Housework and fiscal expansions

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Abstract

We build an otherwise-standard business cycle model with housework, calibrated consistently with data on time use, in order to discipline complementarity between consumption and hours worked and relate its strength to the size of fiscal multipliers. Evidence on the substitutability between home and market goods confirms that complementarity is an empirically relevant driver of fiscal multipliers. However, we also find that in a housework model substantial complementarity can be generated without imposing a low wealth effect, which contradicts the microeconomic evidence. Also, explicitly modeling housework matters for assessing the welfare effects of government spending, which are understated by theories that neglect substitutability between home-produced and market goods.

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1. Introduction

The propagation of exogenous changes in public consumption to macroeconomic variables is at the center of a controversial and ongoing debate. Fiscal multipliers depend on assumptions about preferences, technology, policies and various frictions like nominal rigidities or the presence of hand-to-mouth consumers. Lack of consensus in the theoretical debate reflects disagreement about these assumptions. Recent contributions, such as Nakamura and Steinsson [38], Christiano, Eichenbaum and Rebelo [19], Bilbiie [9], Hall [28] and Monacelli and Perotti [34, 35], focus on preferences. In particular, they emphasize the importance of complementarity between consumption and hours worked for fiscal multipliers. The intuition is straightforward: a government expenditure shock generates a need for higher labor supply. If consumption and hours worked are complements, the surge in labor supply further stimulates output and consumption. Hence, complementarity is potentially an important driver of fiscal multipliers.

Since complementarity is often interpreted as an outcome of housework, in this paper we explicitly model a home-production sector and study the transmission of government expenditure shocks. As argued by Becker [6], consumption is the final stage of production, which takes place at the household level and combines time with expenditure on market goods. The amount of time varies across consumption activities: a meal purchased and consumed at a cafeteria can be less time intensive than a home-produced meal. If households substitute towards market goods and work longer hours on the market when the opportunity cost of time is high, their expenditure on consumption goods increases in market hours, even if labor income is controlled for. In other words, substitutability between home-produced and market goods generates complementarity between market consumption and hours worked.

Explicitly modeling home production might have some advantages, even if complementarity can be captured by hard-wiring it in preferences over consumption and leisure. On the one hand, direct evidence on the strength of complementarity is rather scant. Yet, estimates about the substitutability between home and market goods have recently been made available by the home-production literature. These estimates can be used to discipline complementarity and assess its relevance for fiscal multipliers. On the other hand, one might suspect that the welfare implications of government expenditure shocks are potentially different, depending on whether complementarity is modeled in a structural way or simply embedded in preferences. As emphasized by Aguiar and Hurst [1], drawing welfare-relevant implications from changes in consumption expenditure might be misleading if substitution pushes consumption expenditure and consumption in opposite directions.

Following Benhabib, Rogerson and Wright [7], we build an otherwise-standard business cycle model with nominal price rigidities, where the household can employ time and capital to produce a good that is non-tradable on the market, and we calibrate the model consistently with data on time use in the United States. We contribute to the literature on fiscal multipliers in several respects. First, our analysis confirms that complementarity is a quantitatively relevant mechanism. After showing that substitutability between home and market goods generates complementarity, we document that if substitutability is calibrated on the empirically relevant range, the model can span the whole range of fiscal multipliers estimated from vector autoregressions (VARs). Consistently with our model, we refer to estimates relative to temporary and unexpected increases in deficit-financed government-consumption expenditures that are unproductive. Second, we show that interpreting theories relying on Jaimovich and Rebelo [31] (JR henceforth) or Greenwood, Hercowitz and Huffman [27] (GHH henceforth) preferences as equivalent to housework is misleading. In fact, in the housework model substantial degrees of complementarity are achieved without ruling out the wealth effect on hours worked, which is sizeable according to the microeconomic evidence (Imbens, Rubin and Sacerdote [30]).[2] Moreover JR preferences

[2]Our findings parallel the results by Furlanetto and Seneca [24]: they show that complementarity accounts for the dynamics of macroeconomic variables, conditional on an investment

are not a reduced form for housework, because they deliver more persistent dynamics by assuming that marginal utility depends on the history of consumption. Finally, we show that housework affects welfare, even if substitutability between consumption and leisure – as advocated by by Bilbiie [9] – can be made observationally equivalent to substitutability between home and market goods. In particular, the cost of a government spending shock is higher when the home sector is included, because it induces substitution away from home goods, which are valuable to the household. But also, overlooking substitution from home to market goods understates the benefits of expanding aggregate demand with government spending when market activity is inefficiently low. As emphasized by Aguiar, Hurst and Karabarbounis [2], substitution between housework and market work at business-cycle frequencies is not only relevant, it is also a more elastic margin than substitution between market work and leisure. Omitting housework might result in misleading welfare calculations.

The rest of the paper is organized as follows: Section 2 presents the model; Section 3 inspects our mechanism and compares it to the alternatives proposed by the literature; Section 4 studies the quantitative relevance of complementarity and conducts robustness analysis; Section 5 concludes.

2. The Model

We consider an otherwise-standard New Keynesian model, where households can combine time and capital to produce non-tradable home goods and enjoy consumption of home goods, market goods and leisure.[3] The fiscal authority buys market goods and subsidizes production so as to offset the steady-state distortion due to firms' market power. Expenditures are financed by levying lump-sum taxes. Finally, the central bank is in charge of setting the nominal

shock, without the need of relying on low wealth effects on hours worked.

[3] As in Benhabib et al. [7] and McGrattan et al. [33], some goods produced on the market, such as houses and durable goods, are interpreted as home capital, which is used as input for home production.

interest rate. We leave derivations in the Appendix.

2.1. Households

Households start every period t with capital stock K_t, a portfolio of state-contingent nominal assets B_t and a time endowment that we normalize to 1. We assume that households are price takers in all markets and that financial markets are complete. The capital stock can be rented to firms at price r_t^k or retained within the household for home production purposes. Let $K_{m,t}$ be the capital stock rented to firms and $K_{n,t}$ the capital stock available for home production. Hence,

$$K_{m,t} + K_{n,t} = K_t. \tag{1}$$

Time can be allocated to market work in exchange for a real wage, W_t, or to housework, so that

$$h_{m,t} + h_{n,t} = h_t, \quad l_t = 1 - h_t, \tag{2}$$

with $h_{m,t}$ and $h_{n,t}$ representing hours worked on the market and at home, respectively, while l_t is the residual time that is enjoyed as leisure after subtracting total hours worked, h_t, from the time endowment. Housework and capital $K_{n,t}$ are combined to produce home goods

$$C_{n,t} = (K_{n,t})^{\alpha_2} (h_{n,t})^{1-\alpha_2}, \quad \alpha_2 \in [0,1], \tag{3}$$

that can only be consumed, but neither traded on the market nor stored. Households also buy infinitely many varieties of market goods indexed by $i \in [0,1]$ at their price $P_t(i)$ and either allocate them to consumption, $C_{m,t}(i)$, or store them for investment purposes, $I_t(i)$. We define aggregate market consumption and investment as

$$C_{m,t} = \left[\int_0^1 (C_{m,t}(i))^{\frac{\varepsilon-1}{\varepsilon}}\, di\right]^{\frac{\varepsilon}{\varepsilon-1}} \text{ and } I_t = \left[\int_0^1 (I_t(i))^{\frac{\varepsilon-1}{\varepsilon}}\, di\right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{4}$$

where $\varepsilon > 1$ is the elasticity of substitution across varieties. The optimal allocation of expenditure across varieties implies the flow budget constraint,

$$B_t + W_t P_t h_{m,t} + r_t^k P_t K_{m,t} + T_t \geq E_t \left\{ Q_{t,t+1} B_{t+1} \right\} + P_t (C_{m,t} + I_t), \quad (5)$$

where the aggregate price index is

$$P_t = \left[\int_0^1 P_t(i)^{1-\varepsilon} \, di \right]^{\frac{1}{1-\varepsilon}}, \quad (6)$$

