

CDMA07/03

# Does Government Spending Optimally Crowd in Private Consumption?\*

Michal Horvath<sup>†</sup>  
CDMA University of St Andrews

MAY 2008

## ABSTRACT

We analyze if a rise in private consumption following an exogenous rise in government spending is a feature of the economy under optimal stabilization in a standard New Keynesian setting augmented for the presence of liquidity-constrained agents and non-separable preferences. Our results provide little evidence in support of a crowd-in effect under ‘timelessly optimal’ policy.

**JEL Classification:** E21, E52, E61, E63.

**Keywords:** Consumption, Government Spending, Optimal Monetary and Fiscal Policy, Non-Separable Preferences, Non-Ricardian Agents.

\* Acknowledgements: The paper benefited from comments received at various stages from Jagjit S. Chadha, Martin Ellison, Sean Holly, Kaushik Mitra, Charles Nolan, Geetha Selvaratnam, from seminar participants at the University of St Andrews, Oxford University, Bank of England and conference participants at the Scottish Economic Society Conference, Royal Economic Society Conference, 22nd Congress of the European Economic Association and the MMF Conference, all in 2007, where earlier versions of this paper were presented. I am indebted to two anonymous referees for their detailed comments and the suggestion to focus the analysis on the question of the effects of government spending on consumption. I should also like to thank the Centre for Dynamic Macroeconomic Analysis at the University of St Andrews for generous research funding.

<sup>†</sup> Centre for Dynamic Macroeconomic Analysis, School of Economics and Finance, Castlecliffe, The Scores, St Andrews, Fife KY16 9AL, Scotland, UK. Tel +44 (0) 1334 462 445, Fax +44 (0) 1334 462 444, E-mail: mh.pobox@gmail.com.

CASTLECLIFFE, SCHOOL OF ECONOMICS & FINANCE, UNIVERSITY OF ST ANDREWS, KY16 9AL  
TEL: +44 (0)1334 462445 FAX: +44 (0)1334 462444 EMAIL: [cdma@st-and.ac.uk](mailto:cdma@st-and.ac.uk)

## 1. Introduction

We model an economy in which both liquidity constraints and non-separable preferences can be introduced as a straightforward generalization of a standard baseline model, and seek an answer to the question: Does a rise in private consumption follow a rise in government spending under optimal stabilization?

The question of the effects of government spending on private consumption has been a matter of intense debate in macroeconomics stretching over many years. Recently, it has been proposed in important contributions to the literature that departures from standard assumptions about consumer behaviour might play a role in providing a theoretical justification for a rise in private consumption following an increase in government spending.<sup>1</sup> Galí et al. (2007), Erceg et al. (2006) and Coenen et al. (2007) have been the most notable theoretical contributions. The empirical literature is more split on the idea but still generally supportive of the basic proposition.<sup>2</sup> The papers we refer to have analyzed the effects of a government spending shock in the context of models that do not assume optimal conduct of policy.

We look at the effects of government spending on private consumption from a normative perspective. We find that a rise in private consumption following a rise in government spending is generally not a feature of the economy under optimal stabilization even if the description of consumer behaviour departs from the conventions of macroeconomics. A crowd-in effect only emerges in circumstances that might be difficult to reconcile with reality in advanced economies. For instance, this is the case in an economy without liquidity constraints in which agents are significantly risk-averse or in an economy with a very large share of

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<sup>1</sup>Such a response in consumption has been identified in a substantial part of empirical literature. See Galí et al. (2007) for a thorough review and some new results.

<sup>2</sup>See Coenen and Straub (2005), López-Salido and Rabanal (2006) and Forni et al. (2007).

liquidity-constrained agents, high labour supply elasticity and low risk aversion.

Our framework is a standard New Keynesian economy in which prices are sticky and preferences can be made non-separable. We augment this framework for the presence of liquidity-constrained agents whom we shall henceforth refer to as *non-Ricardian*. We study dynamics under ‘timelessly-optimal’ monetary and fiscal policy in this economy using a linear-quadratic setup.<sup>3</sup> In a conceptually related analysis, Bilbiie (2008) characterizes optimal discretionary and timelessly optimal monetary policy. Important simplifying assumptions that underlie his setup are that neither the fiscal consequences of monetary policy nor the first-order effects of stabilization policy are considered.<sup>4</sup> In our framework, where monetary and fiscal policy have to be coordinated to attain the optimal outcome and in which stabilization policy has level effects, these first-order effects turn out to play a key role in explaining optimal dynamics in the model.

The rest of the paper is organized as follows. Section 2 sets out the microeconomic foundations of the model. Section 3 presents the model of the linear economy and the quadratic objective function of the policy maker that follow from the micro-foundations. In Section 3 we also characterize the optimal dynamics of the economy using ‘specific targeting rules’ of Svensson (2002, 2003). It is a feature of our analysis worth emphasizing that the policy problem of the non-Ricardian economy as well as the optimal policy rules can be presented as a generalization of the baseline setup with Ricardian agents only, with the functional forms unaffected by the presence of non-Ricardian behaviour. The effects of the rise in government spending on private consumption and the determinants of the consumption response are discussed in Section 4. Section 5 concludes.

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<sup>3</sup>See Woodford (2003), for instance, for a thorough explanation of the concept of policies optimal from a ‘timeless perspective’.

<sup>4</sup>Bilbiie (2008) also finds that the presence of liquidity-constrained agents beyond a threshold share may induce a change in the sign of the slope coefficient in the ‘IS’ relationship, introducing ‘inverted aggregate demand logic’ into the analysis. We shall return to this point in Section 4.2.

## 2. The economy

In this section, we present a general equilibrium framework in which liquidity-constrained agents make up a stable proportion of all agents in the economy. We allow for heterogeneity among agents in terms of access to the asset market but our setup enables us to maintain much of the tractability of the representative agent framework.<sup>5</sup> This feature of the analysis then facilitates the use of modern methods of optimal policy determination.

### 2.1. Consumers

Consider an economy inhabited by a continuum of agents indexed by  $k \in [0, 1]$ . The agents' utility is increasing in consumption  $C$  and leisure  $(1 - H)$ . As in Galí et al. (2004), we assume the following functional form for the utility of agents

$$u = \frac{[C(1 - H)^\omega]^{1 - \tilde{\sigma}^{-1}}}{1 - \tilde{\sigma}^{-1}} \quad (2.1)$$

with  $\omega > 0$  and  $\tilde{\sigma}^{-1} \geq 0$ . Let us assume that the agents are identical in all aspects except for their access to the asset market. Agents indexed  $k \in [0, \lambda]$  have no access to the asset market, whilst agents  $k \in (\lambda, 1]$  can smooth consumption over time by varying their holdings of one-period nominal government debt—the only type of asset available in the economy.

#### 2.1.1. Non-Ricardian agents

Agents who have no access to the asset market have to rely on current after-tax wage income to finance consumption. It can be shown that given a simple budget constraint that makes consumption equal to the after-tax wage, the period utility

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<sup>5</sup>This is partly due to the way preferences of individuals are described and partly due to the formulation of the government's objective. More discussion will follow.

function of the form (2.1) is maximized if the liquidity-constrained agents supply labour

$$H^{NR} = \frac{1}{1 + \omega} \quad (2.2)$$

in which case the optimal consumption of these agents is given by

$$C_t^{NR} = \frac{1 - \tau_t}{1 + \omega} \frac{W_t}{P_t} \quad (2.3)$$

for all  $t$ . The variable  $\tau$  denotes tax on wage income,  $W$  is the economy-wide nominal wage rate and  $P$  is the price index. Constant labour supply by non-Ricardian agents over time and across states of nature facilitates aggregation in the model.

