

THE UNIVERSITY of Jork

Discussion Papers in Economics

No. 13/09

Austerity versus Stimulus: A DSGE Political Economy Explanation

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May 2013

Abstract

The 2008 financial crisis and subsequent global economic downturn has brought fiscal policy back onto the political and academic agenda. Despite the vast literature, the discussion is primarily focused upon the fiscal policy multiplier. This positive analysis omits normative consequences from policy and moreover, fails to consider political frictions to policy: something frequently observed in fiscal debates. By constructing a small scale New Keynesian DSGE model with a proportion of credit constrained (non-Ricardian) agents, this paper address these omissions. The results show that there is a normative justification of fiscal policy, in the presence of modest multipliers and the absence of progressive taxes, but on redistributive rather than aggregate grounds. Shocks impact the two agents differently and in polarising ways: countercyclical fiscal policy can be used to alleviate this divergence. However, aggregate improvements from policy are minimal as the gains of one agent are matched by the losses of another, thus giving rise to political frictions and moreover, predicting the current austerity versus stimulus debate.

Key words: Fiscal policy; heterogeneity; welfare; zero lower bound; liquidity rule-of-thumb; fiscal cyclicality.

JEL Classification: E30; E62; H30.

1 Introduction

The 2008 financial crisis and the subsequent global economic downturn has brought fiscal policy back into the political and academic agenda. Across the developed economies, governments looked to large fiscal stimuli in order to counteract the effects of recession and boast demand. As the world economy continues to stutter, there are renewed exchanges about further fiscal stimuli and their merits. Despite this resurgence and return to fiscal policy there is still much doubt and debate as to whether such policy has the desired effects. Recently in Europe these discussions have centred around the 'austerity versus stimulus' debate. These arguments are conducted both domestically and internationally as the topic of 'fiscal responsibility' has become a key theme in the rhetoric of the current downturn. Recent polling data from European countries in local and national elections suggests that there has been an electoral swing from those supporting austerity measures to those supporting stimulating measures as the recession continues globally.¹ In fiscal debates around the world there consistently appears to be two clear factions in the discussions and 'austerity versus

¹Evidence of this swing has been seen in national elections in countries such as Denmark, Greece and France, and in local elections in countries such as the UK.

stimulus' is no exception. The conduct of fiscal policy and the political frictions associated with it are rife in today's political and economic agenda and are the subject of this paper.

This paper seeks to contribute to two literatures: that reflecting on the heterogeneous welfare impacts of business cycles, and the fiscal-DSGE literature. Lucas (2003) proposed that the impact of business cycles on aggregate welfare was negligible; through analysing movements in aggregate US consumption around trend, the welfare gain of removing economic fluctuations was calculated to be the utility equivalent of less than one-tenth a percentage point increase in average consumption. However, theoretical research addressing this issue suggests that there is heterogeneity across households in this estimate that the aggregation eliminates. Krusell & Smith (1999), Krusell et al. (2009) and Mukoyama & Sahin (2006) conclude that the poor, unskilled and unemployed are more exposed to welfare losses from economic fluctuations: conclusions confirmed both by intuition and recent anecdotal evidence. The dynamic stochastic general equilibrium (DSGE) literature focusing on fiscal conduct has largely abstracted away from the normative gains of policy and has been preoccupied with the question of the size of the fiscal multiplier. Estimates for these multipliers from the empirical literature are often observed to be greater than one (see for example Blanchard & Perotti 2002), however traditional New Keynesian DSGE models fail to predict this. Much of the fiscal-DSGE literature has aimed to rectify this anomaly: see for example Bilbie et al. (2008), Coenen & Straub (2005), Galí et al. (2007), Linnemann (2006), Linnemann & Schabert (2003) and Monacelli & Perotti (2008). The experience of the recent downturn combined with low central bank rates has prompted a discussion on the impact of fiscal policy when the nominal interest rate is at the zero lower bound, and moreover, the appropriate policy mix with respect to the balance between spending and tax movements.² Currently, we argue, the fiscal-DSGE literature has two key omissions: first, through focusing on the positive properties of policy the analysis is lacking a comprehensive consideration of the normative consequences; and second, through focusing on aggregate dynamics and using the often assumed representative agent, the analysis abstracts away from any heterogeneity and political frictions, something clearly evident in the conduct of fiscal policy. This research looks to address these omissions. Moreover, through doing this it reflects upon the heterogeneous impacts of business cycles and potential alleviating measures.