T_t are lump-sum taxes and transfers, including firms' profits, $Q_{t,t+1}$ is the stochastic discount factor for one-period-ahead nominal payoffs and B_{t+1} is the portfolio of state-contingent assets that the household carries to the next period.[4] Given investment and the initial capital stock, capital carried to the next period evolves according to

$$K_{t+1} = (1-\delta) K_t + I_t - \frac{\xi}{2} \left(\frac{K_{t+1}}{K_t} - 1 \right)^2, \quad (7)$$

with $\delta \in (0,1]$ and $\xi > 0$ standing for the depreciation rate and capital adjustment costs, respectively. Households' preferences are defined over consumption and leisure,

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, l_t), \quad (8)$$

where consumption C_t aggregates market and home goods,

$$C_t = \left[\alpha_1 (C_{m,t})^{b_1} + (1-\alpha_1)(C_{n,t})^{b_1} \right]^{\frac{1}{b_1}}, \quad \alpha_1 \in [0,1] \quad b_1 < 1, \quad (9)$$

at a constant elasticity $1/(1-b_1)$. We assume that utility is increasing in both arguments and concave. Let λ denote the marginal utility of market consumption:

$$\lambda_t = U_C(C_t, l_t) \alpha_1 \left(\frac{C_{m,t}}{C_t} \right)^{b_1 - 1}, \quad (10)$$

where U_C stands for the derivative of utility with respect to total consumption C_t. The solution to the households' problem needs to satisfy three intra-

[4] The stochastic discount factor in period t is the price of a bond that delivers one unit of currency if a given state of the world realizes in period $t+1$, divided by the conditional probability that the state of the world occurs given the information available in t. The nominal interest rate, R_t, relates to the discount factor according to $(1 + R_t) = \{E_t Q_{t,t+1}\}^{-1}$ by a standard no-arbitrage argument.

temporal conditions:[5]

$$W_t = \frac{U_l(C_t, l_t)}{\lambda_t}, \tag{11}$$

$$\frac{U_l(C_t, l_t)}{(1-\alpha_1)U_C(C_t, l_t)} \left(\frac{C_{n,t}}{C_t}\right)^{1-b_1} = \frac{(1-\alpha_2)C_{n,t}}{h_{n,t}}, \tag{12}$$

$$\frac{\alpha_1}{1-\alpha_1} \left[\frac{C_{m,t}}{C_{n,t}}\right]^{b_1-1} = \frac{\alpha_2 C_{n,t}}{r_t^k K_{n,t}}, \tag{13}$$

where U_l stands for the derivative of utility with respect to leisure. Equation (11) is the standard optimality condition solving for the allocation of time between leisure and market consumption. Equation (12) captures the additional housework-leisure tradeoff and equalizes the marginal rate of substitution between leisure and home consumption to the corresponding relative price, i.e., the marginal productivity of labor in the non-market sector. Similarly, equation (13) requires that the marginal rate of substitution between the two consumption goods is equal to the ratio of returns to capital in the two sectors. Finally, two conventional Euler equations are required for the allocation to be optimal intertemporally, one for the capital stock and one for financial assets:

$$\begin{aligned} \beta E_t \Bigg\{ \frac{\lambda_{t+1}}{\lambda_t} \left[1 + \frac{\xi}{K_t}\left(\frac{K_{t+1}}{K_t} - 1\right)\right]^{-1} \\ \left[1 - \delta + r_{t+1}^k + \xi \left(\frac{K_{t+2}}{K_{t+1}} - 1\right)\left(\frac{K_{t+2}}{K_{t+1}^2}\right)\right]\Bigg\} = 1, \end{aligned} \tag{14}$$

$$\beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} (1 + R_t) \Pi_{t+1}^{-1} \right\} = 1. \tag{15}$$

2.2. Firms

In the economy, there are infinitely many monopolistically competitive firms indexed by $i \in [0, 1]$. Each firm buys market capital and hours worked on perfectly competitive markets in order to produce a variety i of the market good, according to the following production function:

$$Y_t(i) = (K_{m,t}(i))^{\alpha_3} (h_{m,t}(i))^{1-\alpha_3}, \quad \alpha_3 \in [0, 1]. \tag{16}$$

[5] We present the details of households' maximization problem in the Appendix.

We follow Calvo [15] and we assume that in any given period each firm resets its price $P_t(i)$ with a constant probability $(1-\theta)$. At a given price $P_t(i)$, production has to satisfy demand:

$$Y_t(i) = \left[\frac{P_t(i)}{P_t}\right]^{-\varepsilon} Y_t^d, \tag{17}$$

where aggregate demand, Y_t^d, is taken as given. We further assume that production is subsidized by the government, which pays a fraction τ of the unit cost of production, so that the discounted sum of current and future profits reads as

$$E_t \left\{ \sum_{j=0}^{\infty} \theta^j Q_{t,t+j} \left[P_t(i) Y_{t+j}(i) - P_{t+j}(1-\tau) RMC_{t+j} Y_{t+j}(i) \right] \right\}. \tag{18}$$

$Q_{t,t+j}$ denotes the stochastic discount factor in period t for nominal profits j periods ahead

$$Q_{t,t+j} = \beta^j E_t \left\{ \frac{\lambda_{t+j}}{\lambda_t} \Pi_{t,t+j}^{-1} \right\}. \tag{19}$$

The real marginal cost, RMC_t, is constant across firms because of constant returns to scale in production and perfect competition on factor markets and, by cost minimization, it satisfies

$$RMC_t = \frac{r_t^k K_{m,t}(i)}{\alpha_3 Y_t(i)} = \frac{W_t h_{m,t}(i)}{(1-\alpha_3) Y_t(i)}. \tag{20}$$

2.3. Policy and Market Clearing

The fiscal authority buys market varieties, $G_t(i)$, at their market price and aggregate government expenditure, G_t, is defined as

$$G_t = \left[\int_0^1 \left(G_t(i) \right)^{\frac{\varepsilon-1}{\varepsilon}} \, di \right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{21}$$

We assume that the government chooses quantities $G_t(i)$ in order to minimize total expenditure, given G_t. $log(G_t)$ evolves exogenously according to a first-order autoregressive process with persistence ρ_g. Define aggregate output

$$Y_t = \left[\int_0^1 \left(Y_t(i) \right)^{\frac{\varepsilon-1}{\varepsilon}} \, di \right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{22}$$

