\rho_c > \rho'_c$). In addition, patient households face larger costs of adjusting their durables stock ($\phi > \phi'$). The posterior mean of the inverse Frisch elasticities of labor supply in both models are higher than the prior and are well identified in the data (as can be seen from comparing prior and posterior distributions in Figure G.1, Appendix G). Estimates of the Taylor rule parameters show a high degree of policy inertia, and a stronger response to inflation than to output, a likely consequence of estimating the model over a sample including the Great Moderation. Overall, estimates from both models are quite close to each other.

As regards price stickiness in the two sectors, when we employ the broad measure of durable goods (baseline DSGE) the posterior means are very similar – with confidence intervals almost entirely overlapping. The point estimates of durables and nondurables price stickiness ($\vartheta_d = 24.45, \vartheta_c = 23.38$) correspond to Calvo probabilities of resetting the price of 35.9% and 36.5% and an average price duration of 2.8 and 2.7 quarters respectively. Conversely, in the housing DSGE the posterior mean of house prices ($\vartheta_d = 1.79$) is dramatically lower than that of nondurables ($\vartheta_c = 26.06$) corresponding to Calvo probabilities of resetting the price of 78.1% and 35% and average price durations of 1.3 and 2.8 quarters respectively. In addition, confidence intervals never overlap. Here, the estimated degree of wage stickiness ($\vartheta^W = 168.06$) guarantees that the comovement between consumption in the two sectors is still attained despite house prices being estimated to be quasi-flexible.[26]

Figure 3 shows the prior and posterior distributions of the price stickiness parameters in both models. First, we notice that the data is informative as the posterior distributions are rather apart from the prior. In the baseline DSGE (left box), the two distributions almost entirely overlap thus pointing to a negligible difference in the price stickiness across the nondurables and durables sectors. Conversely, in the housing DSGE (right box) the posterior distribution of the housing price stickiness moves towards zero and in opposite direction with respect to the posterior distribution of nondurables prices. Such estimates highlight that when a broad measure of durables is employed, then prices display the same degree of stickiness with respect to nondurables whereas, if the durables sector coincides with the housing sector, then prices are estimated to reset almost every quarter.

addition, Appendix H.1 discusses the implications of changing the income share of patient households.

[26]The importance of wage stickiness for the comovement between the two sectors is also highlighted in a calibrated version of the model with flexible durables prices, see Figure H.1 in Appendix H.

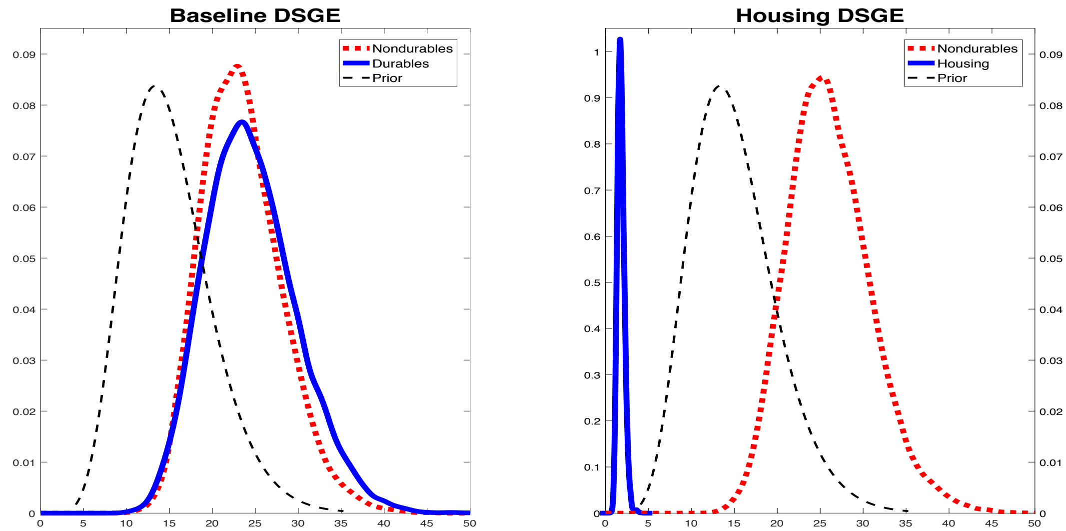


Figure 3: Prior and posterior densities of price stickiness parameters. Left box: baseline DSGE. Right box: housing DSGE (left-scale refers to distribution of housing parameter, right-scale refers to nondurables).

This result that durables prices are as sticky as nondurables contrasts with Kim and Katayama (2013) who find that prices of durables are substantially more flexible than prices of nondurables, in a model with homogenous households and no role for durables as collateral, fewer shocks and different observables.[27] We try and be as close as possible to mainstream estimated models as far as shocks and observables are concerned, with the natural addition of observables related to durables consumption and durables inflation. Moreover, such results are closer to the latest microeconometric evidence. In particular, Nakamura and Steinsson (2008), Klenow and Malin (2010) and Petrella and Santoro (2012) use highly disaggregated data and find no decisive evidence that categories of nondurables are stickier than durables. In addition, Boivin et al. (2009) argue that inflation in sectors with high price stickiness display a high autocorrelation and low volatility. They estimate that durables inflation has higher autocorrelation and lower volatility than nondurables inflation hence it is possible to infer that prices of durables are stickier than nondurables.

[27]Also Bouakez et al. (2009) provide qualitatively similar results to Kim and Katayama (2013) in a larger model estimated using GMM and a different dataset.

3.6.3 Impulse response functions

In order to investigate the dynamic properties of the models, Figure 4 displays the estimated impulse responses of the variables of interest to a one standard-deviation increase in the nominal interest rate across the baseline and housing DSGE models.[28] As the estimated parameters are very similar across the two models, the mean responses do not show large differences. Taking into account the 68%, 90% and the 95% confidence bands (see Figures F.1 and F.2 in Appendix F) further highlights these similarities. An increase in the monetary policy rate leads to an output contraction and a decrease in overall and sectoral inflations. Furthermore, the presence of wage and price stickiness generates the desired comovement between durables and nondurables. The only noticeable difference between the two models concerns the response of the relative price, due to the different degree of estimated price stickiness. In the baseline model, prices of durables and nondurables are equally sticky hence the response of the relative price is flat whereas in the housing model, house prices are almost flexible and prices of nondurables are sticky hence the relative price falls in response to a monetary policy contraction. Figure 5 highlights the Bayesian impulse responses of the relative prices in the two models together with the 68%, 90% and the 95% confidence bands. The credible set of estimated impulse responses in the baseline model does not exclude zero at any of the confidence levels considered whereas it is significantly negative in the housing DSGE. Such dynamic properties of the models are consistent with the findings of the SVAR models estimated in Section 2 (see Figures 1 and 2) and represent the main novel contribution of our paper.[29]

To sum up, we have estimated prices of durables (defined as the sum of durable goods and residential investments) to be as sticky as nondurables which is at odds with the assumption made in most two-sectors New-Keynesian models that they are fully flexible. We have then demonstrated that such assumption is consistent only with a narrow definition of durables sector that coincide with exclusively with residential investments.

[28]Impulse responses represent percentage deviations from the steady state. Bayesian impulse responses of each model together with confidence bands are reported in Appendix F.

[29]In general, qualitatively the responses of the estimated DSGE models are consistent with those of the SVAR model. Also from a quantitative perspective, durables turn out to be more volatile than nondurables and output, as in the SVAR results.

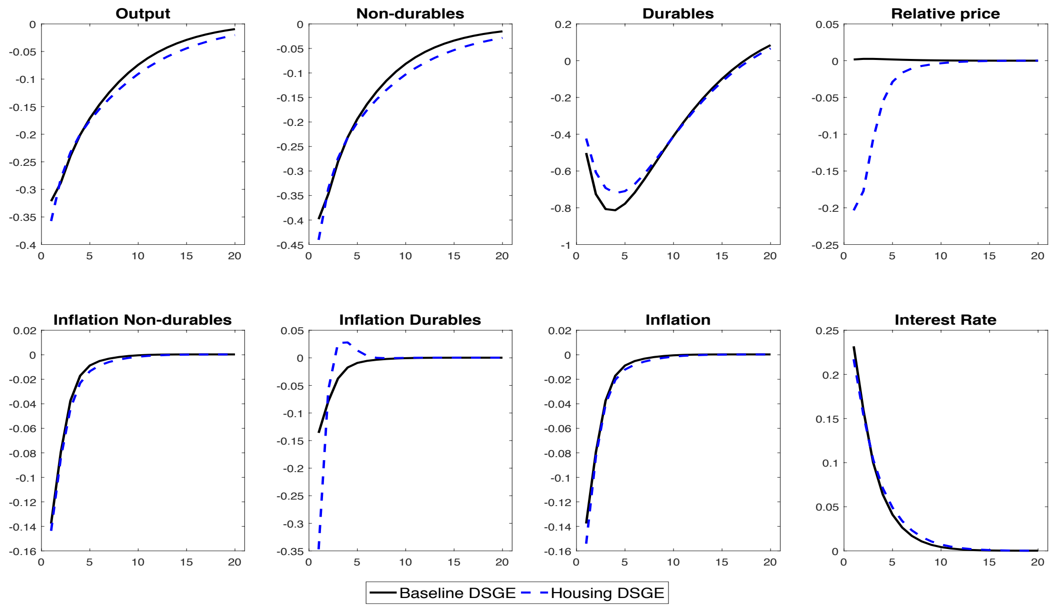


Figure 4: Bayesian impulse responses to a contractionary monetary policy shock. Bold lines: mean responses baseline model. Dashed lines: mean responses housing model.

3.7 Estimated sectoral price stickiness in extended models

The two-sector DSGE model estimated in the previous section builds mainly on Barsky et al. (2007) with the addition of several frictions and of the collateral constraint as in Monacelli (2009), Iacoviello and Neri (2010) and Sterk (2010). In this section we extend the model to account for two additional features affecting sectoral Phillips curves, namely imperfect sectoral labor mobility and price indexation. We re-estimate the DSGE model jointly with the additional parameters. Then, we further generalize our analysis and estimate a three-sector DSGE model in which housing and non-housing durables are treated separately and display heterogeneity in terms of rate of depreciation, adjustment costs and degree of substitutability with nondurable goods. Table 6 reports the estimated sectoral price stickiness across the extended models whereas the full set of estimated parameters is in Appendix I.

3.7.1 Imperfect sectoral labor mobility

Households in two-sector models are allowed to optimally choose the quantity of labor to supply in each sector according to their preferences. Standard two-sector models typically assume either that labor is perfectly mobile hence sectoral wages are equalized

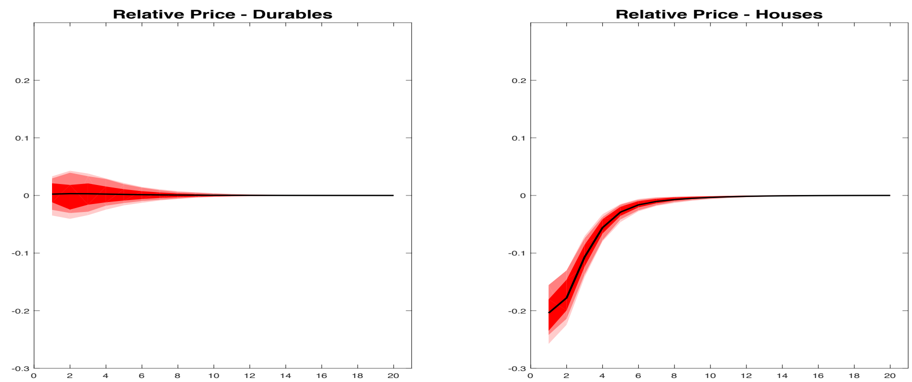


Figure 5: Bayesian impulse responses of relative prices to a contractionary monetary policy shock (bold lines are mean responses, dark-shaded areas are 68% confidence bands, medium and lighter shaded areas represent 90% and 95% confidence bands respectively)

across the two sectors or assume no mobility at all.[30] However, more recent contributions have emphasized the importance of limited labor mobility in accounting for the behavior of the economy in multi-sector models. Indeed, Bouakez et al. (2009) argue that imperfect labor mobility affects the dispersion of hours across sectors whereas Bouakez et al. (2011) show that accounting for limited labor mobility jointly with intersectoral linkages solves the comovement puzzle. Moreover, Iacoviello and Neri (2010) find evidence of limited labor mobility across the consumption and housing sectors.[31]

In the context of our main two-sector model above, perfect labor mobility implies that the production structure and thus marginal costs are always the same across the two sectors. Therefore, it seems sensible to modify it to allow for limited labor mobility, and hence for different dynamics of wages and the marginal costs across the two sectors, and to check the robustness of our results as regards the estimation of the price stickiness parameters. Following the abovementioned contributions, limited labor mobility is introduced by specifying a constant elasticity of substitution (CES) aggregator between sectoral hours for each household:

$$N_t = \left[\left(\chi^C\right)^{-\frac{1}{\lambda}} \left(N_t^C\right)^{\frac{1+\lambda}{\lambda}} + \left(1-\chi^C\right)^{-\frac{1}{\lambda}} \left(N_t^D\right)^{\frac{1+\lambda}{\lambda}} \right]^{\frac{\lambda}{1+\lambda}}, \tag{39}$$

[30]See, among others, Aoki (2001), Huang and Liu (2005), Barsky et al. (2007), Monacelli (2009), Sterk (2010), Jeske and Liu (2013), Kim and Katayama (2013), Katayama and Kim (2013), Jeske and Liu (2013) and Barsky et al. (2016) for models with perfect labor mobility and Erceg and Levin (2006) and Benigno (2004) for models with no labor mobility.

[31]Imperfect sectoral labor mobility plays a role also for the conduct of optimal monetary policy, as demonstrated by Petrella and Santoro (2011) and Petrella et al. (2017).

where the intra-temporal elasticity of substitution $\lambda \in (0, \infty)$ governs the degree of labor mobility.[32] Note that $\lambda \to 0$ denotes the case of labor immobility, while as $\lambda \to \infty$ labor can be freely reallocated and all workers earn the same wage at the margin. For $\lambda < \infty$ the economy displays a limited degree of labor mobility and sectoral wages are not equal. Moreover, $\chi^C \equiv N^C/N$ represents the steady-state share of labor supply in the nondurables sector.

We then replace the labor market clearing conditions (27) and (28) with the CES aggregators and bring the model to the data. Typically, limited labor mobility is calibrated at a value of $\lambda = 1$ (see Bouakez et al. 2009, Petrella and Santoro 2011 and Petrella et al. 2017), except Bouakez et al. (2011) who explore values between 0.5 and 1.5 whereas Iacoviello and Neri (2010) estimate values of 1.51 and 1.03 for savers and borrowers, respectively.[33] Accordingly, we set the prior mean of the labor mobility parameters at the posterior estimates of Iacoviello and Neri (2010) and bring the model to the data.

The third and fourth columns of Table 6 report the estimated price stickiness in the baseline and housing DSGE models with imperfect sectoral labor mobility and show that the results of our main model (first and second columns of Table 6) continue to hold. In the baseline DSGE, price stickiness is similar across the two sectors with 90% confidence intervals widely overlapping. Conversely, in the housing DSGE prices of nondurables are significantly stickier than house prices, which are quasi-flexible. The top panel of Figure 6 plots the posterior distribution of the price stickiness parameters in the baseline and housing DSGE models with imperfect sectoral labor mobility. While in the baseline DSGE the two posterior distributions widely overlap, in the housing DSGE the posterior distributions are rather apart from each other thus implying a significant difference between the two sectoral price stickiness parameters. In addition, labor mobility in the housing DSGE is estimated to be somewhat lower than in the baseline DSGE (see Table I.1, Appendix I).[34]

[32]The same functional form is assumed for impatient households, with variables and parameters specific to them denoted by $'$. Details about the symmetric equilibrium are in Appendix D.3.1.

[33]Iacoviello and Neri (2010) specify the CES aggregator such that the labor mobility parameter is the inverse of λ. They find values of 0.66 and 0.97 for savers and borrowers respectively hence the values of 1/0.66=1.51 and 1/0.97=1.03 we reported.

[34]Confidence bands of the estimated elasticities do not overlap for patient households, but they overlap for impatient households.

3.7.2 Price indexation

The price setting behavior of firms specified in equations (20) and (21) yield purely forward-looking sectoral Phillips curves. In this section we introduce a backward-looking component of the Phillips curves by estimating the degree of sectoral indexation to past inflation and verify that the results reported in Section 3.6.2 as regards price stickiness are not driven by the absence of indexation. Following Ireland (2007; 2011) and Ascari et al. (2011) we introduce indexation in the Rotemberg price adjustment cost specification, which now read as:

$$\frac{\vartheta_j}{2}\left(\frac{P_{i,t}^j}{\Pi_{t-1}^{j,\varsigma_j} P_{i,t-1}^j}-1\right)^2 Y_t^j, \tag{40}$$

where $\varsigma_j \in [0,1]$ determines the degree of indexation to past inflation and $j = C, D$.[35]

When bringing the extended model to the data, we set the prior mean of the sectoral indexation parameters as in Smets and Wouters (2007) and Iacoviello and Neri (2010) at 0.50 and standard deviation 0.20. Table 6 (fifth and sixth columns) shows that the estimated sectoral price stickiness is very similar across sectors in the baseline DSGE, whereas in the housing DSGE nondurables prices are much stickier than house prices, which are virtually flexible. This confirms the results of the main model. Looking at the posterior distributions of the price stickiness parameters in the baseline and housing DSGE models with sectoral price indexation (middle panel of Figure 6) leads to the same inference as in the main model. The estimated degrees of price rigidity are not significantly different in the baseline DSGE whereas in the housing DSGE house prices are significantly more flexible than nondurable prices. Finally, we estimate a low degree of sectoral price indexation (see Table I.2, Appendix I).[36]

3.7.3 Three-sector model

We have so far demonstrated that the definition of the durables sector plays a crucial role in the estimation of the sectoral price stickiness. In this section, we verify that

[35] Appendix D.3.2 provides details about the modified symmetric equilibrium.