### 2.1.2. Ricardian agents

The problem to be solved by the Ricardian agents—as we shall refer to the agents who smooth consumption over time—can be written as a problem of a representative agent choosing a sequence  $\{C_T^R, H_T^R, b_T^R\}_{T=t}^\infty$  to maximize

$$U_t = E_t \sum_{T=t}^\infty \beta^{T-t} \frac{[C_T^R (1 - H_T^R)^\omega]^{1-\tilde{\sigma}^{-1}}}{1 - \tilde{\sigma}^{-1}} \quad (2.4)$$

subject to

$$C_T^R + \frac{b_T^R}{1 + i_T} = (1 - \tau_T) \frac{W_T}{P_T} H_T^R + D_T + b_{T-1}^R \frac{P_{T-1}}{P_T} \quad (2.5)$$

for all  $T \geq t$ . The variable  $b^R$  stands for  $(1 + i) B^R / P$  in which  $B^R$  is the stock of nominal, one-period government debt held by the Ricardian agents. The nominal interest rate is denoted  $i$ . While the non-Ricardian agents are workers only, Ricardian agents hold stakes in firms. The variable  $D$  denotes dividends received on the basis of ownership of firms.

Combining the first-order conditions with respect to  $C^R$  and  $H^R$  from the above problem yields (with  $T = t$ )

$$C_t^R = \frac{(1 - \tau_t) W_t}{\omega} \frac{1}{P_t} (1 - H_t^R) \quad (2.6)$$

and we also obtain the Euler equation

$$\beta \frac{E_t (C_{t+1}^R)^{-\tilde{\sigma}^{-1}} (1 - H_{t+1}^R)^{\omega(1-\tilde{\sigma}^{-1})}}{(C_t^R)^{-\tilde{\sigma}^{-1}} (1 - H_t^R)^{\omega(1-\tilde{\sigma}^{-1})}} \frac{(1 + i_t)}{(1 + E_t \pi_{t+1})} = 1, \quad (2.7)$$

in which  $E_t \pi_{t+1}$  is expected inflation with  $\pi_t = P_t/P_{t-1}$ . The relationship (2.7) solved in a multi-period form also defines the asset pricing kernel  $Q_{t,T}$ .

### 2.1.3. Aggregation

For aggregate consumption in our economy, it holds that

$$\begin{aligned} C_t &= \int_0^\lambda C_t^{NR} dk + \int_\lambda^1 C_t^R dk \\ &= \lambda C_t^{NR} + (1 - \lambda) C_t^R. \end{aligned} \quad (2.8)$$

A similar relationship holds for labour supply

$$H_t = \lambda H^{NR} + (1 - \lambda) H_t^R. \quad (2.9)$$

Since our asset holders are identical in all aspects, the holdings of assets will be distributed among them uniformly across time and state of nature. If aggregate asset holdings in the economy are denoted  $B$ , it follows that

$$B_t^R = \frac{B_t}{1 - \lambda}$$

for all  $t$ . In aggregate then, labour supply and consumption respectively are given by

$$H_t = \frac{\lambda}{1 + \omega} + (1 - \lambda) H_t^R, \quad (2.10)$$

$$C_t = \frac{(1 - \tau_t) W_t}{\omega P_t} (1 - H_t). \quad (2.11)$$

Combining (2.2), (2.3), (2.6) and (2.11), yields

$$C_t^{NR} = \frac{\omega}{1 + \omega} \frac{C_t}{(1 - H_t)}, \quad (2.12)$$

$$C_t^R = \frac{C_t}{(1 - \lambda)} \left[ 1 - \frac{\omega \lambda}{(1 - H_t)(1 + \omega)} \right]. \quad (2.13)$$

We can thus express all variables in terms of aggregate variables and carry on solving the model using standard methods developed to identify optimal policy in representative agent frameworks.

## 2.2. Firms

Let us assume a continuum of monopolistically competitive producers of differentiated intermediate goods (indexed  $j$ ). These goods then serve as an input in the production of a single final good. The production technology of the final good—produced by a representative firm operating in a perfectly competitive environment—is described by a Dixit-Stiglitz (1977) aggregator

$$Y_t = \left[ \int_0^1 y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}}, \quad (2.14)$$

where  $y(j)$  is the quantity of an intermediate good used in the production of  $Y$ . The coefficient  $\varepsilon$  denotes the costant elasticity of substitution between individual goods. A simple cost minimization exercise by final goods producers yields the expression for the demand for intermediate good  $j$

$$y_t(j) = Y_t \left( \frac{p_t(j)}{P_t} \right)^{-\varepsilon} \quad (2.15)$$

and the aggregate price index

$$P_t = \left[ \int_0^1 p_t(j)^{1-\varepsilon} dj \right]^{\frac{1}{1-\varepsilon}}. \quad (2.16)$$

Let us also assume that the production of the intermediate goods is described by the production function

$$y_t(j) = H_t(j)^{1/\alpha} \quad (2.17)$$

with  $\alpha > 1$ . In equilibrium it holds that

$$\begin{aligned} H_t &= \int_0^1 H_t(j) dj \\ &= Y_t^\alpha \delta_t \end{aligned} \quad (2.18)$$

with

$$\delta_t = \int_0^1 \left( \frac{p_t(j)}{P_t} \right)^{-\varepsilon \alpha} dj \quad (2.19)$$

denoting price dispersion.

The producers of intermediate goods maximize profits given by

$$\Upsilon(j) = p(j) y(j) - W H(j). \quad (2.20)$$

They do so in a forward-looking way, evaluating an expected stream of profits. We assume a price setting mechanism of the type put forward by Calvo (1983) with  $\gamma \in (0, 1)$  denoting the probability for a firm of charging unchanged prices in any period. With  $p_t^*$  being the price chosen for period  $t$  by all firms who can re-optimize their prices, the first order condition from this problem is written as

$$E_t \sum_{T=t}^{\infty} \gamma^{T-t} Q_{t,T} Y_T \left( \frac{p_t^*}{P_T} \right)^{-\varepsilon} \left[ (1 - \tau_T) - \mu \frac{W_T}{P_T} \alpha Y_T^{\alpha-1} \left( \frac{p_t^*}{P_T} \right)^{-\varepsilon(\alpha-1)-1} \right] = 0 \quad (2.21)$$

and the dynamics of the price level is then given by

$$P_t = \left[ (1 - \gamma) p_t^{*1-\varepsilon} + \gamma P_{t-1}^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}. \quad (2.22)$$

### 2.3. Government

The government raises revenues  $T$  via *distortionary* taxes on wage income to finance exogenous government spending  $G$ . It issues one-period nominal bonds to



bridge the gap between taxation and spending. The government, therefore, faces the flow budget constraint

$$B_t = (1 + i_{t-1}) B_{t-1} - P_t s_t \quad (2.23)$$

where  $B$  denotes the volume of one-period nominal bonds issued by the fiscal authority and  $s = T - G$  is the primary budget surplus. This constraint can be rewritten as

$$\frac{b_t}{(1 + i_t)} = \frac{b_{t-1}}{(1 + \pi_t)} - s_t \quad (2.24)$$

Monetary and fiscal authorities, the two branches of the central government, coordinate their actions to ensure that social welfare given by the discounted sum of weighted period utilities of Ricardian and non-Ricardian agents

$$U_t = E_t \sum_{T=t}^{\infty} \beta^{T-t} \{ \lambda u_T^{NR} + (1 - \lambda) u_T^R \} \quad (2.25)$$

is maximized. Arguably, maximizing the discounted value of weighted period utilities is a valid representation of social welfare if lack of access to the asset market comes from constraints rather than individual preferences.<sup>6</sup>