We assume that the central bank decides on the nominal interest rate by following a Taylor-type rule,

$$(1+R_t) = (1+R_{t-1})^{\rho_m} \left(\beta^{-1} \Pi_t^{\Phi_\pi} \left(\frac{Y_t}{Y_t^n} \right)^{\Phi_y} \right)^{1-\rho_m} \left(\frac{Y_t/Y_t^n}{Y_{t-1}/Y_{t-1}^n} \right)^{\Phi_{dy}}, \quad (23)$$

targeting inflation $\Pi_t \equiv (P_t/P_{t-1})$ as well as output and output growth, both in deviation from the flexible-price equilibrium Y_t^n. ρ_m, Φ_π, Φ_y and Φ_{dy} are parameters chosen by the monetary authority.[6] The clearing of goods, labor and capital markets imply

$$Y_t = Y_t^d = C_{m,t} + I_t + G_t, \quad h_{m,t} = \int_0^1 h_{m,t}(i)\ di, \quad K_{m,t} = \int_0^1 K_{m,t}(i)\ di, \quad (24)$$

and the aggregate production function

$$Y_t = \Delta_t^{-1} \left(K_{m,t}\right)^{\alpha_3} \left(h_{m,t}\right)^{1-\alpha_3}, \quad (25)$$

where Δ_t denotes relative price dispersion

$$\Delta_t \equiv \int_0^1 \left(\frac{P_t(i)}{P_t} \right)^{-\varepsilon} di, \quad (26)$$

which evolves according to

$$\Delta_t = (1-\theta) \left(\frac{P_t^*}{P_t} \right)^{-\varepsilon} + \theta \Pi_t^{\varepsilon} \Delta_{t-1}. \quad (27)$$

It is well known that $log\left(\Delta_t\right)$ is a second-order term and can thus be neglected at a first-order approximation around the non-stochastic steady state.

3. Housework, complementarity and the transmission of fiscal shocks

This section documents that substitutability between home and market goods generates complementarity between consumption expenditure and hours

[6] Among others, this rule has been considered by Smets and Wouters [46]. Due to the production subsidy, the flexible-price equilibrium is constrained efficient, thus the monetary rule targets a welfare-relevant output gap. In a separate appendix, we provide extensive robustness analysis on the monetary rule.

worked on the market, positively affecting the size of fiscal multipliers. We also show that interpreting GHH or JR preferences as equivalent to housework is misleading, because our channel does not imply low wealth effect on hours worked. In addition, while housework can be made observationally equivalent to substitutability between consumption and leisure, modelling housework in reduced form leads to misleading welfare calculations by overlooking substitution between home and market goods. To ease economic intuition, we consider a simplified version of the model without capital accumulation where government expenditure is nil at the steady state. The full-blown version of the model is used below to quantify the importance of complementarity in rationalizing estimated fiscal multipliers.[7]

3.1. Complementarity: housework and the wealth effect on hours worked

To emphasize the generality of our claims we start by leaving preferences unspecified. We use optimality of households' decisions to express market consumption and hours worked on the market as functions of the marginal utility, λ_t, and the real wage:

$$\begin{aligned} \widehat{C}_{m,t} &= -\eta_{Cm,\lambda}\widehat{\lambda}_t + \eta_{Cm,W}\widehat{W}_t, \\ \widehat{h}_{m,t} &= \eta_{hm,\lambda}\widehat{\lambda}_t + \eta_{hm,W}\widehat{W}_t, \end{aligned} \tag{28}$$

where $\widehat{\cdot}$ stands for log-deviations from the steady state. Coefficients denote Frisch [23] elasticities,

$$\eta_{Cm,\lambda} = -\frac{\varphi}{\varphi(\nu-\gamma)+\nu\gamma} > 0, \qquad \eta_{hm,\lambda} = \frac{\eta_{Cm,\lambda} h}{h_m}\left(\frac{\gamma}{\varphi}+\frac{h_n}{h}\right) > 0, \tag{29}$$

$$\eta_{Cm,W} = \frac{h_n}{h}\left(\frac{1}{1-b_1}-\eta_{Cm,\lambda}\right)+\frac{h_m}{h}\left(\frac{\nu}{\varphi(\nu-\gamma)+\nu\gamma}\right),$$

$$\eta_{hm,W} = \eta_{Cm,W}+\eta_{hm,\lambda},$$

[7] We leave all derivations to the Appendix.

and parameters γ, φ and ν relate to the utility function,[8]

$$\gamma \equiv -\frac{U_{C,C}C}{U_C} + \frac{U_{C,l}C}{U_l} \geq 0, \quad \varphi \equiv -\frac{U_{l,l}h}{U_l} + \frac{U_{C,l}h}{U_C} \geq 0, \quad \nu \equiv \frac{U_{C,l}h}{U_C} \leq \frac{\gamma\varphi}{\gamma+\varphi},$$

and variables without time subscript denote a steady state. Market consumption and hours worked on the market are complements ($\eta_{Cm,W} > 0$) if consumption expenditure rises with the real wage, even if life-time income is controlled for (i.e., for λ constant). In other words, the real wage drives consumption by affecting not only income but also the price of leisure and home goods, relative to market goods. If instead complementarity is nil, expenditure is only driven by the income effect, as in the case of preferences that are separable in consumption and leisure ($\nu = 0$) or when the home sector vanishes ($h_n = 0$).

Equations (29) deliver a key message. Irrespective of preferences, the wage-elasticity of hours worked on the market positively contributes to complementarity, while the wealth effect on hours worked dampens it. The more wage-elastic is market labor supply, the stronger is substitution towards market goods when the opportunity cost of time is high, so that complementarity is higher as well. Instead, a sizeable wealth effect on hours worked induces households to smooth more aggressively income gains on all goods, including leisure. Hence, it reduces complementarity by detaining the surge in expenditure due to a wage rise. An important implication of this fact is that any mechanism that magnifies complementarity acts by either increasing the wage-elasticity of market labor supply or by reducing the importance of the wealth effect on hours worked. Hence, all mechanisms that boost complementarity can be classified according to one (or both) of these margins. Following this classification, we can compare housework with alternative preference-based mechanisms.

In a housework model substitutability between home and market goods af-

[8] $\eta_{Cm,\lambda}$ represents the opposite of the wealth effect on market consumption so that it coincides with the inter-temporal elasticity of substitution of C_m in a model without the home sector and preferences that are separable in consumption and leisure. Constraints on γ, φ and ν are necessary and sufficient to guarantee concavity of preferences and joint non-inferiority of consumption and leisure.

fects complementarity through the wage-elasticity of market labor supply, leaving all wealth effects, $\eta_{Cm,\lambda}$ and $\eta_{hm,\lambda}$, unchanged. In particular, complementarity positively depends on the elasticity of substitution between home and market goods, $1/(1-b_1)$. In fact, as home and market goods become better substitutes, the household is more willing to reallocate time and consumption to the market sector when the opportunity cost of time is high. This effect is stronger the larger is the size of the home sector.

Substitutability between consumption and leisure ($\nu < 0$) – as advocated by Bilbiie [9] – can be made equivalent to housework. In fact, γ and φ can be chosen to replicate the dynamics of macroeconomic variables implied by our model, even in the absence of a home sector. Intuitively, substitutability between consumption and leisure can be made large enough to make up for the absence of substitutability between home and market goods. This equivalence however does not hold for any type of preferences. For instance, JR preferences

$$U(C_t, l_t, X_{t-1}) = \frac{\left[C_t - \psi(1-l_t)^{\bar{\nu}} X_t\right]^{1-\bar{\sigma}}}{1-\bar{\sigma}}, \quad X_t = C_t^{\bar{\gamma}} X_{t-1}^{1-\bar{\gamma}}, \quad X_{-1} = 1, \quad (30)$$

are not a reduced-form for housework. In fact, the household's optimality conditions cannot be represented by (28) that changes to

$$\begin{aligned} \widehat{C}_{m,t}^{JR} &= -\eta_{Cm,\lambda}\widehat{\lambda}_t + \eta_{Cm,W}\widehat{W}_t + \eta_{Cm,X}\widehat{X}_{t-1}, \\ \widehat{h}_{m,t}^{JR} &= \eta_{hm,\lambda}\widehat{\lambda}_t + \eta_{hm,W}\widehat{W}_t + \eta_{hm,X}\widehat{X}_{t-1}. \end{aligned} \quad (31)$$

Elasticities with respect to λ and W coincide with expressions (29), but coefficients $\eta_{Cm,X}$ and $\eta_{hm,X}$ are non-zero for $\bar{\gamma} \in (0,1]$. Therefore, even if parameters are calibrated to equalize Frisch elasticities to the ones obtained with housework, dynamics are more persistent because marginal utility depends on the history of consumption.[9]

[9] As we show in the Appendix, an implication of this fact is that JR preferences need higher complementarity and lower wealth effect on hours worked to generate the same impact fiscal multipliers as housework. Dynamic differences cannot be undone.