[36] Our estimates of the price indexation parameters are in line with Smets and Wouters (2007) and Ascari et al. (2011). In contrast, Benati (2008) and Iacoviello and Neri (2010) report higher values whereas Ireland (2007; 2011) finds evidence of no indexation. However, to the best of our knowledge, this is the first that estimates the sectoral degree of price indexation within a two-sector DSGE model with durable and nondurable goods (Iacoviello and Neri, 2010 estimate price stickiness and price indexation only for the nondurables sector).

our results continue to hold when we generalize the model to a three-sector economy producing nondurables, housing and non-housing durables, where only housing goods serve as collateral. Non-housing and housing durables display several sources of heterogeneity with respect to each other: (i) different depreciation rates, i.e. different degrees of durability; (ii) different adjustment costs in investment in these two goods; (iii) different degree of substitutability between housing and non-housing durables with nondurable goods. In particular, here parameter δ denotes the depreciation rate only of non-housing durables, while parameter $\delta^H \neq \delta$ denotes the depreciation of housing goods. Similarly, while parameters ϕ and ϕ' refer to investment adjustment costs of non-housing durables, parameters ϕ^H and ϕ'^H refer to adjustment costs of housing goods. Finally, accounting for different degrees of substitutability between housing and non-housing durables with nondurable goods requires a generalization of the consumption aggregator, which we specify as a nested constant-elasticity-of-substitution (CES) function of the three goods as follows:

$$X_t = \left[(1-\alpha)\, \tilde{C}_t^{\frac{\rho-1}{\rho}} + \alpha H_t^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}, \tag{41}$$

$$\tilde{C}_t = \left[(1-\tilde{\alpha})\, Z_t^{\frac{\tilde{\rho}-1}{\tilde{\rho}}} + \tilde{\alpha} D_t^{\frac{\tilde{\rho}-1}{\tilde{\rho}}} \right]^{\frac{\tilde{\rho}}{\tilde{\rho}-1}}, \tag{42}$$

where parameters $\rho, \tilde{\rho} \in (0, \infty)$ represent the elasticities of substitution between non-housing (durables and nondurables) and housing goods and between nondurable and non-housing durable goods, respectively. The resulting degree of substitutability between non-durables and housing and between non-durables and non-housing durables is then a function of these two elasticities and is allowed to be different.[37]

Housing goods are used as collateral by impatient households, hence the borrowing constraint (12) now reads as:

$$B_t' \leq m E_t \left(\frac{Q_{t+1}^H H_t' \Pi_{t+1}^C}{R_t} \right), \tag{43}$$

with $Q_t^H \equiv \dfrac{P_t^H}{P_t^C}$ being the relative house price. Firms in the housing sector behave as firms in the nondurables and durables sector, as outlined in Section 3.2: they maximize

[37] The same CES aggregators are used for impatient households, with the corresponding variables denoted by $'$. Full description of the symmetric equilibrium is provided in Appendix D.3.3.

profits and are subject to quadratic costs of adjusting prices, with three different price stickiness parameters: $\vartheta_c, \vartheta_d, \vartheta_h \in [0, \infty)$, denoting price stickiness in the non-durables, non-housing durables and housing durables sector, respectively. Finally, distinguishing between housing and non-housing investment requires making a distinction between (i) housing and non-housing investment-specific shocks; and (ii) housing and non-housing durables price markup shocks. These are assumed to follow AR(1) and ARMA(1,1) processes, respectively, in line with the analysis above. This means that the extended model features two more shocks relative to that in Section 3.

Consistently to this new structure, we bring the model to the data by distinguishing between residential and non-residential investment in durable goods, as well as inflation in the housing and non-housing durables sectors. Since now the observables of durables investment and inflation exclude housing goods, we need to add the following two measurement equations for residential investment and house price inflation respectively:

$$\Delta I^o_{H,t} = \gamma + \hat{I}^*_{H,t} - \hat{I}^*_{H,t-1}, \tag{44}$$

$$\Pi^o_{H,t} = \bar{\pi}_H + \hat{\Pi}^H_t. \tag{45}$$

In addition to the parameters calibrated in Table 4, we set the elasticity of substitution in the housing sector ϵ_h to 6 and the distributional parameters of the CES consumption aggregators $\alpha, \tilde{\alpha} \in [0, 1]$ to match the sectoral expenditure shares over the sample considered. The calibration of depreciation rates of the non-housing durables δ and housing goods δ^H deserves more attention. These parameters are crucial for the property of quasi-constancy of the shadow-value of long-lived goods, as demonstrated by Barsky et al. (2007) and Barsky et al. (2016). The literature has used a variety of values, ranging from a quarterly depreciation of 0.01 (see, among others, Monacelli, 2009; Sterk, 2010; Iacoviello and Neri, 2010; Chen and Liao, 2014), to 0.025 (see Erceg and Levin, 2006; Carlstrom and Fuerst, 2010; Petrella and Santoro, 2011; Sudo, 2012).[38] In accordance with the microeconometric evidence (see, e.g. Fraumeni, 1997) and the literature just mentioned, we assume that non-housing durables display a higher depreciation rate than housing goods. We thus calibrate $\delta = 0.025$ and $\delta^H = 0.01$. Price stickiness and investment adjustment costs parameters are estimated using the same priors as outlined in Section 3.6.1 whereas we set the prior mean of the consumption

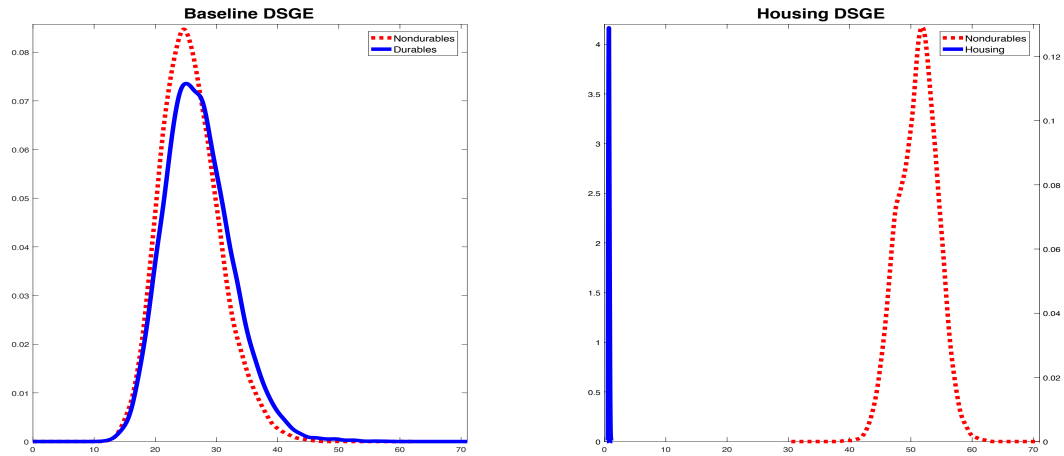
[38]Other values used in the literature are 0.0125 (Barsky et al., 2007; Kim and Katayama, 2013; Katayama and Kim, 2013; Barsky et al., 2016) and 0.0035 (Jeske and Liu, 2013). Barsky et al. (2016) explore the implications for optimal monetary policy of several values between 0.01 and 0.20.

	Main model		Imperfect Labor Mobility		Price Indexation		Three sector
	Baseline	Housing	Baseline	Housing	Baseline	Housing	
ϑ_c	23.38	26.06	25.72	51.08	20.58	23.87	33.37
	[15.82;30.61]	[18.56;33.99]	[18.07;33.85]	[45.73;56.06]	[13.63;27.65]	[16.55;31.31]	[24.07;42.82]
ϑ_d	24.45	1.79	27.02	0.72	22.05	1.26	46.13
	[16.09;33.26]	[1.13;2.43]	[17.95;35.59]	[0.56;0.85]	[13.77;30.25]	[0.69;1.79]	[34.99;57.06]
ϑ_h	\	\	\	\	\	\	4.70
							[2.34;7.09]

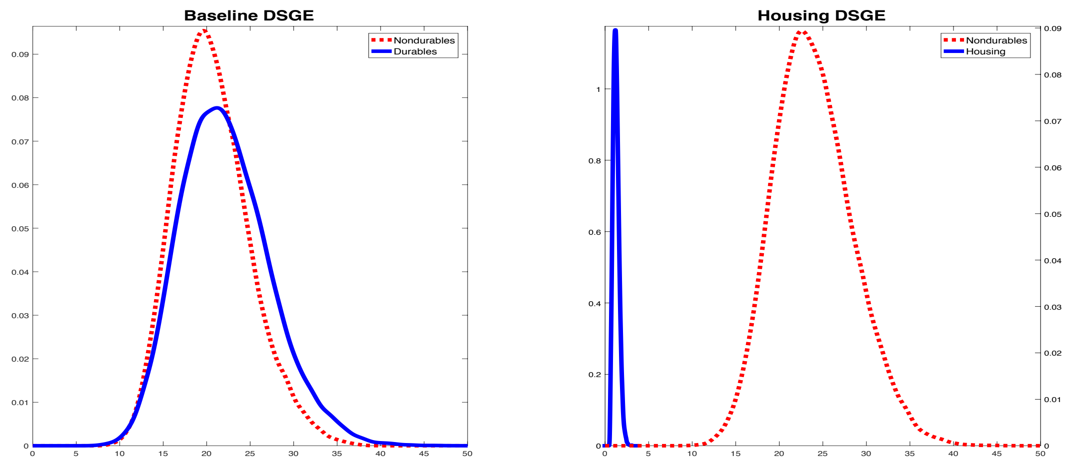
Table 6: Estimated price stickiness parameters in extended models (90% confidence bands in square brackets)

elasticities of substitution ρ and $\tilde{\rho}$ to 1 (which imply a nested Cobb-Douglas aggregator), and a standard deviation of 0.1.

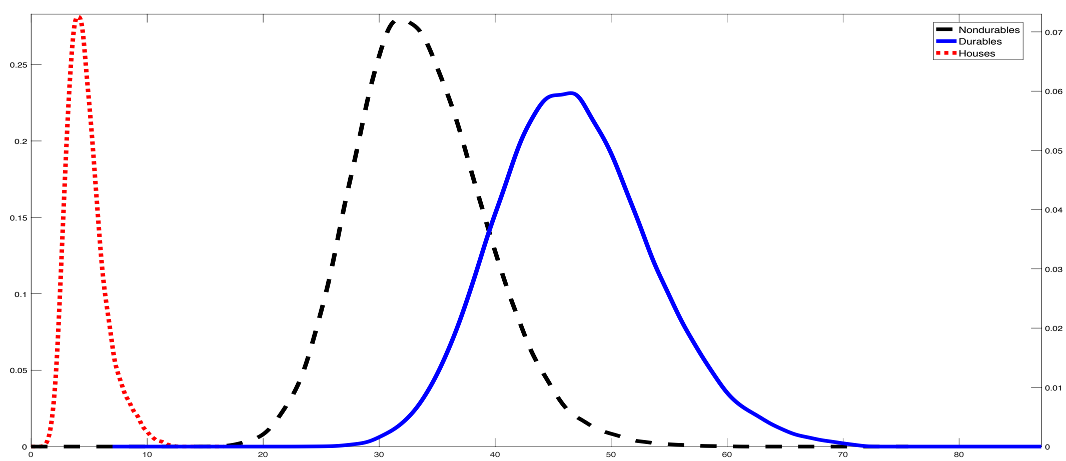
It turns out that point estimates of investment adjustment cost parameters differ across sectors, and confidence intervals of both consumption elasticities of substitution do not exclude the Cobb-Douglas case (Tables I.3 and I.4, Appendix I). The last column of Table 6 reports the estimated price stickiness parameters across the three sectors. Although the distance between the point estimates of non-housing durables and nondurables price stickiness is larger than that existing between overall durables and nondurable (see two-sector model estimates, Table 6, column 1), their confidence intervals overlap at any conventional confidence level, as it can also be seen by inspecting the posterior distributions (bottom panel of Figure 6). This means that they are not significantly different from each other in a statistical sense. It is not surprising that, with respect to our main model, the posterior distribution of the non-housing durable price stickiness moves further to the right, as we have deducted housing from the relevant observables. Indeed, house prices robustly continue to be the most flexible component of durables prices also in the three-sector model. Confidence intervals of house price stickiness still never overlap with the other two, given that its posterior distribution moves rather apart from the others towards zero (see bottom panel of Figure 6).



(a) Imperfect Labor Mobility



(b) Price Indexation



(c) Three-sector model

Figure 6: Posterior distributions of price stickiness parameters in extended models

4 Concluding remarks

Several papers engaged in building a two-sector New-Keynesian model able to generate the comovement between durable and nondurable goods following a monetary policy shock, as documented by the SVAR literature. This paper contributes to the existing literature by focusing on a less studied but equally important issue: the effects of a monetary policy innovation on the relative price of durables.

We show that, robustly across identifications and subsamples, in SVAR models the response of the relative price of durables to monetary policy shocks crucially depends on the definition of the durables sector. If durables include both non-housing durable goods and residential investment (as common in the literature), the relative price marginally increases or stays flat in response to a monetary policy contraction. Conversely, employing a narrow measure of durable goods that includes only new houses generates a fall in the relative price.

To rationalize the SVAR results, we build a rather canonical two-sector DSGE model in which impatient households borrow from patient households against the value of their durables collateral. We bring the model to the data using Bayesian methods employing, first, the broad definition of durables (non-housing durables and residential investments) and then the narrow measure of durables including only residential investment. Similarly to the most recent microeconomic evidence, we estimate the degree of price stickiness to be almost the same when non-housing durables are bundled with residential investment. It follows that the credible set of responses of the relative price of durables to a monetary policy shock includes zero. Conversely, durables -defined as including only residential investment- display a much lower stickiness than nondurables hence the credible set of responses of the relative price of durables to a monetary policy shock is significantly negative. Such results not only agree, but also rationalize our SVAR estimates. The results regarding the estimation of price stickiness parameters survive extensions of the DSGE model affecting sectoral Phillips curves and a three-sector generalization.

The importance of these findings is twofold. First, when building a two-sector New-Keynesian model it is desirable to assume that prices of durable goods are sticky, unless the aim is modeling the housing sector in isolation from other durables. When this is the case, the comovement puzzle is no longer an issue: if prices are sticky in both sectors, durables and nondurables will move in the same direction in response to monetary innovations. A three-sector model is needed to fully capture the intrinsic differences between housing and non-housing durables, such as the type of goods that can be used as collateral and their different degree of durability. Second, from a policy viewpoint, while the central bank is not likely to create big allocative distortions between the durables and nondurables sector, it may indeed create allocative distortions regarding the housing sector. Whether this has large welfare implications, and the optimal monetary policy design in this context, are beyond the scope of this paper, but these issues should certainly be investigated in future research.

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Appendix

A Data: sources and transformations

Series	Definition	Source	Mnemonic
DUR^N	Nominal Durable Goods	BEA	Table 2.3.5 Line 3
RI^N	Nominal Residential Investment	BEA	Table 1.1.5 Line 13
ND^N	Nominal Nondurable Goods	BEA	Table 2.3.5 Line 8
S^N	Nominal Services	BEA	Table 2.3.5 Line 13
P_{DUR}	Price Deflator, Durable Goods	BEA	Table 1.1.9 Line 4
P_{RI}	Price Deflator, Residential Investment	BEA	Table 1.1.9 Line 13
P_{ND}	Price Deflator, Nondurable Goods	BEA	Table 1.1.9 Line 5
P_S	Price Deflator, Services	BEA	Table 1.1.9 Line 6
Y^N	Nominal GDP	BEA	Table 1.1.5 Line 1
P_Y	Price Deflator, GDP	BEA	Table 1.1.9 Line 1
FFR	Effective Federal Funds Rate	FRED	FEDFUNDS
N	Nonfarm Business Sector: Average Weekly Hours	FRED	PRS85006023
W	Nonfarm Business Sector: Compensation Per Hour	FRED	COMPNFB
POP	Civilian Non-institutional Population, over 16	FRED	CNP16OV
CE	Civilian Employment, 16 over	FRED	CE16OV
NH^N	Nominal New-single family houses	BEA	Table 5.3.5 Line 23
P_{NH}	Price Deflator, New-single family houses	BEA	Table 5.3.4 Line 23
MH^N	Nominal Multifamily houses	BEA	Table 5.3.5 Line 24
P_{MH}	Price Deflator, Multifamily houses	BEA	Table 5.3.4 Line 23

Table A.1: Data Sources

A.1 Durables and Residential Investments

1. Sum nominal series: $DUR^N + RI^N = DR^N$
2. Calculate sectoral weights of deflators: $\omega^D = \frac{DUR^N}{DR^N}$; $\omega^{RI} = \frac{RI^N}{DR^N}$

3. Calculate Deflator: $P_D = \omega^D P_{DUR} + \omega^{RI} P_{RI}$
4. Calculate Real Durable Consumption: $D = \frac{DUR^N + RI^N}{P_D}$

A.2 Nondurables and Services

1. Sum nominal series: $ND^N + S^N = NS^N$
2. Calculate sectoral weights of deflators: $\omega^{ND} = \frac{ND^N}{NS^N}$; $\omega^S = \frac{S^N}{NS^N}$
3. Calculate Deflator: $P_C = \omega^{ND} P_{ND} + \omega^S P_S$
4. Calculate Real Nondurable Consumption: $C = \frac{ND^N + S^N}{P_C}$

A.3 Only broad measure of houses

1. Sum nominal series: $NH^N + MH^N = DR^N$
2. Sectoral weights of deflators: $\omega^{NH} = \frac{NH^N}{DR^N}$; $\omega^{MH} = \frac{MH^N}{DR^N}$
3. Calculate Deflator: $P_D = \omega^{NH} P_{NH} + \omega^{MH} P_{MH}$
4. Calculate Real Durable Consumption: $D = \frac{NH^N + MH^N}{P_D}$

A.4 Durable goods and New-single family houses

1. Sum nominal series: $DUR^N + NH^N = DR^N$
2. Calculate sectoral weights of deflators: $\omega^D = \frac{DUR^N}{DR^N}$; $\omega^{NH} = \frac{NH^N}{DR^N}$
3. Calculate Deflator: $P_D = \omega^D P_{DUR} + \omega^{NH} P_{NH}$
4. Calculate Real Durable Consumption: $D = \frac{DUR^N + NH^N}{P_D}$

A.5 Durable goods and broad measure of houses

1. Sum nominal series: $DUR^N + NH^N + MH^N = DR^N$
2. Sectoral weights of deflators: $\omega^D = \frac{DUR^N}{DR^N}$; $\omega^{NH} = \frac{NH^N}{DR^N}$; $\omega^{MH} = \frac{MH^N}{DR^N}$
3. Calculate Deflator: $P_D = \omega^D P_{DUR} + \omega^{NH} P_{NH} + \omega^{MH} P_{MH}$
4. Calculate Real Durable Consumption: $D = \frac{DUR^N + NH^N + MH^N}{P_D}$

A.6 Data transformation for Bayesian estimation

Variable	Description	Construction
POP_{index}	Population index	$\frac{POP}{POP_{2009:1}}$
CE_{index}	Employment index	$\frac{CE}{CE_{2009:1}}$
Y^o	Real per capita GDP	$\ln\left(\frac{\frac{Y^N}{P_Y}}{POP_{index}}\right)100$
I_D^o	Real per capita investment: durables	$\ln\left(\frac{I_D}{POP_{index}}\right)100$
I_H^o	Real per capita investment: houses	$\ln\left(\frac{I_H}{POP_{index}}\right)100$
C^o	Real per capita consumption: nondurables	$\ln\left(\frac{C}{POP_{index}}\right)100$
W^o	Real wage	$\ln\left(\frac{W}{P_Y}\right)100$
N^o	Hours worked per capita	$\ln\left(\frac{H \times CE_{index}}{POP_{index}}\right)100$
Π_C^o	Inflation: nondurables sector	$\Delta\left(\ln P_C\right)100$
Π_D^o	Inflation: durables sector	$\Delta\left(\ln P_D\right)100$
Π_H^o	Inflation: housing sector	$\Delta\left(\ln P_H\right)100$
R^o	Quarterly Federal Funds Rate	$\frac{FFR}{4}$

Table A.2: Data transformation - Observables

B SVAR methodologies

B.1 Recursive approach

Let Σ_ε be the variance-covariance matrix of the reduced-form shocks of the SVAR model. Under the recursive approach, the structural shocks are identified through a Cholesky decomposition of Σ_ε. Consequently, the order of the variables in vector x_t matters for the identification of the monetary disturbance. Indeed, at time t one variable is affected by the previous but not from those which follow. In our estimation, we make the standard assumption that the monetary policy variable is ordered last hence it has no contemporaneous effect on the other variables (see Bernanke and Mihov, 1998, among others). Our SVAR model includes a vector of constant terms and four lags, as commonly assumed in the literature for a monetary SVAR with quarterly frequency.