It does this through building upon the recent research using non-Ricardian or 'rule-of-thumb' agents. These agents are assumed not to have access to credit and therefore consume 'hand-to-mouth' by spending their disposable income each period. This assumption means that these agents cannot smooth their consumption, unlike the traditional Ricardian agents who follow the permanent income hypothesis, and there inclusion in models is as a result of the empirical observation that for many individuals their spending closely tracks their income: see for example Campbell & Mankiw (1989).³ We propose that these two agents (the Ricardian and non-Ricardian households) represent two clear distinct groups in society of empirically non-trivial proportions, and that the latter will come from those individuals at the lower end of the income distribution; although the results are not sensitive to this hypothesis it provides additional interpretations. Evidence from both micro and macro-econometric studies suggest that it is those agents with a lack of assets, and with it collateral, who cannot gain access to capital: see for example Jappelli & Pagano (1989), Zeldes

²See for example Eggertsson (2009), Hall (2011), Christiano et al. (2011) and Woodford (2011). Within this literature, the effectiveness of policy is measured through the aggregate effects on the economy: the fiscal multiplier.

 $^{^{3}}$ Campbell & Mankiw (1989) represents the seminal empirical work in identifying non-Ricardian households but the results have been replicated in further studies: see for example Jappelli & Pagano (1989), Evans & Karras (1996) and Sarantis & Stewart (2003). The results are shown to be robust to the specification, time period and country used.

(1989), Sarantis & Stewart (2003) and Sullivan (2008). The ex-ante justification for the inclusion of rule-of-thumb households in DSGE models is ex-post supported by the observation that these models better match empirical data: see for example Galí et al. (2007), Furlanetto & Seneca (2012), Boscá et al. (2011), Furlanetto & Seneca (2009), Andrés et al. (2008) and Graham (2008). Rule of thumb consumers also appear in many central banks and policy institutions DSGE models.⁴ However, despite the growing use of these models, limited analysis currently exists on disaggregated variables. Although some papers report heterogeneous dynamics, these tend to only give more detail behind the aggregate variables and no in depth analysis of any frictions or divergences are discussed.

The contribution of this paper is to address this key omission by using a simple New Keynesian DSGE model with a proportion of rule-of-thumb agents to analyse the heterogeneous welfare impacts of fiscal policy. The model is similar to Galí et al. (2007), the seminal work in the literature, but it abstracts away from physical capital accumulation. This abstraction makes the analytical properties of the model more accessible and with it a more detailed algebraic analysis, independent of arbitrary parameter calibrations, can be performed. The dichotomy of agents between those with access to credit and those without is crude, but it is used here for three main reasons: first, the use of these models in the existing literature and in policy institutions makes the procedures developed here easily implementable and tractable. Second, we argue that these models are best suited towards explaining a situation where rule-of-thumb households would rather borrow than save, because it seems implausible that credit institutions would prohibit deposits from individuals. This is apt for the current economic climate and the *credit crunch*; for this reason the paper focuses on adverse shocks, defined as those which lead to a negative output gap. Third, although the division of households in two types of agents is not true of a diverse population, it does appropriately fit real-world debates on the conduct of fiscal policy. Two resolute camps can be observed in these debates, those in favour of big public sectors and fiscal intervention, and those staunchly not. Having this simple dichotomy of agents provides the opportunity for the model to predict these two polar views.

This paper proposes and presents new procedures that can be implemented in DSGE models with heterogeneity amongst households. Through developing agent specific welfare criteria using a second order Taylor series expansion of the utility function, normative analyses of exogenous shocks and subsequent policy can be made. This adds insight into the different experiences of agents but moreover identifies whether there are any frictions associated with policy: something highly observed in the case of fiscal policy. Through identifying these frictions not only can the model predict dynamics under different policies, it can also predict political barriers to such policy and therefore comment on why some are observed when others might be prescribed: the model can be used to discuss political motives. Any discussion on the welfare impacts of fiscal policy is highly sensitive to empirically questionable utility functions, both in terms of the inclusion, or not, of government spending but moreover through any assumed separability. We bypass this issue by only considering those policies where movements in net government spending are negligible: two clear policy experiments result. First, one where increases in government spending today are financed by future spending cuts; although interest is accrued on debt resulting in more spending cuts than spending increases, once future actions are discounted net movements are zero. Second, a policy whereby tax cuts today are financed by future rises.