Finally, GHH preferences – nested by (30) for $\bar{\gamma} = 0$ – imply $\widehat{X} = 0$, $\gamma = 0$ and thus $\eta_{hm,\lambda} = 0$ when $h_n = 0$. Hence, the housework channel is not equivalent to the one embedded in GHH preferences, because only the latter rules out the wealth effect on hours worked, which, however, is documented to be empirically relevant (Imbens et al. [30]).

3.2. Inspecting the mechanism

To gain intuition on the role of substitutability between home and market goods for fiscal multipliers, we cast the simplified model in the canonical New-Keynesian form. Two are the building blocks: the labor-supply schedule and the Euler equation. The first one is obtained by combining equations (28) to eliminate marginal utility:

$$\widehat{h}_{m,t} = \left[\eta_{Cm,W}\left(1 + \frac{\eta_{hm,\lambda}}{\eta_{Cm,\lambda}}\right) + \eta_{hm,\lambda}\right]\widehat{W}_t - \frac{\eta_{hm,\lambda}}{\eta_{Cm,\lambda}}\widehat{C}_{m,t}. \tag{32}$$

Since $\eta_{hm,\lambda} = \eta_{hm,W}$ if $\eta_{Cm,W} = 0$, when complementarity is nil the wage-elasticity of labor supply *given market consumption* coincides with the Frisch-elasticity of labor supply. Positive complementarity instead increases the response of hours worked to the real wage above and beyond $\eta_{hm,W}$, because the household substitutes away from both leisure and housework. Complementarity also affects inter-temporal smoothing of market consumption:

$$\widehat{C}_{m,t} = E_t\widehat{C}_{m,t+1} - \eta_{Cm,\lambda}\left(r_t - E_t\pi_{t+1} + log\beta\right) - \eta_{Cm,W}\left(E_t\widehat{W}_{t+1} - \widehat{W}_t\right), \tag{33}$$

$$r_t \equiv log(1 + R_t), \qquad \pi_t \equiv log(\Pi_t),$$

which obtains after using (28) to substitute for λ into the log-linearized version of (15). Expected real-wage growth increases future marginal utility, inducing the household to postpone current market consumption. As a result, when complementarity is positive, the expansionary effect of an interest-rate cut is stronger (weaker) the higher (the lower) is the current real wage, relative to the future. Labor supply, the Euler equation and feasibility constraints imply

$$y_t = E_t y_{t+1} - \frac{1}{\sigma}\left(r_t - E_t\pi_{t+1} - r_t^n\right), \quad \pi_t = \beta E_t\pi_{t+1} + \frac{(1-\theta)(1-\theta\beta)}{\theta}\kappa y_t, \tag{34}$$

where the following definitions apply

$$\sigma \equiv \left\{ \eta_{Cm,W} \left(1 + \frac{\eta_{Cm,\lambda}}{\eta_{hm,\lambda}} \right) + \eta_{Cm,\lambda} \right\}^{-1}, \quad \kappa \equiv \sigma \left(1 + \frac{\eta_{Cm,\lambda}}{\eta_{hm,\lambda}} \right)$$

$$y_t^n \equiv \frac{\sigma}{\kappa} \widehat{g}_t, \quad \widehat{g}_t = \rho_g \widehat{g}_{t-1} + \vartheta_t, \quad r_t^n \equiv \frac{\sigma(1-\rho_g)}{\kappa \eta_{hm,\lambda}} \widehat{g}_t, \quad y_t \equiv \widehat{Y}_t - y_t^n.$$

y_t^n, r_t^n and y_t stand for natural output, natural interest rate and the output gap, respectively, $\rho_g \in (0,1)$, and ϑ_t is an i.i.d. shock to the share of government purchases in GDP.[10]

A few lessons can be learnt by inspecting the canonical form. To begin with, our model with housework is isomorphic to the baseline New-Keynesian model. If $h_n = 0$, $\eta_{Cm,W} = 0$ and $\kappa = \sigma + \varphi$ as in Galí [25], where a government expenditure shock works through two main channels. On the one hand, the shock reduces the present discounted value of disposable income. Hence, because of a negative wealth effect on hours worked, households find it optimal to work longer hours for any given wage. Since consumption is a normal good, the wealth effect drives market consumption down. It is evident from the expression of natural output that this is the only channel at work in a flexible-price economy: production increases and consumption is crowded out ($\sigma/\kappa < 1$). On the other hand, nominal rigidities generate an aggregate demand effect. The shock pushes the natural interest rate up and, for a given nominal interest rate, stimulates aggregate demand, compressing price markups and consequently raising the real wage. The wealth and the aggregate demand effects reinforce each other in increasing hours worked, but they push real wages and consumption in opposite directions. Nominal rigidities and the response of monetary policy to the shock are key forces in determining the strength of the demand effect and whether market consumption is crowded in or out. In particular, if inflationary pressures are fully offset by the central bank, the output gap remains closed and the

[10]Specifically, $g_t \equiv G_t/Y$, where Y is the steady-state level of market output. In this section we define a process over the share of government spending in GDP, rather than to its level, because $G = 0$ at the steady state so that $(G_t - G)/G$ is not well defined.

economy converges to the flexible-price equilibrium, where consumption falls.[11]

If $h_n > 0$, substitutability between home and market goods steepens the dynamic IS curve and flattens the Phillips curve. Aggregate demand becomes more sensitive to changes in the real interest rate, relative to its natural level. In fact, the initial expansion of aggregate demand triggers a rise in the real wage that, due to complementarity, further expands market consumption. In addition, expansionary policies become less inflationary because higher wage-elasticity of labor supply translates into lower elasticity of the real marginal cost to output. We can then conclude that substitutability between home and market goods acts *exclusively* through the aggregate demand channel and, by leaving the wealth effect on hours worked unaffected, it does not alter the dynamics of natural output.