B.2 Sign restrictions approach

The second approach we employ is the pure sign restrictions proposed by Uhlig (2005). This method implies that shocks are identified when they follow specific and unique patterns by imposing restrictions on the impulse response functions (IRFs) of the SVAR model. Several orthogonal matrices linking the reduced-form and the structural shocks are drawn, where we retain those generating impulse responses that satisfy the set of restrictions while discarding the others.[39] We employ the model-based methodology outlined by Canova (2002) and applied in Dedola and Neri (2007), Pappa (2009) and Bermperoglu et al. (2013), among others, according to which the restrictions are extracted from a theoretical model. We can summarize the procedure in three main steps:

1. Build a nested DSGE model in which nominal and real frictions can be removed via appropriate parametrizations. We do this in Section 3, where our two-sector model encompasses a continuum of models featuring different subsets of frictions.

2. Define ranges for the structural parameters, generate thousands of random draws of the parameter values from their support and obtain IRFs for each draw.[40]

[39] We repeat this process a large number of times until 500 draws are accepted.

[40] See section E of the Appendix for a discussion of the choice of ranges, the dynamics of the impulse response functions and further details of the methodology employed.

3. Use the robust IRFs to impose sign restrictions on the IRFs of the SVAR model.

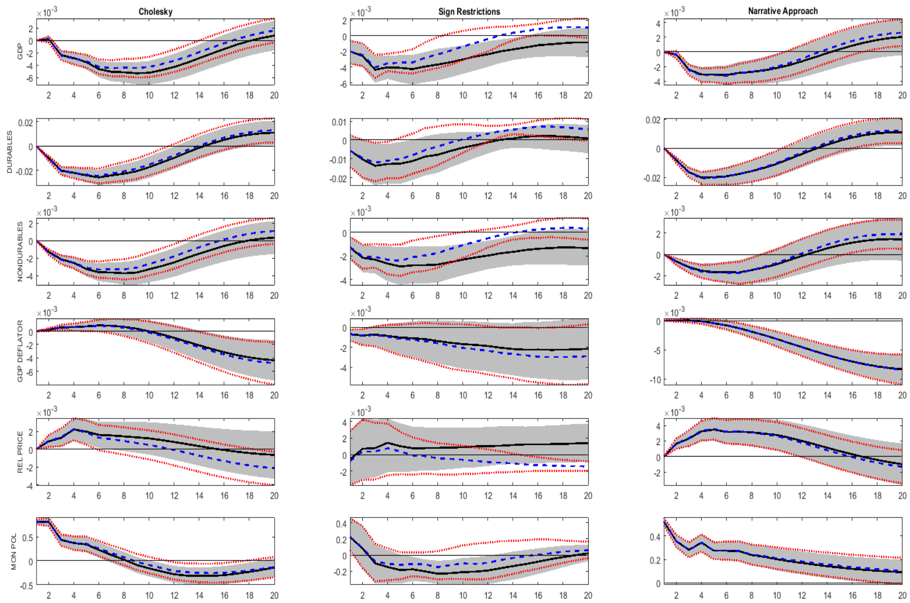
B.3 Narrative approach

The third approach we employ is based on the contribution of Romer and Romer (2004). RR develop a new measure of U.S. monetary policy shock that is somewhat immune to two problems embedded in monetary policy variables such as the actual FFR. Indeed, RR argue that such measures suffer from *endogeneity* and *anticipatory movements*. In particular, the former implies that the FFR moves with changes in economic conditions hence not with changes in the conduct of monetary policy. The latter implies that movements in the FFR represent responses to information about future events in the economy. As a result, RR argue that such measures of monetary policy do not really represent exogenous shocks and they derive a new measure that enables the researcher to overcome these shortcomings.

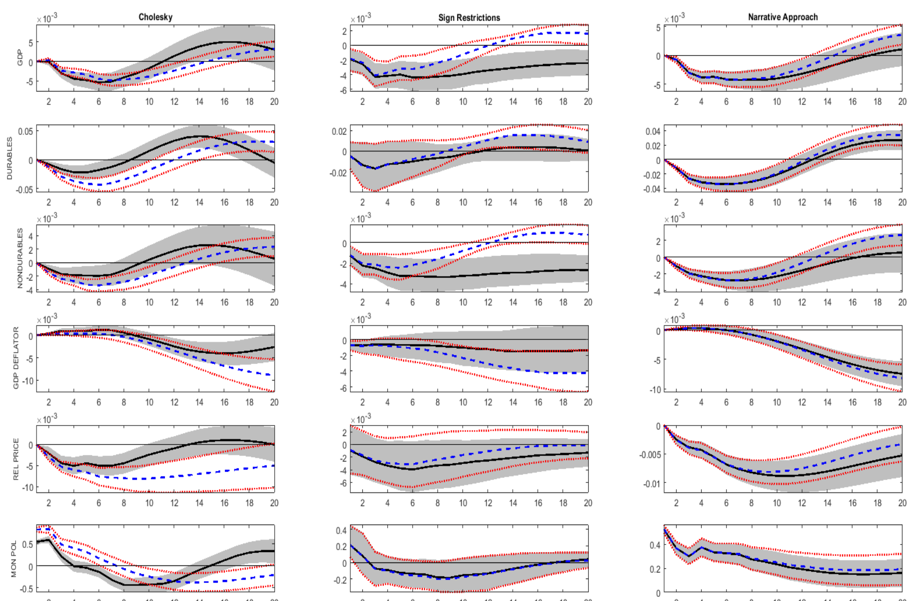
The derivation of the alternative monetary policy variable consists of two main steps. RR first derive a series of *intended FFR changes* around meetings of the Federal Open Market Committee (FOMC) of the Federal Reserve (Fed). They rely on a combination of narrative and quantitative evidence in order to retrieve the direction and the magnitude of such intended changes. This step eliminates the endogeneity between the interest rate and economic conditions thus solving the first of the two shortcomings outlined above. The second step consists of controlling for the Fed's internal forecasts in order to disentangle the effects of information about future economic developments. RR then regress the change in the intended FFR on its level, on the level and the changes of forecasts about GDP growth and the GDP deflator, and forecasts about the unemployment rate. Then they take the residuals of this regression as the new measure of monetary policy shocks. Consequently, the resulting series gains a higher degree of exogeneity with respect to the FFR since it represents movements in the monetary policy measure not stemming from forecasts about inflation, GDP growth and unemployment.

C Robustness checks for the SVAR model

C.1 SVAR Models with trend



(a) Baseline SVAR



(b) Housing SVAR

Figure C.1: Impulse responses: SVAR models with trend (bold lines = baseline model without trend; dashed lines = baseline model with trend; shaded areas and dotted lines = one-standard-deviation confidence bands)

C.2 Alternative definitions of durables

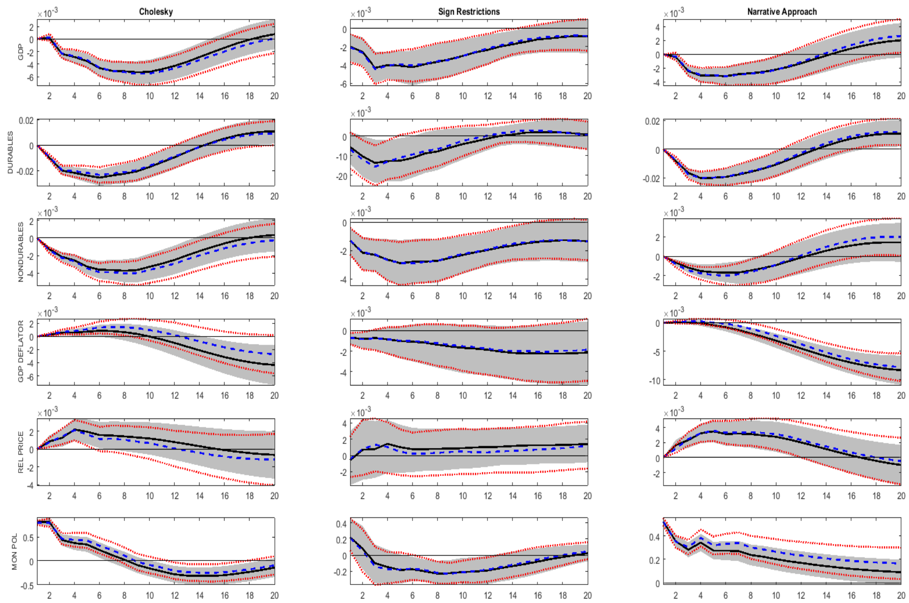


Figure C.2: SVAR impulse responses. Sample: 1969Q2-2007Q4 (bold lines = baseline model; dashed lines = durables goods and new single family houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

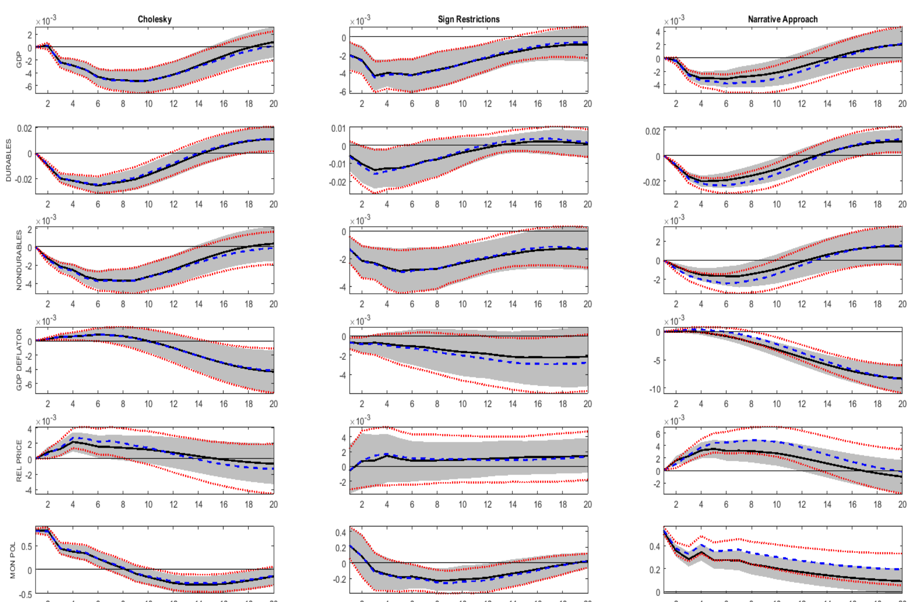


Figure C.3: SVAR impulse responses. Sample: 1969Q2-2007Q4 (bold lines = baseline model; dashed lines = durables goods and broad measure of houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

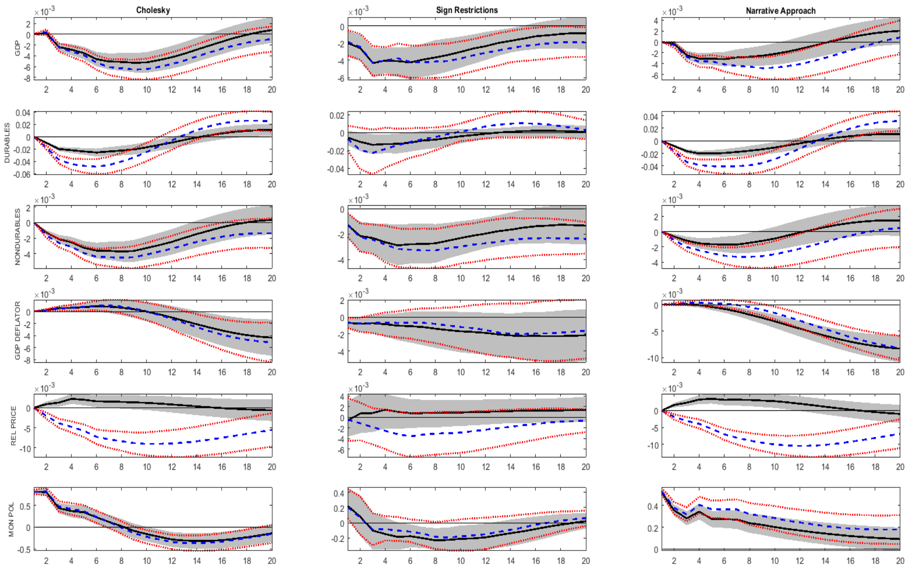


Figure C.4: SVAR impulse responses. Sample: 1969Q2-2007Q4 (bold lines = baseline model; dashed lines = new single family houses; shaded areas and dotted lines represent one-standard-deviation confidence bands)

C.3 Subsample analysis

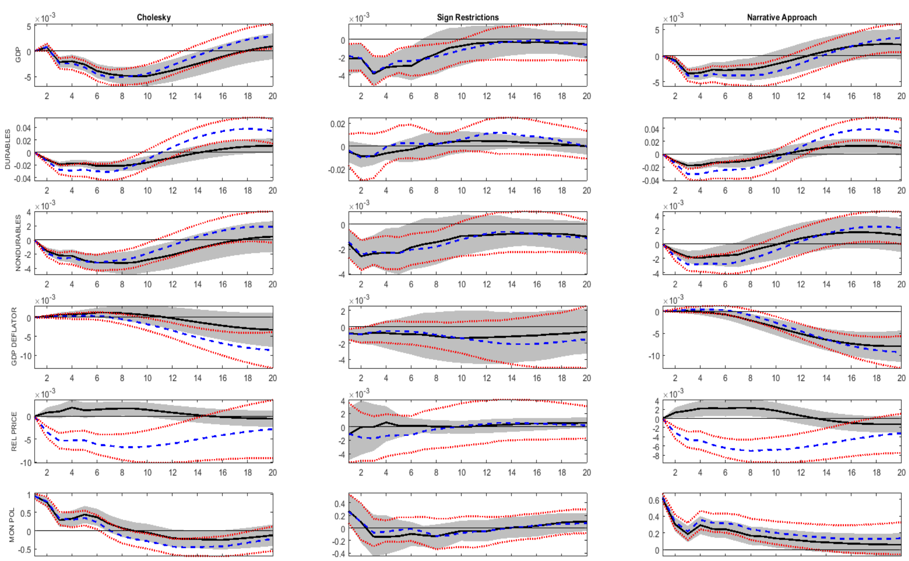


Figure C.5: SVAR impulse responses. Sample: 1969Q2-1993Q1 (bold lines = all durable goods; dashed lines = only houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

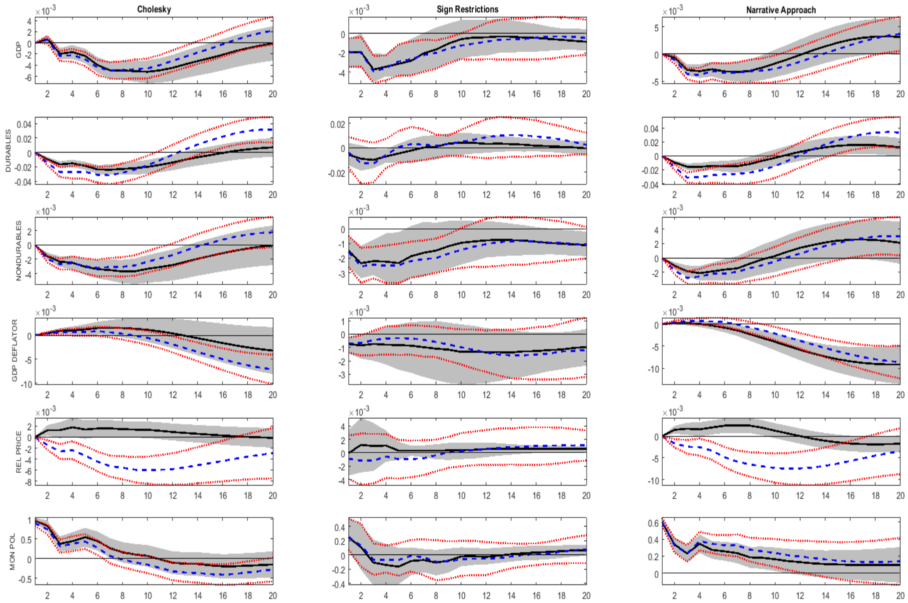


Figure C.6: SVAR impulse responses. Sample: 1971Q4-1995Q3 (bold lines = all durable goods; dashed lines = only houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

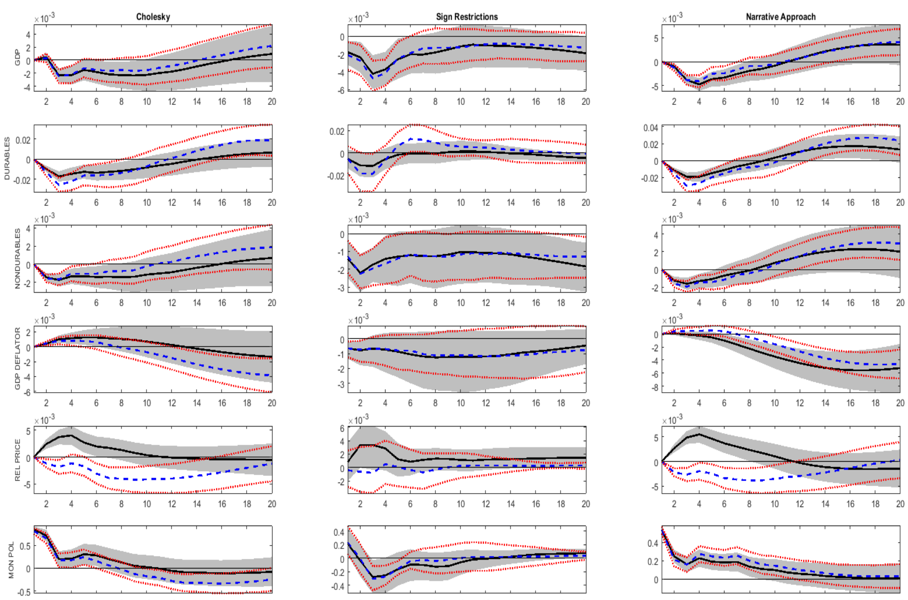


Figure C.7: SVAR impulse responses. Sample: 1974Q2-1998Q1 (bold lines = all durable goods; dashed lines = only houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