There are several ways to proceed from here. In this paper, we solve for the approximate optimal plan by formulating a linear-quadratic approximate policy problem. For models where stabilization policy has significant first-order welfare effects, which happens when there are non-zero linear terms in the approximation to social welfare, the construction of a second-order-accurate welfare ranking

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<sup>6</sup>See Bilbiie (2008). Such a specification of the policy objective is also helpful, as it facilitates the derivation of the approximate Ramsey problem. An alternative way of setting up the same policy problem would be to assume that agents receive a signal whether they have or have no access to the asset market in the beginning of each period. Amato and Laubach (2003) have used this approach to introduce inertial rule-of-thumb behaviour into a framework similar to ours. Such a setup—arguably a less intuitive one in present circumstances—would, however, necessitate some further assumptions to make sure the transversality condition is satisfied and that there is no need to track the distribution of assets as a separate state variable.

criterion requires a second-order approximation to the structural equations. These are then used to substitute out the linear term from the approximation to social welfare. One thus obtains a welfare objective expressed purely in second-order terms with the first-order effects preserved in an implicit form.<sup>7</sup> In the next section, we present the structural elements of the approximate problem. The derivation follows the steps in Benigno and Woodford (2003) and is not presented in this paper.

### 3. The macroeconomic model and the policy problem

The micro-foundations discussed in the previous section imply a simple New Keynesian model of the macroeconomy. The model we present here appears to be very similar to Benigno and Woodford (2003). We left the notation largely unchanged to indicate that we can present the economy with non-Ricardian agents as a generalization of the framework in which consumption-smoothing applies to all consumers. The main difference here is that some key parameters of the model, such as the costliness of volatility in the target variables or the target level of output, will be a function of the share of liquidity-constrained agents in the economy. Whilst we do not provide detailed derivations of the following equations, the Appendix contains definitions of coefficients and variables resulting from the derivations. In the Appendix, we also plot calibrated values of some of the key parameters of the linearized model as a function of the share of non-Ricardian agents.

The supply side of the economy is characterized by the following forward-looking New Keynesian Phillips curve

$$\pi_t = \kappa y_t + \chi_\tau (\hat{\tau}_t - \hat{\tau}_t^*) + \beta E_t \pi_{t+1}. \quad (3.1)$$

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<sup>7</sup>See Benigno and Woodford (2003, 2006) for an extensive treatment.

The supply equation links current inflation  $\pi$  to the welfare-relevant output gap  $y$ , deviation in taxes and expected future inflation. The output gap here is defined as the difference between the actual deviation in output from its steady state and its ‘target deviation’  $\hat{Y}^*$ , where the latter follows from the approximation to welfare. The target deviation  $\hat{Y}^*$  is a function of the exogenous shock(s) only and hence is independent of policy. In general, it is different from the ‘natural rate of output’ commonly referred to in the literature on monetary policy. The ‘target deviation’ in the tax rate  $\hat{\tau}^*$  is the deviation that would offset the cost-push pressure resulting from the increase in government spending.<sup>8</sup> Interestingly, the coefficients in (3.1) turn out to be independent of  $\lambda$ . This follows from the fact that the equilibrium real wage rate and hence also marginal cost in our economy only depends on aggregate variables, as implicitly defined in (2.11).

The government’s flow budget constraint can be shown to yield the following fiscal sustainability condition expressed in terms of the ‘gap-variables’ in (3.1)

$$\begin{aligned} \hat{b}_{t-1} - \pi_t - \Phi^{-1}y_t + \varphi_t &= (1 - \beta) [f_y y_t + f_\tau (\hat{\tau}_t - \hat{\tau}_t^*)] \\ &+ \beta E_t [\hat{b}_t - \pi_{t+1} - \Phi^{-1}y_{t+1} + \varphi_{t+1}]. \end{aligned} \quad (3.2)$$

$\varphi$  is the ‘fiscal stress’ term introduced in Benigno and Woodford (2003) as a composite measure of the consequences for fiscal solvency of the spending shock.

Finally, it follows from (2.25) that the central government conducts monetary and fiscal policy in a coordinated fashion to minimize the quadratic loss function

$$L_t = E_t \sum_{T=t}^{\infty} \beta^{T-t} \left\{ \frac{1}{2} q_y y_T^2 + \frac{1}{2} q_\pi \pi_T^2 \right\}. \quad (3.3)$$

Benigno and Woodford (2003, 2006) explain the methodological background of deriving a quadratic function such as (3.3) that is able provide a second-order

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<sup>8</sup>See Benigno and Woodford (2003) for an in-depth treatment of these concepts.

accurate welfare ranking of alternate policies in the presence of non-negligible level effects, whilst the structural equations, (3.1) and (3.2), together with appropriate initial commitments (to be discussed below), are accurate only up to the first order.

We now follow Woodford (2003) and derive the policy optimal from a ‘timeless perspective’. We need to restrict the policy choices for period  $t$  so that the policy maker uses the same procedure to formulate policy as in later periods. The problem facing the policy maker is, therefore, given by the following Lagrangian:

$$\begin{aligned}
J_t = & E_t \sum_{T=t}^{\infty} \beta^{T-t} \left\{ \left( \frac{1}{2} q_y y_T^2 + \frac{1}{2} q_\pi \pi_T^2 \right) \right. \\
& + \phi_{1,T} [\pi_T - \kappa y_T - \chi_\tau (\hat{\tau}_T - \hat{\tau}_T^*) - \beta E_t \pi_{T+1}] \\
& + \phi_{2,T} \left[ \hat{b}_{T-1} - \pi_T - \Phi^{-1} y_T + \varphi_T - (1 - \beta) f_y y_T - (1 - \beta) f_\tau (\hat{\tau}_T - \hat{\tau}_T^*) \right. \\
& \left. \left. - \beta \hat{b}_T + \beta E_t \pi_{T+1} + \beta E_t \Phi^{-1} y_{T+1} \right] \right\} + (\phi_{2,t-1} - \phi_{1,t-1}) \pi_t + \Phi^{-1} \phi_{2,t-1} y_t
\end{aligned} \tag{3.4}$$

The final two terms represent the additional constraints concerning the initial period

$$\pi_t = \bar{\pi}_t,$$

$$y_t = \bar{y}_t.$$

These are commitments regarding values of endogenous variables the expectations of which are relevant for the determination of equilibrium in period  $t - 1$ . The specification of these commitments follows from the long-run solution to the model. Policies that satisfy these commitments are necessarily time-consistent.

The first-order conditions from this policy problem can be combined to obtain the ‘specific targeting rules’ in the sense of Svensson (2002, 2003)

$$E_t \pi_T = 0 \tag{3.5}$$

for all  $T > t$  and

$$\pi_t + \frac{n_\phi}{m_\phi} \pi_{t-1} - \frac{\omega_\phi}{m_\phi} (y_t - y_{t-1}) = 0. \quad (3.6)$$

These rules define the relationships between aggregate variables that the monetary and fiscal branches of the central government authority should aim to bring about in a coordinated fashion. Again, we preserved the notation from Benigno and Woodford (2003). However, the coefficients in (3.6) will be a function of  $\lambda$ . The system comprising these targeting rules and the constraints in (3.4) defines the optimal dynamics of the economy.