To analyze the role of substitutability between home and market goods for fiscal multipliers, one cannot abstract from monetary policy, which needs to be kept constant as complementarity varies. Even though there are alternative natural ways to fix monetary policy, the message is clear and robust: complementarity always magnifies fiscal multipliers. Some examples follow. If monetary policy does not fully offset changes in aggregate demand due to government expenditure, the real interest rate falls below its natural level. For a given path of the real interest rate, the higher slope of the IS curve yields a larger positive response of the output gap. Since natural output does not vary with complementarity, the impact on the level of output and consumption is unambiguously larger. For a given response of inflation to the shock, such as $\pi_t = \phi_g \widehat{g}_t$, the output gap is

$$y_t = \frac{\phi_g(1-\beta\rho_g)\theta}{\kappa(1-\theta)(1-\theta\beta)}\widehat{g}_t,$$

so that complementarity magnifies the expansionary effect of government expen-

[11] This point has already been made by Bilbiie [8] who shows that when markups are constant market consumption increases only if leisure is an inferior good. For an empirical argument documenting the importance of monetary accommodation see Canova and Pappa [16] and Bouakez and Eyquem [13].

diture via a reduction of κ.[12] One could finally consider monetary policy rule (23) and, for illustrative purposes, set $\rho_m = \Phi_y = \Phi_{dy} = 0$, $\Phi_\pi = 1.5$. We also restrict to the case of a KPR utility function that implies $\gamma = 1$, $\varphi = h/(1-h)$ and $\nu = h(1 - 1/\eta_{Cm,\lambda})$ where we fix $\eta_{Cm,\lambda}$, h_n, h_m, θ and ρ_g to the values displayed in Table 1. Figure 1 analyzes the impact of an exogenous increase in government expenditure normalized to one percentage point of steady-state GDP on the level of market consumption, hours worked on the market, the real wage and GDP.[13] We express GDP, hours worked and the real wage in terms of percentage deviations from their steady state. Market consumption is reported in percentage points of GDP and its response can be read as a fiscal multiplier. It is evident that the shock becomes more expansionary as substitutability between home and market goods increases.

Finally, a low wealth effect on hours worked is substantially different from the mechanism we study. Similarly to a housework model, it strengthens the aggregate demand channel, but it also affects the dynamics of natural output, which become less responsive to the shock. In the limiting case of GHH preferences, natural output is constant ($\eta_{hm,\lambda} = 0$). This is another word of caution against interpreting GHH and housework as equivalent.

3.3. Welfare: consumption versus expenditure

We conclude by comparing welfare implications of changes in government spending across two alternative models, one that explicitly takes into account housework, and one that only considers substitutability between market consumption and leisure but generates the same dynamics of all market variables.[14] Following [10], we use the nonlinear utility function and the resource constraint

[12] After substituting the output gap in the IS curve to solve for the implied interest rate, say r_t^*, such equilibrium can be implemented with rule $r_t = r_t^* + \phi_\pi(\pi_t - \phi_g \widehat{g}_t)$, $\phi_\pi > 1$.

[13] Accordingly, impulse responses sum gaps to natural levels for each variable.

[14] To ease economic comparison, we limit the analysis to specifications for which substitutability between consumption and leisure can be made equivalent to housework. For this reason we exclude JR preferences, as they are not equivalent to houswork (see Section 3.1).

to take into account the resource cost of inflation. We obtain

$$\frac{dU}{dG} = \lambda_t W_t \Delta_t \left[\underbrace{\left(\frac{1}{W_t \Delta_t} - 1 \right) \frac{dC_m}{dG}}_{\text{multiplier channel}} - \underbrace{1}_{\text{income effect}} - \underbrace{\frac{C_{m,t}}{\Delta_t} \frac{d\Delta}{dG} - \frac{G_t}{\Delta_t} \frac{d\Delta}{dG}}_{\text{inflation distortion}} \right], \quad (35)$$

which has the same form as the one in [10], irrespective of whether housework is included or not. The multiplier on market consumption, dC_m/dG, positively contributes to welfare if the ratio of the marginal rate of transformation to the marginal rate of substitution between consumption and leisure, $(\Delta_t W_t)^{-1} > 1$, is positive. This is the case when the output gap is negative, i.e. when price markups push the real wage below the marginal productivity of labor on the market. Terms labeled "income effect" and "inflation distortion" refer to the resource cost of government spending, which is pure waste, and the inflation cost stemming from price stickiness, respectively. Overall, a change in welfare due to higher government spending is positive under two conditions: if the multiplier channel is positive; if the gain of expanding market consumption compensates for the costs, which can only happen when the output gap is negative.

Since the two alternative models are observationally equivalent, welfare comparisons are straightforward. In fact, the only difference stems from the dynamics of marginal utility, λ_t. It is clear from equations (28) and (29) that the marginal utility of market consumption increases with the elasticity of substitution between home and market goods and the size of the home sector, for given market consumption and the real wage. Since welfare is scaled by λ_t, abstracting from housework understates costs *and* benefits of changes in government spending.

Assume that the shock hits the economy when the output gap is closed. Following an increase in government spending, the output gap turns positive and welfare falls. The welfare cost is however understated if housework is neglected, because substitution away from home goods is not taken into account. Assume instead that the shock hits the economy when the output gap is negative. Since workers are paid less than their marginal productivity on the market, they substitute into both leisure and home production, which are inefficiently high. Accordingly, if the multiplier channel is strong enough to compensate for the costs, the model without housework overlooks the benefit of reducing the inefficiently high consumption of home goods.

We conclude that neglecting housework delivers misleading welfare calculations if substitution between home and market goods is important, as confirmed by microeconomic evidence.

4. Housework and fiscal multipliers

To give a more general character to our results we turn to the model presented in Section 2 and calibrate it to match the size of the home sector, relative to the market, as observed in the data. Evidence on the substitutability between home and market goods is then used to discipline the complementarity between consumption expenditure and hours worked on the market. We then assess the quantitative relevance of complementarity for fiscal multipliers and conclude by conducting extensive robustness exercises. Table 1 summarizes parameter values and the corresponding source and/or calibration targets.

4.1. Data

We collect seasonally adjusted time series of capital, investment, market consumption, government expenditure and the GDP deflator (price index for gross domestic product) from the U.S. Bureau of Economic Analysis. All the series refer to the time period 1950:Q1–2007:Q2, which excludes the financial crisis. Data are available at a quarterly frequency, with the exception of capital, which is annual. The series have been downloaded in current dollars and divided by the GDP deflator. Market consumption includes non-durable goods and services, net of services from housing and utilities, commonly considered as part of the home sector (e.g., McGrattan et al. [33]). Consistently, we assign fixed non-residential assets to market capital and residential assets and the stock of durable goods to home capital. We obtain total investment by adding purchases of durable goods to the fixed investment component, both residential and non-residential, but we leave out inventories as in Smets and Wouters [46]. For government expenditure, we only include purchases of goods, while we omit purchases of non-military durable goods and structures. A measure of GDP is derived consistently with the model by summing up market consumption, investment and government expenditure. We measure time use by relying on the information contained in the American Time Use Survey (ATUS), as summarized by Aguiar et al. [2], over the period 2003–2010. We exclude sleeping, eating and personal care from the time endowment.[15]

4.2. Baseline calibration

All variables without time subscript denote a steady state. We fix β to 0.99 and $\Pi = 1$, implying an annual real interest rate on bonds of roughly 4 percent per year, and we specify a KPR utility function,

$$U(C_t, l_t) = \frac{\left[(C_t)^b (l_t)^{1-b}\right]^{1-\sigma} - 1}{1-\sigma}, \quad b \in (0,1), \quad \sigma \geq 1.$$

Parameters α_1, α_2, α_3, G, δ and b are chosen to match the steady-state value of the following variables with their sample average: the ratio of investment to the capital stock, $i \equiv I/K$, capital-output ratios, $k_m \equiv K_m/Y$ and $k_n \equiv K_n/Y$, hours worked, h_m and h_n, and the share of government expenditure in GDP, $g \equiv G/Y$. Parameters δ, α_3 and G, together with prices and market quantities, are determined through the Euler equation on capital (14), firms' optimality and market feasibility:

$$\delta = i, \quad r^k = \frac{1-\beta(1-\delta)}{\beta}, \quad \alpha_3 = r^k k_m, \quad Y = k_m^{\frac{\alpha_3}{1-\alpha_3}} h_m, \tag{36}$$