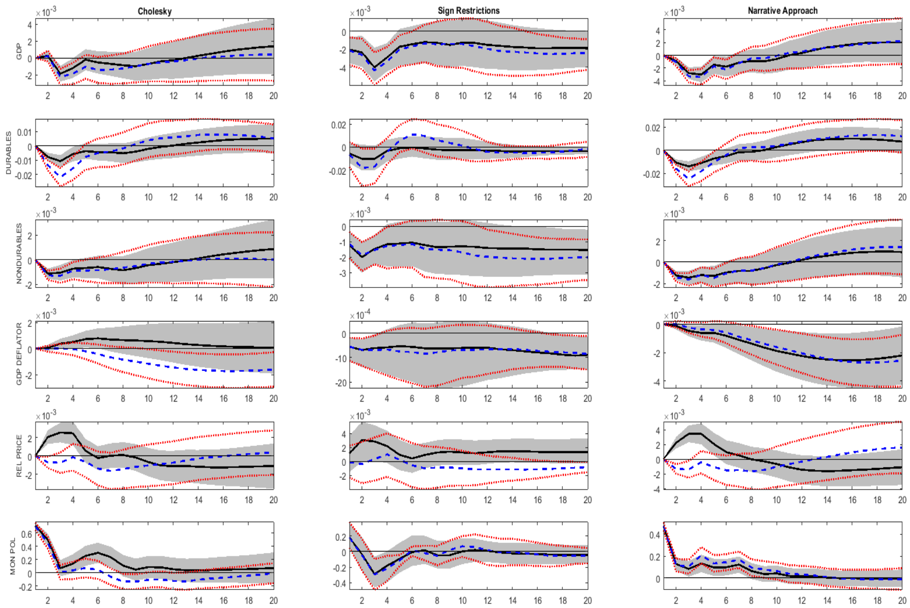


Figure C.8: SVAR impulse responses. Sample: 1976Q4-2000Q3 (bold lines = all durable goods; dashed lines = only houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

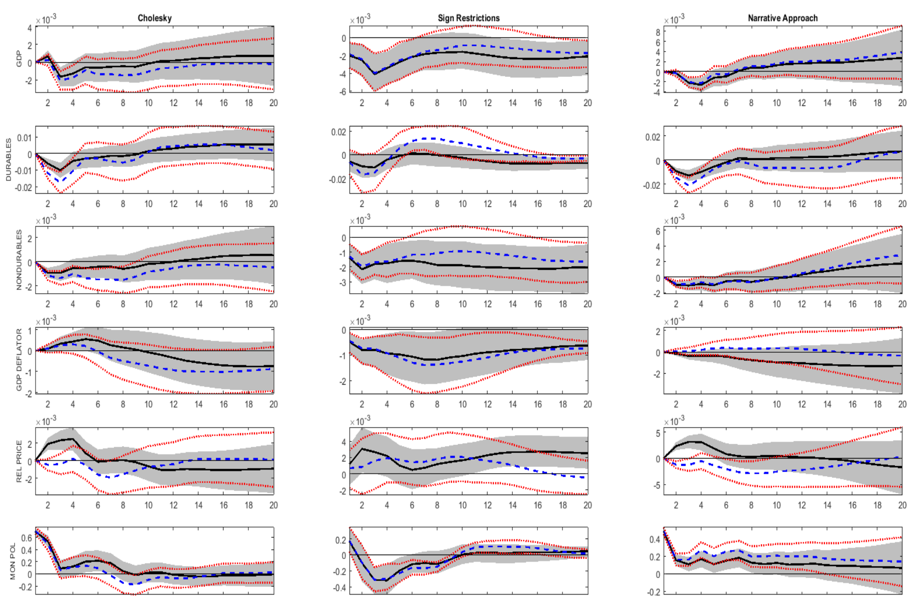


Figure C.9: SVAR impulse responses. Sample: 1979Q2-2003Q1 (bold lines = all durable goods; dashed lines = only houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

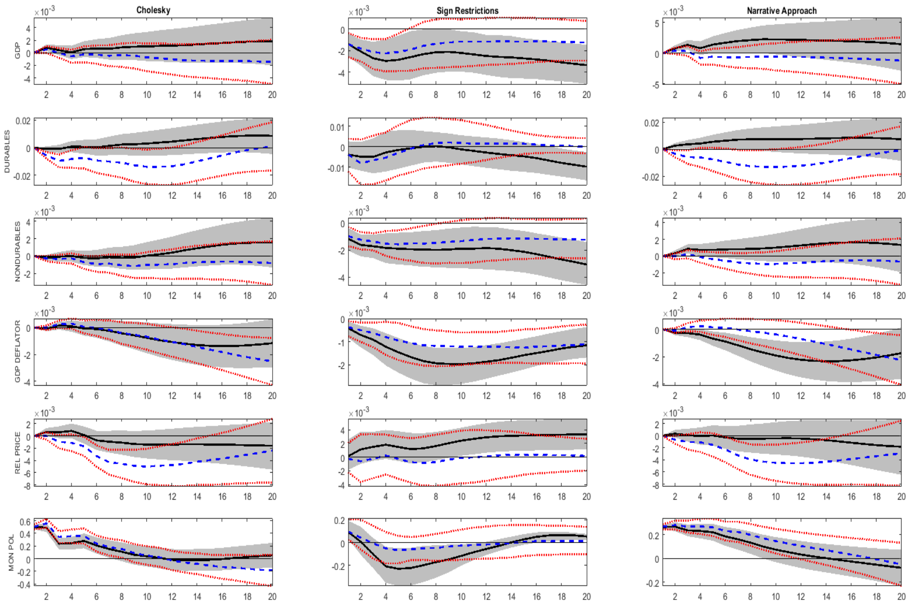


Figure C.10: SVAR impulse responses. Sample: 1981Q4-2005Q3 (bold lines = all durable goods; dashed lines = only houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

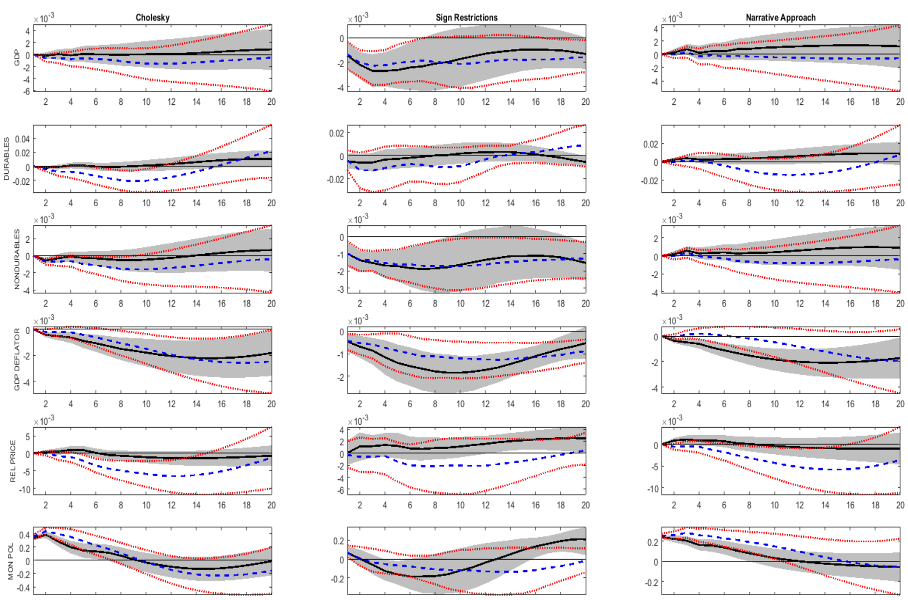


Figure C.11: SVAR impulse responses. Sample: 1984Q2-2007Q4 (bold lines = all durable goods; dashed lines = only houses; shaded areas and dotted lines = one-standard-deviation confidence bands)

C.4 Sign restrictions

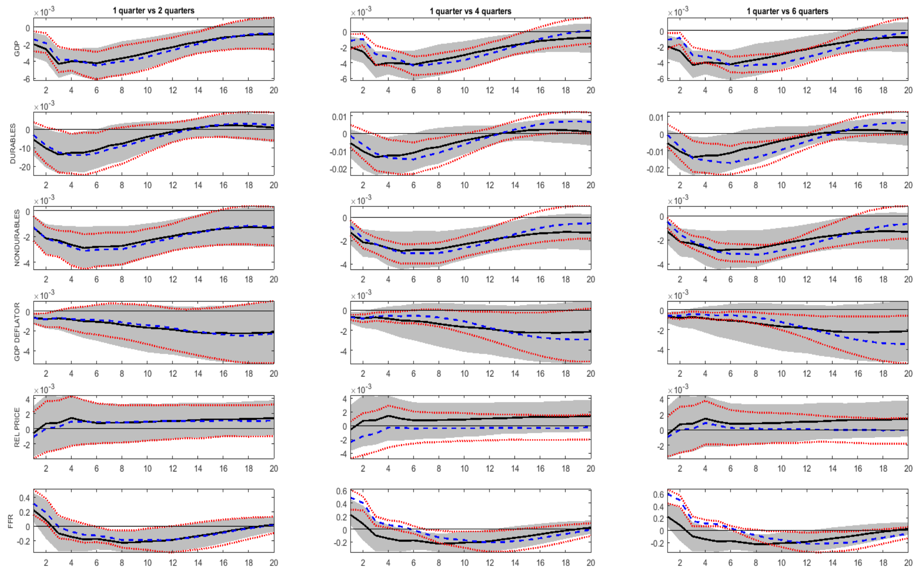


Figure C.12: Sign restrictions imposed for 2, 4 and 6 quarters against 1 quarter, baseline model. Sample: 1969Q2-2007Q4 (bold lines = one quarter; dashed lines = more quarters; shaded areas and dotted lines = one-standard-deviation confidence bands)

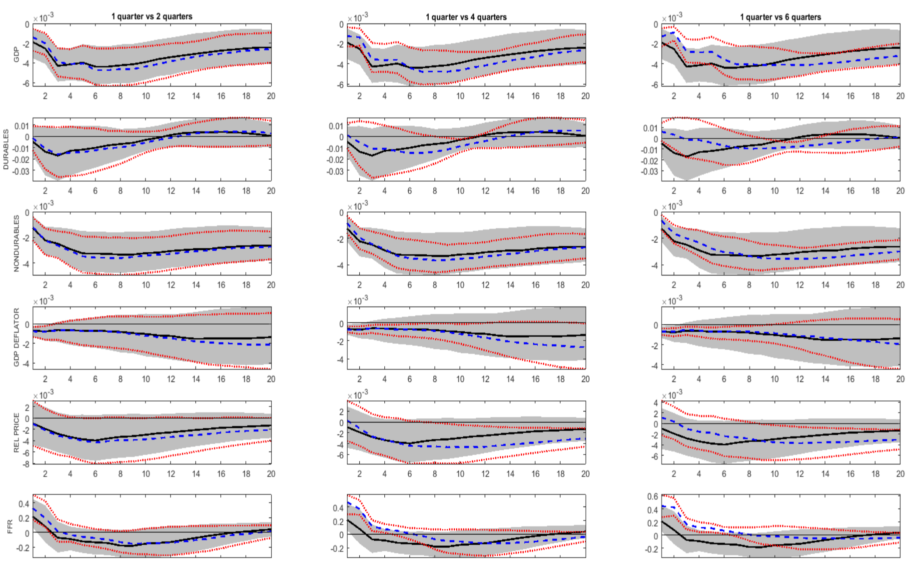


Figure C.13: Sign restrictions imposed for 2, 4 and 6 quarters against 1 quarter, model with broad measure of houses as durables. Sample: 1969Q2-2007Q4 (bold lines = one quarter; dashed lines = more quarters; shaded areas and dotted lines = one-standard-deviation confidence bands)

C.5 Proxy SVAR approach

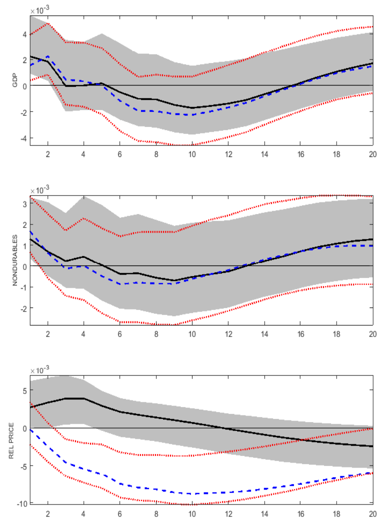


Figure C.14: Proxy SVAR impulse responses to a one standard deviation increase in the monetary policy measure. Sample: 1969Q2-2007Q4 (bold lines refer to the model with all durable goods; dashed lines refer to the model with only houses; shaded areas and dotted lines represent one-standard-deviation confidence bands)

C.6 Three-sector SVAR model

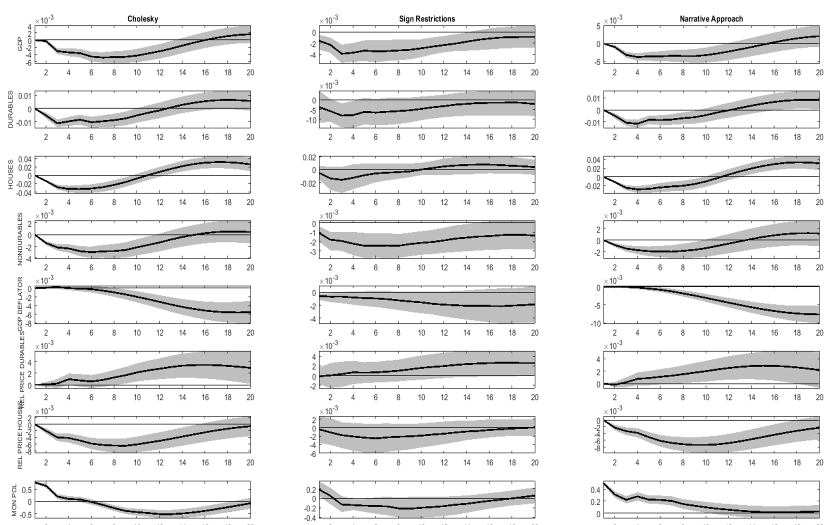


Figure C.15: SVAR impulse responses in a three-sector SVAR model. Sample: 1969Q2-2007Q4 (bold lines = mean response; shaded areas = one-standard-deviation confidence bands)

D The DSGE models

D.1 Symmetric equilibrium

D.1.1 Patient households

$$X_t = Z_t^{1-\alpha} D_t^{\alpha} \tag{D.1}$$

$$Z_t = C_t - \zeta S_{t-1} \tag{D.2}$$

$$S_t = \rho_c S_{t-1} + (1-\rho_c) C_t \tag{D.3}$$

$$U\left(X_t, N_t\right) = \log\left(X_t\right) - \nu \frac{N_t^{1+\varphi}}{1+\varphi} \tag{D.4}$$

$$U_{Z,t} = \frac{(1-\alpha)}{Z_t} \tag{D.5}$$

$$U_{D,t} = \frac{\alpha}{D_t} \tag{D.6}$$

$$U_{N,t} = -\nu N_t^{\varphi} \tag{D.7}$$

$$\Lambda_{t,t+1} \equiv \beta \frac{U_{Z,t+1}}{U_{Z,t}} \frac{e_{t+1}^B}{e_t^B} \tag{D.8}$$

$$\begin{aligned}\left[1 - e_t^W \eta\right] + \frac{e_t^W \eta}{\mu_t} &= \vartheta^W \left(\Pi_t^W - \Pi^C\right) \Pi_t^W + \\ &\quad + E_t \left[\Lambda_{t,t+1} \vartheta^W \left(\Pi_{t+1}^W - \Pi^C\right) \Pi_{t+1}^W \frac{w_{t+1} N_{t+1}}{w_t N_t}\right]\end{aligned} \tag{D.9}$$

$$\mu_t = -\frac{U_{Z,t}}{U_{N,t}} w_t \tag{D.10}$$

$$Q_t \psi_t = \frac{U_{D,t}}{U_{Z,t}} + (1-\delta)\, E_t \left[\Lambda_{t,t+1} Q_{t+1} \psi_{t+1}\right] \tag{D.11}$$

$$\begin{aligned}1 &= \psi_t e_t^I \left[1 - S\left(\frac{I_t^D}{I_{t-1}^D}\right) - S^{'}\left(\frac{I_t^D}{I_{t-1}^D}\right) \frac{I_t^D}{I_{t-1}^D}\right] + \\ &\quad + E_t \left\{\Lambda_{t,t+1} \psi_{t+1} \frac{Q_{t+1}}{Q_t} e_{t+1}^I \left[S^{'}\left(\frac{I_{t+1}^D}{I_t^D}\right)\left(\frac{I_{t+1}^D}{I_t^D}\right)^2\right]\right\}\end{aligned} \tag{D.12}$$

$$S\left(\frac{I_t^D}{I_{t-1}^D}\right) = \frac{\phi}{2}\left(\frac{I_t^D}{I_{t-1}^D} - 1\right)^2 \tag{D.13}$$

$$S^{'}\left(\frac{I_t^D}{I_{t-1}^D}\right) = \phi\left(\frac{I_t^D}{I_{t-1}^D} - 1\right) \tag{D.14}$$

$$1 = E_t \left[\Lambda_{t,t+1} \frac{R_t}{\Pi_{t+1}^C}\right] \tag{D.15}$$

D.1.2 Impatient households

$$X'_t = {Z'_t}^{1-\alpha} {D'_t}^{\alpha} \tag{D.16}$$

$$Z'_t = C'_t - \zeta' S'_{t-1} \tag{D.17}$$

$$S'_t = \rho'_c S'_{t-1} + (1-\rho'_c) C'_t \tag{D.18}$$

$$U\left(X'_t, N'_t\right) = \log\left(X'_t\right) - \nu' \frac{{N'_t}^{1+\varphi'}}{1+\varphi'} \tag{D.19}$$

$$U_{Z',t} = \frac{1-\alpha}{Z'_t} \tag{D.20}$$

$$U_{D',t} = \frac{\alpha}{D'_t} \tag{D.21}$$

$$U_{N',t} = -\nu' \left(N'_t\right)^{\varphi'} \tag{D.22}$$

$$\lambda'_t = e^B_t U_{Z',t} \tag{D.23}$$

$$\lambda'_t = \beta' E_t \left[\lambda'_{t+1} \frac{R_t}{\Pi^C_{t+1}}\right] + \lambda^{BC}_t R_t \tag{D.24}$$

$$Q_t \psi'_t = \frac{U_{D',t}}{U_{Z't}} + \beta' \left(1-\delta\right) E_t \left[\frac{\lambda'_{t+1}}{\lambda'_t} \psi'_{t+1} Q_{t+1}\right] \tag{D.25}$$