The results found are in line with both intuition and what is observed in the real world. In

⁴Institutions that use such households include the Euopean Central Bank (NAWM), the European Commission (QUEST III), the Federal Reserve Board (SIGMA) and the International Monetary Fund (GIMF).

the absence of fiscal policy credit constrained agents experience a lower level of welfare than their non-constrained counterparts who are seen to gain as a result of adverse shocks. This divergence is quantitatively non-trivial and is due to the employment decision of the rule-of-thumb households: from this benchmark the impact of policy can be analysed with four key results observed. First, counter-cyclical fiscal policy is to the benefit of rule-of-thumb agents and the detriment of their Ricardian neighbours: there is a political economy to policy. This occurs because the Ricardian agents gain as a result of the adverse shocks due to the responses of their credit constrained neighbours, and through stabilising the economy the fiscal authority are reducing this impact. Second, these rule-of-thumb agents benefit more through counter-cyclical policy that is paid back slowly over the medium term whereas Ricardian households prefer prompt repayment: they are more debt averse than the non-Ricardian households. Third, counter-cyclical measures which favour spending increases over tax cuts are more productive for the economy as a whole and to improving the welfare of credit constrained individuals. Finally, there is a normative justification for countercyclical fiscal measures, however the quantitative aggregate gains of stabilisation policy are minimal: this is in line with the results from Lucas (2003). The real normative justification comes from the redistributional attributes of counter-cyclical policy, reducing the inequality of adverse shocks, with the gains from policy of the rule-of-thumb agents being (nearly) matched by the losses of the Ricardian agents; in many respects, the conduct of fiscal policy is performed in a de-facto zero sum game. This is the source of the political frictions in the model and provides a clear commentary of the current austerity versus stimulus debate. It is the non-Ricardian agents who have a preference towards stimulus and their Ricardian neighbours who have a preference towards austerity. This is with respect to both the cyclical response and debt aversion priorities of the two households, with the same conclusions reached from the two perspectives; moreover, these debates are observed to be amplified when monetary policy is at the zero lower bound. These results come from a model that assumes away progressive taxes, and one with modest multipliers: the normative justification comes despite the lack of a significant positive justification.

The paper proceeds in the following way. Section 2 builds a model that includes a share of non-Ricardian households and Section 3 reviews the algebraic properties of fiscal variables in the model. Section 4 discusses both the positive and normative consequences of fiscal policy across households, and Section 5 considers further extensions to this benchmark case. Section 6 performs sensitivity analysis confirming the robustness of the key themes and results and Section 7 concludes.

2 The model

The model presented below is a simple cashless DSGE model with sticky prices including six types of economic agents; a continuum of households split into two heterogeneous groups, a continuum of monopolistically competitive firms producing intermediate goods and a perfectly competitive firm producing the final good, and a monetary and fiscal authority. The model is similar to Galí et al. (2007), the seminal paper in the rule of thumb DSGE literature and the benchmark from which most subsequent models follow. The model differentiates itself from Galí et al. (2007) by abstracting away from physical capital accumulation: this is to simplify the model such that algebraic properties can be observed. Moreover, the shocks come from non-policy sources and as such the government sector is modelled fully through reaction functions, responding to the business cycle and levels of debt.

2.1 Households

There is a continuum [0, 1] of infinitely lived households, all of which consume the final good and supply labour to firms. A proportion of these households $(1 - \lambda)$ are 'Ricardian' who have access to capital markets and can trade in a full set of state contingent securities. The remaining proportion (λ) are 'non-Ricardian' who have no access to capital markets. The period utility function is assumed to be the same for both types of household and is given by:

$$U_t^i = \varepsilon_t^b \left(\frac{\left(C_t^i\right)^{1-\sigma}}{1-\sigma} - \frac{\left(N_t^i\right)^{1+\varphi}}{1+\varphi} \right)$$
(1)

where C_t and N_t are the amount of consumption and employment consumed and supplied respectively in period t and ε_t^b represents an exogenous shock to the discount rate which affects intertemporal substitution preferences of households. The parameter σ is the coefficient of relative risk aversion and φ is the inverse elasticity of work with respect to the real wage. Superscript *i* differentiates these variables between Ricardian (i = R) and non-Ricardian (i = NR) households. Households are assumed to supply labour in a perfectly competitive market with no frictions or time delays: sensitivity of the results to this labour market assumption is performed.

