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Does Government Spending Crowd In Private Consumption? Theory and Empirical Evidence for the Euro Area

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Does Government Spending Crowd In Private Consumption?
Theory and Empirical Evidence for the Euro Area

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Abstract

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In this paper, we revisit the effects of government spending shocks on private consumption within an estimated New-Keynesian DSGE model of the euro area featuring non-Ricardian households. Employing Bayesian inference methods, we show that the presence of non-Ricardian households is in general conducive to raising the level of consumption in response to government spending shocks when compared with the benchmark specification without non-Ricardian households. However, we find that there is only a fairly small chance that government spending shocks crowd in consumption, mainly because the estimated share of non-Ricardian households is relatively low, but also because of the large negative wealth effect induced by the highly persistent nature of government spending shocks.

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I. INTRODUCTION

Recent years have witnessed the development of a new generation of New-Keynesian dynamic stochastic general equilibrium (DSGE) models that build on explicit microfoundations with optimizing agents. Major advances in estimation methodology allowed estimating variants of these models that are able to compete with more standard time-series models, such as vector autoregressions. Accordingly, the new generation of microfounded DSGE models provides a framework that appears particularly suited for evaluating the consequences of alternative macroeconomic policies.

While the literature has largely focused on using variants of the New-Keynesian DSGE model to analyze the consequences of monetary policy, we are interested in elucidating the effects of fiscal policy within such framework. Specifically, we focus on the effects of government spending shocks on private consumption—an issue which has been at centre stage of the policy debate for quite a long time. Standard versions of the New-Keynesian DSGE model typically predict a strong negative response of consumption to government spending shocks, while the empirical literature suggests that such shocks have a positive or, at least, no significant negative effect on consumption (see, e.g., Perotti, 2002; Fatás and Mihov, 2001; Canzoneri, Cumby and Diba, 2002; Mountford and Uhlig, 2001; and Galí, López-Salido and Vallés, 2004). Clearly, in order to provide reliable policy advice, it is of key importance to ascertain to which extent models used for quantitative policy analysis can be reconciled with this established feature of the data.

The main reason for the failure of standard DSGE models to predict a positive consumption response to government spending shocks has already been identified in a much simpler Real Business Cycle (RBC) framework by Baxter and King (1993). As the authors show, government spending shocks (financed by lump-sum taxes) generate a negative wealth effect which induces households to work more but to consume less. Following the earlier analysis by Baxter and King, there have been several attempts in the recent literature to resolve the apparent consumption puzzle. Linnemann and Schabert (2003), for example, analyze the effects of government spending shocks in a standard New-Keynesian sticky-price model. The idea of introducing imperfect competition together with sticky prices into the RBC framework was promising for at least two reasons. First, imperfect competition generates an aggregate demand externality according to which an increase in output leads to a rise in profits and income. Higher profits and income in turn may help to offset the negative wealth effect. Second, sticky prices raise the possibility that labour demand reacts stronger than labour supply, with real wages increasing alongside labour supply. However, as shown by Linnemann and Schabert, in the standard New-Keynesian model a positive consumption response can only arise if monetary policy is sufficiently accommodative. Even a modestly aggressive monetary policy rule implies a sharp decline in consumption after a government spending shock because the households' consumption choice is still dominated by the negative wealth effect. Thus, any successful attempt to resolve the consumption puzzle must aim at dampening the dominant role of the latter.

In the standard New-Keynesian model, the negative wealth effect is amplified by the fact that all households are forward looking and able to smooth consumption by trading in physical and/or

financial assets. As a consequence, consumption is a function of permanent rather than current disposable income and "Ricardian equivalence" holds. However, there is growing scepticism whether such framework represents a good approximation to reality. Empirically, consumption seems to track current income more closely than predicted by standard representative-agent models (see, e.g., Hall, 1978; and Campbell and Mankiw, 1989). In the light of this observation, Mankiw (2000) has emphasized the need to build a new type of model for analyzing the effects of fiscal policy shocks. Such type of model should allow for heterogeneity of a particular form: some households should act in an optimizing, fully forward-looking manner, while others ought to follow a simple rule of thumb that renders consumption smoothing impossible. Mankiw argues that such form of heterogeneity can be easily reconciled with stylized facts at both the micro and macro level. First, by reviewing micro studies on the consumption pattern of households in the United States, Mankiw provides evidence supporting the view that consumption tracks current income far more than it should. Evidently, there are many reasons why consumption smoothing is far from perfect, amongst which the existence of borrowing and/or liquidity constraints, myopia on the part of households and very high discounting are obvious candidates. Second, based on the shape of the wealth and income distributions in the United States, Mankiw concludes that a large fraction of households does not save and therefore does not have the means to smooth consumption.

On the basis of this evidence, Galí, López-Salido and Vallés (2004) have extended the standard New-Keynesian sticky-price model by allowing for the coexistence of "non-Ricardian" and "Ricardian" households, with the former following a rule-of-thumb and simply consuming their after-tax disposable income each period and the latter optimizing in a forward-looking manner and thereby smoothing consumption over time. Galí et al. demonstrate how the interaction of the two types of households with firms that infrequently adjust prices and a fiscal authority which issues debt to finance part of its expenditure can account for the existing evidence on the effects of government spending shocks. Notwithstanding, the quantitative impact of a government spending shock on consumption largely depends on the degree of debt financing and on whether the real wage increases or decreases on impact. As a consequence, the response pattern of consumption is highly dependent on the form of the fiscal policy rule and on how the real wage is determined in the labour market. Regarding the latter, Galí et al. assume the existence of a generalized wage schedule according to which households are willing to meet firms' demand for labour at the real wage offered. This assumption allows generating a sharp increase in the real wage after a government spending shock which in turn helps to offset the negative wealth effect. However, as argued in Bilbiie and Straub (2004a), such sharp increase is at odds with the observed a-cyclical behavior of the real wage. Indeed, since standard RBC models predict strongly pro-cyclical movements in the real wage, shocks to government spending have naturally been thought of as an additional source of fluctuations that could help reduce the predicted strong pro-cyclical pattern (see, e.g., Christiano and Eichenbaum, 1992). Moreover, the real-wage response to government spending shocks tends to be small empirically (see, e.g., Fatás and Mihov, 2001).

In the light of this discussion, we revisit the effects of government spending shocks on consumption utilizing an extended version of the estimated euro area model by Smets and Wouters

(2003). This model supplements the standard New-Keynesian DSGE model with sticky prices by adding sticky wages and various types of real frictions in an attempt to capture the high degree of persistence characterizing macroeconomic time series. In our extended version of this model we allow, like Galí et al., for the coexistence of non-Ricardian and Ricardian households. In addition, we allow for a more detailed fiscal policy framework with a fiscal policy rule in place that stabilizes the evolution of government debt and with different types of distortionary taxes as well as lump-sum taxes/transfers. Adopting the empirical approach used by Smets and Wouters, we first employ Bayesian estimation methods to determine the relative importance of non-Ricardian households in the euro area under different assumptions regarding the fiscal policy framework. We then proceed to analyze the influences of non-Ricardian households and fiscal policy on the equilibrium dynamics of the estimated model. In particular, we investigate the role played by non-Ricardian households in the propagation of government spending and monetary policy shocks and in accounting for observed fluctuations in consumption.

Our results indicate that the estimated share of non-Ricardian households in the euro area is relatively small, suggesting that financial deregulation over the last two decades has lowered financial-market participation costs and lending support to the observation that the effects of fiscal policy have become weaker over time (see, e.g., Fatás and Mihov, 2001; and Perotti, 2002). At the same time, we find that the inclusion of non-Ricardian households in our model has important consequences for the estimation of the preference parameters influencing the intertemporal consumption choices of Ricardian households. In particular, the Ricardian households' willingness to smooth consumption is found to be lower than in the benchmark specification without non-Ricardian households. This, at least partially, offsets the positive impact that non-Ricardian households exert on consumption in response to government spending shocks. Nevertheless, we show that, when compared with the benchmark specification, the inclusion of non-Ricardian households is in general conducive to raising the level of consumption in response to a government spending shock, notably in an environment where the tax burden largely rests with Ricardian households. As a practical matter, however, we find that there is only a fairly small chance that a government spending shock crowds in consumption, mainly because the estimated share of non-Ricardian agents is relatively low, but also due to the large negative wealth effect induced by the highly persistent nature of government spending shocks. In contrast to the calibrated model used by Galí et al., we observe that our estimated model does not generate a sharp increase in the real wage that would help to offset the negative wealth effect. Finally, we document that reasonable variations in the parameters of the estimated model have no qualitative impact on our findings.

The remainder of this paper is organized as follows. Section II outlines our extended version of the Smets-Wouters (2003) model featuring non-Ricardian households. Section III briefly describes our empirical approach to estimating the extended model and documents the estimation results. Section IV investigates the importance of non-Ricardian households for shaping the propagation of government spending and monetary policy shocks and for explaining fluctuations in consumption. Section V reports the results of additional sensitivity analysis, and Section 6 concludes.

II. THE MODEL

Our model is an extended version of the medium-scale New-Keynesian DSGE model of the euro area developed by Smets and Wouters (2003), henceforth referred to as SW (2003). This model features four types of economic agents: households, firms, a monetary authority, and a fiscal authority, the latter being completely passive though. In our extended version, we allow for two different types of households: optimizing households, who can trade in asset markets and thus are able to smooth consumption, and liquidity constrained households, who cannot participate in asset markets and therefore just consume their after-tax disposable income. We also allow for a richer fiscal policy framework with a fiscal policy rule stabilizing the fiscal authority's intertemporal budget and with distortionary taxes as well as lump-sum taxes/transfers. In the following we briefly outline the behaviors of the different types of agents.

A.   Households

There is a continuum of households indexed by $h \in [\, 0, 1 \,]$. A share $1 - \omega$ of this continuum of households—referred to as Ricardian households and indexed by $i \in [\, 0, 1 - \omega \,)$—have access to financial markets, where they buy and sell government bonds, and accumulate physical capital, the services of which they rent out to firms. The remaining share ω of households—referred to as non-Ricardian households and indexed by $j \in [\, 1 - \omega, 1 \,]$—do not trade in assets and simply consume their after-tax disposable income.[2] It is assumed that the households supply differentiated labour services to a continuum of unions within the household sector—indexed over the same range as the households, $h \in [\, 0, 1 \,]$—which act as wage setters in monopolistically competitive markets. The unions pool the wage income of all households and then distribute the aggregate wage income in equal proportions amongst the latter. Formally, this may be justified by the existence of state-contingent securities that are traded among unions in order to insure households against variations in household-specific wage income. The households, in turn, are assumed to supply sufficient labour services to satisfy labour demand.