$$\begin{aligned} 1 &= \psi'_t e^I_t \left[1 - S\left(\frac{I^{D'}_t}{I^{D'}_{t-1}}\right) - S'\left(\frac{I^{D'}_t}{I^{D'}_{t-1}}\right) \frac{I^{D'}_t}{I^{D'}_{t-1}}\right] + \\ &+ \beta' E_t \left\{ \frac{\lambda'_{t+1} Q_{t+1}}{\lambda'_t Q_t} \psi'_{t+1} e^I_{t+1} \left[S'\left(\frac{I^{D'}_{i,t+1}}{I^{D'}_{i,t}}\right) \left(\frac{I^{D'}_{i,t+1}}{I^{D'}_{i,t}}\right)^2 \right] \right\} \end{aligned} \tag{D.26}$$

$$S\left(\frac{I^{D'}_t}{I^{D'}_{t-1}}\right) = \frac{\phi'}{2} \left(\frac{I^{D'}_t}{I^{D'}_{t-1}} - 1\right)^2 \tag{D.27}$$

$$S'\left(\frac{I^{D'}_t}{I^{D'}_{t-1}}\right) = \phi' \left(\frac{I^{D'}_t}{I^{D'}_{t-1}} - 1\right) \tag{D.28}$$

$$\begin{aligned} 0 &= \left[1 - e^W_t \eta\right] + \frac{e^W_t \eta}{\mu'_t} - \vartheta^W \left(\Pi^{W'}_t - \Pi^C\right) \Pi^{W'}_t + \\ &+ \beta' E_t \left[\frac{\lambda'_{t+1}}{\lambda'_t} \vartheta^W \left(\Pi^{W'}_{t+1} - \Pi^C\right) \Pi^{W'}_{t+1} \frac{w'_{t+1} N'_{t+1}}{w'_t N'_t}\right] \end{aligned} \tag{D.29}$$

$$\mu'_t = -w'_t \frac{U_{Z',t}}{U_{N',t}} \tag{D.30}$$

D.1.3 Firms

$$
\begin{aligned}
Y_t^C &= e_t^A \left(N_t^C\right)^{\tilde{\psi}} \left(N_t'^C\right)^{1-\tilde{\psi}} && \text{(D.31)} \\
Y_t^D &= e_t^A \left(N_t^D\right)^{\tilde{\psi}} \left(N_t'^D\right)^{1-\tilde{\psi}} && \text{(D.32)} \\
\left(1 - e_t^C \epsilon_c\right) + e_t^C \epsilon_c MC_t^C &= \vartheta_c \left(\Pi_t^C - 1\right) \Pi_t^C - \\
&\quad -\vartheta_c E_t \left[\Lambda_{t,t+1} \frac{Y_{t+1}^C}{Y_t^C} \left(\Pi_{t+1}^C - 1\right) \Pi_{t+1}^C\right] && \text{(D.33)} \\
w_t &= MC_t^C \tilde{\psi} \frac{Y_t^C}{N_t^C} && \text{(D.34)} \\
w_t' &= MC_t^C \left(1 - \tilde{\psi}\right) \frac{Y_t^C}{N_t'^C} && \text{(D.35)} \\
\left(1 - e_t^D \epsilon_d\right) + e_t^D \epsilon_d MC_t^D &= \vartheta_d \left(\Pi_t^D - 1\right) \Pi_t^D - \\
&\quad -\vartheta_d E_t \left[\Lambda_{t,t+1} \frac{Q_{t+1}}{Q_t} \frac{Y_{t+1}^D}{Y_t^D} \left(\Pi_{t+1}^D - 1\right) \Pi_{t+1}^D\right] && \text{(D.36)} \\
w_t &= MC_t^D \tilde{\psi} \frac{Q_t Y_t^D}{N_t^D} && \text{(D.37)} \\
w_t' &= MC_t^D \left(1 - \tilde{\psi}\right) \frac{Q_t Y_t^D}{N_t'^D} && \text{(D.38)} \\
\widetilde{\Pi}_t &= \left(\Pi_t^C\right)^{1-\tau} \left(\Pi_t^D\right)^{\tau} && \text{(D.39)}
\end{aligned}
$$

D.1.4 Monetary policy and market clearing

$$
\log\left(\frac{R_t}{R}\right) = \rho_r \log\left(\frac{R_{t-1}}{R}\right) + (1-\rho_r)\left[\rho_\pi \log\left(\frac{\tilde{\Pi}_t}{\tilde{\Pi}}\right) + \rho_y \log\left(\frac{Y_t}{Y}\right)\right] + \epsilon_t^M \quad \text{(D.40)}
$$

$$
\begin{aligned}
Y_t &= Y_t^C + Q_t Y_t^D + \frac{\vartheta^W}{2}\left(\Pi_t^W - 1\right)^2 w_t N_t + \frac{\vartheta^W}{2}\left(\Pi_t^{W\prime} - 1\right)^2 w_t' N_t' && \text{(D.41)} \\
Y_t^C &= C_t + C_t' + G_t + \frac{\vartheta_c}{2}\left(\Pi_t^C - 1\right)^2 Y_t^C && \text{(D.42)} \\
Y_t^D &= \left[D_t - (1-\delta) D_{t-1}\right] + \left[D_t' - (1-\delta) D_{t-1}'\right] + \frac{\vartheta_d}{2}\left(\Pi_t^D - 1\right)^2 Y_t^D && \text{(D.43)} \\
0 &= B_t + B_t' && \text{(D.44)} \\
N_t &= N_t^C + N_t^D && \text{(D.45)} \\
N_t' &= N_t'^C + N_t'^D && \text{(D.46)}
\end{aligned}
$$

D.2 Steady state

In the deterministic steady state all expectation operators are removed and for each variable it holds that $x_t = x_{t+1} = x$. Moreover, the stochastic shocks are absent. The variables $U_Z, U_{Z'}, Q, N^{D'}$ solve equations (D.5), (D.20), (D.37) and (D.46) respectively. In steady state $N = N' = 0.33$ and the parameters ν and ν' are endogenized to match these values. The remaining variables are found recursively as follows:

$$\Lambda = \beta \tag{D.47}$$

$$R = \frac{1}{\beta} \tag{D.48}$$

$$\psi = 1 \tag{D.49}$$

$$\mu = \frac{\eta}{\eta - 1} \tag{D.50}$$

$$\psi' = 1 \tag{D.51}$$

$$\mu' = \frac{\eta}{\eta - 1} \tag{D.52}$$

$$MC^C = \frac{\epsilon_c - 1}{\epsilon_c} \tag{D.53}$$

$$MC^D = \frac{\epsilon_d - 1}{\epsilon_d} \tag{D.54}$$

$$U_D = Q\psi U_Z \left[1 - \beta\left(1 - \delta\right)\right] \tag{D.55}$$

$$D = \frac{\alpha}{U_D} \tag{D.56}$$

$$\lambda' = U_{Z'} \tag{D.57}$$

$$\lambda^{BC} = \frac{\left(1 - \beta' R\right)\lambda'}{R} \tag{D.58}$$

$$U_{D'} = Q\psi' U_{Z'} \left[1 - \beta'\left(1 - \delta\right)\right] - \lambda^{BC} m Q \tag{D.59}$$

$$D' = \frac{\alpha}{U_{D'}} \tag{D.60}$$

$$B' = m\frac{QD'}{R} \tag{D.61}$$

$$Y^D = \delta\left(D + D'\right) \tag{D.62}$$

$$w' = MC^D\left(1 - \tilde{\psi}\right)\frac{QY^D}{N'^D} \tag{D.63}$$

$$N^D = \left[\frac{Y^D}{N'^D}\right]^{\frac{1}{\tilde{\psi}}} N'^D \tag{D.64}$$

$$N^C = N + N^D \tag{D.65}$$

$$U_{N'} = -w'\frac{U_{Z'}}{\mu'} \tag{D.66}$$

$$\nu' = -\frac{U_{N'}}{N'^{\varphi'}} \tag{D.67}$$

$$C' = (1-R)\,B' + w'N' - Q\delta D' \tag{D.68}$$

$$S' = C' \tag{D.69}$$

$$Z' = C' - \zeta S' \tag{D.70}$$

$$X' = Z'^{1-\alpha} D'^{\alpha} \tag{D.71}$$

$$N'^{C} = \left[MC^C \left(1-\tilde{\psi}\right) \frac{\left(N^C\right)^{\tilde{\psi}}}{w'} \right]^{\frac{1}{\tilde{\psi}}} \tag{D.72}$$

$$Y^C = \left[N^C\right]^{\tilde{\psi}} \left[N'^{C}\right]^{1-\tilde{\psi}} \tag{D.73}$$

$$w = MC^C \tilde{\psi} \frac{Y^C}{N^C} \tag{D.74}$$

$$U_N = -w\frac{U_Z}{\mu} \tag{D.75}$$

$$\nu = -\frac{U_N}{N^{\varphi}} \tag{D.76}$$

$$Y = Y^C + QY^D \tag{D.77}$$

$$G = g_y Y \tag{D.78}$$

$$C = Y^C - C' - G \tag{D.79}$$

$$S = C \tag{D.80}$$

$$Z = C - \zeta S \tag{D.81}$$

$$X = Z^{1-\alpha} D^{\alpha} \tag{D.82}$$

D.3 Symmetric equilibrium of the extended models

This section reports the changes in the symmetric equilibrium of Appendix D.1 when the model is extended to allow for limited labor mobility, indexation and a three-sector economy as in Sections 3.7.1, 3.7.2 and 3.7.3, respectively.

D.3.1 Imperfect Sectoral Labor Mobility

Equations (D.45) and (D.46) are replaced by the CES aggregators of sectoral hours:

$$N_t = \left[\left(\chi^C\right)^{-\frac{1}{\lambda}}\left(N_t^C\right)^{\frac{1+\lambda}{\lambda}} + \left(1-\chi^C\right)^{-\frac{1}{\lambda}}\left(N_t^D\right)^{\frac{1+\lambda}{\lambda}}\right]^{\frac{\lambda}{1+\lambda}} \tag{D.83}$$

$$N_t' = \left[\left(\chi'^C\right)^{-\frac{1}{\lambda'}}\left(N_t'^C\right)^{\frac{1+\lambda'}{\lambda'}} + \left(1-\chi'^C\right)^{-\frac{1}{\lambda'}}\left(N_t'^D\right)^{\frac{1+\lambda'}{\lambda'}}\right]^{\frac{\lambda'}{1+\lambda'}} \tag{D.84}$$

Given these labor aggregators, each households determines the following labor supply schedules:

$$N_t^j = \chi^j\left(\frac{w_t^j}{w_t}\right)^{\lambda} N_t, \tag{D.85}$$

$$N_t'^j = \chi'^j\left(\frac{w_t'^j}{w_t'}\right)^{\lambda'} N_t', \tag{D.86}$$

with $j = C, D$. Finally, sectoral wages are different hence equations (D.34), (D.35), (D.37) and (D.38) are replaced by:

$$w_t^C = MC_t^C\tilde{\psi}\frac{Y_t^C}{N_t^C}, \tag{D.87}$$

$$w_t'^C = MC_t^C\left(1-\tilde{\psi}\right)\frac{Y_t^C}{N_t'^C}, \tag{D.88}$$

$$w_t^D = MC_t^D\tilde{\psi}\frac{Q_tY_t^D}{N_t^D}, \tag{D.89}$$

$$w_t'^D = MC_t^D\left(1-\tilde{\psi}\right)\frac{Q_tY_t^D}{N_t'^D}. \tag{D.90}$$

D.3.2 Price Indexation

The sectoral price setting equations (D.33) and (D.36) are amended as follows:

$$\begin{aligned}\left(1-e_t^C\epsilon_c\right)+e_t^C\epsilon_c MC_t^C &= \vartheta_c\left(\frac{\Pi_t^C}{\Pi_{t-1}^{C,\varsigma_C}}-1\right)\frac{\Pi_t^C}{\Pi_{t-1}^{C,\varsigma_C}}- \\ &\quad -\vartheta_c E_t\left[\Lambda_{t,t+1}\frac{Y_{t+1}^C}{Y_t^C}\left(\frac{\Pi_{t+1}^C}{\Pi_t^{C,\varsigma_C}}-1\right)\frac{\Pi_{t+1}^C}{\Pi_t^{C,\varsigma_C}}\right], \quad (D.91)\\ \left(1-e_t^D\epsilon_d\right)+e_t^D\epsilon_d MC_t^D &= \vartheta_d\left(\frac{\Pi_t^D}{\Pi_{t-1}^{D,\varsigma_D}}-1\right)\frac{\Pi_t^D}{\Pi_{t-1}^{D,\varsigma_D}}- \\ &\quad -\vartheta_d E_t\left[\Lambda_{t,t+1}\frac{Q_{t+1}}{Q_t}\frac{Y_{t+1}^D}{Y_t^D}\left(\frac{\Pi_{t+1}^D}{\Pi_t^{D,\varsigma_D}}-1\right)\frac{\Pi_{t+1}^D}{\Pi_t^{D,\varsigma_D}}\right]. \quad (D.92)\end{aligned}$$

Then, since the price adjustment costs enter the sectoral market clearing conditions, equations (D.42) and (D.43) now read as:

$$Y_t^C = C_t+C_t'+G_t+\frac{\vartheta_c}{2}\left(\frac{\Pi_t^C}{\Pi_{t-1}^{C,\varsigma_C}}-\Pi^C\right)^2 Y_t^C, \quad (D.93)$$

$$Y_t^D = \left[D_t-(1-\delta)D_{t-1}\right]+\left[D_t'-(1-\delta)D_{t-1}'\right]+\frac{\vartheta_d}{2}\left(\frac{\Pi_t^D}{\Pi_{t-1}^{D,\varsigma_D}}-\Pi^D\right)^2 Y_t^D \quad (D.94)$$

D.3.3 Three-sector model

$$1 = E_t\left[\Lambda_{t,t+1}\frac{R_t}{\Pi_{t+1}^C}\right], \quad (D.95)$$

$$Q_t\psi_t = \frac{U_{D,t}}{U_{Z,t}}+(1-\delta)E_t\left[\Lambda_{t,t+1}Q_{t+1}\psi_{t+1}\right], \quad (D.96)$$

$$1 = \psi_t e_t^I\left[1-S\left(\frac{I_t^D}{I_{t-1}^D}\right)-S'\left(\frac{I_t^D}{I_{t-1}^D}\right)\frac{I_t^D}{I_{t-1}^D}\right]+ \quad (D.97)$$

$$+ \; E_t\left\{\Lambda_{t,t+1}\psi_{t+1}\frac{Q_{t+1}}{Q_t}e_{t+1}^I\left[S'\left(\frac{I_{t+1}^D}{I_t^D}\right)\left(\frac{I_{t+1}^D}{I_t^D}\right)^2\right]\right\}, \quad (D.98)$$

$$Q_t^H\psi_t^H = \frac{U_{H,t}}{U_{Z,t}}+\left(1-\delta^H\right)E_t\left[\Lambda_{t,t+1}Q_{t+1}^H\psi_{t+1}^H\right], \quad (D.99)$$

$$
\begin{aligned}
1 &= \psi_t^H e_t^{I^H}\left[1 - S\left(\frac{I_t^H}{I_{t-1}^H}\right) - S'\left(\frac{I_t^H}{I_{t-1}^H}\right)\frac{I_t^H}{I_{t-1}^H}\right] + \\
&\quad + E_t\left\{\Lambda_{t,t+1}\psi_{t+1}^H \frac{Q_{t+1}^H}{Q_t^H} e_{t+1}^{I^H}\left[S'\left(\frac{I_{t+1}^H}{I_t^H}\right)\left(\frac{I_{t+1}^H}{I_t^H}\right)^2\right]\right\}, &\text{(D.100)}\\
0 &= \left[1 - e_t^W \eta\right] + \frac{e_t^W \eta}{\mu_t} - \vartheta^W\left(\Pi_t^W - \Pi^C\right)\Pi_t^W + \\
&\quad + E_t\left[\Lambda_{t,t+1}\vartheta^W\left(\Pi_{t+1}^W - \Pi^C\right)\Pi_{t+1}^W \frac{w_{t+1}N_{t+1}}{w_t N_t}\right], &\text{(D.101)}\\
D_{t+1} &= (1-\delta)D_t + e_t^I I_t^D\left[1 - S\left(\frac{I_t^D}{I_{t-1}^D}\right)\right], &\text{(D.102)}\\
H_{t+1} &= (1-\delta^H)H_t + e_t^{I^H} I_t^H\left[1 - S\left(\frac{I_t^H}{I_{t-1}^H}\right)\right], &\text{(D.103)}\\
X_t &= \left[(1-\alpha)\,\tilde{C}_t^{\frac{\rho-1}{\rho}} + \alpha H_t^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}, &\text{(D.104)}\\
Z_t &= C_t - \zeta S_{t-1}, &\text{(D.105)}\\
S_t &= \rho_c S_{t-1} + (1-\rho_c)C_t, &\text{(D.106)}\\
\tilde{C}_t &= \left[(1-\tilde{\alpha})\,Z_t^{\frac{\tilde{\rho}-1}{\tilde{\rho}}} + \tilde{\alpha} D_t^{\frac{\tilde{\rho}-1}{\tilde{\rho}}}\right]^{\frac{\tilde{\rho}}{\tilde{\rho}-1}}, &\text{(D.107)}\\
N_t &= N_t^C + N_t^D + N_t^H, &\text{(D.108)}\\
\Lambda_{t,t+1} &= \beta \frac{U_{Z,t+1}}{U_{Z,t}} \frac{e_{t+1}^B}{e_t^B} &\text{(D.109)}\\
\mu_t &= -w_t \frac{U_{Z,t}}{U_{N,t}}, &\text{(D.110)}\\
U_{Z,t} &= \frac{(1-\alpha)}{\tilde{C}_t^{\frac{1}{\rho}} X_t^{\frac{\rho-1}{\rho}}} \frac{(1-\tilde{\alpha})\,\tilde{C}_t^{\frac{1}{\tilde{\rho}}}}{Z_t^{\frac{1}{\tilde{\rho}}}}, &\text{(D.111)}\\
U_{D,t} &= \frac{(1-\alpha)}{\tilde{C}_t^{\frac{1}{\rho}} X_t^{\frac{\rho-1}{\rho}}} \frac{\tilde{\alpha}\tilde{C}_t^{\frac{1}{\tilde{\rho}}}}{D_t^{\frac{1}{\tilde{\rho}}}}, &\text{(D.112)}\\
U_{H,t} &= \frac{\alpha}{H_t^{\frac{1}{\rho}} X_t^{\frac{\rho-1}{\rho}}}, &\text{(D.113)}\\
U_{N,t} &= -\nu N_t^{\varphi}, &\text{(D.114)}
\end{aligned}
$$

$$\lambda_t' = e_t^B U_{Z',t}, \tag{D.115}$$

$$\lambda_t' = \beta' E_t \left[\lambda_{t+1}' \frac{R_t}{\Pi_{t+1}^C}\right] + \lambda_t^{BC} R_t, \tag{D.116}$$

$$Q_t \psi_t' = \frac{U_{D',t}}{U_{Z't}} + \beta' (1-\delta) E_t \left[\frac{\lambda_{t+1}'}{\lambda_t'} \psi_{t+1}' Q_{t+1}\right], \tag{D.117}$$