[15] As reported by Aguiar et al. [2] in Table B1 of their online appendix, the average respondent devotes 31.62 hours to market work and 18.12 hours to home production per week. Our figures obtain after subtracting from the weekly time endowment sleeping, personal care and eating, for a total of 72.92 hours. Instead, if those activities are included, market work and home production time result in 0.18 and 0.11, respectively. Both ways of accounting time are used in the home production literature. We choose the former in our benchmark calibration, but our results are robust to the latter definition.

$$C_m = Y\left(1 - g - \delta(k_m + k_n)\right), \quad G = gY, \quad W = (1-\alpha_3)Y/h_m.$$

Households' optimality and housework technological constraints determine α_1, α_2 and b, together with non-market variables:

$$\alpha_2 = \frac{k_n r^k Y}{k_n r^k Y + W h_n}, \quad C_n = (k_n Y)^{\alpha_2} h_n^{1-\alpha_2}, \quad \alpha_1 = \frac{\frac{(1-\alpha_2)C_n^{b_1}}{W h_n}}{C_m^{b_1 - 1} + \frac{(1-\alpha_2)C_n^{b_1}}{W h_n}}, \quad (37)$$

$$h = h_m + h_n, \qquad l = 1 - h, \qquad b = \frac{(1-\alpha_2)C_m + W h_n}{(1-\alpha_2)(Wl + C_m) + W h_n}.$$

The corresponding parameters are consistent with the ones typically found in the home production literature – see for instance Aruoba et al. [3].

Parameters ε, θ, ξ and σ only affect dynamics and we choose them by referring to previous studies. The elasticity of substitution between market varieties, $\varepsilon = 11$, matches a 10 percent steady-state markup, while $\theta = 0.75$ implies a conventional price duration of four quarters. A production subsidy, $\tau = 1/\varepsilon$, offsets the steady-state distortion due to monopolistic competition. As far as capital adjustment costs are concerned, estimates on the private investment multiplier range from mildly positive to negative.[16] We calibrate ξ for the model to generate a mid-range private-investment multiplier of -0.1. We choose σ to fix the wealth effect on market consumption to 0.5.[17] We also restrict to monetary rule (23) under the assumption that $\rho_m = \Phi_y = \Phi_{dy} = 0$ and $\Phi_\pi = 1.5$.

4.3. Quantitative Relevance of Complementarity

A variety of macro- and micro-economic studies suggests that substitutability between home and market goods falls in the empirically relevant range $[1.5, 4]$. The preferred calibration chosen by Benhabib et al. [7] in their seminal contribution is 5, which retrospectively is probably too high. McGrattan et al.

[16] See e.g., Fatas and Mihov [22], Blanchard and Perotti [12], Perotti [40], Mountford and Uhlig [37].

[17] As argued in Hall [29] the empirical studies on the inter-temporal elasticity of substitution might not reveal the wealth effect on consumption if complementarity is not taken into account. However, Basu and Kimball [5], who estimate σ^{-1} allowing for non separability between consumption and leisure, find values consistent with other studies ($\sigma^{-1} \in [0.35, 0.6]$).

[33] use macroeconomic data to estimate the model by Benhabib et al. [7] via maximum likelihood and find values between 1.5 and 1.8. In the same vein, Chang and Schorfheide [18] use Bayesian techniques and estimate an elasticity of about 2.3. Karabarbounis [32] shows that a value of 4 accounts for cyclical fluctuations of the labor wedge. More on the micro side, Rupert, Rogerson and Wright [45] estimate the restrictions that a housework model imposes on consumption expenditure, market work, housework and wages, all of which are observed in PSID data, and find an elasticity of substitution between 1.8 and 2. Aguiar et al. [2] use data from the American Time Use Survey (ATUS). After establishing that home production absorbs about 30 percent of foregone market hours worked at business cycle frequencies, they show that the Benhabib et al. [7] model is consistent with the ATUS evidence under a 2.5 elasticity.

The size of fiscal multipliers depends on a number of factors such as the type of government spending, its persistence and how it is financed. Our model captures a temporary, but persistent, unexpected increase in deficit-financed government-consumption expenditures that do not affect households' and firms' decisions directly, i.e. they do not enter preferences and private production functions. Ramey [41] provides an extensive survey of the empirical literature that measures the effects of such a shock on GDP, suggesting a multiplier between 0.8 and 1.5. Importantly, despite significant differences in samples and identification methods, one can safely conclude that the literature agrees on this range. The private consumption multiplier is instead a source of divide. If the shock is identified using war dates or revisions of future defense spending (Ramey and Shapiro [43], Edelberg et al. [20], Burnside et al. [14], and Ramey [41]), consumption multipliers on impact are mildly negative hovering -0.1 or insignificant (see Hall [28] for a survey). If the shock is identified using a SVAR or a sign-restrictions approach (Fatas and Mihov [22], Mountford and Uhlig [37], Blanchard and Perotti [12]), private consumption is crowded in. In particular, Galí et al. [26] find that the consumption multiplier ranges from 0.17 on impact to 0.95 after eight quarters, using the 1954:Q1–2003:Q4 sample which excludes the Korean war that was largely financed with taxes. Perotti [40] controls for taxes on the post-WWII sample and finds consumption multipliers of about 0.5 in response to exogenous defense spending shocks.[18] We abstract from the issue of whether multipliers are larger in recessions (Auerbach and Gorodnichenko [4]) or when the zero lower bound binds (Christiano et al. [19] and Eggertsson [21]).[19] Accordingly, we refer to estimates that average consumption responses over recessionary and expansionary periods and periods of loose or tight monetary policy. Finally, we also abstract from the stimulus package implemented during the recent financial crisis. In fact, as pointed out by Oh and Reis [39], government consumption barely increased in 2009 and 2010 because the package was mostly allocated to transfers. Our representative-agent model without borrowing constraints is necessarily silent about this type of policy intervention.

Figure 2 shows that for the empirically relevant range of b_1 the housework model delivers fiscal multipliers that agree with the VAR evidence, irrespective of whether capital is included or not, and of whether either housing or durable goods are excluded from the home capital stock. In particular, for the middle-range value of substitutability, the consumption multiplier is mildly positive and amounts to 0.10 percent, while the output multiplier is roughly equal to 1. The implied Frisch elasticity of labor supply, $\eta_{hm,W}$, is fairly high and about 1.6, but it is consistent with the value advocated by Hall [29], accounting for both the intensive and the extensive margins of employment.

4.4. Robustness

Modeling assumptions and parametrization may hide forces that under- or overestate the quantitative importance of our channel.[20] First, our findings are robust to the case of constant-elasticity-of-substitution (CES) production

[18] As argued by Ramey [42], federal non-defense spending is negligible in the United States, while state and local non-defense spending – public education, health, and public safety – likely has direct productive effects on the economy which we do not capture in the model.

[19] Yet consensus still has to be reached in this respect. For instance, see (Ramey and Zubairy [44]).