Ricardian Households

Each Ricardian household i maximizes its lifetime utility by choosing consumption, $C_{i,t}$, investment, $I_{i,t}$, next period's financial wealth in form of one-period government bonds, $B_{i,t+1}$, next period's physical capital stock, $K_{i,t+1}$, and the intensity with which the installed capital stock

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[2]While the notion of non-Ricardian behaviour typically refers to the misperception on the part of agents that a reduction in current taxes financed by a rise in government debt (i.e., by higher future tax liabilities) represents an increase in wealth, we follow the convention in the literature and label those households that do not trade in assets and simply consume their disposable income as non-Ricardian. Alternatively, Erceg, Guerrieri and Gust (2003) refer to hand-to-mouth households in this context.

is utilized, $Z_{i,t}$, given the following lifetime utility function:

$$\mathrm{E}_t \left[\sum_{k=0}^{\infty} \beta^k \varepsilon_{t+k}^b \left(\frac{1}{1-\varsigma} \left(C_{i,t+k} - \vartheta\, C_{i,t+k-1}^* \right)^{1-\varsigma} - \frac{\varepsilon_{t+k}^n}{1+\zeta} \left(N_{i,t+k} \right)^{1+\zeta} \right) \right]. \tag{1}$$

Here, β is the discount factor, ς denotes the coefficient of relative risk aversion and ζ is the inverse of the elasticity of work effort with respect to the real wage. The parameter ϑ measures the degree of external habit formation in consumption. Thus, the household's utility depends positively on the difference between the current, individually chosen level of consumption, $C_{i,t}$, and the average consumption level that was chosen in the previous period by the Ricardian peer group, $C_{i,t-1}^*$, and negatively on labour supply, $N_{i,t}$.[3] Two serially correlated shocks enter the utility function: $\varepsilon_t^b = \rho_b\, \varepsilon_{t-1}^b + \eta_t^b$ is a preference shock that affects the Ricardian household's willingness to smooth consumption over time, and $\varepsilon_t^n = \rho_n\, \varepsilon_{t-1}^n + \eta_t^n$ represents a shock to labour supply.

The Ricardian household faces the following budget constraint (expressed in real terms):

$$(1 + \tau^c)\, C_{i,t} + I_{i,t} + R_t^{-1} \frac{B_{i,t+1}}{P_t} + \Psi(Z_{i,t})\, K_{i,t} \tag{2}$$

$$= \frac{(1 - \tau^d)}{(1 + \tau^w)} \frac{W_t}{P_t}\, N_t + (1 - \tau^d) \frac{R_t^K}{P_t}\, Z_{i,t}\, K_{i,t} + \tau^d\, \delta\, K_{i,t} + (1 - \tau^d) \frac{D_{i,t}}{P_t} + \frac{T_{i,t}}{P_t} + \frac{B_{i,t}}{P_t},$$

where the terms on the left-hand side show how the household uses its resources, while the terms on the right-hand side indicate the resources the household has at its disposal. R_t denotes the risk-less return on government bonds, and P_t is the aggregate price level. The function $\Psi(\cdot)$ represents the cost of varying the intensity of capital utilization. R_t^K indicates the rental rate for the capital services rent out to firms, $Z_{i,t}\, K_{i,t}$, and $D_{i,t}$ are the dividends paid by household-owned firms. The fiscal authority absorbs part of the gross income of the household to finance government expenditure. τ^w is the pay-roll tax rate levied on the household's pooled wage income, $W_t\, N_t$, while τ^d denotes the income tax rate levied on all sources of income (except for the returns on government bonds and minus physical capital depreciation), and τ^c is the consumption tax rate.[4] $T_{i,t}$ indicates lump-sum taxes paid (or transfers received).

The capital stock owned by the Ricardian household evolves according to the following capital accumulation equation,

$$K_{i,t+1} = (1 - \delta)\, K_{i,t} - (1 - \Upsilon(\varepsilon_t^i I_{i,t}/I_{i,t-1}))\, I_{i,t}, \tag{3}$$

where δ is the time-invariant depreciation rate, $\Upsilon(\cdot)$ represents a generalized adjustment cost function in investment, and $\varepsilon_t^i = \rho_i\, \varepsilon_{t-1}^i + \eta_t^i$ is a serially correlated shock affecting investment

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[3]The pooling of wage income ensures that the marginal utility of wealth out of wage income is identical across Ricardian households. As a result, $C_{i,t} = C_{i,t}^*$ holds in equilibrium.

[4]For simplicity, we assume that pay-roll taxes are paid by households alone. Similarly, it is assumed that dividends are taxed at the household level.

adjustment cost.

Letting Λ_t and $\Lambda_t Q_t$ denote the Lagrange multipliers associated with the budget constraint (2) and the capital accumulation equation (3), respectively, the first-order conditions for maximizing the household's lifetime utility function (1) with respect to $C_{i,t}$, $I_{i,t}$, $B_{i,t+1}$, $K_{i,t+1}$ and $Z_{i,t}$ are given—in that order—by:

$$(1 + \tau^c) \Lambda_t = \varepsilon_t^b (C_{i,t} - \vartheta C_{i,t-1}^*)^{-\varsigma},$$

$$
\begin{aligned}
Q_t \left(1 - \Upsilon(\varepsilon_t^i I_{i,t}/I_{i,t-1})\right) &= Q_t \, \Upsilon'(\varepsilon_t^i I_{i,t}/I_{i,t-1}) \, \varepsilon_t^i \, \frac{I_{i,t}}{I_{i,t-1}} \\
&\quad - \beta \, \mathrm{E}_t \left[\frac{\Lambda_{t+1}}{\Lambda_t} Q_{t+1} \, \Upsilon'(\varepsilon_{t+1}^i I_{i,t+1}/I_{i,t}) \, \varepsilon_{t+1}^i \, \frac{I_{i,t+1}^2}{I_{i,t}^2} \right] + 1,
\end{aligned}
\tag{4}
$$

$$\beta \, R_t \, \mathrm{E}_t \left[\frac{\Lambda_{t+1}}{\Lambda_t} \frac{P_t}{P_{t+1}} \right] = 1,$$

$$Q_t = \beta \, \mathrm{E}_t \left[\frac{\Lambda_{t+1}}{\Lambda_t} \left((1 - \delta) Q_{t+1} + (1 - \tau^d) \frac{R_{t+1}^K}{P_{t+1}} Z_{i,t+1} + \tau^d \delta - \Psi(Z_{i,t+1}) \right) \right] + \eta_t^q, \tag{5}$$

$$(1 - \tau^d) \frac{R_t^K}{P_t} = \Psi'(Z_{i,t}), \tag{6}$$

where the latter condition implies that the intensity of capital utilization is identical across households; that is, $Z_{i,t} = Z_t$.

Following SW (2003), we have augmented equation (5), which determines the value of installed capital (that is, Tobin's Q), with a serially uncorrelated shock η_t^q. This shock is meant to capture stochastic variation in the external finance premium.[5]

Non-Ricardian Households

In our framework, the non-Ricardian households do not optimize—neither intertemporally nor intratemporally. Each Ricardian household j simply follows a rule of thumb and sets nominal consumption expenditure equal to after-tax disposable wage income:

$$(1 + \tau^c) C_{j,t} = \frac{(1 - \tau^d)}{(1 + \tau^w)} \frac{W_t}{P_t} N_t - \frac{T_{j,t}}{P_t}.$$

Like for the Ricardian households, it is assumed that the non-Ricardian households take the pooled wage income as given and supply sufficient labour services to satisfy labour demand.

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[5]While this way of capturing stochastic variation in the external finance premium is largely ad hoc, it could be justified on deeper grounds by introducing stochastic financial intermediation costs which would affect the rental rate of capital. Here, as in SW, the inclusion of the shock is motivated by empirical considerations.

Wage Setting

There is a continuum of monopolistically competitive unions within the household sector indexed by $h \in [0,1]$, which act as wage setters for the differentiated labour services supplied by the two types of households taking the aggregate nominal wage rate, W_t, and aggregate labour demand, N_t, as given.

Following Calvo (1983), unions receive permission to optimally reset their nominal wage rate in a given period t with probability $1 - \xi_w$. All unions that receive permission to reset their wage rate choose the same wage rate $W_{h,t}^*$. Those unions that do not receive permission are allowed to adjust their wage rate at least partially according to the following scheme:

$$W_{h,t} = \left(\frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_w} W_{h,t-1}, \tag{7}$$

where the parameter γ_w measures the degree of indexation to past changes in the aggregate price index P_t.

Each union h that receives permission to optimally reset its wage rate in period t is assumed to maximize household lifetime utility, as represented by equation (1), taking into account the wage-indexation scheme (7) and the demand for labour services of variety h, the latter being given by

$$N_{h,t} = \left(\frac{W_{h,t}}{W_t} \right)^{-\frac{1+\lambda_{w,t}}{\lambda_{w,t}}} N_t,$$

where the stochastic parameter $\lambda_{w,t} = \lambda_w + \eta_t^w$ determines the wage markup in the unionized labour markets.[6]

Hence, we obtain the following first-order condition for the union's optimal wage-setting decision in period t:[7]

$$\mathrm{E}_t \left[\sum_{k=0}^{\infty} \xi_w^k \beta^k N_{h,t+k} \left(\Lambda_{t+k} \frac{(1-\tau^d)}{(1+\tau^w)} \frac{W_{h,t}^*}{P_{t+k}} \left(\frac{P_{t+k-1}}{P_{t-1}} \right)^{\gamma_w} \right. \right. \tag{8}$$
$$\left. \left. - (1 + \lambda_{w,t+k}) \, \varepsilon_{t+k}^n \, (N_{h,t+k})^{\zeta} \right) \right] = 0.$$

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[6]In the log-linear version of the model, the serially uncorrelated wage markup shock η_t^w can be interpreted as a cost-push shock to wage inflation.

[7]Alternatively, we could distinguish two groups of unions that act in the interest of either Ricardian or non-Ricardian households. In this case, the unions would choose different wage rates, reflecting the different consumption patterns of the two types of households. As a practical matter, however, the differences in wage rates ought to be limited because our estimation results suggest that both the degree of wage stickiness, ξ_w, and the degree of indexation, γ_w, are relatively high.

Aggregate labour demand, N_t, and the aggregate nominal wage rate, W_t, are determined by the following Dixit-Stiglitz indices:

$$N_t = \left(\int_0^1 (N_{h,t})^{\frac{1}{1+\lambda_{w,t}}} \, dh \right)^{1+\lambda_{w,t}}, \tag{9}$$

$$W_t = \left(\int_0^1 (W_{h,t})^{-\frac{1}{\lambda_{w,t}}} \, dh \right)^{-\lambda_{w,t}}. \tag{10}$$

With the union-specific wage rates $W_{h,t}$ set according to equation (7) and equation (8), respectively, the evolution of the aggregate nominal wage rate (10) is then determined by the following expression:

$$W_t = \left((1 - \xi_w)(W_{h,t}^*)^{-\frac{1}{\lambda_{w,t}}} + \xi_w \left(\frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_w} (W_{h,t-1})^{-\frac{1}{\lambda_{w,t}}} \right)^{-\lambda_{w,t}}. \tag{11}$$

Aggregation

The aggregate level in per-capita terms of any household-specific variable $X_{h,t}$ is given by $X_t = \int_0^1 X_{h,t} \, dh = (1 - \omega) X_{i,t} + \omega X_{j,t}$, as households in each of the two groups are identical. Hence, aggregate consumption is given by

$$C_t = (1 - \omega) C_{i,t} + \omega C_{j,t},$$

while aggregate hours worked are given by

$$N_t = (1 - \omega) N_{i,t} + \omega N_{j,t}$$

with the labour-market equilibrium being characterized by $N_t = N_{i,t} = N_{j,t}$.[8]

Since only Ricardian households hold financial assets, we obtain the following condition for aggregate holdings of bonds:

$$B_{t+1} = (1 - \omega) B_{i,t+1}. \tag{12}$$

Similarly, only Ricardian households accumulate physical capital,

$$K_{t+1} = (1 - \omega) K_{i,t+1}, \tag{13}$$
$$I_t = (1 - \omega) I_{i,t}, \tag{14}$$

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[8]This is a consequence of the assumption that unions pool the wage income of both groups of households. To ensure that pooling finally results in the same wage income, hours worked in both groups need to be equal in equilibrium.

and only Ricardian households receive dividends from firms,

$$D_t = (1 - \omega) D_{i,t}. \tag{15}$$

Finally, aggregate lump-sum taxes/transfers are given by

$$T_t = (1 - \omega) T_{i,t} + \omega T_{j,t}. \tag{16}$$

B. Firms

There are two types of firms. A continuum of monopolistically competitive firms indexed by $f \in [0,1]$, each of which produces a single differentiated intermediate good, $Y_{f,t}$, and a distinct set of perfectly competitive firms, which combine all the intermediate goods into a single final good, Y_t.