Ricardian households

Ricardian households gain income from their labour supply (at a wage rate W_t), from the dividends paid on share ownership, D_t^R , and from maturing one period bonds purchased in the previous time period, B_t^R . They can use this income in order to reinvest in the bond market (at a given return R_t), purchase the consumption good (at a price P_t), and to pay any lump sum tax levied by the fiscal authority, T_t^R . This leaves a budget constraint to Ricardian households given by:

$$P_t C_t^R + \frac{B_{t+1}^R}{R_t} \le B_t^R + W_t N_t^R - P_t T_t^R + D_t^R$$
(2)

Ricardian households maximise expected lifetime utility (given by the sum of all occurrences of function (1) from t = 0 to $t = \infty$) discounting future periods of utility by a factor $\beta \in (0, 1)$, subject to the budget constraint (2) with respect to consumption, employment and bond purchases where all prices are taken as given.

Non-Ricardian households

Non-Ricardian households do not have access to bonds markets and as such cannot intertemporally substitute consumption. Moreover they do not own company shares. They simply consume, period by period, their disposal income generated through their supply of labour; this provides the non-Ricardian consumption function:

$$P_t C_t^{NR} = W_t N_t^{NR} - P_t T_t^{NR} \tag{3}$$

where equality is given by assumed strictly positive marginal utility from consumption. Non-Ricardian households still optimise their period by period utility by making decisions on how much labour to supply at a given wage rate: maximisation of (1) subject to the budget constraint (3) with respect to consumption and employment where prices and wages are taken as given.

Steady state consumption, employment and utility

It will be assumed that the government set steady state lump sum taxes on the two types of households such that the increased income effect of the dividends for the Ricardian agents is eliminated. This assumption combined with the identical utility function assumed for the two types of households leads to the same consumption and employment profile of the heterogeneous households in steady state: $C^{NR} = C^R = C$ and $N^{NR} = N^R = N$. This assumption simplifies the calculations but is not critical to the main results of the model.⁵ However it provides the compelling benchmark whereby if the economy remains in steady state, both types of households with consume and work in identical proportions and consequently derive identical utilities.

2.2 Firms

The production sector is made up of a continuum of monopolistically competitive producers, $j \in [0, 1]$, who employ household labour in order to produce differentiated intermediate goods. These goods are then purchased by a perfectly competitive firm who makes the final good Y, consumed by both households and government.

2.2.1 Final good firm

The agent which produces the final good is modelled as a single representative perfectly competitive firm which combines the intermediate goods using a standard Dixit-Stiglitz aggregator:

$$Y_{t} = \left(\int_{0}^{1} Y_{t}(j)^{\frac{1}{1+\mu_{t}}} dj\right)^{1+\mu_{t}}$$

where Y_t represents the final good, $Y_t(j)$ represents the intermediate good quantity produced by firm j, and μ_t represents a (stochastic) time varying markup charged by intermediate good firms given by $\mu_t = \mu + \varepsilon_t^{\mu}$. This markup is possible because each intermediate firm produces a differentiated product with the elasticity of substitution across goods given by ϵ , such that the steady state markup is given by $\mu = 1/(\epsilon - 1)$: ε_t^{μ} represents an AR(1) shock process in log linear form. Profit maximisation of the final good firm, taking all prices as given, yields the following standard demand schedules:

$$Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\frac{1+\mu_t}{\mu_t}} Y_t \quad \forall \ j \in [0,1]$$

$$\tag{4}$$

where $P_t(j)$ is the price of the intermediate good $Y_t(j)$ and P_t is the price of the final good, in period t. The final good firm is perfectly competitive and as such makes zero profits which provides the following aggregate price index condition:

$$P_{t} = \left(\int_{0}^{1} P_{t}(j)^{-\frac{1}{\mu_{t}}} dj\right)^{-\mu_{t}}$$

⁵This assumption does go against the hypothesis discussed above that non-Ricardian households are poorer than Ricardian households. However, the results are not sensitive to this equality assumption, and significant results can be obtained without imposing this hypothesis on the model. Sensitivity to this assumption is performed.