To make our structural framework complete, we derive the log-linearized version of (2.7) using the approximation to consumption and welfare-relevant output gaps to obtain the intertemporal ‘IS’ relationship, which describes the demand side of the economy

$$y_t = E_t y_{t+1} - \Phi \left( \hat{i}_t - E_t \pi_{t+1} - \hat{r}_t^* \right). \quad (3.7)$$

The variable  $\hat{r}^*$  here represents the deviation in the interest rate that is consistent with the preference-driven target deviation in output  $\hat{Y}^*$  under stable prices.  $\hat{r}^*$  depends on exogenous real variables only and hence, cannot be affected by government policy.  $\hat{i}_t = \log \frac{1+i_t}{1+\bar{i}}$ , where  $\bar{i}$  is the steady state interest rate determined by the rate of time preference. Combining this equation with (3.6) in an appropriate manner gives us the ‘expectations-based’ reaction function for the interest rate<sup>9</sup>

$$\begin{aligned} i_t = & \hat{r}_t^* + E_t \pi_{t+1} + \Phi^{-1} E_t y_{t+1} - \Phi^{-1} \frac{m_\phi}{\omega_\phi} \pi_t \\ & - \Phi^{-1} \frac{n_\phi}{\omega_\phi} \pi_{t-1} - \Phi^{-1} y_{t-1}. \end{aligned} \quad (3.8)$$

From this, it follows that the long-run response to inflation is given by

$$1 - \frac{\Phi^{-1}}{\omega_\phi} (m_\phi + n_\phi). \quad (3.9)$$

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<sup>9</sup>See Evans and Honkapohja (2006).

In the next section, we shall concentrate on one particular aspect of the optimal dynamics. We shall examine the effects of an exogenous increase in government spending on private consumption under optimal stabilization.

## 4. Effects of government spending on private consumption

We study numerical calibrations of the optimal dynamics derived in the previous section and examine if departures from conventional modelling of consumer behaviour—as suggested by Campbell and Mankiw (1989), Mankiw (2000) and Basu and Kimball (2000)—could significantly alter the conclusions regarding the effect of government spending on consumption under optimal policy. A link between the way consumer behaviour is modelled and the nature of the response in consumption to a spending shock has been suggested in the context of models assuming a simple rule-based conduct of policy, as explained in the introduction.<sup>10</sup>

### 4.1. Calibration

We calibrate the model of the optimal economy using the following structural parameter values. The *quarterly* discount rate,  $\beta$ , is calibrated to a commonly used value of 0.99, implying an annualized steady-state rate of interest just over 4 percent. The consumption share of national income,  $c$ , is 0.8. The value of  $\tilde{\sigma}^{-1}$  is set to 1 in the baseline calibration, which implies a log-linear (separable) functional form and is varied from low values of around 0.13 estimated in Rotemberg and Woodford (1997) to high values exceeding 1 commonly used in the literature which estimates the elasticity of consumption to the real interest rate to be very low. The value of  $\omega$  in the utility function is calibrated so that the Frisch elasticity of labour supply (given by  $(1 - \bar{H}) / \bar{H}$  from (2.11)) takes on a value of 1, as in

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<sup>10</sup>In section A.3 of the Appendix, we present a simple algebraic analysis that helps linking our model to earlier literature on consumer behaviour.

Galí et. al (2004). Apart from this baseline case, we consider a significantly less elastic labour supply function and a significantly more elastic one. We assume an approximate 11 percent price markup in the product market, arising due to imperfect competition among intermediate goods producers. We set  $\alpha = 1.25$  so that the production function governing the production of intermediate goods is of decreasing-returns-to-scale type. The price stickiness parameter in the Calvo-pricing model  $\gamma$  has been set to 0.65. The steady state labour income tax rate is 30 percent. These parameter values imply a steady-state surplus-to-GDP ratio of 0.016 and hence  $\bar{b}/\bar{Y} = 1.6$  or a debt level of 40 percent of steady-state output on an annual basis.

Solving the firms' first-order condition under no price dispersion yields two solutions for the steady-state output, one of which represents a special case with the Ricardian agents consuming no leisure ( $\bar{H}^R = 1$ ) so that  $\bar{H} = \frac{1+\omega-\omega\lambda}{1+\omega}$ . By (2.6), this implies a corner solution case, a case of zero consumption for Ricardians in the steady state. A positive deviation from this steady state then implies an infinite increase in utility for Ricardian agents and for the whole economy too. We therefore concentrate on the interior solution. The corresponding steady-state level of output is independent of  $\lambda$ . This follows from the fact that the economy-wide real wage rate, and hence also marginal cost, depend only on aggregate variables, as defined in (2.11). The share of non-Ricardian agents in the economy  $\lambda$  is varied from 0 to an upper bound of lambda  $\bar{\lambda}$ . This upper bound represents the share of non-Ricardian agents at which Ricardian agents stop supplying labour to the economy. This result arises, as it holds in the steady state that  $\bar{H}^R \leq \bar{H} < \bar{H}^{NR}$  for all  $\lambda$ .

In the analysis presented here, including all calibrations in the sensitivity analysis, the parameter values yield positive coefficients  $q_y$  and  $q_\pi$  in the loss function (3.3). The objective function is then convex and the optimal solutions

presented in the next section are consistent with minimum losses in terms of the loss function (3.3).

## 4.2. Determinacy issues

For most parameter values used in the calibration exercise, the dynamic system comprising the first-order conditions from the policy problem and the structural equations yields an optimal solution which can be implemented as a unique and stable solution to the dynamic system of structural equations if policy is set according to optimal expectations-based reaction functions for policy instruments. There are a few special cases when such a solution cannot be obtained. This happens when the aggregate demand relationship changes its slope and at some point becomes perfectly inelastic.<sup>11</sup>

The fact that the IS relationship can swivel is an issue identified in Bilbiie (2008). He referred to the phenomenon of having an upward-sloping aggregate demand relationship as ‘inverted aggregate demand logic’. We find evidence of this phenomenon in our model too. For large values of  $\tilde{\sigma}^{-1}$ , the change of slope occurs at relatively low levels of  $\lambda$ . We can confirm that this also implies a change in the optimal long-run response to inflation in the ‘expectations-based’ interest rate reaction function, which is greater than one for standard downward-sloping aggregate demand relationships and becomes less than one when consumption rises in response to a rise in the real interest rate. Figure 4.1 shows how the (inverse) slope of the aggregate demand relationship varies with  $\lambda$  for  $\tilde{\sigma}^{-1} = 8$  as well as the corresponding optimal long-run response of the interest rate to inflation.

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<sup>11</sup>Mathematically, these determinacy problems do not arise if the optimal policy is implemented through the specific targeting rules specified above. In practice, the problem might prevail, as even though policy is formulated and communicated via targeting rules, it may be unavoidable to specify an interest-rate path to implement the optimal policy at operational level using reaction functions.