Final-Good Firms

The final-good producing firms combine the differentiated intermediate goods $Y_{f,t}$ using a standard Dixit-Stiglitz aggregator,

$$Y_t = \left(\int_0^1 Y_{f,t}^{\frac{1}{1+\lambda_{p,t}}} df \right)^{1+\lambda_{p,t}}, \tag{17}$$

where the stochastic parameter $\lambda_{p,t} = \lambda_p + \eta_t^p$ determines the price markup in the intermediate-goods markets.[9]

Minimizing the cost of production subject to the aggregation constraint (17) results in demands for the differentiated intermediate goods as a function of their price $P_{f,t}$ relative to the price of the final good P_t,

$$Y_{f,t} = \left(\frac{P_{f,t}}{P_t} \right)^{-\frac{1+\lambda_{p,t}}{\lambda_{p,t}}} Y_t, \tag{18}$$

where the price of the final good P_t is determined by the following index:

$$P_t = \left(\int_0^1 P_{f,t}^{-\frac{1}{\lambda_{p,t}}} df \right)^{-\lambda_{p,t}}.$$

Intermediate-Goods Firms

Each intermediate-goods firm f produces its differentiated output using an increasing-returns-to-scale technology,

$$Y_{f,t} = \max \left[\varepsilon_t^a \tilde{K}_{f,t}^\alpha N_{f,t}^{(1-\alpha)} - \Phi, 0 \right], \tag{19}$$

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[9]In the log-linear version of the model, the serially uncorrelated price markup shock η_t^p can be interpreted as a cost-push shock to price inflation.

utilizing as inputs homogenous capital services rent from the households in a centralized market, $\tilde{K}_{f,t} = Z_t K_{f,t}$, and an index of differentiated labour services, $N_{f,t}$. The variable $\varepsilon_t^a = \rho_a \varepsilon_{t-1}^a + \eta_t^a$ is a serially correlated technology shock, and the parameter Φ represents fixed cost of production.[10]

Taking the rental cost of capital, R_t^K, and the aggregate wage index, W_t, as given, cost minimization subject to the production technology (19) yields first-order conditions for the inputs which can be expressed as relative factor demands and nominal marginal cost:

$$\frac{\tilde{K}_{f,t}}{N_{f,t}} = \left(\frac{\alpha}{1-\alpha}\right) \frac{W_t}{R_t^K},$$

$$MC_t = \frac{1}{\varepsilon_t^a \, \alpha^\alpha (1-\alpha)^{(1-\alpha)}} \, W_t^{(1-\alpha)} (R_t^K)^\alpha.$$

Price Setting

Following Calvo (1983), intermediate-goods producing firms receive permission to optimally reset their price in a given period t with probability $1 - \xi_p$. All firms that receive permission to reset their price choose the same price $P_{f,t}^*$. Those firms which do not receive permission are allowed to adjust their price at least partially according to the following scheme:

$$P_{f,t} = \left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma_p} P_{f,t-1}, \tag{20}$$

where the parameter γ_p measures the degree of indexation to past changes in the aggregate price index P_t.

Each firm f receiving permission to optimally reset its price in period t maximizes the discounted sum of expected nominal profits,

$$\mathrm{E}_t \left[\sum_{k=0}^{\infty} \xi_p^k \, \chi_{t,t+k} \, D_{f,t+k} \right],$$

subject to the demand for its output (18) and the price-indexation scheme (20), where $\chi_{t,t+k}$ is the stochastic discount factor of the households owning the firm and

$$D_{f,t} = P_{f,t} Y_{f,t} - MC_t (Y_{f,t} + \Phi)$$

are period-t nominal profits which are distributed as dividends to the households.

Hence, we obtain the following first-order condition for the firm's optimal price-setting decision

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[10]The fixed cost of production will be chosen to ensure zero profits in steady state. This in turn guarantees that there is no incentive for other firms to enter the market in the long run.

in period t:

$$\mathrm{E}_t \left[\sum_{k=0}^{\infty} \xi_p^k \, \chi_{t,t+k} \, Y_{f,t+k} \left(P_{f,t}^* \left(\frac{P_{t+k-1}}{P_{t-1}} \right)^{\gamma_p} - (1 + \lambda_{p,t+k}) \, MC_{t+k} \right) \right] = 0. \qquad (21)$$

With the intermediate-goods prices $P_{f,t}$ set according to equation (20) and equation (21), respectively, the evolution of the aggregate price index is then determined by the following expression:

$$P_t = \left((1 - \xi_p)(P_{f,t}^*)^{-\frac{1}{\lambda_{p,t}}} + \xi_p \left(\frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_p} (P_{f,t-1})^{-\frac{1}{\lambda_{p,t}}} \right)^{-\lambda_{p,t}}.$$

C. Fiscal and Monetary Authorities

The fiscal authority purchases the final good, G_t, issues bonds, B_{t+1}, and raises taxes with details on the latter being given above. The fiscal authority's budget constraint then has the following form:

$$G_t + \frac{B_t}{P_t} = \frac{\tau^d}{(1 + \tau^w)} \frac{W_t}{P_t} N_t + \tau^d \frac{R_t^K}{P_t} Z_t K_t - \tau^d \delta K_t \qquad (22)$$
$$+ \tau^d \frac{D_t}{P_t} + \tau^c C_t + \frac{T_t}{P_t} + R_t^{-1} \frac{B_{t+1}}{P_t},$$

where all quantities are expressed in real per-capita terms.

Since our model features non-Ricardian households, the time paths of government debt and taxes matter for the evolution of the economy. To select among the set of feasible time paths, and to stabilize government debt, we choose, as in Galí et al. (2004), a simple log-linear fiscal policy rule:

$$t_t = \phi_b \, b_t + \phi_g \, g_t,$$

where ϕ_b and ϕ_g are the elasticities of lump-sum taxes with respect to government debt and government spending, respectively. Notice that t_t, b_t and g_t are the log-linear counterparts of lump-sum taxes, government debt and government spending, respectively.[11]

Here, government spending is assumed to evolve exogenously according to a serially correlated process,

$$g_t = \rho_g \, g_{t-1} + \eta_t^g, \qquad (23)$$

where η_t^g represents a serially uncorrelated shock.

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[11]More specifically, we define the deviation of the fiscal variables from their respective steady-state values in relative terms as a percentage of steady-state output; that is, $t_t = (T_t/P_t - T/P)/Y$, $b_t = (B_t/P_{t-1} - B/P)/Y$ and $g_t = (G_t - G)/Y$.

As in SW (2003), the monetary authority sets the nominal interest rate according to a simple log-linear monetary policy rule,

$$r_t \;=\; \phi_r\, r_{t-1} + (1 - \phi_r)\left(\bar{\pi}_t + \phi_\pi\left(\pi_{t-1} - \bar{\pi}_t\right) + \phi_y\left(y_t - y_t^*\right)\right) \tag{24}$$
$$+ \phi_{\Delta\pi}\left(\pi_t - \pi_{t-1}\right) + \phi_{\Delta y}\left(y_t - y_t^* - \left(y_{t-1} - y_{t-1}^*\right)\right) + \eta_t^r,$$

where $r_t = \log(R_t/R)$ is the log-deviation of the nominal interest rate from its steady-state value and $\pi_t = \log(P_t/P_{t-1})$ denotes the quarter-on-quarter inflation rate. y_t is the logarithm of aggregate output, while y_t^* is the logarithm of the aggregate output level that would prevail if wages and prices were flexible. $\bar{\pi}_t = \rho_{\bar{\pi}}\,\bar{\pi}_{t-1} + \eta_t^{\bar{\pi}}$ represents the monetary authority's inflation objective, which is assumed to follow a serially correlated process, with mean zero and η_t^r is a serially uncorrelated shock to the interest rate.

The particular form of the monetary policy rule—including a reaction to changes in both inflation and the output gap—reflects empirical considerations. The time-varying inflation objective is meant to capture the disinflation process in the run up to the formation of the European Monetary Union in 1999.

D.   Market Clearing

The labour market is in equilibrium when the demand for the index of labour services by the intermediate-goods firms equals the differentiated labour services supplied by households at the wage rates set by unions. Similarly, the market for physical capital is in equilibrium when the demand for capital services by the intermediate-goods firms equals the capital services supplied by households at the market rental rate. The market for government bonds is in equilibrium when the outstanding government bonds are held by households at the market interest rate. Lastly, the final-good market is in equilibrium when the supply by the final-good firms equals the demand by households and government:

$$Y_t = C_t + I_t + G_t + \Psi(Z_t)\, K_t,$$

where the last term accounts for the resource cost of varying the intensity of capital utilization.

III. Bayesian Estimation of the Model

We adopt the empirical approach outlined in SW (2003) and estimate our augmented DSGE model with non-Ricardian households employing Bayesian inference methods. This involves obtaining the posterior distribution of the parameters of the model based on its log-linear state-space representation and assessing its empirical performance in terms of its marginal likelihood. In the following we briefly sketch the adopted approach and describe the data and the prior distributions used in its implementation. We then present our estimation results.

A.   Methodology

Employing Bayesian inference methods allows formalizing the use of prior information obtained

from earlier studies at both the micro and macro level in estimating the parameters of a possibly complex DSGE model.[12] This seems particularly appealing in situations where the sample period of the data is relatively short, as is the case for the euro area. From a practical perspective, Bayesian inference may also help to alleviate the inherent numerical difficulties associated with solving the highly non-linear estimation problem.

Formally, let $p(\theta|m)$ denote the prior distribution of the parameter vector $\theta \in \Theta$ for some model $m \in \mathcal{M}$, and let $\mathcal{L}(Y_T|\theta, m)$ denote the likelihood function for the observed data, $Y_T = \{ y_t \}_{t=1}^{T}$, conditional on parameter vector θ and model m. The posterior distribution of the parameter vector θ for model m is then obtained by combining the likelihood function for Y_T and the prior distribution of θ,

$$p(\theta|Y_T, m) \quad \propto \quad \mathcal{L}(Y_T|\theta, m)\, p(\theta|m),$$

where "$\propto$" indicates proportionality.