2.2.2 Intermediate goods firms

A continuum of firms indexed $j \in [0, 1]$ are assumed to produce the differentiated intermediate goods, $Y_t(j)$, subject to Cobb-Douglas technology where capital is fixed and normalised:

$$Y_t(j) = \varepsilon_t^a N_t(j)^{1-\alpha}$$
(5)

where $N_t(j)$ is the level of labour employment by firm j and ε_t^a represents an AR(1) productivity shock in log linear form. A Calvo (1983) pricing structure is assumed for intermediate goods, where firms in any period get the opportunity to reset prices at a probability $(1 - \theta)$. This probability is fixed, exogenous, and independent of when the firm was last randomly selected to reset their prices. With assumed identical intermediate firms, all $(1 - \theta)$ firms 'reseting' their price in period t will do so at the same price, P_t^* . A firm that is able to reset their price in any given period will do so such as to maximise expected future profits given the new reset price, P_t^* ; algebraically:

$$\max_{P_{t}^{*}} \sum_{k=0}^{\infty} E_{t} \left\{ Q_{t,t+k} \left(P_{t}^{*} Y_{t+k|t} \left(j \right) - \Psi_{t+k} \left(Y_{t+k|t} \left(j \right) \right) \right) \right\}$$

subject to the demand from the final good firms (4) where $\Psi_{t+k}(.)$ is a nominal cost function, $Y_{t+k|t}(j)$ is the expected output in period t+k for a firm who last reset it's price in period t, and $Q_{t,t+k} = \beta^k E_t \{ (C_{t+k}/C_t)^{-\sigma} (P_t/P_{t+k}) \}$ is the stochastic discount function for nominal payoffs. Solving this problem provides the following first order condition:

$$\sum_{t=0}^{\infty} \theta^k E_t \left\{ Q_{t,t+k} Y_{t+k|t} \left(j \right) \left(P_t^* - (1+\mu_t) \psi_{t+k|t} \right) \right\} = 0$$
(6)

where $\psi_{t+k|t} = \Psi'_{t+k}$ denotes the nominal marginal cost in period t+k for a firm who reset its price in period t. The remaining suppliers, θ , must maintain the same price as they had in period t-1.

2.3 Monetary authority

For the conduct of monetary policy a simple log-linear Taylor rule is assumed where the nominal interest rate responds positively and contemporaneously to deviations in both inflation and output:

$$r_t = \varphi_\pi \pi_t + \varphi_y y_t + \varepsilon_t^r \tag{7}$$

Throughout the paper lower case letters represent log deviations of variables from their nonstochastic, zero inflation, zero government debt, steady state values; r_t is the log deviation in the nominal interest rate in period t, π_t the log inflation rate between period t and t - 1, and y_t is the log deviation of output from steady state. The policy parameters φ_{π} and φ_y define the responsiveness of the nominal interest rates from movements away from target rates of inflation and output, respectively. An exogenous AR(1) shock process ε_t^r is included in the monetary policy setting process, which represents movements in the nominal interest rate which are not determined by movements in the aggregate economy.

2.4 Fiscal authority

The government (or fiscal authority) purchases a proportion of the final goods for public consumption, G_t , raises lump sum taxation from the two households, T_t^R and T_t^{NR} , and issues nominal risk-free one-period bonds, B_{t+1} . As such, the flow constraint of the government is given by:

$$P_t G_t + B_t \le P_t (T_t^R + T_t^{NR}) + \frac{B_{t+1}}{R_t}$$
(8)