[20] We leave all derivations in the Appendix.

functions and of steady-state distortionary taxation – which we assume not to respond to the shock since we focus on deficit spending. Second, habit persistence in consumption does not alter the mapping of b_1 into complementarity in a quantitatively relevant manner, but rather magnifies fiscal multipliers through the intertemporal margin, by lowering wealth effects on consumption and hours worked.[21] Finally, sluggish adjustment of real wages, modeled as in [11], dampens the aggregate demand effect of government spending and ultimately leads to lower fiscal multipliers, similarly to Monacelli et al. [36].[22] Nevertheless, for the mid-range value of b_1 the consumption multiplier is still mildly positive and the output multiplier hovers 1. Figures 3 and 4 illustrate these results.

In regard to our baseline parametrization, additionally to price stickiness and b_1, several features are naturally expected to be relevant: risk aversion, σ; the capital adjustment cost, ξ; the monetary rule; the persistence of the shock, ρ_g. Hence, we perform robustness exercises following Canova and Paustian [17]. We consider $50,000$ parameter draws from uniform distributions over an empirically relevant range: $\theta \in [0.2, 0.9]$, $\sigma \in [1, 4]$, $\xi \in [0, 500]$, $\rho_m \in [0, 0.9]$, $\Phi_\pi \in [1.05, 2.5]$, $\Phi_y \in [0.05, 0.25]$, $\Phi_{dy} \in [0.15, 0.30]$ and $\rho_g \in [0, 0.95]$. For convenience, we collect and report these values in Table 2. We obtain a distribution of impulse response functions and report the median impact multiplier of market consumption in Figure 5. We display the results both for a given value of θ and for the case where θ is randomly drawn. The experiment confirms our main results.

5. Conclusion

Recent theoretical contributions point to complementarity between consumption and hours worked as an important driver of fiscal multipliers. This paper shows that substitutability between home and market goods offers a nat-

[21]This result is in line with Monacelli and Perotti [34].

[22]We do not plot elasticities in this case because they are hardly interpretable given that, as argued by [11], rigidities capture distortions rather than preferences.

ural interpretation of complementarity and confirms its quantitative relevance. However, we also show that explicitly modeling housework is preferable to hard-wiring complementarity in preferences over consumption and leisure. On the one hand, most of the alternatives commonly used in the literature, such as JR or GHH preferences, are not equivalent to housework. On the other hand, in a model with complementarity, housework matters for welfare: neglecting substitutability between home and market goods leads to misleading welfare policy evaluation, because it obscures welfare-relevant differences between consumption expenditure and actual consumption.

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Mnemonic	Value	Target/Source
β	0.99	4% average real return
ϵ	11	10% price markup
θ	3/4	price duration
ξ	250	private-investment multiplier -0.1
σ	2	wealth effect on private market consumption 0.5
ρ_g	0.8	Monacelli and Perotti [34, 35]
α_1	0.5513	$K_m/Y = 5.16$
α_2	0.3278	$h_m = 0.33$
b	0.5083	$K_n/Y = 6.76$
α_3	0.1765	$h_n = 0.19$
δ	0.0241	$I/K = 0.0241$
G	0.0601	$G/Y = 0.18$
b_1	0.75	4% elasticity of substitution between C_m and C_n

Table 1: Benchmark Calibration

Parameter	Description	Support
θ	price stickiness	$[0.2, 0.9]$
σ	risk aversion	$[1, 4]$
ξ	capital adjustment cost	$[0, 500]$
ρ_g	AR(1) parameter government spending	$[0, 0.95]$
ρ_m	interest rate smoother	$[0, 0.9]$
Φ_π	policy response to inflation	$[1.05, 2.5]$
Φ_y	policy response to output gap	$[0.05, 0.25]$
Φ_{dy}	policy response to growth in output gap	$[0.15, 0.30]$

Table 2: Support for the structural parameters in the Canova-Paustian simulations

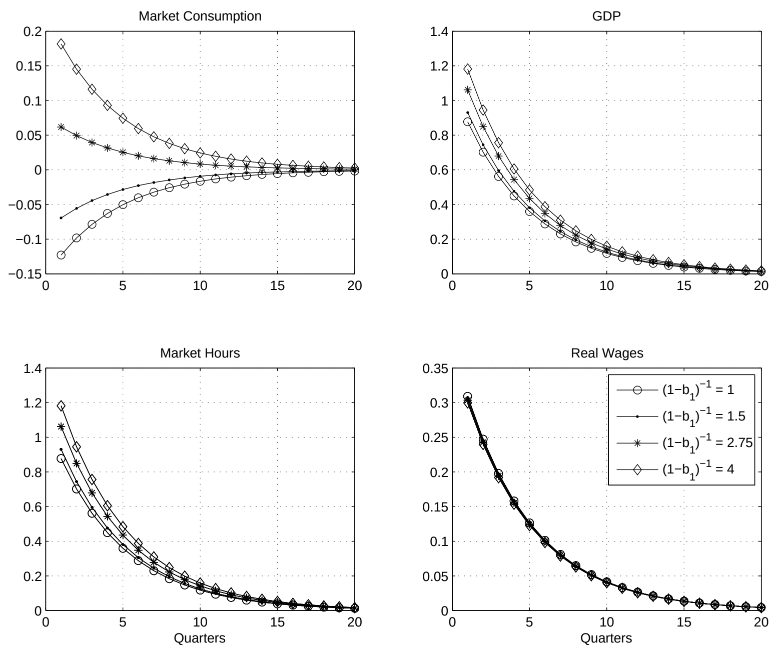

Figure 1: Impulse response functions to an exogenous increase in government expenditure normalized to one percentage point of steady-state GDP in a housework model with $K_m/Y = K_n/Y = G/Y = 0$.