This distribution is typically characterized by standard measures of central location, such as the mode or the mean, measures of dispersion, such as the standard deviation, or selected percentiles.[13]

As discussed in Geweke (1999), Bayesian inference also provides a framework for comparing non-nested and potentially misspecified models on the basis of their marginal likelihood. For a given model m the latter is obtained by integrating out its parameter vector θ,

$$\mathcal{L}(Y_T|m) \quad = \quad \int_{\theta \in \Theta} \mathcal{L}(Y_T|\theta, m)\, p(\theta|m)\, d\theta.$$

Thus, the marginal likelihood gives an indication of the overall likelihood of a model conditional on the observed data.

B.   Data and Prior Distributions

Since we wish to use the SW model as our benchmark for assessing the performance of the augmented DSGE model with non-Ricardian households, we follow SW (2003) in our implementation of the Bayesian estimation methodology as closely as possible. Thus, as in SW, we estimate the augmented model using aggregate euro area data on real GDP, consumption, investment, employment, wage income, GDP inflation and the short-term nominal interest rate. The data cover the period 1980Q1 through 1999Q4. Real variables are expressed in logarithms

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[12]For recent examples of Bayesian estimation of DSGE models see Adolfson, Laséen, Lindé, and Villani (2004), Juillard, Karam, Laxton, and Pesenti (2005), and Schorfheide and Lubik (2005).

[13]As in SW (2003), and following Schorfheide (2000), we adopt a Monte-Carlo Markov-Chain (MCMC) sampling method to determine the posterior distribution of the parameter vector θ. More specifically, we rely on the Metropolis-Hastings (MH) algorithm to obtain a large number of random draws from the posterior distribution of θ. The mode and the Hessian of the posterior distribution, the latter evaluated at the mode, are used to initialize the MH algorithm. For all computations, we employ the Dynare software of Juillard (2004).

and then detrended by removing individual linear trends, while inflation and the interest rate are detrended under the assumption that these variables share a common linear trend reflecting the protracted disinflation process prior to the formation of the European Monetary Union in 1999.[14] We also allow for ten exogenous shocks driving the stochastic behavior of the model: four serially correlated shocks arising from preferences and technology (ε_t^b, ε_t^n, ε_t^a and ε_t^i), three serially uncorrelated cost-push shocks affecting price and wage setting and the price of installed capital (η_t^p, η_t^w and η_t^q), a serially correlated government spending shock (g_t), and two monetary policy shocks (η_t^r and $\bar{\pi}_t$) capturing unexpected moves in the short-term nominal interest rate and persistent changes in the monetary authority's unobserved inflation objective, respectively. Although we will focus on the consequences of only a subset of these shocks in the subsequent analysis, the inclusion of a comprehensive set of shocks is important in order to match the time-series properties of the data satisfactorily.

Regarding the choice of prior distributions for the parameters of the model, we follow SW (2003) in fixing several parameters throughout the estimation. This includes setting the subjective discount factor β to 0.99, the production function parameter α to 0.3, the depreciation rate δ to 0.025, and the steady-state wage markup λ_w to 0.5. The steady-state ratios of government spending and government debt over GDP, G/Y and $(B/P)/Y$, are set equal to 0.18 and 0.6×4, respectively. Most of these parameters are related to the steady-state values of observed variables in an obvious way. In contrast to SW, we assume that the steady-state price markup λ_p is equal to the share of the fixed costs in production, Φ/Y, implying zero profits in steady state. For versions of the model incorporating distortionary taxation, we set the income tax rate τ^d, the pay-roll tax rate τ^w and the consumption tax rate τ^c equal to 0.14, 0.45 and 0.20, respectively.[15]

We also follow SW (2003) in choosing the same prior distributions for the parameters that need to be estimated and that are common to the benchmark model and our augmented specification. A complete listing of the details on the prior distributions, including their means and standard deviations, can be found in Table 3 and 4 . Here, we only wish to mention that the preference, technology, and price and wage-setting parameters are assumed to follow either a Normal distribution or a Beta distribution, the latter constraining individual parameters to fall in the range of zero to one, if prescribed by theory. The parameters controlling the persistence of the shock processes are assumed to have a Beta distribution with uniform mean 0.85 and uniform standard deviation 0.1. The latter assumption facilitates the identification of persistent as opposed to non-persistent shocks. The conditional standard deviations of the shock processes are assumed to have an Inverted Gamma distribution with two degrees of freedom. This distribution guarantees a

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[14]As in SW, we use the period 1970Q1 to 1979Q4 to obtain good initial values of the unobserved variables in the model's linear state-space representation and then use the period 1980Q1 to 1999Q4 to compute the likelihood with the Kalman filter.

[15]The calibration of tax rates is based on the time series of government revenues contained in the data set provided by Fagan, Henry, and Mestre (2001). Lacking a more detailed breakdown of tax categories, we use indirect taxes minus subsidies as our proxy for consumption taxes. The results documented below are robust to reasonable variations in the steady-state tax rates.

positive standard deviation with a relatively large support. Finally, the parameters of the monetary policy rule are assumed to follow a Normal distribution, except for the coefficient on the lagged nominal interest rate which is assumed to follow a Beta distribution.

The prior distributions which remain to be specified are those for the share of non-Ricardian households, ω, and the parameters of the fiscal policy rule, ϕ_b and ϕ_g. In line with the baseline calibrations used in Galí et al. (2004), we assume that ω has a Beta distribution with mean 0.5 and standard deviation 0.1. This value is consistent with estimates obtained by Campbell and Mankiw (1989) for the fraction of liquidity-constrained households in the United States for the pre-1990 period. The fiscal policy parameter prescribing the response of lump-sum taxes to debt, ϕ_b, is assumed to follow an Inverted Gamma distribution with mean 0.1 and degrees of freedom equal to 2.[16] Finally, the parameter governing the response of lump-sum taxes to government spending is assumed to have a Normal distribution with mean 0.1 and standard deviation 0.05.

C.   Estimation Results

Table 1 reports the means of the posterior distributions for a subset of parameters that are a priori considered to be of particular relevance in accounting for possible differences between the benchmark specification of SW (2003) and our augmented specification with non-Ricardian households.[17] In total, we report estimation results for four different specifications, including the benchmark specification of SW and three alternative specifications with non-Ricardian households that differ with respect to the details of the tax scheme in place.[18] In the first two out of these three alternative specifications, we only consider lump-sum taxation; that is, we set the distortionary tax rates equal to zero. Specification I assumes that both Ricardian and non-Ricardian households pay lump-sum taxes in equal proportions, while specification II assumes that the levied lump-sum taxes are unevenly distributed across the two groups of households. Specifically, we consider the extreme case where non-Ricardian households are completely exempted from paying taxes to exemplify the differences in household behavior. Specification III extends specification I by also incorporating distortionary taxes: an income tax levied on all sources of income (except for returns on bonds), a pay-roll tax on wage income and a tax on consumption. To the extent that these specifications affect the income at the disposal of non-Ricardian households in different ways, they are a priori expected to have quite different implications for the role of non-Ricardian households in the propagation of shocks.

Panel A of Table 1 indicates the posterior means of the parameters directly influencing the

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[16]The choice of the Inverted Gamma distribution guarantees that the likelihood of obtaining estimates that result in unstable debt dynamics is negligible.

[17]Further estimation results are reported in Table 5. The 10 and 90 percentiles of the posterior distributions are available from the authors on request.

[18]Small deviations of the estimates reported for the benchmark specification from those reported in SW may result from using a slightly extended sample, incorporating capital utilization cost in the aggregate resource constraint, small discrepancies in the calibration of the model's steady state, as well as differences in the implementation of the Metropolis-Hastings sampling algorithm.

consumption choices of Ricardian and non-Ricardian households, including the share of non-Ricardian households, ω, the preference parameters ς and ϑ, and the parameters governing the process of the intertemporal preference shock, ρ_b and $\sigma(\eta_t^b)$. Here, $\sigma(\cdot)$ generically indicates the (conditional) standard deviation of a shock. Starting with the posterior mean of ω, we observe that the estimated share of non-Ricardian households is quite a bit smaller than the mean of the prior distribution which was set equal 0.5 on the basis of estimates obtained for the pre-1990 period in the United States (see, e.g., Campbell and Mankiw, 1989). Specifically, the posterior mean of the share of non-Ricardian households equals one-fourth or roughly one-third, depending on the presence of distortionary taxes. A possible interpretation of this finding is that our sample only covers observations from the period 1980 through 1999 which was a period of far-reaching financial deregulation that dramatically reduced financial-market participation costs.[19]

At the same time, the inclusion of non-Ricardian households has some noticeable effects on the parameters influencing the intertemporal consumption choices of Ricardian households. In particular, the estimated intertemporal elasticity of substitution, $1/\varsigma$, is quite a bit larger than the estimate obtained for the benchmark specification, implying a lower willingness to smooth consumption on the part of Ricardian households. In fact, for the specifications featuring non-Ricardian households the estimated intertemporal elasticity of substitution is close to unity and consumption preferences are thus broadly consistent with a logarithmic specification. Similarly, the estimated degree of habit formation ϑ is significantly smaller than the estimate obtained for the benchmark specification. Consequently, changes in the short-term interest rate ought to have a comparatively large impact on the consumption choices of Ricardian households.

Panel B of Table 1 reports the posterior means of the parameters affecting labour supply and unionized wage setting. The estimate of the inverse elasticity of labour supply with respect to the real wage, ζ, turns out to be somewhat higher in the specifications with non-Ricardian households. However, variations in the labour-supply elasticity of this order of magnitude have little consequence for the dynamics of the type of model examined in this paper. Similarly, we observe some variation in the estimates of the parameters characterizing the labour-supply shock, ρ_n and $\sigma(\eta_t^n)$, although these estimates tend to move in opposite directions, leaving the unconditional variation of the labour-supply shocks across specifications broadly unchanged. Finally, the posterior means of the parameters influencing the unions' wage-setting decisions, ξ_w, γ_w and $\sigma(\eta_t^w)$, are virtually unaffected by the inclusion of non-Ricardian households.

Panel C shows the posterior means of the fiscal policy parameters. Of course, in the benchmark specification without non-Ricardian households, but also in the specification where non-Ricardian households are assumed to be exempted from paying taxes, the particular time path along which government debt evolves does not matter and, thus, we have imposed a periodically balanced government budget with $\phi_b = 1$ and $\phi_g = 0$. For the two remaining specifications, we observe quite some heterogeneity regarding the responsiveness of lump-sum taxes to government debt, ϕ_b,

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[19]This interpretation is consistent with the findings of Bilbiie and Straub (2004b) who show that the share of non-Ricardian households in the United States fell significantly after the Depository and Institutions Deregulation and Monetary Control Act (DIDMCA) had passed legislation in 1980.

with the posterior mean being equal to 0.07 or 0.29, depending on the presence of distortionary taxes. In contrast, the fraction of government spending that is instantaneously financed by lump-sum taxes, ϕ_g, has a mean of about 0.12, irrespective of the presence of distortionary taxes. Not surprisingly, the parameters of the exogenous shock process characterizing government spending, ρ_g and $\sigma(\eta_t^g)$, are very similar across all four specifications. Importantly, the estimated degree of persistence is close to 0.95 and, hence, government spending shocks ought to induce a large negative wealth effect in the model.