$$\begin{aligned} 1 &= \psi_t' e_t^I \left[1 - S\left(\frac{I_t^{D\prime}}{I_{t-1}^{D}{}'}\right) - S'\left(\frac{I_t^{D\prime}}{I_{t-1}^{D}{}'}\right)\frac{I_t^{D\prime}}{I_{t-1}^{D}{}'}\right] + \\ &+ \beta' E_t \left\{\frac{\lambda_{t+1}' Q_{t+1}}{\lambda_t' Q_t} \psi_{t+1}' e_{t+1}^I \left[S'\left(\frac{I_t^{D\prime}}{I_{t-1}^{D}{}'}\right)\left(\frac{I_t^{D\prime}}{I_{t-1}^{D}{}'}\right)^2\right]\right\}, \end{aligned} \tag{D.118}$$

$$Q_t^H \psi_t^{H'} = \frac{U_{H',t}}{U_{Z',t}} + E_t \left[\beta' \frac{\lambda_{t+1}'}{\lambda_t'} \psi_{t+1}^{H'} Q_{t+1}^H \left(1-\delta^H\right) + \frac{\lambda_t^{BC}}{\lambda_t'} m \left(Q_{t+1}^H \Pi_{t+1}^C\right)\right], \tag{D.119}$$

$$\begin{aligned} 1 &= \psi_t^{H'} e_t^{I^H} \left[1 - S\left(\frac{I_t^{H\prime}}{I_{t-1}^{H}{}'}\right) - S'\left(\frac{I_t^{H\prime}}{I_{t-1}^{H}{}'}\right)\frac{I_t^{H\prime}}{I_{t-1}^{H}{}'}\right] + \\ &+ E_t \left\{\psi_{i,t+1}^{H'} \frac{\lambda_{i,t+1}' Q_{t+1}^H}{\lambda_{i,t}' Q_t^H} e_{t+1}^{I^H} \left[S'\left(\frac{I_{t+1}^{H}{}'}{I_t^{H\prime}}\right)\left(\frac{I_{t+1}^{H}{}'}{I_t^{H\prime}}\right)^2\right]\right\}, \end{aligned} \tag{D.120}$$

$$\begin{aligned} 0 &= \left[1 - e_t^W \eta\right] + \frac{e_t^W \eta}{\mu_t'} - \vartheta^W \left(\Pi_t^{W\prime} - \Pi^C\right) \Pi_t^{W\prime} + \\ &+ \beta' E_t \left[\frac{\lambda_{t+1}'}{\lambda_t'} \vartheta^W \left(\Pi_{t+1}^{W}{}' - \Pi^C\right) \Pi_{t+1}^{W}{}' \frac{w_{t+1}' N_{t+1}'}{w_t' N_t'}\right], \end{aligned} \tag{D.121}$$

$$B_t' = m E_t \left(\frac{Q_{t+1}^H H_t' \Pi_{t+1}^C}{R_t}\right), \tag{D.122}$$

$$D_{t+1}' = (1-\delta) D_t' + e_t^I I_t^{D\prime} \left[1 - S\left(\frac{I_t^{D\prime}}{I_{t-1}^{D}{}'}\right)\right], \tag{D.123}$$

$$H_{t+1}' = (1-\delta^H) H_t' + e_t^{I^H} I_t^{H'} \left[1 - S\left(\frac{I_t^{H'}}{I_{t-1}^{H'}}\right)\right], \tag{D.124}$$

$$X_t' = \left[(1-\alpha) \tilde{C}_t'^{\frac{\rho-1}{\rho}} + \alpha H_t'^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}, \tag{D.125}$$

$$Z_t' = C_t' - \zeta S_{t-1}', \tag{D.126}$$

$$S_t' = \rho_c S_{t-1}' + (1-\rho_c) C_t', \tag{D.127}$$

$$\tilde{C}_t' = \left[(1-\tilde{\alpha}) Z_t'^{\frac{\tilde{\rho}-1}{\tilde{\rho}}} + \tilde{\alpha} D_t'^{\frac{\tilde{\rho}-1}{\tilde{\rho}}}\right]^{\frac{\tilde{\rho}}{\tilde{\rho}-1}}, \tag{D.128}$$

$$N'_t = N'^C_t + N'^D_t + N'^H_t, \tag{D.129}$$

$$\begin{aligned} B'_t &= C'_t + Q_t I^{D\prime}_t + Q^H_t I^{H\prime}_t + \\ &+ \frac{\vartheta^W}{2}\left(\frac{w'_t}{w'_{t-1}}\Pi^C_t - \Pi^C\right)^2 w'_t N'_t + R_{t-1}B'_{t-1} - w'_t N'_t \end{aligned} \tag{D.130}$$

$$\mu'_t = -w'_t \frac{U_{Z',t}}{U_{N',t}}, \tag{D.131}$$

$$U_{Z',t} = \frac{(1-\alpha)}{\tilde{C}'^{\frac{1}{\rho}}_t X'^{\frac{\rho-1}{\rho}}_t} \frac{(1-\tilde{\alpha})\,\tilde{C}'^{\frac{1}{\tilde{\rho}}}_t}{Z'^{\frac{1}{\tilde{\rho}}}_t}, \tag{D.132}$$

$$U_{D',t} = \frac{(1-\alpha)}{\tilde{C}'^{\frac{1}{\rho}}_t X'^{\frac{\rho-1}{\rho}}_t} \frac{\tilde{\alpha}\tilde{C}'^{\frac{1}{\tilde{\rho}}}_t}{D'^{\frac{1}{\tilde{\rho}}}_t}, \tag{D.133}$$

$$U_{H',t} = \frac{\alpha}{H'^{\frac{1}{\rho}}_t X'^{\frac{\rho-1}{\rho}}_t}, \tag{D.134}$$

$$U_{N',t} = -\nu' \left(N'_t\right)^{\varphi}, \tag{D.135}$$

$$Y^C_t = A_t \left[N^C_t\right]^{\tilde{\psi}} \left[N^{C\prime}_t\right]^{1-\tilde{\psi}} \tag{D.136}$$

$$Y^D_t = A_t \left[N^D_t\right]^{\tilde{\psi}} \left[N^{D\prime}_t\right]^{1-\tilde{\psi}} \tag{D.137}$$

$$Y^H_t = A_t \left[N^H_t\right]^{\tilde{\psi}} \left[N^{H\prime}_t\right]^{1-\tilde{\psi}} \tag{D.138}$$

$$w_t = MC^C_t \tilde{\psi} \frac{Y^C_t}{N^C_t}, \tag{D.139}$$

$$w'_t = MC^C_t \left(1-\tilde{\psi}\right) \frac{Y^C_t}{N^{C\prime}_t}, \tag{D.140}$$

$$\begin{aligned} \left(1 - e^C_t \epsilon_c\right) + e^C_t \epsilon_c MC^C_t &= \vartheta_c \left(\Pi^C_t - 1\right)\Pi^C_t - \\ &- \vartheta_c E_t \left[\Lambda_{t,t+1} \frac{Y^C_{t+1}}{Y^C_t} \left(\Pi^C_{t+1} - 1\right)\Pi^C_{t+1}\right], \end{aligned} \tag{D.141}$$

$$w_t = MC^D_t \tilde{\psi} \frac{Q_t Y^D_t}{N^D_t}, \tag{D.142}$$

$$w'_t = MC^D_t \left(1-\tilde{\psi}\right) \frac{Q_t Y^D_t}{N^{D\prime}_t}, \tag{D.143}$$

$$\begin{aligned} \left(1 - e^D_t \epsilon_d\right) + e^D_t \epsilon_d MC^D_t &= \vartheta_d \left(\Pi^D_t - 1\right)\Pi^D_t - \\ &- \vartheta_d E_t \left[\Lambda_{t,t+1} \frac{Q_{t+1}}{Q_t} \frac{Y^D_{t+1}}{Y^D_t} \left(\Pi^D_{t+1} - 1\right)\Pi^D_{t+1}\right], \end{aligned} \tag{D.144}$$

$$w_t = MC_t^H \tilde{\psi} \frac{Q_t^H Y_t^H}{N_t^H}, \tag{D.145}$$

$$w'_t = MC_t^H \left(1 - \tilde{\psi}\right) \frac{Q_t^H Y_t^H}{N_t^{H\prime}}, \tag{D.146}$$

$$\left(1 - e_t^H \epsilon_h\right) + e_t^H \epsilon_h MC_t^H = \vartheta_h \left(\Pi_t^H - 1\right) \Pi_t^H - \tag{D.147}$$

$$- \vartheta_h E_t \left[\Lambda_{t,t+1} \frac{Q_{t+1}^H}{Q_t^H} \frac{Y_{t+1}^H}{Y_t^H} \left(\Pi_{t+1}^H - 1\right) \Pi_{t+1}^H\right],$$

$$\log\left(\frac{R_t}{\bar{R}}\right) = \rho_r \log\left(\frac{R_{t-1}}{\bar{R}}\right) + \tag{D.148}$$

$$+ (1 - \rho_r)\left[\rho_\pi \log\left(\frac{\tilde{\Pi}_t}{\bar{\tilde{\Pi}}}\right) + \rho_y \log\left(\frac{Y_t}{\bar{Y}}\right)\right] + \epsilon_t^M, \tag{D.149}$$

$$\widetilde{\Pi}_t = \left(\Pi_t^C\right)^{(1-\tau)} \left(\Pi_t^D\right)^{\tau(1-\tilde{\tau})} \left(\Pi_t^H\right)^{\tau\tilde{\tau}}, \tag{D.150}$$

$$Y_t = Y_t^C + Q_t Y_t^D + Q_t^H Y_t^H + \frac{\vartheta^W}{2}\left(\Pi_t^W - \Pi^C\right)^2 w_t N_t +$$

$$+ \frac{\vartheta^W}{2}\left(\Pi_t^{W\prime} - \Pi^C\right)^2 w'_t N'_t, \tag{D.151}$$

$$Y_t^C = C_t + C'_t + G_t + \frac{\vartheta_c}{2}\left(\frac{\Pi_t^C}{\Pi_{t-1}^C} - 1\right)^2 Y_t^C, \tag{D.152}$$

$$Y_t^D = \left[D_t - (1 - \delta) D_{t-1}\right] + \left[D'_t - (1 - \delta) D'_{t-1}\right] +$$

$$+ \frac{\vartheta_d}{2}\left(\Pi_t^D - 1\right)^2 Y_t^D \tag{D.153}$$

$$Y_t^H = \left[H_t - \left(1 - \delta^H\right) H_{t-1}\right] + \left[H'_t - \left(1 - \delta^H\right) H'_{t-1}\right] +$$

$$+ \frac{\vartheta_h}{2}\left(\Pi_t^H - 1\right)^2 Y_t^H \tag{D.154}$$

E Robust impulse responses

This section describes the methodology employed to impose the sign restrictions in Section 2.1. Let θ be a $N \times 1$ vector of the structural parameters of the model. We assume that each parameter is uniformly distributed over a particular range Θ_i, that is each parameter i in θ is defined over $\Theta = \prod_i \Theta_i$. Each interval is set around a value consistent with a quarterly calibration of the U.S. economy and its length is determined both to include reasonable values and to avoid indeterminacy. As a result, some ranges are narrower whereas others are broader, but overall our choices should be uncontroversial. Table E.1 summarizes the supports of the structural parameters. Consistently with the calibration of the two-sector NK models so far used in the literature, we define the same range for the parameters of price stickiness but we impose the restriction $\vartheta_c \geq \vartheta_d$ so that prices of nondurables are stickier or at least as sticky as prices of durables. Note that this condition does not prevent us from obtaining a fully-flexible price model whenever a random draw implies that $\vartheta_c = \vartheta_d = 0$. We perform our main simulations by randomly drawing the values of the Rotemberg parameter of wage stickiness from the support $[0, 180]$ hence including cases in which wages are completely flexible. However, in order to highlight the crucial role played by wage stickiness in solving the comovement puzzle, we perform another set of simulations with flexible wages while keeping the same ranges for the remaining parameters.[41] Then we randomly draw the parameter values $\theta_i^m,\ i = 1, ..., N;\ m = 1, ..., 10034$ from each Θ_i, where m is the number of random draws. Two issues are likely to arise when parameter values are randomly drawn from their support. The first is indeterminacy whenever the Blanchard-Kahn conditions are not satisfied. The second consists of violating the condition that we impose on the degree of price stickiness in the two sectors. In order to make our analysis robust, our aim is to generate about 10000 sets of impulse response functions. That is why we performed 22000 draws, of which 10034 were accepted. 92% of the discarded draws did not satisfy the restriction on price stickiness and only 7% of them did not satisfy the Blanchard-Kahn conditions. Finally, for each accepted draw, we construct a $K \times 1$ vector of impulse response functions of the data $h\left(y_t\left(\theta^m|u_t\right)\right)$ to the structural shocks u_t and order them increasingly. A function $h^K\left(y_t\left(\theta|u_t\right)\right)$ is considered robust if in the impact period the signs of the 84th and 16th percentiles of the simulated distribution of $h\left(y_t\left(\theta|u_t\right)\right)$ are the same, that is $sign\left[h_U^K\left(y_t\left(\theta|u_t\right)\right)\right] = sign\left[h_L^K\left(y_t\left(\theta|u_t\right)\right)\right]$ where h_U and h_L are the 84th and 16th percentiles respectively.

Figure E.1 plots the 68% probability bands of impulse responses to a 1% increase in the nominal interest rate for two sets of simulations. The first leaves the wage stickiness parameter unrestricted (blue dashed lines) whereas, in the second, wages are fully flexible (red dotted lines). Regarding the first set of simulations, on impact,

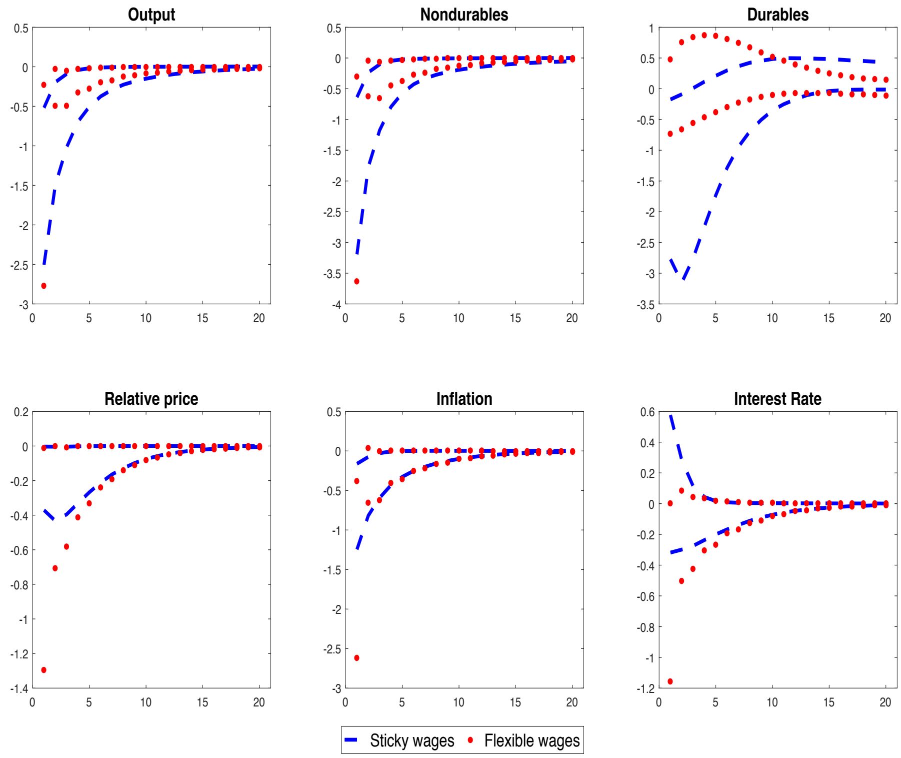
[41] We calibrate $\vartheta^W = 2$. Calibrating $\vartheta^W < 2$ leads to severe indeterminacy issues. However, a value of 2 implies almost fully flexible wages. Indeed, in Section (3.6) we estimate $\vartheta^W = 153$ in the baseline model and $\vartheta^W = 168$ in the housing DSGE. These values are extremely larger than 2 that is why we are confident that such value represents a good approximation of the case of fully flexible wages.

Parameter		Range
Patient households' discount factor	β	$[0.985, 0.995]$
Impatient households' discount factor	β'	$[0.96, 0.984]$
Durables depreciation rate	δ	$[0.0025, 0.025]$
Durables share of total expenditure	α	$[0.05, 0.35]$
Elasticity of substitution in nondurables	ϵ_c	$[4, 11]$
Elasticity of substitution in durables	ϵ_d	$[4, 11]$
Elasticity of substitution in labor	η	$[4, 25]$
Inverse Frisch elasticities	φ, φ'	$[0.3, 3]$
Disutilities of labor	ν, ν'	$N, N' \in [0.2, 0.5]$
Habits degree parameters	ζ, ζ'	$[0, 0.9]$
Habits persistence parameters	ρ_c, ρ_c'	$[0, 0.9]$
Price stickiness in nondurables	ϑ_c	$[0, 58]^*$
Price stickiness in durables	ϑ_d	$[0, 58]^*$
Nominal wage rigidities	ϑ^W	$[0, 180]$
Investment adjustment cost parameters	ϕ, ϕ'	$[0, 5]$
Loan-to-value ratio	m	$[0.55, 0.95]$
Share of patient households	$\tilde{\psi}$	$[0.60, 0.90]$
Share of durables inflation in inflation aggregator	τ	$[0, 1]$
Steady state government share of output	g_y	$[0.1, 0.3]$
Monetary policy to inflation	ρ_π	$[1.05, 5]$
Monetary policy to output gap	ρ_y	$[0, 0.5]$
Interest rate smoothing	ρ_R	$[0, 0.9]$
Persistence of monetary policy shock	ρ_{e^R}	$[0, 0.95]$
Persistence of business cycle shock	ρ_{e^A}	$[0, 0.95]$
Persistence of preference shock	ρ_{e^B}	$[0, 0.95]$
Persistence of durables investment shock	ρ_{e^I}	$[0, 0.95]$
Persistence of wage markup shock	ρ_{e^W}	$[0, 0.95]$
Persistence of nondurables price markup shock	ρ_{e^C}	$[0, 0.95]$
Persistence of durables price markup shock	ρ_{e^D}	$[0, 0.95]$
Persistence of government consumption shock	ρ_{e^G}	$[0, 0.95]$

Note: * denotes that parameters are subject to the restriction $\vartheta_c \geq \vartheta_d$.

Table E.1: Parameter ranges

output, nondurable and durable consumption, and inflation exhibit robust negative responses. In fact, our model features frictions such as wage and price rigidities that solve the comovement puzzle for different combinations of parameter values. In order to be consistent with the literature, we impose that price stickiness of durables can either be lower or equal to price rigidity in the nondurables sector but never higher.