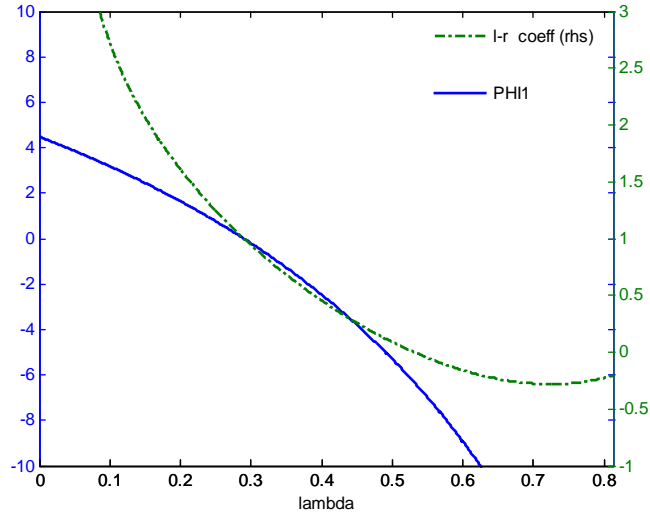


Figure 4.1: The (inverse) slope of the IS relationship and the long-run response to inflation in the interest rate reaction function

### 4.3. Optimal consumption dynamics

We now turn to examining optimal consumption dynamics following an exogenous, serially-uncorrelated rise in government spending of 1 percent of steady-state output. Figure 4.2 plots the impulse response functions for private consumption under different calibrations of agents' preferences and price stickiness in an economy without liquidity constraints.<sup>12</sup> Two properties need to be highlighted here. First, the optimal behaviour of private consumption is non-stationary in an environment with nominal rigidity. This is in line with the observations made in Benigno and Woodford (2003) and Schmitt-Grohé and Uribe (2004). Under flexible prices though, inflation can be freely used to deal with the fiscal consequences of the government spending shock and taxes vary only to ensure the

<sup>12</sup>1 on the vertical axis denotes a one-percent deviation from the pre-shock steady-state value.

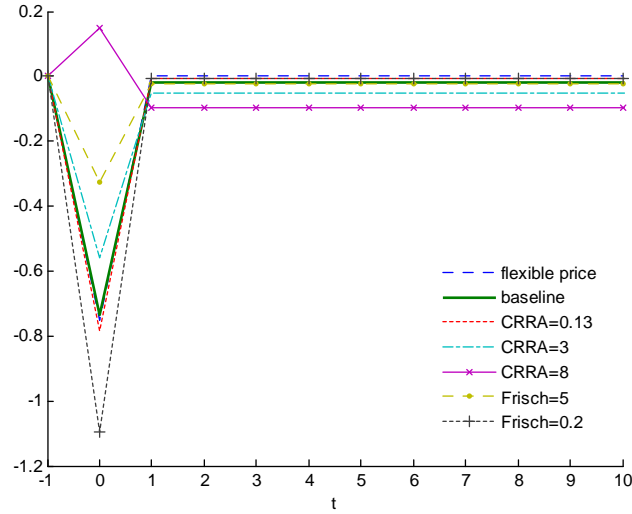


Figure 4.2: Private consumption dynamics in response to the rise in government spending in an economy with Ricardian agents only

output gap is zero throughout. Hence, once the shock dies out and the steady-state level of output becomes the target level, all variables return to their pre-shock steady state levels. Second, we see that the optimal initial response in private consumption is consistently negative for most calibrations. However, it is also clear that higher degrees of risk aversion and higher values of labour supply elasticity tend to make the response less negative. In fact, when risk aversion is very high, the optimal response ultimately becomes positive.

Next, we examine how the optimal initial response in private consumption changes as we introduce and gradually raise the share of non-Ricardian agents in the economy. Figure 4.3 summarizes our findings. We find that the above mentioned positive optimal response in consumption at high levels of risk aversion is generally not a feature of economies with non-Ricardian agents. However, a positive response in consumption can be shown to be consistent with optimal

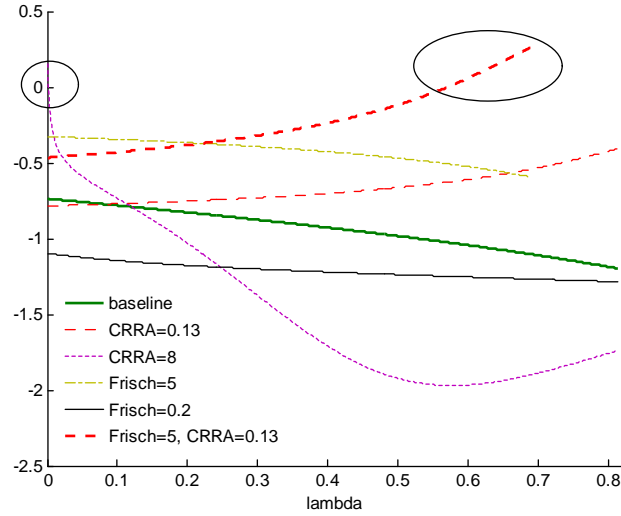


Figure 4.3: Optimal response in private consumption to a rise in government spending

policy when the share of non-Ricardian agents is high, labour supply elasticity is high and the coefficient of relative risk aversion is low.

Neither of the situations when a positive private consumption response occurs is, however, likely to be easily reconcilable with reality in advanced economies. Hence, in our setup, crowding out of private consumption by government spending is generally consistent with timelessly optimal policy.

#### 4.4. The role of the first-order effects of stabilization policy

Whilst there are several factors playing a role in explaining optimal aggregate dynamics in the economy, it turns out that the first-order effects (or level effects) of stabilization policy play a dominant role among these.

It follows from the approximation to the firms' first-order condition that there is a trade-off between volatility and average outcomes. Forward-looking

optimizing firms, when faced with a more stable environment, would either change prices less in response to a shock (*ceteris paribus*), leading to less price dispersion and higher efficiency, or, in other words, could allow for somewhat higher average levels (in fact, a smaller fall) of production and hence average marginal cost over time for a given chosen price.<sup>13</sup> Of course, the public finance implications of such a trade-off have to be taken into account too when assessing the first-order effects of a reduction in volatility. Having lower volatility necessitates higher average tax levels (and hence lower output levels) over time to compensate for the positive effect of volatility on tax receipts due to the convexity of the tax schedule.

The costliness of a given degree of output volatility,  $q_y$ , then to a decisive extent depends (positively) on the welfare effects of the potential first-order output gains arising from lower volatility. An increased average level of output could bring more utility through a rise in consumption but one also needs to account for the loss of utility due to the extra labour supply that goes with increased output levels. The measure of the costliness of volatility in turn determines the target level of output—that is the level around which we aim to stabilize the economy—as well as the optimal size of the output gap. The coefficient  $q_y$  is inversely related to both of them. For a sufficiently low  $q_y$ , the optimal response in output becomes large enough to be consistent with a rise in consumption. On the supply side, such a large response in output is implemented through tax policy, which takes the form of a short-term tax cut. The contemporaneous response in net real wages is then large enough to offset the negative wealth effect on private consumption caused by the need to keep taxes permanently higher in the long-run to meet the

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<sup>13</sup>See Benigno and Woodford (2003) for details on the approximation. The story put forward here is related to Siu (2004) who explains that in a highly volatile environment, risk-averse producers would always set prices as if they expected a large, positive (inflationary) spending shock. This happens because they try to avoid a situation in which they would set prices too low and facing high demand, they would run losses. By contrast, if they set prices too high, the worst outcome is that they face zero demand and make zero profit.

fiscal solvency requirement.

Given the preferences of agents, when risk aversion rises beyond the degree corresponding to logarithmic preferences, the net utility gain from a percentage increase in the average level of output shrinks and eventually even becomes negative. Hence,  $q_y$  falls, and volatility becomes less costly in welfare terms. Thus, with rising  $\tilde{\sigma}^{-1}$ , we observe higher volatility, larger initial responses in output and hence also consumption. Ultimately, the implied consumption response becomes positive.<sup>14</sup>

It is, however, enough to have a very small degree of non-Ricardian behaviour present in the model for the crowd-in effect to disappear. It happens because the welfare gains from higher levels of output rise significantly, as we include non-Ricardian consumers enjoying extra consumption, whilst the marginal welfare costs of increased output actually fall due to the convexity of the agents' utility function in labour.<sup>15</sup> Hence, more stability becomes desirable.