Finally, Panel D indicates the marginal likelihood for the four specifications which allows to assess their relative performance conditional on the data. Surprisingly, none of the augmented specifications with non-Ricardian households succeeds in outperforming the benchmark model. Obviously, there may be various reasons for this relatively poor empirical performance of the augmented model. For example, the presence of non-Ricardian households, while tilting the operating characteristics of the model in response to government spending shocks in the desired direction, may adversely affect the response pattern of the model to alternative shocks, possibly originating in the influence that the inclusion of non-Ricardian households exerts on the estimated preference parameters. Alternatively, the quantitative importance of government spending shocks may possibly be overstated when evaluated through the lens of a New-Keynesian model allowing for non-Ricardian elements. In the subsequent analysis we will therefore systematically examine the role of non-Ricardian households for the equilibrium dynamics of the model.

IV. ASSESSING THE ROLE OF NON-RICARDIAN HOUSEHOLDS

Having estimated alternative specifications of the augmented DSGE model of the euro area, we now proceed to investigate the role played by non-Ricardian households in the propagation of shocks and in accounting for observed fluctuations in consumption to enhance our understanding of the relatively poor empirical performance of the specifications with non-Ricardian households. In this context, we focus our analysis on the effects of government spending and monetary policy shocks, but also review the consequences of a number of other shocks that have been identified in the previous section as potentially important for explaining the influences of non-Ricardian households on consumption dynamics.

A. Impulse-Response Analysis

For each of the four estimated specifications, **Figure 1** depicts the dynamic responses of selected variables to a persistent government spending shock equal to 1 percent of steady-state output. For ease of comparison, the parameter governing the degree of persistence is set equal to the posterior mean of $\rho_g = 0.943$ that has been obtained for the benchmark specification without non-Ricardian households. All dynamic responses are depicted as percentage-point deviations from steady state.

As can be seen in the upper left panel in Figure 1, aggregate consumption in the benchmark specification without non-Ricardian households (referred to as benchmark and indicated by a solid line) falls noticeably on impact in response to a government spending shock before gradually returning to steady state, with the adjustment path exhibiting a hump-shaped pattern.

Apparently, for the augmented specifications I to III featuring non-Ricardian households aggregate consumption falls by less when compared to the consumption response in the benchmark specification. Yet again, in all three specifications with non-Ricardian households government spending shocks fail to crowd in aggregate consumption and thereby do not generate a fiscal multiplier with respect to output that exceeds one. Even worse, the stronger impact effect of government spending shocks is very short-lived and eventually followed by a lasting period of pronounced under-shooting of the consumption path obtained in the benchmark specification.

Comparing the consumption patterns of Ricardian and non-Ricardian households helps to understand the differences in the dynamic response pattern of aggregate consumption across specifications. As shown in the middle right panel of Figure 1, the government spending shock succeeds, at least on impact, in stimulating consumption on the part of non-Ricardian households, regardless of the tax scheme in place. For the specification with evenly distributed lump-sum taxes (specification I, dashed line), for example, consumption increases on impact by about 0.5 percentage points. However, consumption starts falling below its steady-state level already after a few quarters, because the build up of government debt leads to a rise in lump-sum taxes which in turn lowers after-tax disposable income and thereby crowds out consumption. When non-Ricardian households are exempted from paying lump-sum taxes (specification II, dashed-dotted line), we observe that the impact multiplier is considerably larger and, importantly, that consumption never falls below its steady-state level in the course of the adjustment process. By contrast, for the specification which, in addition, incorporates distortionary taxes (specification III, dotted line) the impact multiplier is cut in half when compared with the specification that features lump-sum taxation alone. In this case, after-tax disposable income is reduced even more due to the households' income and pay-roll tax obligations. Above and beyond, consumption is retrenched by the existence of the consumption tax.

As regards the consumption profile of Ricardian households, it can be seen in the middle left panel of Figure 1 that consumption falls on impact even further than in the benchmark specification, with the return to steady state eventually somewhat faster though. Thus, while an increase in government spending positively affects consumption spending of non-Ricardian households, at least on impact, this effect tends to be offset by a fall in consumption on the part of Ricardian households. Clearly, with the estimated share of non-Ricardian households being relatively small, the overall effect of government spending shocks on aggregate consumption turns out to be negative.

The lower two panels in Figure 1 depict the responses of hours worked and the real wage. On impact, hours worked increase substantially, reflecting the surge in labour demand following the government spending shock. In contrast, while moving in the desired direction, the real wage rises by only very little due to the high degree of rigidity characterizing wage-setting decisions. This feature of our estimated model contrasts with the much simpler calibrated set up in Galí et al. (2004). The latter abstracts from inertia in the wage-setting process and incorporates a static labour demand schedule instead according to which households are willing to meet firms' demand for labour at the real wage offered. This static set up implies, quite mechanistically, a sharp rise

in the real wage in response to a government spending shock, which in turn boosts disposable income and helps to crowd in aggregate consumption, at least on impact.[20]

To cast further light on the consequences of a government spending shock in our estimated model, **Figure 2** portrays the dynamic responses of monetary policy, as captured by the short-term nominal interest rate, together with the responses of those variables most influential for the monetary authority's rule-based interest-rate decision. As can be seen in the upper right panel of the figure, in the specifications with non-Ricardian households the size of the output gap building up in response to a government spending shock exceeds that in the benchmark specification by almost one-tenth of a percentage point, with the output gap being computed relative to the flexible-price and wage equilibrium. In contrast, the lower left panel shows that the inflation effect is fairly small and roughly comparable across specifications. As demonstrated in the lower right panel, this reflects that the time profile of real marginal cost—the key driver of inflation—is largely similar. Ultimately, as shown in the upper left panel, the more sizeable response of the output gap dominates and thus results in a more pronounced tightening of monetary policy in the specifications with non-Ricardian households. Consistent with the response pattern exposed in Figure 1 above, this exacerbates the decline in consumption spending on the part of Ricardian households, thereby further curbing the impact of a government spending shock.

Finally, **Figure 3** depicts the consequences of a monetary policy shock corresponding to an unexpected one-quarter increase in the short-term nominal interest rate equal to 25 basis points, with the monetary authority following the estimated policy rule thereafter. As shown in the upper left panel of the figure, a rise in the short-term nominal interest rate has a comparatively large negative impact on aggregate consumption in the specifications with non-Ricardian households. As can be seen in the middle left panel, this echoes, at least in the initial periods, a disproportionate fall in consumption on the part of Ricardian households. As we emphasized in our discussion of the estimation results, the latter reflects that the estimates of both the inverse of the intertemporal elasticity of substitution and the degree of habit formation are quite a bit smaller in the specifications with non-Ricardian households. As a consequence, the interest-rate elasticity of consumption is higher, yielding a stronger decline in consumption after a monetary policy shock. However, regarding the overall effect on output, we observe that the stronger decline in aggregate consumption is at least partially offset by a more subdued fall in investment. We also observe that the decrease in hours worked and the real wage is uniformly smaller.

B. Forecast-Error-Variance Decomposition

To provide additional insights into the various mechanisms through which non-Ricardian households may influence the dynamic consumption responses in our model, we analyze the contributions of selected shocks to the forecast-error variance of aggregate consumption and its sub-components at various horizons. The results of the forecast-error-variance decomposition are summarized in **Table 2**, contrasting the results for the benchmark specification with those for the

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[20]For a critical discussion of the labour demand schedule proposed by Galí et al. (2004) and its importance for generating a crowding-in effect see also Mihov (2003).

augmented specification featuring non-Ricardian households and uniformly distributed lump-sum taxes. We focus on those shocks that have already been identified above as primarily important for discerning the influences of non-Ricardian households, namely the government spending shock, the intertemporal preference shock, the labour supply shock and the wage markup shock. In addition, we also report results for the monetary policy shock.

By comparing the results for the benchmark specification in Panel A of Table 2 with those for the specification with non-Ricardian households in Panel B, it can be seen that the contributions of the selected shocks to the forecast-error variance of aggregate consumption are broadly similar across the two specifications. Nevertheless, while differences in the contributions of government spending shocks are hardly discernible at longer horizons, the contributions of government spending shocks are found to be noticeably smaller at shorter horizons in the specification with non-Ricardian households. This is consistent with a more limited crowding-out effect on impact due to the presence of non-Ricardian households (see Figure 1 above). Another noteworthy discrepancy is exhibited by the contributions of wage markup shocks. The latter are found to have a positive, albeit small short-run effect on aggregate consumption in the specification with non-Ricardian households, which is virtually zero in the benchmark specification.

Contrasting the results obtained for the sub-components of aggregate consumption, as shown in the lower part of Panel B in Table 2, reveals a number of notable differences that are conducive to a better understanding of the aggregate results. First, in the short run, government spending shocks account for about 3 percent of the fluctuations in consumption of non-Ricardian households, while they account for only half a percent in the case of Ricardian households. Second, since preference shocks do not directly influence the consumption decision of non-Ricardian households, they explain, regardless of the forecast horizon, only about 15 percent of the variation in non-Ricardian households' consumption, compared to roughly 60 percent for Ricardian households. Similarly, for non-Ricardian households the contribution of labour supply shocks is significantly smaller than for Ricardian households. On the contrary, wage markup shocks, which directly affect the after-tax disposable income of non-Ricardian households, account for more than 25 percent of the short-run fluctuations. All in all, the fact that the estimated share of non-Ricardian households amounts to less than one-fourth may then explain why only fairly small effects can be observed at the aggregate level. Furthermore, the effects of shocks that influence Ricardian and non-Ricardian households in opposite ways, such as the government spending shock, may at least partially cancel out each other.

V. Sensitivity Analysis

We finally present some additional sensitivity analysis to shed light on the general ability of our estimated model to generate crowding-in effects with regard to consumption or even an overall fiscal multiplier larger than one in response to a government spending shock. To this end, we appraise the impact effect of a government spending shock on consumption (aggregated and dis-aggregated) and investment that results when a single parameter is varied holding all other parameters constant at their estimated values. Clearly, if the parameters can vary over a relatively

broad range of values without resulting in a large increase in consumption on impact, there may be no realistic chance to generate an overall fiscal multiplier that exceeds one within the framework of our estimated model.

Figure 4 depicts the sensitivity of the impact multiplier of a government spending shock for the specification with non-Ricardian households and uniformly distributed lump-sum taxes. We focus on those parameters that are most likely to have a positive influence on the size of the consumption response, notably the share of non-Ricardian households, ω, the fiscal policy parameters, ρ_g, ϕ_b and ϕ_g, and the parameters influencing unionized wage-setting decisions, ξ_w and γ_w. Each panel of the figure shows the percentage-point deviation from steady state for aggregate consumption, consumption on the part of both Ricardian and non-Ricardian households and aggregate investment as a single parameter is varied, with the estimated mean of the parameter indicated by a solid vertical line.