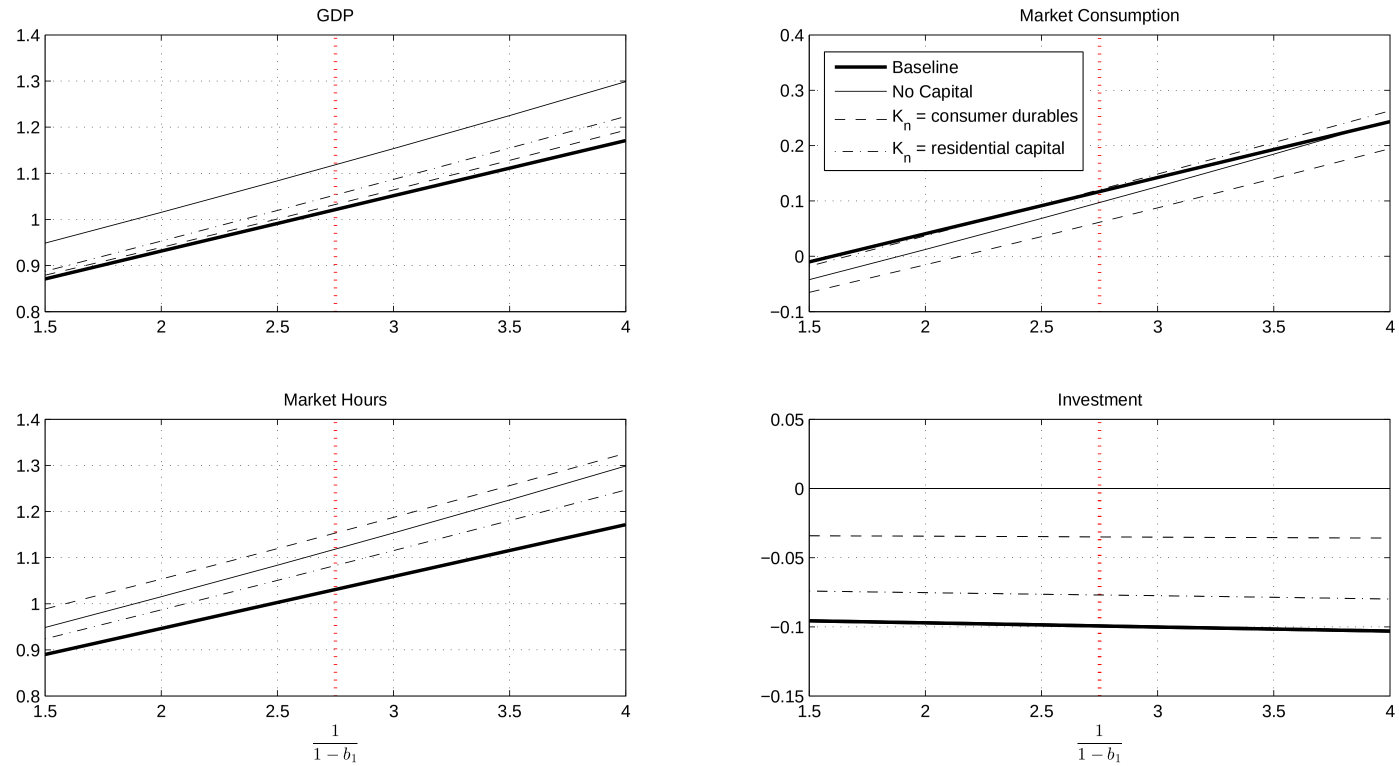

Figure 2: Fiscal multipliers of GDP, market consumption, market hours and investment to an exogenous increase in government expenditure normalized to one percentage point of steady-state GDP, for different values of the elasticity of substitution between home and market goods, $(1-b_1)^{-1}$, and for different capital specifications: Baseline $K_m/Y = 5.16$ and $K_n/Y = 6.76$; No capital $K_m/Y = K_n/Y = 0$; Consumer Durables $K_n/Y = 1.61$; Residential Capital $K_n/Y = 5.14$.

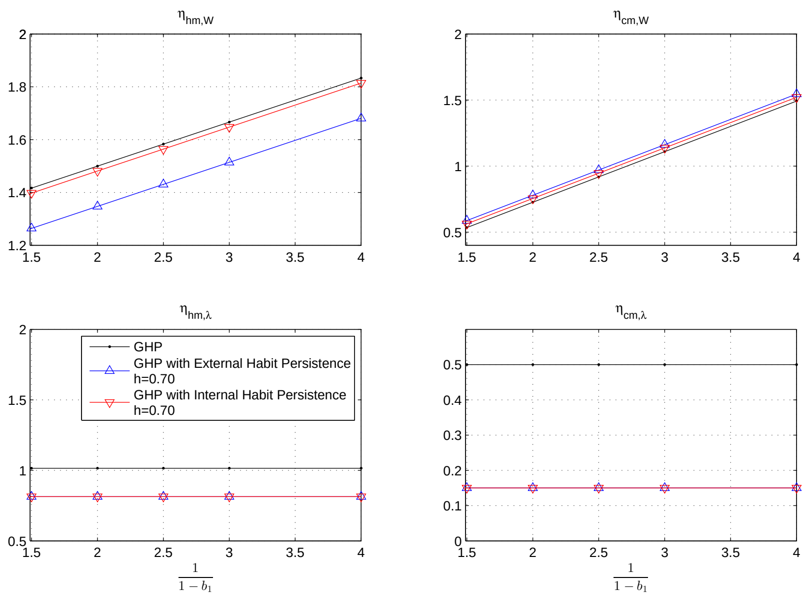

Figure 3: Frisch elasticities in versions of the housework models with external or internal habit persistence.

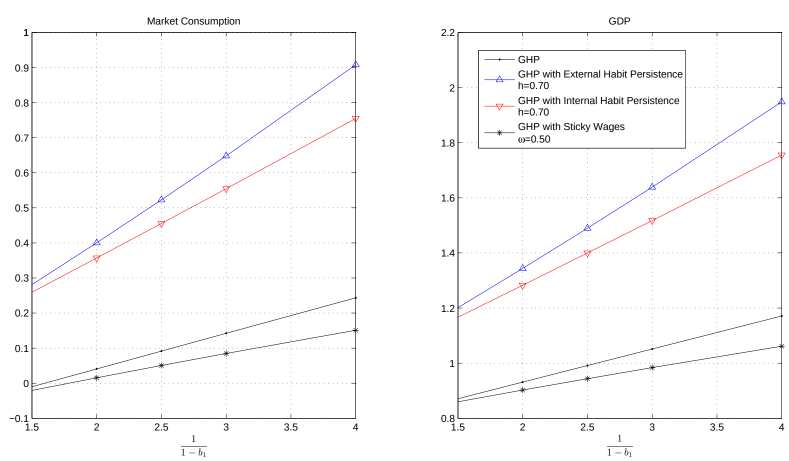

Figure 4: Impact fiscal multipliers in versions of the housework models with external or internal habit persistence, or with real wage stickiness.

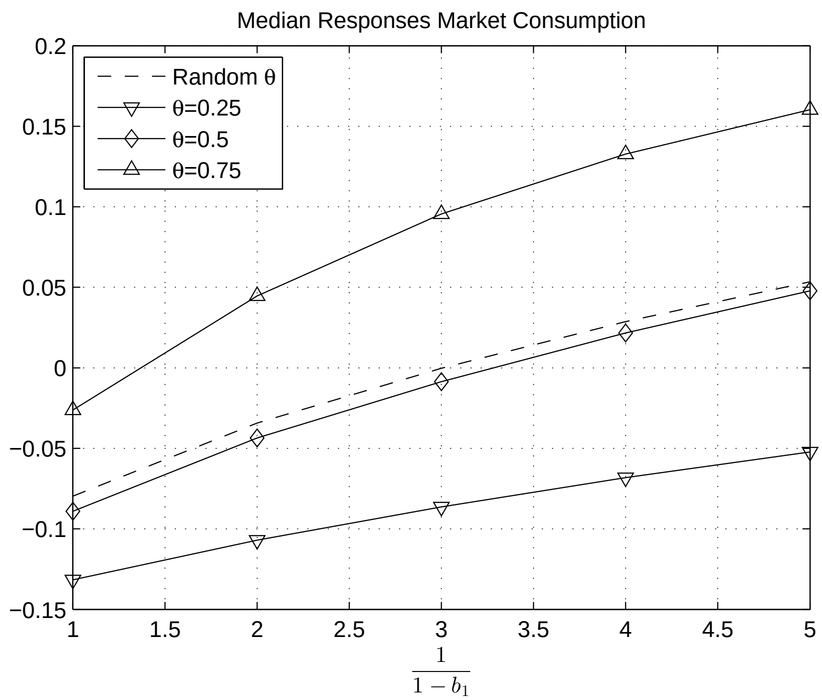

Figure 5: Median impact fiscal multipliers of market consumption to a G shock for $50,000$ draws from uniform distributions of the following parameters, with their respective bounds, as summarized in Table 2: $\theta \in [0.2, 0.9]$, $\sigma \in [1, 4]$, $\xi \in [0, 500]$, $\rho_m \in [0, 0.9]$, $\Phi_\pi \in [1.05, 2.5]$, $\Phi_y \in [0.05, 0.25]$, $\Phi_{dy} \in [0.15, 0.30]$, $\rho_g \in [0, 0.95]$. All remaining parameters are chosen as in Table 1.