On the other hand, when labour supply elasticity is high and the degree of risk aversion is small, the welfare gains from extra consumption are relatively small, and also only small wage hikes are sufficient to induce the needed supply of extra labour by the Ricardians. There is thus little potential welfare gain to be reaped by the non-Ricardian agents from higher output levels. Moreover, the Ricardians' welfare function is then concave in labour causing that supplying extra units of labour becomes more costly in welfare terms as their share in the population falls. Then, as we increase the share of non-Ricardian agents, the welfare gains from more stability are decreasing. More volatility will become desirable and the initial response in consumption can again become positive.

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<sup>14</sup>Note that given the non-separability in preferences, there is complementarity between consumption and leisure (labour) and  $\tilde{\sigma}^{-1}$  also affects the disutility of labour. See López-Salido and Rabanal (2006) for further discussion.

<sup>15</sup>Recall that the steady-state labour supply of Ricardian consumers falls as we include hand-to-mouth consumers.

In all other circumstances, the desirable degree of volatility is not large enough to be consistent with a rise in private consumption in the period when the spending shock hits the economy. In other words, optimal stabilization policy does not induce a sufficiently large short-term response in net real wages in order for aggregate consumption to rise in response to the rise in government spending.

## 5. Concluding remarks

We have presented a normative analysis of the question of the crowding out effect of government spending. We have done this in a framework which included the possibility of limited asset market participation by agents and non-separable individual preferences—two features that were suggested in positive work as an explanation for the empirically detected traces of a crowd-in effect. Our results overwhelmingly do not support a positive answer to the question asked in the title of this paper.

Whilst our analysis sends out a fairly unambiguous message, let us point to a few issues that have not been dealt with in this paper and could affect its conclusions in either direction. We have used a framework and a solution method that represent the current state-of-the-art in macroeconomics, nevertheless, we have made some sacrifices in the name of tractability and policy-relevance. First, the absence of capital in the model seems to be the most obvious simplifying assumption. Relaxing the assumption of capital being constant and normalized to one would lead to a better understanding of the wealth effects of increased government spending. Second, in our model, wages adjust instantaneously to make sure the labour market clears. As argued in Christiano et al. (1997), this normally implies a sharp response in real wages which is not supported by empirical evidence. A different approach to modelling individual preferences and the labour market, as in Galí et al. (2007) for instance, could allow for nominal

wage rigidities to be modelled alongside imperfectly flexible price adjustment in an economy where some agents are liquidity constrained. Third, serial correlation in the spending shock could widen the range of cases when a crowd in effect is consistent with optimal policy. It is, however, not straightforward to incorporate serially-correlated spending shocks into the numerical analysis presented in the paper, as the fiscal stress term—through which the shock enters the system—does not simply inherit the time-series properties of the spending shock.

This discussion suggests that analyzing optimal consumption dynamics in the context of a medium-scale macroeconomic framework such as Christiano et al. (2005) extended for the features of consumer behaviour used in this paper represents a fruitful research agenda. Schmitt-Grohé and Uribe (2005) offer a method for solving such optimal policy problems numerically. However, significant sacrifices in terms of the tractability of the solution would seem inevitable in such a framework.

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## A. Appendix

### A.1. Definition of key coefficients

In the first section of the Appendix, we define some key coefficients used in the model in terms of the structural parameters of Section 2.

$$\omega_p = \alpha - 1$$

$$\mu = \varepsilon / (\varepsilon - 1)$$

$$c = \bar{C} / \bar{Y}$$

$$\bar{H} = \bar{Y}^\alpha$$

$$\bar{Y} = \left[ \frac{1 - \bar{\tau}}{\mu \alpha \omega c + 1 - \bar{\tau}} \right]^{\frac{1}{\alpha}}$$

$$\omega_H = \bar{H} / (1 - \bar{H})$$

$$\bar{R} = \frac{1}{\beta}$$

$$\bar{R} = (1 + \bar{r})$$

$$\bar{s} = (1 - \beta) \bar{b}$$

$$z_y = c^{-1} - \alpha \Omega_H + \alpha \chi_H + \alpha - 1$$

$$x_y = (1 - 2\tilde{\sigma}^{-1}) (c^{-1} - \alpha \Omega_H) - [2\omega (1 - \tilde{\sigma}^{-1}) - 1] \alpha \chi_H + \alpha + 1$$

$$\begin{aligned} z_{yy} = & c^{-1} (1 - c^{-1}) - \Omega_H \alpha^2 \frac{\left[ (1 + \omega) (1 - \bar{H}^2) - \omega \lambda \right]}{(1 - \bar{H}) [(1 + \omega) (1 - \bar{H}) - \omega \lambda]} \\ & + \chi_H (1 + \chi_H) \alpha^2 \end{aligned}$$

$$\chi_y = \tilde{\sigma}^{-1} \alpha \Omega_H - \omega (1 - \tilde{\sigma}^{-1}) \alpha \chi_H - \tilde{\sigma}^{-1} c^{-1}$$

$$d_\tau = \frac{\bar{s}}{\bar{T}}$$

$$d = \frac{\bar{s}}{\bar{Y}}$$

$$(1 - \beta) \bar{W} = \bar{\Delta} \left( \bar{C}^R \right)^{-\tilde{\sigma}^{-1}} \left( 1 - \bar{H}^R \right)^{\omega(1-\tilde{\sigma}^{-1})}$$

$$(1 - \beta) \bar{W} f_H = \frac{\partial [(1 - \beta) \bar{W}]}{\partial \bar{H}}$$

$$(1 - \beta) \bar{W} f_{HH} = \frac{\partial^2 [(1 - \beta) \bar{W}]}{\partial \bar{H}^2}.$$

$$\begin{aligned} f_{YY} = & d_\tau^{-1} \left[ c^{-1} + \frac{(1 + 2\omega_H) \alpha^2}{1 - \bar{H}} + \frac{\alpha c^{-1}}{1 - \bar{H}} \right] - \tilde{\sigma}^{-1} c^{-1} + \tilde{\sigma}^{-1} (\tilde{\sigma}^{-1} + 1) c^{-2} + f_H \bar{H} \alpha^2 \\ & + f_{HH} \bar{H}^2 \alpha^2 - 2\tilde{\sigma}^{-1} c^{-1} f_H \bar{H} \alpha - 2d_\tau^{-1} \left( \frac{\alpha}{1 - \bar{H}} + c^{-1} \right) (\tilde{\sigma}^{-1} c^{-1} - f_H \bar{H} \alpha) \end{aligned}$$

$$\begin{aligned} f_{YG} = & \frac{d_\tau^{-1}}{1 - \bar{H}} \alpha c^{-1} - (\tilde{\sigma}^{-1} c^{-1} - f_H \bar{H} \alpha) (d_\tau^{-1} c^{-1} + d^{-1}) \\ & - \tilde{\sigma}^{-1} c^{-1} d_\tau^{-1} \left( \frac{\alpha}{1 - \bar{H}} + c^{-1} \right) + \tilde{\sigma}^{-1} (\tilde{\sigma}^{-1} + 1) c^{-2} - \tilde{\sigma}^{-1} c^{-1} f_H \bar{H} \alpha \end{aligned}$$

$$f_y = f_H \bar{H} \alpha - \tilde{\sigma}^{-1} c^{-1} + d_\tau^{-1} \left( \frac{\alpha}{1 - \bar{H}} + c^{-1} \right)$$