The upper left panel in Figure 4 depicts the sensitivity of the impact multiplier to variations in the share of non-Ricardian households, ω. Once the value of ω exceeds 0.35, the response of aggregate consumption to a government spending shock turns out to be positive, with the response of investment remaining broadly unchanged. In contrast, as shown in the upper right panel, the degree of persistence of the government spending shock, ρ_g, would need to fall below 0.87 in order to succeed in generating a positive response of aggregate consumption. The reason is that, with an estimated share of non-Ricardian households of about one-quarter, the negative wealth effect induced by a government spending shock exhibiting the estimated degree of persistence weighs too heavily on the Ricardian households. It also crowds out investment by a significant amount.

The two panels in the middle of Figure 4 portray the consequences of variations in the parameters of the fiscal policy rule. Interestingly, and in contrast to the findings presented in Galí et al. (2004), varying the responsiveness of lump-sum taxes to government debt, ϕ_b, has almost no effect on the instantaneous consumption response. This reflects that government debt is a predetermined variable which only gradually builds up over time, leaving disposable income and thus consumption on the part of non-Ricardian households largely unaffected on impact. In contrast, lowering the share of government spending that is instantaneously financed by lump-sum taxes, as captured by parameter ϕ_g, tends to bolster disposable income and thus consumption. However, even lowering ϕ_g to zero does not result in a positive impact effect.

Finally, the two lower panels in Figure 4 depict the consequences of varying the parameters that govern unionized wage setting. Both the frequency of receiving permission to reset wages, $1 - \xi_w$, and the degree of wage indexation, γ_w, are found to have negligible effects on the impact responses of consumption and investment. Obviously, variations in these parameters are not conducive to generating a positive impact multiplier either, at least for plausible values of the parameters concerned.[21] The reason is that the real wage and, thus, the disposable income of

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[21]Broadly similar results are obtained for the parameters governing the price-setting behavior of firms, ξ_p and γ_p.

non-Ricardian households rise by only very little if nominal wages are relatively sticky.

Overall, our sensitivity analysis reveals that there is only a fairly small chance that government spending shocks do crowd in consumption or do even generate an overall fiscal multiplier larger than one within the framework of our estimated DSGE model of the euro area. Indeed, the actual parameter estimates all fall in regions that are largely incompatible with a positive response of aggregate consumption to a government spending shock. Notwithstanding these findings, the analysis suggests that the inclusion of non-Ricardian households does tilt the consumption response to government spending shocks in the desired direction. At the same time, the negative wealth effect induced by government shocks still weighs too heavily on Ricardian households. This points to a need to modify the model in directions which help to further mitigate the induced negative wealth effect.

VI. CONCLUSIONS

In this paper, we have undertaken an attempt to reconcile the existing evidence on the effects of government spending shocks with the predictions of a New-Keynesian DSGE model that builds on explicit microfoundations with optimizing agents. To account for the limited ability of households to smooth consumption over time we have modified the model by allowing for the coexistence of non-Ricardian and Ricardian households. Employing Bayesian inference methods to estimate this model for the euro area over the period 1980 through 1999, we find that the estimated share of non-Ricardian households in the euro area is relatively small, tentatively suggesting that financial deregulation over the last two decades has lowered financial-market participation costs. At the same time, we show that the presence of non-Ricardian households is in general conducive to raising the level of consumption in response to government spending shocks when compared with a benchmark specification of the model without non-Ricardian households. However, there is only a fairly small chance that government spending shocks do actually crowd in consumption. The main reason is that the estimated share of non-Ricardian households is relatively low. In order to predict crowding-in effects, the model would need to be modified in directions which help to further mitigate the negative wealth effect induced by the highly persistent nature of government spending shocks.

While our model allows for a relatively detailed fiscal policy set up with different types of taxes that determine government revenues and a fiscal policy rule that stabilizes government debt, this paper has proceeded under the simplifying assumption that government spending evolves exogenously according to a highly persistent shock process. In subsequent work it will be interesting to explore the consequences when agents have limited information about the future path of exogenous government spending shocks and must form expectations about the nature of unobserved shocks. As shown in Erceg, Guerrieri, and Gust (2003), such mechanism may help to reduce the negative wealth effect induced by highly persistent government spending shocks. Similarly, the induced negative wealth effect is likely to be mitigated once the possibility of an endogenous response of the long-run government debt-to-GDP ratio to persistent government spending shocks is taken into account. These extensions may ultimately lessen the need to

include non-Ricardian elements; but, at the same time, they may help to improve the empirical performance of the model. Finally, in the light of empirical evidence that distortionary taxes tend to rise in response to lasting increases in government spending (see, e.g., Fatás and Mihov, 2001; and Burnside, Eichenbaum and Fisher, 2003), it would also be interesting to extend the analysis by allowing for alternative fiscal policy rules with distortionary rather than lump-sum taxes responding to developments in government spending and debt.

Table 1. Selected Estimates for the Augmented DSGE Model of the Euro Area

	Benchmark Specification (SW 2003)	Specifications with Non-Ricardian Households		
		Lump-Sum Taxation I	Asym. Lump-Sum Taxation II	Lump-Sum & Distort. Taxation III
A. Parameters Influencing Consumption Choices				
ω		0.246	0.249	0.370
ς	1.339	1.099	0.985	1.101
ϑ	0.597	0.411	0.412	0.412
ρ_b	0.820	0.840	0.847	0.825
$\sigma(\eta_t^b)$	0.414	0.373	0.346	0.386
B. Parameters Influencing Labor Supply and Wage Setting				
ζ	2.168	2.660	2.638	2.343
ρ_n	0.889	0.917	0.904	0.894
$\sigma(\eta_t^n)$	3.706	3.361	3.603	3.628
ξ_w	0.731	0.741	0.739	0.747
γ_w	0.711	0.712	0.731	0.724
$\sigma(\eta_t^w)$	0.291	0.296	0.295	0.296
C. Fiscal Policy Parameters				
ϕ_b	1.000*	0.074	1.000*	0.292
ϕ_g	0.000*	0.118	0.000*	0.123
ρ_g	0.943	0.947	0.952	0.944
$\sigma(\eta_t^g)$	0.323	0.320	0.318	0.319
D. Marginal Likelihood				
$\ln \mathcal{L}(Y_T \| m)$	-286.10	-296.96	-295.24	-292.00

Note: For the alternative specifications with and without non-Ricardian households, this table reports the posterior means of the parameters influencing the households' consumption choices (Panel A), the parameters affecting labor supply and wage setting (Panel B) and the fiscal policy parameters (Panel C). The posterior means are obtained through the Metropolis-Hastings sampling algorithm. The inclusion of an asterisk indicates that a periodically balanced government budget has been assumed, since the Ricardian households are indifferent to the time path along which government debt evolves. The table also indictes the marginal likelihood for the alternative specifications (Panel D). Notice that the marginal likelihood for the specification with distortionary taxes but without non-Ricardian households equals 288.23.

Table 2. Forecast-Error-Variance Decomposition of Consumption

Forecast Horizon (Quarters)	Selected Shocks of the Estimated DSGE Model				
	Government Spending (η_t^g)	Intertemp. Preferences (η_t^b)	Labor Supply (η_t^n)	Wage Markup (η_t^w)	Monetary Policy (η_t^r)
A. Consumption in the Benchmark Specification					
1	0.5	69.7	12.1	0.1	11.8
4	0.7	64.2	14.8	0.0	12.7
10	0.9	59.1	16.7	0.0	13.5
100	1.3	54.5	18.1	0.1	14.0
B. Consumption in Specification I with Lump-Sum Taxation					
Aggregate Consumption					
1	0.1	68.4	14.0	1.7	12.8
4	0.3	62.5	16.2	0.9	14.3
10	0.6	57.0	18.3	0.7	15.9
100	1.5	51.1	20.9	0.6	17.1
Consumption: Ricardian Households					
1	0.5	65.7	13.4	0.0	10.5
4	0.6	61.3	15.4	0.0	10.6
10	0.7	57.5	16.9	0.0	10.5
100	0.9	53.5	18.9	0.1	10.6
Consumption: Non-Ricardian Households					
1	3.0	14.7	3.1	27.5	7.0
4	1.6	18.7	6.3	22.3	18.7
10	1.7	14.5	8.8	16.0	30.6
100	7.6	10.1	11.6	10.6	34.1

Note: This table reports selected results of a forecast-error-variance decomposition of consumption for the benchmark specification of the estimated DSGE model (Panel A) and for the augmented specification with non-Ricardian households and uniformly distributed lump-sum taxes (Panel B).

Table 3. Prior Distributions for the Augmented DSGE Model of the Euro Area

| | | Prior Distribution | |
	Type	Mean	Standard Deviation
A. Parameters Influencing Consumption Choices			
ω	Beta	0.50	0.10
ς	Normal	1.00	0.375
ϑ	Beta	0.70	0.10
ρ_b	Beta	0.85	0.10
$\sigma(\eta_t^b)$	Inverse Gamma	0.20	2
B. Parameters Influencing Labour Supply and Wage Setting			
ζ	Normal	2.00	0.75
ρ_n	Beta	0.85	0.10
$\sigma(\eta_t^n)$	Inverse Gamma	1.00	2
ξ_w	Beta	0.75	0.05
γ_w	Beta	0.75	0.15
$\sigma(\eta_t^w)$	Inverse Gamma	0.25	2
C. Parameters Characterising Technology			
φ	Normal	0.45	0.25
υ	Normal	4.00	1.50
ψ	Normal	0.20	0.075
ρ_a	Beta	0.85	0.10
$\sigma(\eta_t^a)$	Inverse Gamma	0.40	2
ρ_i	Beta	0.85	0.10
$\sigma(\eta_t^i)$	Inverse Gamma	0.10	2
$\sigma(\eta_t^q)$	Inverse Gamma	0.40	2
D. Parameters Influencing Price Setting			
ξ_p	Beta	0.75	0.05
γ_p	Beta	0.75	0.15
$\sigma(\eta_t^p)$	Inverse Gamma	0.15	2

Note: For each of the estimated parameters of the augmented DSGE model of the euro area, this table reports the type of prior distribution, its mean and its standard deviation. For the Inverted Gamma distribution, the degrees of freedom, rather than the standard deviation, are indicated.

Table 4. Prior Distributions for the Augmented DSGE Model of the Euro Area (cont.)

|	Prior Distribution		
	Type	Mean	Standard Deviation
E. Fiscal Policy Parameters			
ϕ_b	Inverse Gamma	0.10	2
ϕ_g	Normal	0.10	0.05
ρ_g	Beta	0.85	0.10
$\sigma(\eta_t^g)$	Inverse Gamma	0.30	2
F. Monetary Policy Rule Parameters			
ϕ_r	Beta	0.80	0.10
ϕ_π	Normal	1.70	0.10
ϕ_y	Normal	0.125	0.05
$\phi_{\Delta\pi}$	Normal	0.30	0.10
$\phi_{\Delta y}$	Normal	0.0625	0.05
$\sigma(\eta_t^r)$	Inverse Gamma	0.10	2
$\rho_{\bar{\pi}}$	Beta	0.85	0.10
$\sigma(\eta_t^{\bar{\pi}})$	Inverse Gamma	0.02	2

Note: See above.