Note: Blue dashed lines refer to the model in which wages are sticky. Red dotted lines refer to a model with flexible wages. Each pair of lines depicts the 84th and 16th percentiles of the distribution of impulse responses. The shock is a 1% increase in the nominal interest rate.

Figure E.1: Robust impulse responses to a contractionary monetary policy shock

Consequently, the response of the relative price of durables is by construction bounded below zero. The response of the nominal interest rate deserves more attention as it is not robust and in some cases at odds with the monetary policy shock being restrictive. However, this is a common issue of two-sector NK models as reported by BHK and Sterk (2010). According to BHK, the counter-intuitive response of the nominal interest rate follows from the near constancy of the shadow value of durables which makes their real rate of return constant thus forcing the nominal interest rate to track expected inflation in the durable goods sector.

We next proceed to discuss the results of the simulations of the model with fully-flexible wages (red dotted lines of Figure E.1). As expected, nominal wage rigidities play a crucial role in solving the comovement puzzle (see Carlstrom and Fuerst 2006, 2010). Indeed, when wages are kept flexible, there exist combinations of parameter

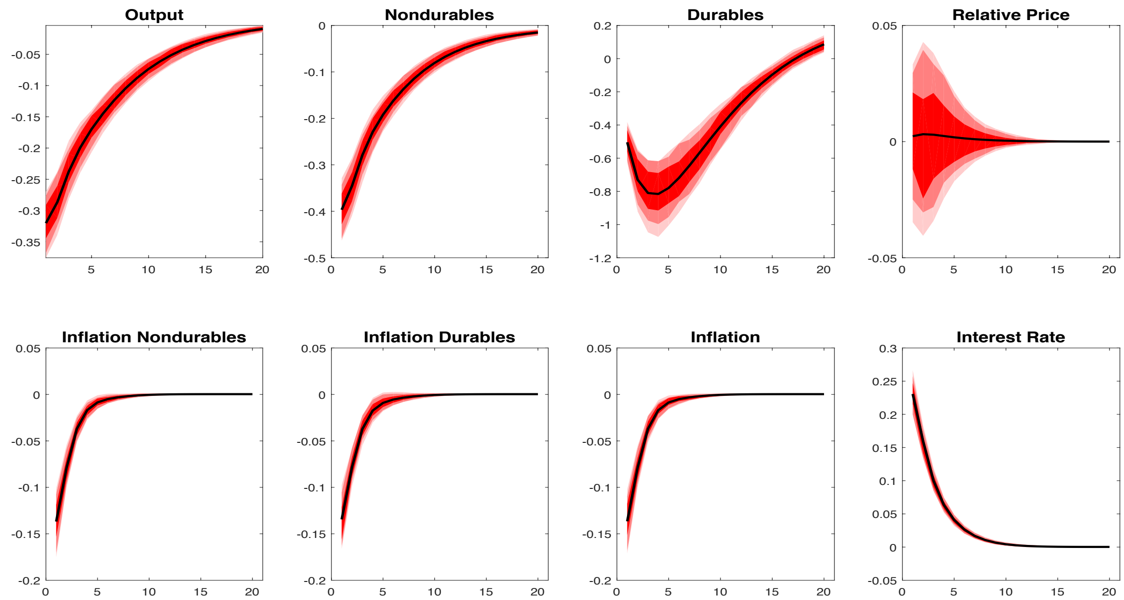


Figure F.1: Bayesian impulse responses of relative prices to a contractionary monetary policy shock in the baseline DSGE (bold lines are mean responses, dark-shaded areas are 68% confidence bands, medium and lighter shaded areas represent 90% and 95% confidence bands respectively)

values such that consumption of durables increases in response to a monetary policy tightening. Furthermore, also in this second set of simulations there are cases in which the comovement between durables and nondurables is attained due to specific values of the parameters of price stickiness (see Sterk, 2010). However, the aim of this second set of simulations is to show that when wages are assumed to be flexible there exist fewer combinations of parameter values that generate a comovement between consumption in the two sectors.

F Bayesian impulse responses

In this section we plot the Bayesian impulse responses of the models estimated in Section 3.6 together with the 68%, 90% and 95% confidence bands. Figure F.1 refers to the baseline DSGE whereas Figure F.2 refers to the housing DSGE. The same conclusions as in Section 3.6.3 can be drawn also when taking into account the different confidence levels. Indeed, in both models the comovement is attained due to the presence of prices and wages stickiness whereas the only noticeable difference concerns the response of the relative prices, as discussed in the main text.

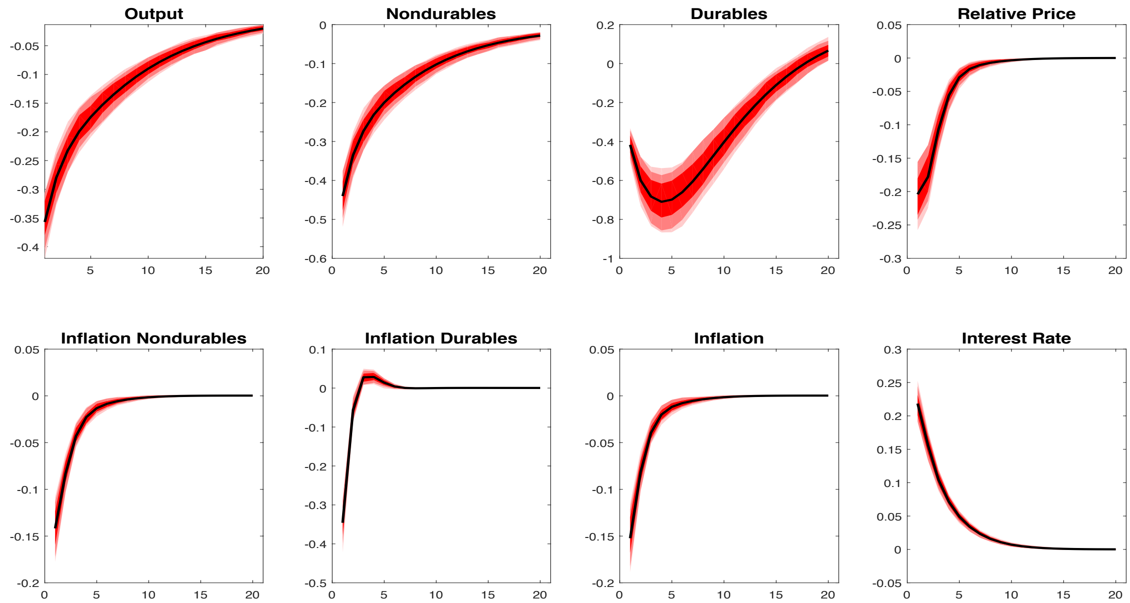


Figure F.2: Bayesian impulse responses of relative prices to a contractionary monetary policy shock in the housing DSGE (bold lines are mean responses, dark-shaded areas are 68% confidence bands, medium and lighter shaded areas represent 90% and 95% confidence bands respectively)

G Posterior distributions of Inverse Frisch Elasticities

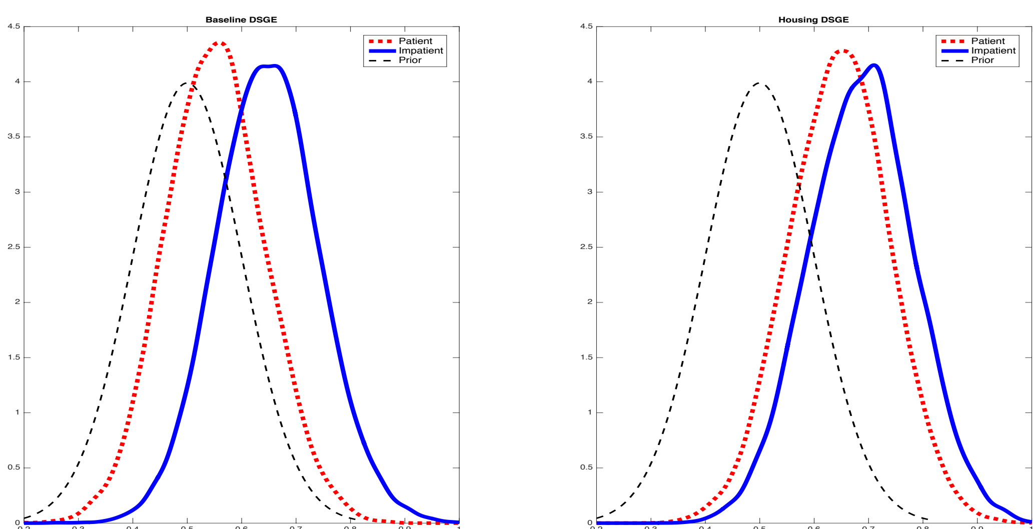


Figure G.1: Prior and posterior densities of Inverse Frisch Elasticities. Left box: baseline DSGE. Right box: housing DSGE (left-scale refers to distribution of housing parameter, right-scale refers to nondurables).

H Models comparison

We take two approaches to assess how well our (unrestricted) model's features help fitting the data. First, we perform a likelihood race between the baseline and five restricted models, in which the DSGE model is estimated with one friction removed at a time.[42] Then, we plot the impulse responses of the baseline and a few restricted models to a contractionary monetary policy shock.

Table H.1 reports the log-marginal likelihoods of the models, in conjunction with the statistic by Kass and Raftery (1995, KR henceforth).[43] The KR statistic decisively favors the baseline model. Indeed, there is slight evidence in favor of this with respect to the model in which the central bank responds only to inflation in nondurables ($\tau = 0$). Furthermore, very strong evidence is found against a model with flexible prices in the durables sector ($\vartheta_d = 0$), a model with flexible wages ($\vartheta^W = 0$), a model without IAC in durable goods ($\phi = \phi' = 0$), and a model without habit formation in consumption of nondurable goods ($\zeta = \zeta' = 0$). These results suggest that the frictions considered are important when the theoretical model is brought to the data, although the main result about the sectoral price stickiness survives in the restricted models, except for the case of flexible wages. Indeed, Table H.2 shows that the point estimate of the price stickiness parameter in the durables sector is higher than the price stickiness parameter in the nondurables sector, although by a small margin. In all cases, the confidence intervals of the two parameters widely overlap thus pointing to the fact that there is only a negligible difference between the two.

The importance of the real and nominal frictions is further depicted in Figure H.1. The black-solid line represents the same impulse responses of the baseline model as in Figure 4, while the blue-dashed line depicts the dynamic behavior of a model with flexible wages.[44] Thanks to price stickiness in durable goods, the responses are

[42] We perform such estimations only for the baseline DSGE model.

[43] The KR statistic is computed as twice the log of the Bayes Factor (BF), with the BF between the baseline models m_i and the restricted model m_j being

$$BF_{i/j} = \frac{L(Y|m_i)}{L(Y|m_j)} = \frac{exp(LL(Y|m_i))}{exp(LL(Y|m_j))}$$

where $L(Y|m_i)$ is the marginal data density of model i for the common dataset Y and LL stands for log-marginal likelihood. Values of the KR statistics above 10 can be considered "very strong" evidence in favor of model i relative to model j; between 6 and 10 represent "strong" evidence; between 2 and 6 "positive" evidence; while values below 2 are "not worth more than a bare mention".

[44] We calibrate the parameters with the point estimates of the baseline model and remove a friction at a time. Impulse responses are rescaled to generate a 1% increase in the policy rate. In order to ease

Model	Restrictions	Log-marg. likelihood	Kass-Raftery
Baseline		-1472.494	
Flexible Wages	$\vartheta^W = 0$	-1672.300	399.612
Flexible Durables Prices	$\vartheta_d = 0$	-1538.150	131.312
No IAC	$\phi = \phi' = 0$	-1970.003	995.018
No Habit	$\zeta = \zeta' = 0$	-1698.053	451.118
No Durables Inflation	$\tau = 0$	-1473.396	1.804

Table H.1: Likelihood comparison

Model	Restrictions	Price stickiness nondurables ϑ_c	Price stickiness durables ϑ_d
Baseline		23.38 [15.82;30.61]	24.45 [16.09;33.26]
Flexible Wages	$\vartheta^W = 0$	1.2032 [0.5643;1.7338]	2.4006 [1.4801;3.3098]
No IAC	$\phi = \phi' = 0$	47.135 [32.832;62.022]	51.378 [37.533;65.994]
No Habit	$\zeta = \zeta' = 0$	27.629 [19.122;35.731]	30.482 [19.540;41.270]
No Durables Inflation	$\tau = 0$	22.338 [15.209;28.933]	25.961 [16.311;35.075]

Table H.2: Estimated price stickiness parameters in restricted models

close to the baseline model and the comovement between durables and nondurables is attained. When prices of durables are assumed to be flexible and wages are sticky (red-dotted line), the comovement still survives. The only tangible difference lies in the response of the relative price, which is almost flat in the baseline case, whereas it decreases in the restricted scenario. Excluding habit formation in consumption of nondurable goods (red-dashed and dotted line) leads to a considerable larger fall in nondurables and output. In particular, we confirm the results of Katayama and Kim (2013) that including this friction is crucial to obtain reasonable sizes in the responses of nondurables consumption and output. Similarly, IACs in durable goods are crucial to account for plausible magnitudes of the responses of durables and output. Indeed, the black-rounded lines show that in the absence of IACs, at the trough, durables fall by almost 7% whereas output falls by about 0.4%. Thus the maximum fall in durables is about 17.5 times larger than the maximum fall of output, an implausible result according to our SVAR estimates.

the graphical analysis, we do not plot the responses of the model in which the central bank responds only to inflation in nondurables since they overlap with the others. These are available upon request.

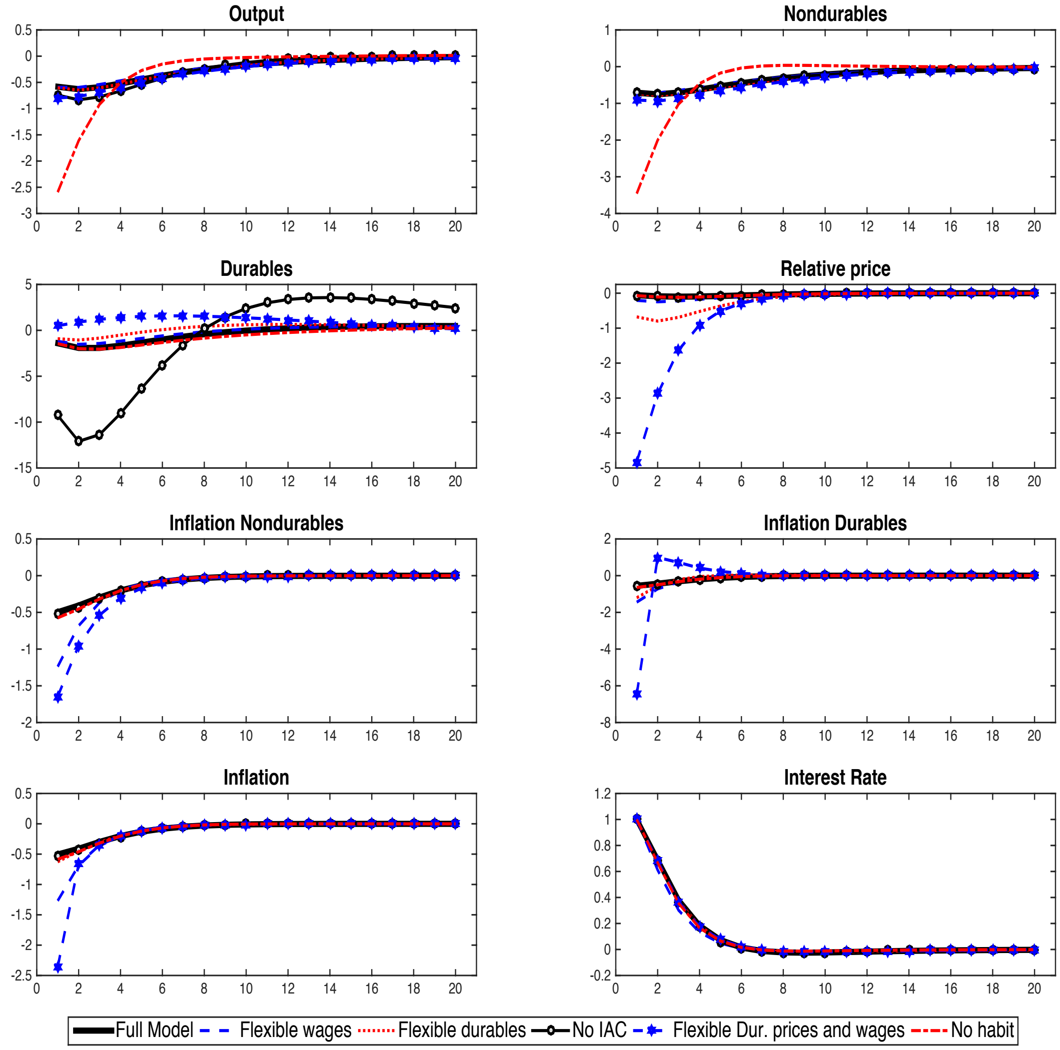


Figure H.1: Impulse responses to a 1% increase in the nominal interest rate across restricted models

H.1 The importance of the income share of patient households

All the results reported above assume an income share of the patient households of 79%, as estimated by Iacoviello and Neri (2010). This is also in line with estimates by Jappelli (1990), who reports a share of 80% for savers in the U.S. economy. In this section, we use a calibrated version of the baseline DSGE using the posterior mean of all parameters reported in Section 3.6 and alternative values for the income share of patient households to assess the importance of this parameter for the dynamic responses of macroeconomic variables to a monetary policy shock. Figure H.2 shows the impulse responses to an increase in the policy rate for different values of $\tilde{\psi}$. Qualitatively, the

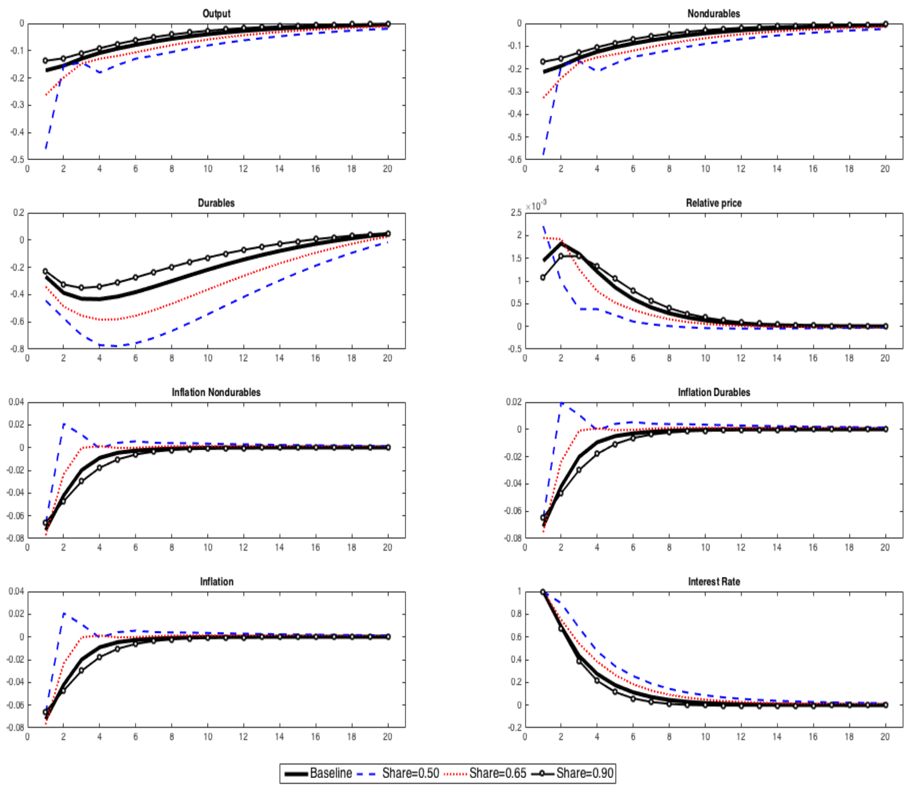


Figure H.2: Impulse responses to a 1% increase in the nominal interest rate for different values of the income share of impatient households

dynamic responses of the baseline DSGE are not affected by changes in the income share of the two households. However, a quantitative inspection yields interesting insights. Increasing the share of impatient households (blue-dashed and red-dotted lines) exacerbates the negative effects of the monetary policy shock. The simple reason is that a higher share of households are credit constrained hence on aggregate, durables investment and nondurables consumption fall more. Here, it is also evident that the transmission channel of monetary policy through the collateral constraint is in fact important and should not be neglected. Conversely, lowering the share of impatient households (black-rounded line) mitigates the effects of a monetary policy shock.