$$f\tau = \frac{d_\tau^{-1}}{1 - \bar{\tau}}$$

$$\begin{aligned} K = & \lambda (1 - \bar{H})^{\tilde{\sigma}^{-1}-1} \left( \frac{\omega}{1 + \omega} \right)^{(1+\omega)(1-\tilde{\sigma}^{-1})} + \\ & (1 - \lambda)^{\tilde{\sigma}^{-1}} \left[ 1 - \frac{\omega \lambda}{(1 - \bar{H})(1 + \omega)} \right]^{1-\tilde{\sigma}^{-1}} \left[ 1 - \frac{\bar{H}}{1 - \lambda} + \frac{\lambda}{(1 - \lambda)(1 + \omega)} \right]^{\omega(1-\tilde{\sigma}^{-1})} \end{aligned}$$

$$\begin{aligned}
L &= \lambda (1 - \bar{H})^{\tilde{\sigma}^{-1}-2} \left( \frac{\omega}{1+\omega} \right)^{(1+\omega)(1-\tilde{\sigma}^{-1})} \\
&\quad - \left[ 1 - \frac{\bar{H}}{1-\lambda} + \frac{\lambda}{(1-\lambda)(1+\omega)} \right]^{\omega(1-\tilde{\sigma}^{-1})} \left[ 1 - \frac{\omega\lambda}{(1-\bar{H})(1+\omega)} \right]^{-\tilde{\sigma}^{-1}} \\
&\quad \times \left\{ \frac{\lambda\omega(1-\lambda)^{\tilde{\sigma}^{-1}}}{(1+\omega)(1-\bar{H})^2} + \frac{\omega(1-\lambda)^{\tilde{\sigma}^{-1}} [(1+\omega)(1-\bar{H}) - \omega\lambda]}{(1-\bar{H}) [(1-\lambda-\bar{H})(1+\omega) + \lambda]} \right\}
\end{aligned}$$

$$\begin{aligned}
M &= \lambda \left( \frac{\omega}{1+\omega} \right)^{(1+\omega)(1-\tilde{\sigma}^{-1})} (2 - \tilde{\sigma}^{-1}) (1 - \bar{H})^{\tilde{\sigma}^{-1}-3} \\
&\quad + \left[ 1 - \frac{\bar{H}}{1-\lambda} + \frac{\lambda}{(1-\lambda)(1+\omega)} \right]^{\omega(1-\tilde{\sigma}^{-1})} \left[ 1 - \frac{\omega\lambda}{(1-\bar{H})(1+\omega)} \right]^{-\tilde{\sigma}^{-1}} \frac{\omega(1-\lambda)^{\tilde{\sigma}^{-1}}}{(1-\bar{H})} \\
&\quad \times \left\{ \frac{2\omega\lambda(1-\tilde{\sigma}^{-1})}{(1-\bar{H}) [(1-\lambda-\bar{H})(1+\omega) + \lambda]} - \frac{2\lambda}{(1+\omega)(1-\bar{H})^2} \right. \\
&\quad \left. - \frac{\omega\tilde{\sigma}^{-1}\lambda^2}{(1+\omega)(1-\bar{H})^2 [(1+\omega)(1-\bar{H}) - \omega\lambda]} \right. \\
&\quad \left. + \frac{[\omega(1-\tilde{\sigma}^{-1}) - 1](1+\omega) [(1+\omega)(1-\bar{H}) - \omega\lambda]}{[(1-\lambda-\bar{H})(1+\omega) + \lambda]^2} \right\}
\end{aligned}$$

$$\Theta_Y = (Kc^{-1} + L\bar{H}\alpha)$$

$$\Omega = z_y d_\tau^{-1} - \omega_\tau (1 - \bar{\tau}) f_y$$

$$\begin{aligned}
q_y &= \frac{\Theta_Y}{\Omega} d_\tau^{-1} (z_{yy} + z_y x_y) - \frac{\Theta_Y}{\Omega} \bar{\tau} f_{YY} - Kc^{-1} (1 - \tilde{\sigma}^{-1} c^{-1}) \\
&\quad - L\bar{H}\alpha (\alpha + 2(1 - \tilde{\sigma}^{-1}) c^{-1}) - M\bar{H}^2 \alpha^2
\end{aligned}$$

$$q_{YG} = K\tilde{\sigma}^{-1}c^{-2} - L\bar{H}\alpha c^{-1}(1 - \tilde{\sigma}^{-1}) - \frac{\Theta_Y}{\Omega}\bar{\tau}f_{YG} - \frac{\Theta_Y}{\Omega}d_\tau^{-1}x_{YG}$$

$$q_\pi = \frac{\varepsilon(1+\omega_p)}{\zeta} \left[ \frac{\Theta_Y}{\Omega} (1 - \bar{\tau}) \left( \frac{d_\tau^{-1}}{1 - \bar{H}} + f_H \bar{H} \right) - L\bar{H} \right]$$

$$\hat{Y}_T^* = \frac{q_{YG}}{q_y} \hat{G}_T$$

$$\begin{aligned}
y_t &= \widehat{Y}_t - \widehat{Y}_t^* \\
\kappa &= \zeta z_y \\
\chi_\tau &= \zeta \omega_\tau \\
\widehat{\tau}_t^* &= \frac{z_y}{\omega_\tau} \left( \frac{c^{-1}}{z_y} - \frac{q_{YG}}{q_y} \right) \widehat{G}_t \\
\varphi_t &= \left( \widetilde{\sigma}^{-1} c^{-1} - \Phi^{-1} \frac{q_{YG}}{q_y} \right) \widehat{G}_t \\
&\quad + (1 - \beta) E_t \sum_{T=t}^{\infty} \beta^{T-t} \left\{ d_\tau^{-1} c^{-1} + d^{-1} - \widetilde{\sigma}^{-1} c^{-1} \right. \\
&\quad \left. - f_y \frac{q_{YG}}{q_y} - \frac{f_\tau}{\omega_\tau} \left( c^{-1} - z_y \frac{q_{YG}}{q_y} \right) \right\} \widehat{G}_T \\
\Phi^{-1} &= \widetilde{\sigma}^{-1} c^{-1} - \widetilde{\sigma}^{-1} \alpha \Omega_H + \omega \alpha (1 - \widetilde{\sigma}^{-1}) \chi_H \\
\widehat{r}_t^* &= \left( \widetilde{\sigma}^{-1} c^{-1} - \Phi^{-1} \frac{q_{YG}}{q_y} \right) \widehat{G}_t \\
\omega_\phi &= q_\pi^{-1} \left[ 1 + \frac{(1 - \beta) f_\tau}{\chi_\tau} \right] \\
m_\phi &= q_y^{-1} \left[ (1 - \beta) f_y + \Phi^{-1} - \frac{(1 - \beta) f_\tau \kappa}{\chi_\tau} \right] \\
n_\phi &= \frac{\chi_y}{q_y}
\end{aligned}$$

## A.2. Calibrated values of coefficients

In the second section of the Appendix, we plot some of the coefficients defined in the previous section as a function of the population share of non-Ricardian agents under baseline calibration described in Section 4.1 of the paper. We also provide a brief comment on the relative weight of output gap stabilization in the policy objective under different calibrations of structural parameters.