Table 5. Further Estimation Results for the Augmented DSGE Model of the Euro Area

|		Specifications with Non-Ricardian Households		
	Benchmark Specification (SW 2003)	Lump-Sum Taxation I	Asym. Lump-Sum Taxation II	Lump-Sum & Distort. Taxation III
A. Parameters Characterizing Technology				
φ	0.418	0.662	0.629	0.602
υ	7.293	7.302	7.204	7.386
ψ	0.216	0.215	0.225	0.219
ρ_a	0.794	0.875	0.872	0.849
$\sigma(\eta_t^a)$	0.658	0.521	0.526	0.547
ρ_i	0.921	0.905	0.923	0.923
$\sigma(\eta_t^i)$	0.107	0.153	0.108	0.097
$\sigma(\eta_t^q)$	0.629	0.632	0.626	0.636
B. Parameters Influencing Price Setting				
ξ_p	0.911	0.920	0.918	0.914
γ_p	0.452	0.471	0.460	0.456
$\sigma(\eta_t^p)$	0.161	0.165	0.161	0.165
C. Monetary Policy Rule Parameters				
ϕ_r	0.969	0.961	0.967	0.964
ϕ_π	1.700	1.684	1.671	1.692
ϕ_y	0.106	0.103	0.116	0.103
$\phi_{\Delta\pi}$	0.129	0.187	0.171	0.160
$\phi_{\Delta y}$	0.158	0.156	0.158	0.153
$\sigma(\eta_t^r)$	0.081	0.098	0.089	0.088
$\rho_{\bar{\pi}}$	0.870	0.840	0.861	0.828
$\sigma(\eta_t^{\bar{\pi}})$	0.013	0.012	0.020	0.014

Note: This table reports the posterior means of the parameters characterizing technology (Panel A), the parameters affecting firms' price-setting behavior (Panel B) and the monetary policy rule parameters (Panel C). The posterior means are obtained through the Metropolis-Hastings sampling algorithm. The parameter φ denotes the share of fixed cost in production, and the parameters υ and ψ characterize the adjustment cost functions $\Upsilon(\cdot)$ and $\Psi(\cdot)$, respectively.

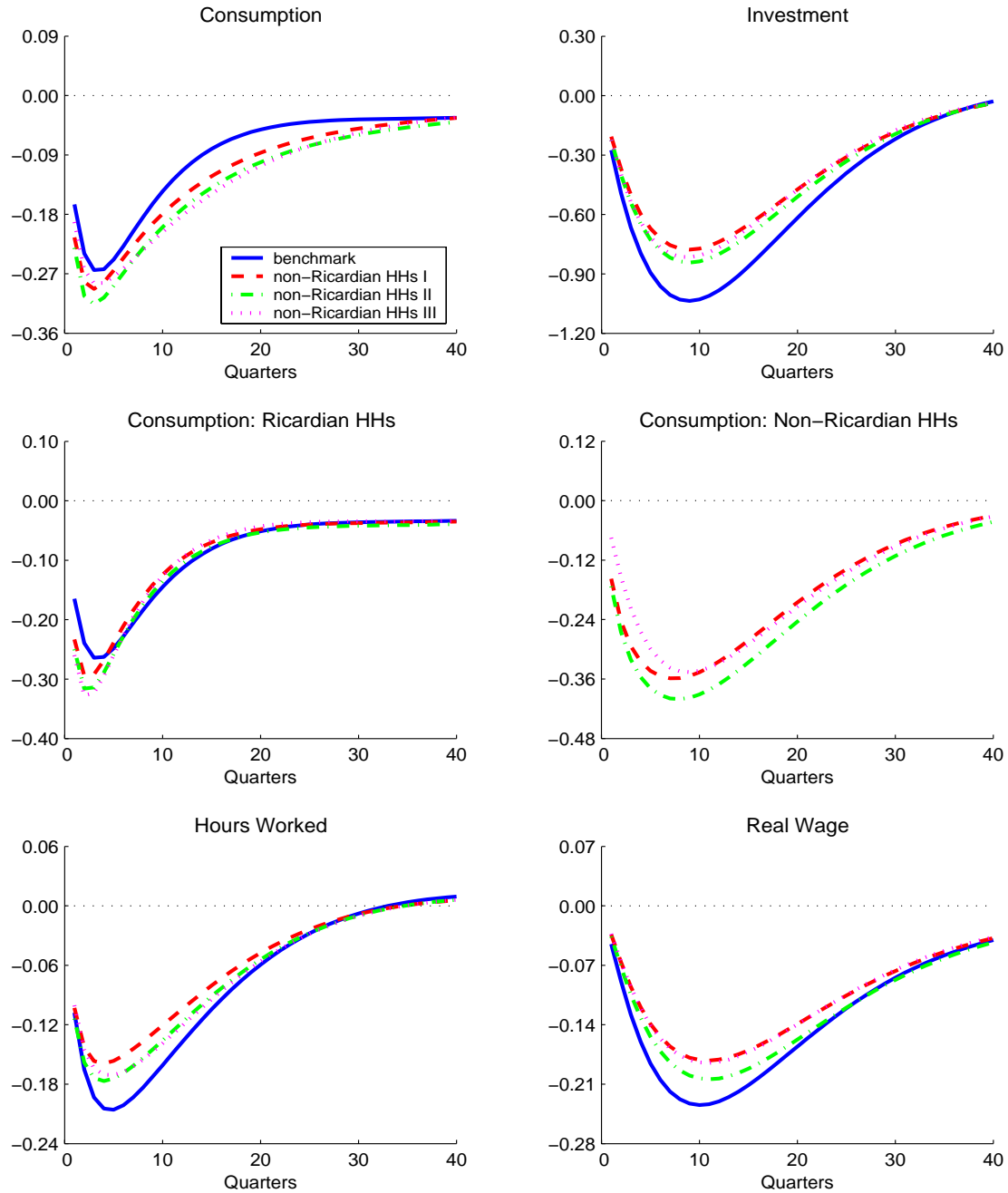Figure 1: Selected Dynamic Responses to a Government Spending Shock
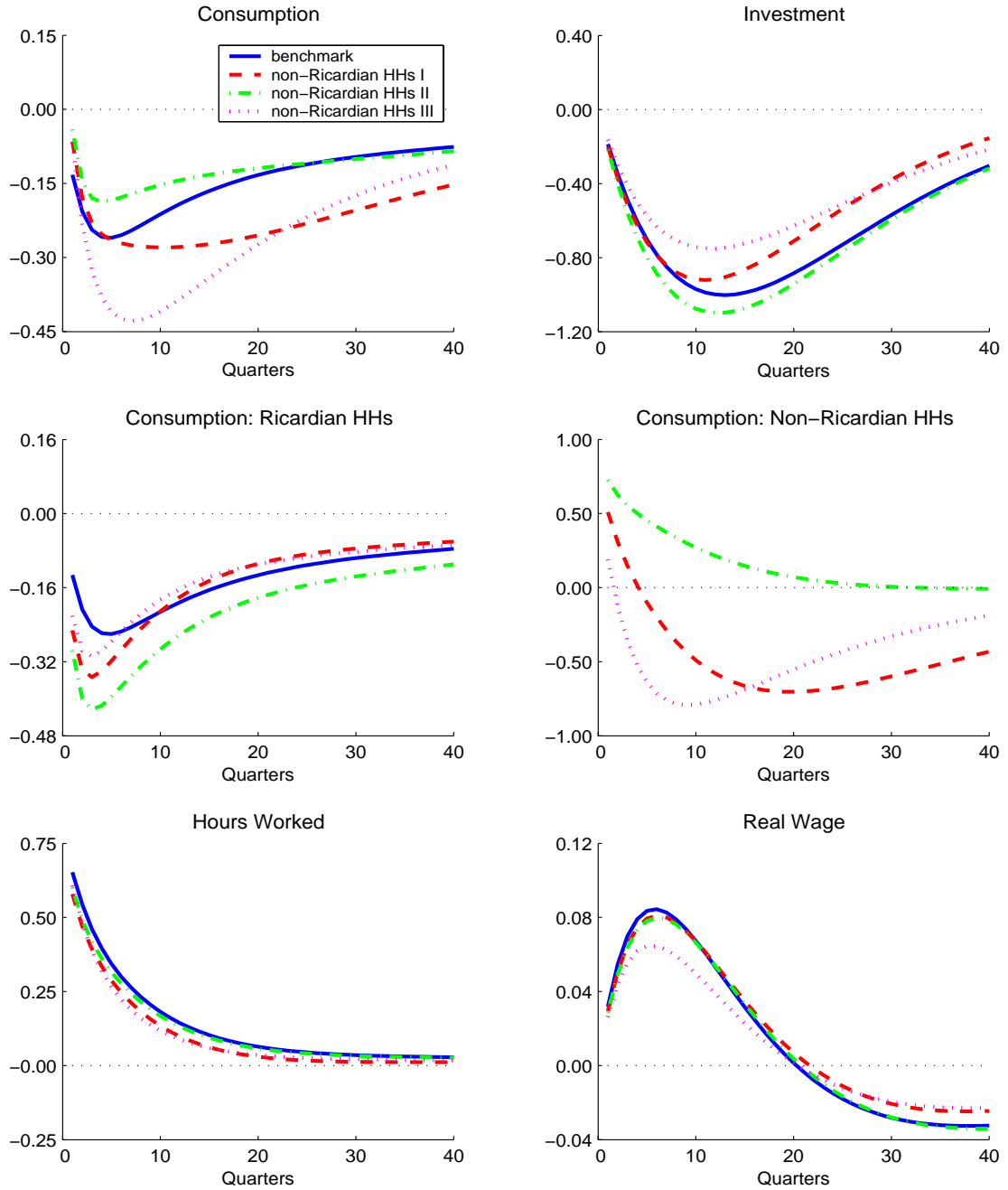
Note: This figure depicts the dynamic responses of selected variables to a persistent government spending shock equal to 1 percent of stead-state output. The parameter governing the degree of persistence is set equal to the estimate for the benchmark specification with $\rho_g = 0.943$. All dynamic responses are depicted as percentage-point deviations from steady state.