I Posterior estimates of extended models

Parameter		Distr.	Prior Mean	Sd/df	Posterior Mean Baseline DSGE	Posterior Mean Housing DSGE
Structural						
Inv. Frisch elasticity patients	φ	N	0.50	0.10	0.5262 [0.3807;0.6765]	0.4996 [0.6441;0.9352]
Inv. Frisch elasticity impatients	φ'	N	0.50	0.10	0.6599 [0.5044;0.8172]	0.7803 [0.5300;0.8431]
Habits patients	ζ	B	0.70	0.10	0.6761 [0.6281;0.7238]	0.7022 [0.6532;0.7557]
Habits. impatients	ζ'	B	0.70	0.10	0.9346 [0.9259;0.9443]	0.9487 [0.9445;0.9526]
Habit persist. patients	ρ_c	B	0.70	0.10	0.5226 [0.4143;0.6299]	0.5399 [0.4471;0.6339]
Habit persist. impatients	ρ_c'	B	0.70	0.10	0.2135 [0.1500;0.2746]	0.2002 [0.1257;0.2695]
Labor mobility patients	λ	N	1.51	0.50	2.6036 [1.9900;3.2098]	0.8628 [0.6649;1.0884]
Labor mobility impatients	λ'	N	1.03	0.50	1.6042 [0.9274;2.2777]	0.7500 [0.1084;1.3567]
Price stickiness nondurables	ϑ_c	G	15.0	5.00	25.72 [18.07;33.85]	51.08 [45.73;56.06]
Price stickiness durables	ϑ_d	G	15.0	5.00	27.02 [17.95;35.59]	0.72 [0.56;0.85]
Wage stickiness	ϑ^W	G	100.0	10.00	159.09 [145.64;176.10]	172.37 [166.50;177.30]
IAC durables patients	ϕ	N	1.5	0.50	3.0043 [2.3778;3.6516]	2.5507 [1.9744;3.1002]
IAC durables impatients	ϕ'	N	1.5	0.50	1.6987 [0.9303;2.4394]	0.0018 [0.0010;0.0027]
Share of durables inflation	τ	B	0.20	0.10	0.2018 [0.1077;0.2887]	0.0534 [0.0359;0.0700]
Inflation -Taylor rule	ρ_π	N	1.50	0.20	1.4099 [1.2523;1.5715]	1.7766 [1.5348;2.0045]
Output -Taylor rule	ρ_y	G	0.10	0.05	0.0187 [0.0063;0.0308]	0.0230 [0.0061;0.0393]
Interest rate smoothing	ρ_r	B	0.80	0.10	0.7052 [0.6656;0.7488]	0.7978 [0.7653;0.8323]
Averages						
Trend growth rate	γ	N	0.49	0.10	0.3957 [0.3606;0.4315]	0.4127 [0.3881;0.4403]
Inflation rate nondurables	$\bar{\pi}_C$	G	1.05	0.10	0.9872 [0.8885;1.0863]	0.9870 [0.9010;1.0775]
Inflation rate durables	$\bar{\pi}_D$	G	0.37	0.10	0.4598 [0.3549;0.5616]	0.5627 [0.3860;0.7343]
Interest rate	$\bar{r}$	G	1.65	0.10	1.5989 [1.4788;1.7287]	1.6211 [1.5215;1.7221]
Exogenous processes						
Technology	ρ_{e^A}	B	0.50	0.20	0.9792 [0.9603;0.9973]	0.9255 [0.8722;0.9765]
	σ_{e^A}	IG	0.10	2.0	0.7053 [0.6304;0.7743]	0.8059 [0.7240;0.8878]
Monetary Policy	ρ_{e^R}	B	0.50	0.20	0.1052 [0.2592;0.3215]	0.0674 [0.0141;0.1151]
	σ_{e^R}	IG	0.10	2.0	0.2908 [0.0252;0.1762]	0.2675 [0.2403;0.2930]
Investment Durables	ρ_{e^I}	B	0.50	0.20	0.3021 [0.1457;0.4544]	0.9292 [0.8937;0.9658]
	σ_{e^I}	IG	0.10	2.0	6.8359 [4.9939;8.6048]	7.4079 [6.6757;8.1498]
Preference	ρ_{e^B}	B	0.50	0.20	0.7427 [0.6703;0.8182]	0.8251 [0.7745;0.8704]
	σ_{e^B}	IG	0.10	2.0	1.9852 [1.6586;2.2950]	2.1079 [1.7502;2.4492]
Price mark-up nondurables	ρ_{e^C}	B	0.50	0.20	0.9253 [0.8830;0.9689]	0.6328 [0.5220;0.7306]
	θ_C	B	0.50	0.20	0.5848 [0.4799;0.6900]	0.2710 [0.0815;0.4536]
	σ_{e^C}	IG	0.10	2.0	2.2650 [1.7960;2.7354]	3.3818 [2.8232;3.9237]
Price mark-up durables	ρ_{e^D}	B	0.50	0.20	0.9549 [0.9160;0.9930]	0.9932 [0.9874;0.9994]
	θ_D	B	0.50	0.20	0.3938 [0.2283 ;.5564]	0.0878 [0.0159;0.1547]
	σ_{e^D}	IG	0.10	2.0	4.9463 [3.6282;6.2196]	1.6186 [1.4276;1.7981]
Wage mark-up	ρ_{e^W}	B	0.50	0.20	0.9498 [0.9277;0.9705]	0.9310 [0.9069;0.9555]
	θ_W	B	0.50	0.20	0.5176 [0.4119;0.6326]	0.4728 [0.3568;0.5897]
	σ_{e^W}	IG	0.10	2.0	5.0858 [4.2308;5.9569]	5.3314 [4.5073;6.1389]
Government spending	ρ_{e^G}	B	0.50	0.20	0.9657 [0.9445;0.9882]	0.9544 [0.9265;0.9827]
	σ_{e^G}	IG	0.10	2.0	3.5223 [3.1895;3.8490]	3.3398 [3.0394;3.6639]

Table I.1: Prior and posterior distributions of estimated parameters: models with imperfect labor mobility (90% confidence bands in square brackets)

Parameter		Distr.	Prior Mean	Sd/df	Posterior Mean Baseline DSGE	Posterior Mean Housing DSGE
Structural						
Inv. Frisch elasticity patients	φ	N	0.50	0.10	0.5442 [0.3963;0.6916]	0.6321 [0.5278;0.8445]
Inv. Frisch elasticity impatients	φ'	N	0.50	0.10	0.6436 [0.4867;0.7980]	0.6853 [0.5300;0.8431]
Habits patients	ζ	B	0.70	0.10	0.6532 [0.6281;0.7238]	0.6701 [0.6298;0.7050]
Habits impatients	ζ'	B	0.70	0.10	0.9357 [0.9271;0.9452]	0.9411 [0.9353;0.9472]
Habit persist. patients	ρ_c	B	0.70	0.10	0.5102 [0.4013;0.6233]	0.6377 [0.5399;0.7388]
Habit persist. impatients	ρ_c'	B	0.70	0.10	0.2249 [0.1635;0.2882]	0.3459 [0.2527;0.4370]
Price stickiness nondurables	ϑ_c	G	15.0	5.00	20.58 [13.63;27.65]	23.87 [16.55;31.31]
Price stickiness durables	ϑ_d	G	15.0	5.00	22.05 [13.77;30.25]	1.26 [0.69;1.79]
Price indexation nondurables	ς_C	B	0.50	0.20	0.2084 [0.0414;0.3636]	0.1439 [0.0263;0.2550]
Price indexation durables	ς_D	B	0.50	0.20	0.1167 [0.0158;0.2146]	0.2131 [0.0270 ;0.3994]
Wage stickiness	ϑ^W	G	100.0	10.00	155.98 [140.08;172.65]	168.02 [158.32;177.30]
IAC durables patients	ϕ	N	1.5	0.50	3.5149 [2.8751;4.1782]	3.7729 [3.2011;4.3405]
IAC durables impatients	ϕ'	N	1.5	0.50	1.9209 [1.2333;2.6121]	0.7077 [0.1961;1.3816]
Share of durables inflation	τ	B	0.20	0.10	0.1535 [0.0646;0.2463]	0.0517 [0.0362;0.0671]
Inflation -Taylor rule	ρ_π	N	1.50	0.20	1.3781 [1.2056;1.5351]	1.7361 [1.5127;1.9526]
Output -Taylor rule	ρ_y	G	0.10	0.05	0.0188 [0.0054;0.0307]	0.0247 [0.0076;0.0411]
Interest rate smoothing	ρ_r	B	0.80	0.10	0.7100 [0.6676;0.7514]	0.7707 [0.7337;0.8071]
Averages						
Trend growth rate	γ	N	0.49	0.10	0.4075 [0.3749;0.4412]	0.4055 [0.3740;0.4364]
Inflation rate nondurables	$\bar{\pi}_C$	G	1.05	0.10	1.0034 [0.9034;1.1051]	1.0419 [0.9393;1.1453]
Inflation rate durables	$\bar{\pi}_D$	G	0.37	0.10	0.4345 [0.3189;0.5476]	0.3475 [0.2152;0.4830]
Interest rate	$\bar{r}$	G	1.65	0.10	1.6108 [1.4854;1.7334]	1.6450 [1.5027;1.7795]
Exogenous processes						
Technology	ρ_{e^A}	B	0.50	0.20	0.9789 [0.9601;0.9977]	0.9590 [0.9290;0.9910]
	σ_{e^A}	IG	0.10	2.0	0.6889 [0.6169:0.7574]	0.7369 [0.6553;0.8163]
Monetary Policy	ρ_{e^R}	B	0.50	0.20	0.1023 [0.0290;0.1769]	0.0811 [0.0189;0.1380]
	σ_{e^R}	IG	0.10	2.0	0.2855 [0.2560;0.3150]	0.2796 [0.2494;0.3096]
Investment Durables	ρ_{e^I}	B	0.50	0.20	0.4674 [0.2882;0.6544]	0.9216 [0.8881;0.9544]
	σ_{e^I}	IG	0.10	2.0	6.4416 [4.3733;8.5367]	6.1710 [5.4138;6.9180]
Preference	ρ_{e^B}	B	0.50	0.20	0.7467 [0.6784;0.8158]	0.8563 [0.8107;0.9026]
	σ_{e^B}	IG	0.10	2.0	1.8816 [1.5636;2.1669]	2.2259 [1.8429;2.6158]
Price mark-up nondurables	ρ_{e^C}	B	0.50	0.20	0.9193 [0.8704;0.9734]	0.9161 [0.8539;0.9806]
	θ_C	B	0.50	0.20	0.6332 [0.5236;0.7532]	0.6872 [0.5678;0.8114]
	σ_{e^C}	IG	0.10	2.0	2.1614 [1.6924;2.5921]	2.3646 [1.8614;2.8512]
Price mark-up durables	ρ_{e^D}	B	0.50	0.20	0.9867 [0.9771;0.9981]	0.9893 [0.9785;0.9994]
	θ_D	B	0.50	0.20	0.7158 [0.6188 0.8176]	0.8766 [0.8365;0.9195]
	σ_{e^D}	IG	0.10	2.0	4.2377 [2.9814;5.4658]	22.506 [18.728;26.259]
Wage mark-up	ρ_{e^W}	B	0.50	0.20	0.9462 [0.9176;0.9771]	0.9533 [0.9310;0.9766]
	θ_W	B	0.50	0.20	0.5483 [0.4430;0.6580]	0.5650 [0.4652;0.6710]
	σ_{e^W}	IG	0.10	2.0	5.3348 [4.3919;6.2104]	5.6656 [4.7591;6.5676]
Government spending	ρ_{e^G}	B	0.50	0.20	0.9671 [0.9469;0.9886]	0.9550 [0.9264;0.9857]
	σ_{e^G}	IG	0.10	2.0	3.5031 [3.1815;3.8188]	3.3336 [3.0230;3.6309]

Table I.2: Prior and posterior distributions of estimated parameters: models with price indexation (90% confidence bands in square brackets)

Parameter			Prior		Posterior Mean
		Distr.	Mean	Sd/df	
Structural					
Inv. Frisch elasticity patients	φ	N	0.50	0.10	0.8084 [0.6630;0.9509]
Inv. Frisch elasticity impatients	φ'	N	0.50	0.10	0.8462 [0.6926;0.9956]
Habits patients	ζ	B	0.70	0.10	0.1676 [0.1127;0.2167]
Habits. impatients	ζ'	B	0.70	0.10	0.8396 [0.7948;0.8915]
Habit persist. patients	ρ_c	B	0.70	0.10	0.6239 [0.4758;0.7678]
Habit persist. impatients	ρ_c'	B	0.70	0.10	0.2135 [0.1500;0.2746]
Elast. sub. consumption	ρ	N	1.00	0.10	1.0642 [0.9082;1.2142]
Elast. sub. consumption	$\tilde{\rho}$	N	1.00	0.10	0.9959 [0.8674;1.1187]
Price stickiness nondurables	ϑ_c	G	15.0	5.00	33.37 [24.07;42.82]
Price stickiness durables	ϑ_d	G	15.0	5.00	46.13 [34.99;57.06]
Price stickiness housing	ϑ_h	G	15.0	5.00	4.70 [2.34;7.09]
Wage stickiness	ϑ^W	G	100.0	10.00	160.88 [146.16;177.30]
IAC durables patients	ϕ	N	1.5	0.50	2.7309 [2.0306;3.4376]
IAC housing patients	ϕ^H	N	1.5	0.50	3.9123 [3.3607;4.4951]
IAC durables impatients	ϕ'	N	1.5	0.50	1.2077 [0.5961;1.0816]
IAC housing impatients	ϕ'^H	N	1.5	0.50	1.6676 [0.9285;2.4074]
Weight in inflation aggregator	τ	B	0.20	0.10	0.2308 [0.1464;0.3156]
Weight in inflation aggregator	$\tilde{\tau}$	B	0.20	0.10	0.0918 [0.0330;0.1476]
Inflation -Taylor rule	ρ_π	N	1.50	0.20	1.5846 [1.4231;1.7410]
Output -Taylor rule	ρ_y	G	0.10	0.05	0.0142 [0.0043;0.0229]
Interest rate smoothing	ρ_r	B	0.80	0.10	0.6803 [0.6343 ;0.7297]
Averages					
Trend growth rate	γ	N	0.49	0.10	0.3719 [0.3240;0.4190]
Inflation rate nondurables	$\bar{\pi}_C$	G	1.05	0.10	1.0275 [0.9339;1.1163]
Inflation rate durables	$\bar{\pi}_D$	G	0.37	0.10	0.4610 [0.3594;0.5624]
Inflation rate housing	$\bar{\pi}_H$	G	0.22	0.10	0.1775 [0.1000;0.2567]
Interest rate	$\bar{r}$	G	1.65	0.10	1.6334 [1.5043;1.7641]

Table I.3: Prior and posterior distributions of estimated parameters: three-sector model (90% confidence bands in square brackets)

Parameter			Prior		Posterior Mean
		Distr.	Mean	Sd/df	
Exogenous processes					
Technology	ρ_{e^A}	B	0.50	0.20	0.9729 [0.9467;0.9974]
	σ_{e^A}	IG	0.10	2.0	0.8172 [0.7258;0.9015]
Monetary Policy	ρ_{e^R}	B	0.50	0.20	0.1195 [0.0397;0.2006]
	σ_{e^R}	IG	0.10	2.0	0.2971 [0.2642;0.3306]
Investment Durables	ρ_{e^I}	B	0.50	0.20	0.2856 [0.0981;0.4679]
	σ_{e^I}	IG	0.10	2.0	7.6195 [4.9130;10.502]
Investment Housing	$\rho_{e^{I^H}}$	B	0.50	0.20	0.9354 [0.9051;0.9700]
	$\sigma_{e^{I^H}}$	IG	0.10	2.0	7.2639 [6.3405;8.1975]
Preference	ρ_{e^B}	B	0.50	0.20	0.8859 [0.8421;0.9303]
	σ_{e^B}	IG	0.10	2.0	1.7621 [1.3200;2.2014]
Price mark-up nondurables	ρ_{e^C}	B	0.50	0.20	0.7660 [0.6767;0.8559]
	θ_C	B	0.50	0.20	0.2986 [0.1224;0.4589
	σ_{e^C}	IG	0.10	2.0	2.5294 [1.9320;3.1054]
Price mark-up durables	ρ_{e^D}	B	0.50	0.20	0.9817 [0.9687;0.9950]
	θ_D	B	0.50	0.20	0.2274 [0.0623;0.3820]
	σ_{e^D}	IG	0.10	2.0	2.1549 [1.7202;2.5783]
Price mark-up housing	ρ_{e^H}	B	0.50	0.20	0.9984 [0.9970;0.9998]
	θ_H	B	0.50	0.20	0.6683 [0.5762;0.7592]
	σ_{e^H}	IG	0.10	2.0	16.336 [12.201;20.351]
Wage mark-up	ρ_{e^W}	B	0.50	0.20	0.9674 [0.9493;0.9856]
	θ_W	B	0.50	0.20	0.6874 [0.6134;0.7675]
	σ_{e^W}	IG	0.10	2.0	5.7254 [4.7684;6.6728]
Government spending	ρ_{e^G}	B	0.50	0.20	0.8977 [0.8589;0.9352]
	σ_{e^G}	IG	0.10	2.0	3.5428 [3.2062;3.8989]

Table I.4: Prior and posterior distributions of exogenous processes: three-sector model (90% confidence bands in square brackets)