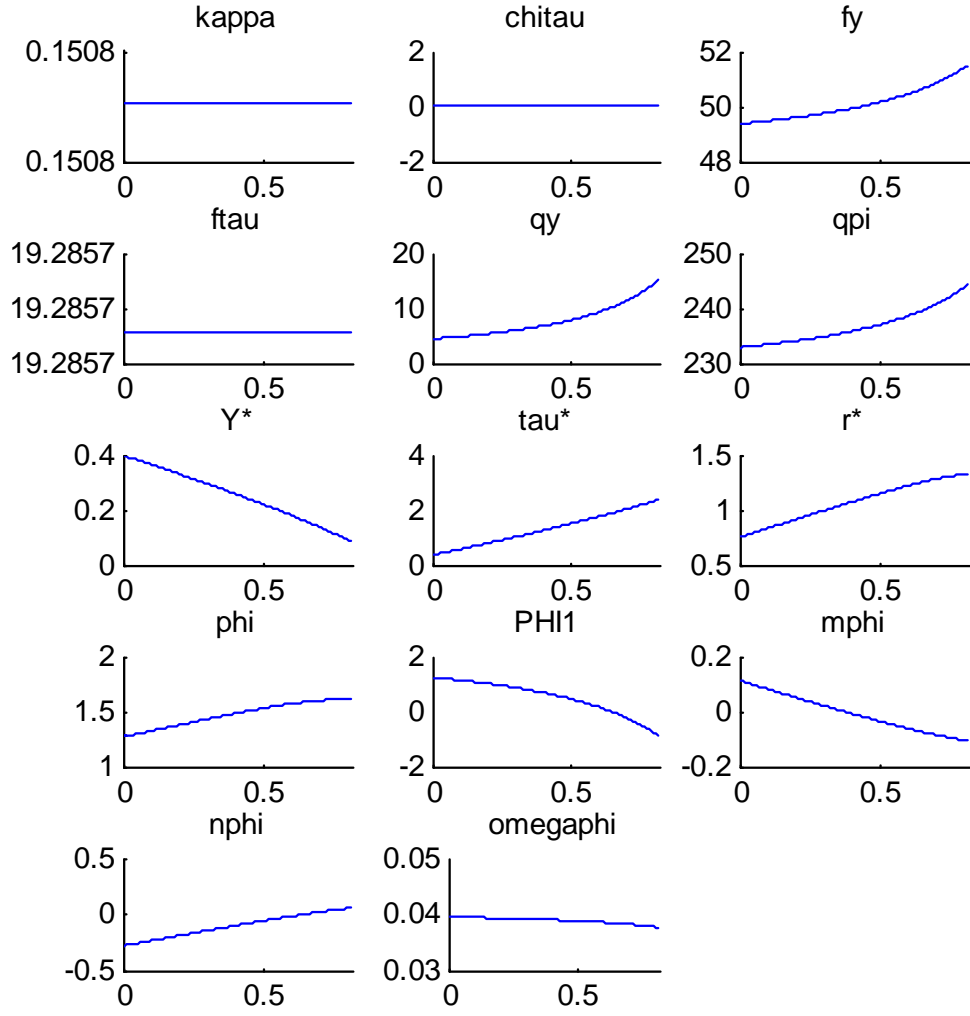


Figure A.1: Coefficient values as a function  $\lambda$



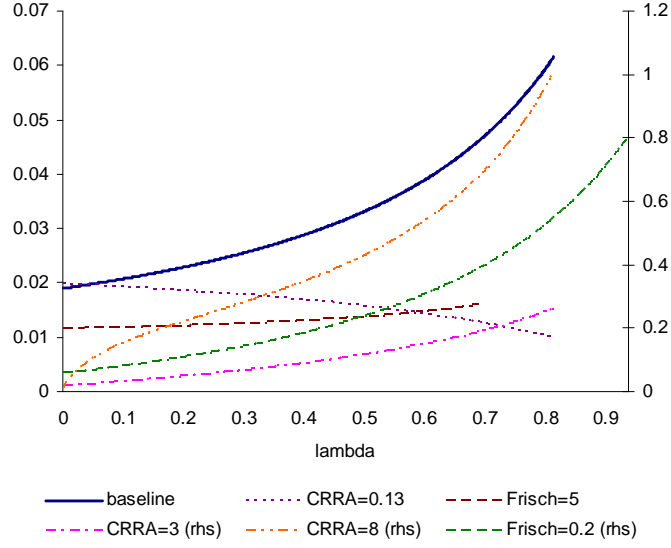


Figure A.2: Relative weight of output gap stabilization as a function of  $\lambda$

As regards the relative weight of output gap stabilization in the policy objective, Figure A.2 shows that it is generally very low for low levels of  $\lambda$ . It falls even further with  $\lambda$ , if risk aversion is low. However, it rises with  $\lambda$  in all other considered cases. For large degrees of risk aversion or inelastic labour supply, coupled with a large share of  $\lambda$ , the importance of output gap stabilization is comparable with that of stabilizing inflation volatility.

### A.3. Links with the literature on consumer behaviour

One way to write the log-linearized version of (2.7) is as follows

$$E_t \Delta \hat{C}_{t+1} = \tilde{\sigma} \left( \hat{i}_t - E_t \pi_{t+1} \right) + \Phi_Y E_t \Delta \hat{Y}_{t+1}. \quad (\text{A.1})$$

Here  $\Delta$  denotes change from previous period. The coefficient  $\Phi_Y$  is of particular importance here. It is defined

$$\Phi_Y = \tilde{\sigma} \left[ \tilde{\sigma}^{-1} \alpha \Omega_H - \omega \alpha (1 - \tilde{\sigma}^{-1}) \chi_H \right]$$

in which

$$\Omega_H = \frac{\bar{H}}{(1 - \bar{H})} \frac{\omega\lambda}{[(1 + \omega)(1 - \bar{H}) - \omega\lambda]},$$

$$\chi_H = \frac{(1 + \omega)\bar{H}}{(1 + \omega)(1 - \lambda - \bar{H}) + \lambda}.$$

$\bar{H}$  denotes steady-state aggregate labour supply.

Notice that with  $\tilde{\sigma}^{-1} = 1$  and  $\lambda = 0$ , which corresponds to the case of a log-linear specification of individual utility and no liquidity constraints,  $\Phi_Y = 0$  and (A.1) breaks down to a standard intertemporal IS relationship. With  $\tilde{\sigma}^{-1} = 1$  and  $\lambda > 0$ , we have  $\Phi_Y = \alpha\Omega_H$ , which will be positive as long as  $\bar{H} < 1 - \omega\lambda/(1 + \omega)$ . This case corresponds to Campbell and Mankiw's (1989) explanation of why researchers estimated a positive coefficient at expected change in aggregate income in (A.1).<sup>16</sup> According to this theory, expected changes in aggregate income are associated with contemporaneous changes in consumption due to the presence of liquidity-constrained agents. By contrast, consider the case when  $\tilde{\sigma}^{-1} \neq 1$  and  $\lambda = 0$ . In such a case,  $\Phi_Y = -\omega\alpha(1 - \tilde{\sigma}^{-1})\tilde{\sigma}\chi_H$ , which can clearly be positive if  $\chi_H > 0$  (which is in turn positive under the same condition as  $\Omega_H$ ) and  $\tilde{\sigma}^{-1} > 1$ . This would correspond to the 'non-separability in preferences' story put forward by Basu and Kimball (2000) as an alternative to Campbell and Mankiw (1989). Interestingly, Basu and Kimball (2000) estimated  $\tilde{\sigma}$  to be low, perhaps around one third, enhancing the consistency with the algebraic analysis presented here. Obviously, a positive coefficient  $\Phi_Y$  might result as a combination of the two effects too.

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<sup>16</sup>See Hall (1978), Flavin (1981) and Zeldes (1989) for earlier empirical evidence questioning the permanent income hypothesis under which no contemporaneous effects of expected changes in income on consumption should be observed.

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Johannes Geissler  
Castlecliffe, School of Economics and Finance  
University of St Andrews  
Fife, UK, KY16 9AL

Email: [jg374@st-andrews.ac.uk](mailto:jg374@st-andrews.ac.uk); Phone: +44 (0)1334 462445; Fax: +44 (0)1334 462444.