Figure 2: The Response of Monetary Policy to a Government Spending Shock
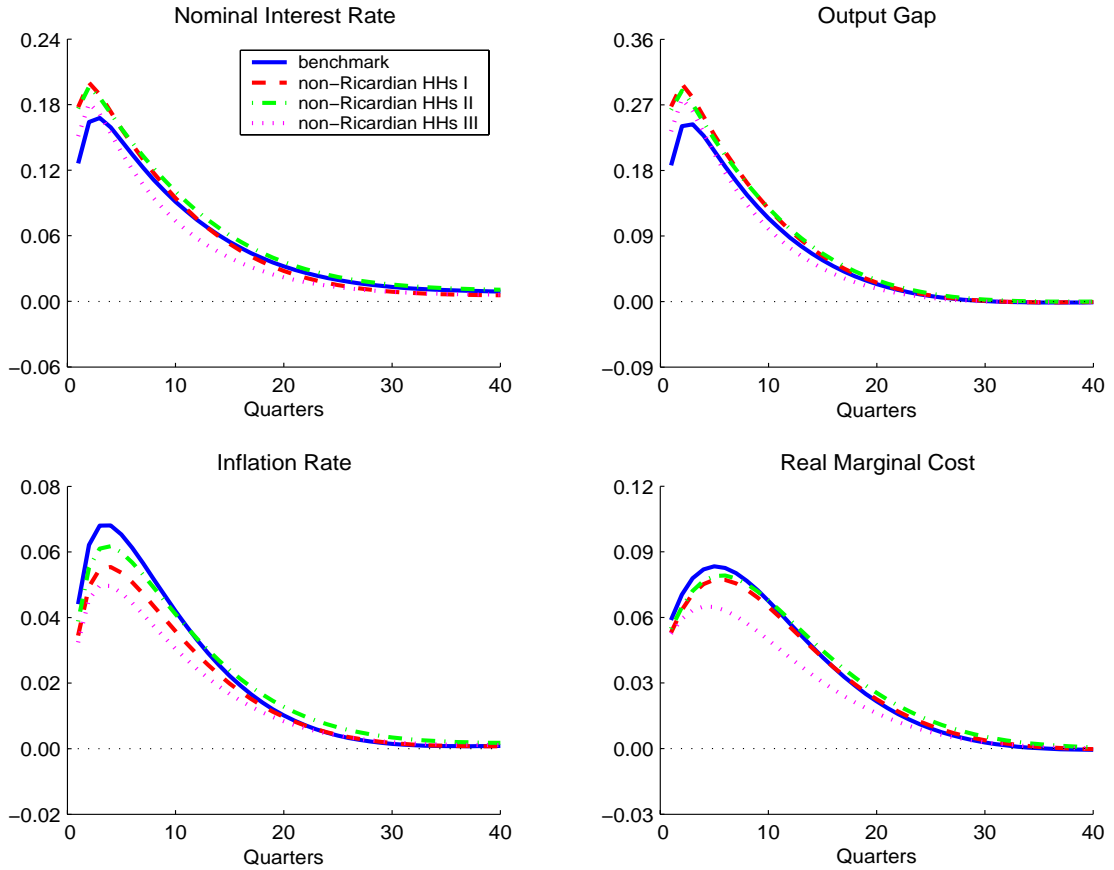
Note: This figure depicts the dynamic responses of selected variables to a persistent government spending shock equal to 1 percent of stead-state output. The parameter governing the degree of persistence is set equal to the estimate for the benchmark specification with $\rho_g = 0.943$. All dynamic responses are depicted as percentage-point deviations from steady state.

Figure 3: Selected Dynamic Responses to a Monetary Policy Shock

Note: This figure depicts the dynamic responses of selected variables to a monetary policy shock corresponding to an unexpected one-quarter increase in the short-term nominal interest rate equal to 25 basis points, whith the monetary authority following the estimated policy rule thereafter. All dynamic responses are reported as percentage-point deviations from steady state.

Figure 4: The Sensitivity of the Impact Multiplier to Variations in Selected Parameters
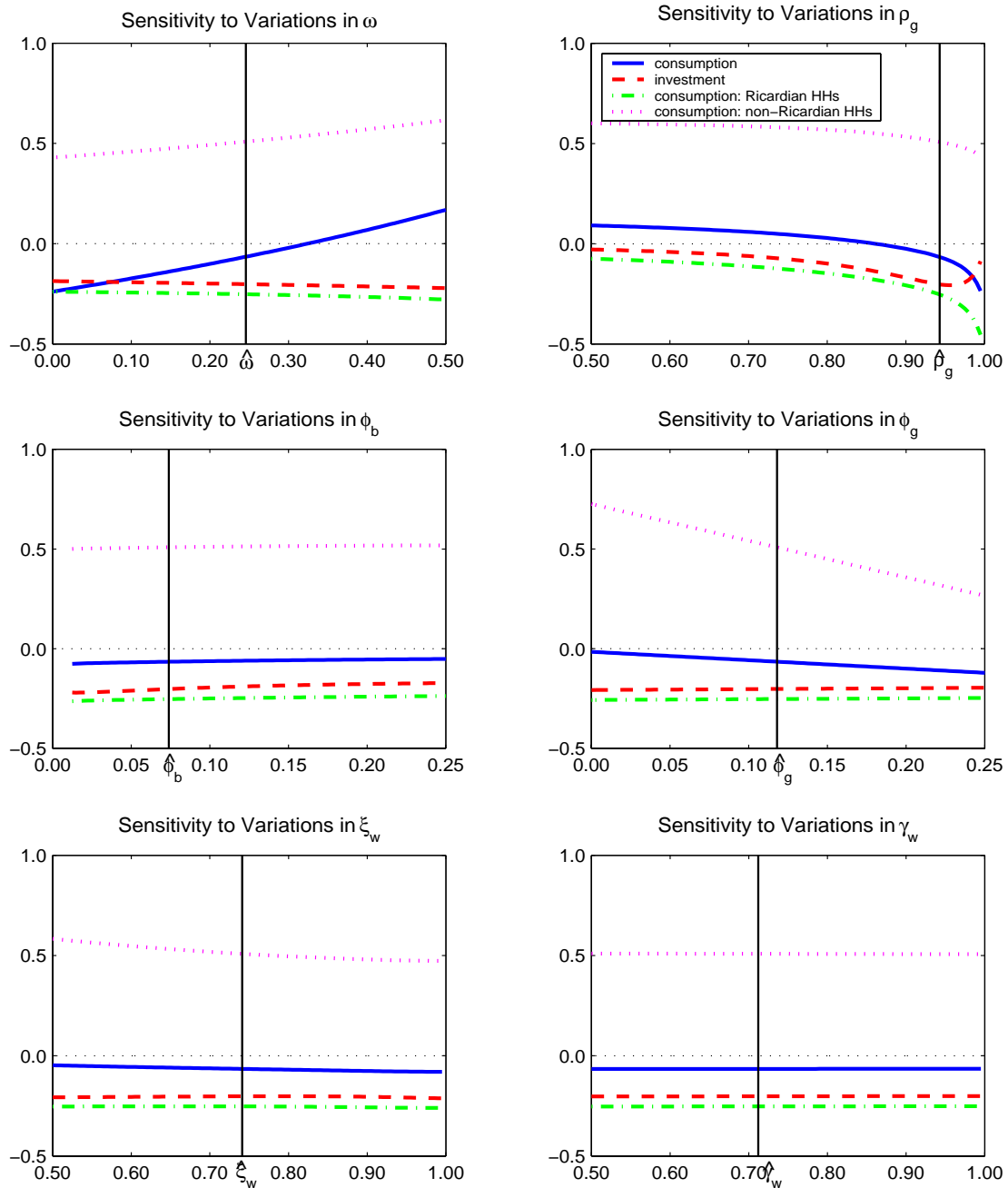
Note: This figure depicts the sensitivity of the impact response of consumption and imvestment to goverment spending shocks for the estimated DSGE model with non-Ricardian households and uniformly distributed lump-sum taxes. The sensitivity is assessed by varying a single parameter holding all other parameters constant at their estimated values.

References

Adolfson, M., S, Laséen, J. Lindé and M. Villani, 2004, "Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through," unpublished; Sveriges Riksbank, Stockholm.

Baxter, M. and R. King, 1993, "Fiscal Policy in General Equilibrium," *American Economic Review*, Vol. 83, pp. 315-344.

Bilbiie, F. and R. Straub, 2004a, "Fiscal Policy, Business Cycles and Labor Market Fluctuations," Magyar Nemzeti Bank Working Paper 2004/6.

Bilbiie, F. and R. Straub, 2004b, "Limited Asset Market Participation and Aggregate Demand: A Rationale for US Monetary Policy during the Great Inflation," (unpublished; Florence: European University Institute).

Burnside, C., M. Eichenbaum and J. D. M. Fisher, 2003, "Fiscal Shocks and Their Consequences," (unpublished; Chicago: Northwestern University).

Calvo, G. A., 1983, "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics*, Vol.12, pp. 383-398.

Campbell, J. Y., and N. G. Mankiw, 1989 , "Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence," in O. J. Blanchard and S. Fischer (eds), NBER Macroeconomics Annual, Cambridge: MIT Press, pp.185-216.

Canzoneri, M. B., R. Cumby and B. Diba, 2002, "Should the European Central Bank and the Federal Reserve Be Concerned about Fiscal Policy?" in Rethinking Stabilization Policy, Symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, pp. 333-389.

Christiano, L. and M. Eichenbaum, 1992, "Current Real Business Cycle Theories and Aggregate Labor Market Fluctutations," *American Economic Review*, Vol. 82, pp. 430-450.

Erceg, C. J., L. Guerrieri and C. Gust, 2003, "SIGMA: A New Open Economy Model for Policy Analyis," (unpublished; Washington DC: Board of Governors of the Federal Reserve System).

Fagan, G., J. Henry, and R. Mestre, 2001, "An Area-Wide Model (AWM) for the Euro Area," ECB Working Paper No. 42, European Central Bank, January.

Fatás, A. and I. Mihov, 2001, "The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence," (unpublished; INSEAD).

Galí, J., J. D. López-Salido and J. Vallés, 2004, "Understanding the Effects of Government Spending on Consumption," ECB Working Paper No. 339, European Central Bank.

Geweke, J. F., 1999, "Using Simulation Methods for Bayesian Econometric Models: Inference, Developments and Communication," (with discussion and rejoinder), *Econometric Reviews*, Vol.18, pp. 1-126.

Hall, R. E., 1978, "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence," *Journal of Political Economy*, Vol. 86, pp. 971-987.

Juillard, M., 2004, "Dynare Manual," (unpublished; CEPREMAP).

Juillard, M., P. Karam, D. Laxton and P. Pesenti, 2005, "Welfare-Based Monetary Policy Rules in an Estimated DSGE Model of the U.S. Economy," (unpublished; Washington DC: International Monetary Fund).

Linnemann, L. and A. Schabert, 2003, "Fiscal Policy in the New Neoclassical Synthesis," *Journal of Money, Credit and Banking*, Vol 35, pp. 911-929.

Mankiw, N. G., 2000, "The Savers-Spenders Theory of Fiscal Policy," *American Economic Review*, Vol. 90, pp. 120-125.

Mihov, I., 2003, Discussion of "Understanding the Effect of Government Spending on Consumption," by J., Galí, J. D. López-Salido and J. Vallés, International Research Forum on Monetary Policy, Washington, DC, November.

Mountford, A. and H. Uhlig, 2001, "What Are the Effects of Fiscal Policy Shocks?" CentER Discussion Paper No. 31, Tilburg University.

Perotti, R., 2002, "Estimating the Effects of Fiscal Policy in OECD Countries,"(unpublished: Florence: European University Institute).

Schorfheide, F., 2000, "Loss-Function-Based Evaluation of DSGE Models," *Journal of Applied Econometrics*, Vol. 15, pp. 645-670.

Schorfheide, F. and T. Lubik, 2005, "A Bayesian Look at New Open Economy Macroeconomics," (unpublished: Philadelphia: University of Pennsylvania).

Smets, F. and R. Wouters, 2003, "An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area," *Journal of the European Economic Association*, Vol.1, pp.1123-1175.