The model includes a proportion of non-Ricardian households and therefore the dynamics and evolution of government expenditures, taxes and debt is relevant. Simple log-linear feedback rules are considered which allow the government to respond to the business cycle and ensure that debt is stabilised. Algebraically:

$$\widehat{g}_t = \varphi_g y_t + \varphi_{b,g} \widehat{b}_t \tag{9}$$

$$\widehat{t}_t = \varphi_t y_t + \varphi_{b,t} \widehat{b}_t \tag{10}$$

where *hatted* lower case variables represent deviations from steady state as a proportion of steady state output; for example $\hat{x}_t = (X_t - X)/Y$. To simplify, it will be assumed throughout the analysis $\hat{t}_t^{NR} = \hat{t}_t^R = \hat{t}_t$; changes in lump sum taxation are equal across all households and there is no redistribution between households through taxation. This means the results abstract away from progressive or regressive taxes. The coefficients φ_g , φ_t , $\varphi_{b,g}$ and $\varphi_{b,t}$ are policy parameters set by the fiscal authority. Setting either $\varphi_g < 0$ or $\varphi_t > 0$ means that government spending rises, or taxes fall in response to a shock resulting in falling output: counter-cyclical fiscal policy. Setting these parameters to nil is equivalent to an a-cyclical policy, or with the signs reversed, a pro-cyclical policy. The above rules allow the fiscal variables to respond to the level of government debt which acts to preserve the solvency constraint.⁶ Log-linearising (8) and substituting (9) and (10) into the resulting provides the condition:

$$\widehat{b}_{t+1} = (1+\rho_R) \left[\widehat{b}_t \left(1+\varphi_{b,g} - \varphi_{b,t} \right) + y_t \left(\varphi_g - \varphi_t \right) \right]$$
(11)

The dynamics of government debt are stationary providing that $(1 + \rho_R)(1 + \varphi_{b,g} - \varphi_{b,t}) < 1$, or equivalently $\varphi_{b,t} - \varphi_{b,g} > \rho_R / (1 + \rho_R)$, where $\rho_R = (1 - \beta)/\beta$ is the steady state interest rate; this condition states that in the long run the fiscal authority must pay back debt faster than interest accrues on it.⁷

The paper reflects upon normative consequences of fiscal policy which are sensitive to the assumed presence, or not, of government spending in the utility function. We propose to bypass this issue by only focusing on those policy actions which do not lead to a net discounted movement in government spending over the lifetime of the policy.⁸ This has the advantage that any conclusions

⁶The government is also assumed to satisfy the solvency constraint that in the long run all debts are fully repaid. Algebraically, $\lim_{t\to\infty} B_{t+1}/R_t = 0$.

⁷Note that the condition $\varphi_g = \varphi_t$ provides a balanced budget at all times and nil government debt; the counter(pro)cyclical reaction of one fiscal policy variable must be matched by an equal and opposite pro(counter)cyclical reaction in the other variable.

⁸Note that if government spending entered the utility function separably, net discounted government spending would enter a welfare criterion based on a second order Taylor series expansion of this utility function separably. Therefore if this is zero the utility derived from government spending is irrelevant to households over the lifetime of the policy.

reached are not sensitive to this empirically questionable issue. This process leaves two policy experiments which to focus the analysis on. The first (from now on referred to as 'policy experiment 1') is where short term government spending rises are repaid in the longer term through future spending cuts ($\varphi_g < 0, \varphi_{b,g} < 0$). As demonstrated in the log linear government flow constraint (11) interest accrues on debt at a rate of β^{-t} whereas the impact on utility will be discounted at β^t . This experiment therefore results in nil discounted government spending movement. The second (from now on referred to as 'policy experiment 2') is where short term tax cuts are repaid in the longer term through tax rises ($\varphi_t > 0, \varphi_{b,t} > 0$).

2.5 Market clearing, aggregation and equilibrium conditions

In equilibrium, aggregate consumption and employment are equal to the weighted average of the two variables across households:

$$C_t = (1 - \lambda) C_t^R + \lambda C_t^{NR}, \quad N_t = (1 - \lambda) N_t^R + \lambda N_t^{NR}$$
(12)

Moreover, all output must be consumed by either the government or private individuals:

$$Y_t = C_t + G_t \tag{13}$$

The model is solved by deriving log linear approximations of the key optimality conditions and policy rules around the non-stochastic steady state with zero inflation and zero government bonds. Once all calculations have been performed the general equilibrium model can be expressed through the policy and non-policy blocks, the latter of which can be represented through the following two equations.

Aggregate demand

The aggregate demand relationship can be obtained by combining the log linear versions of the goods market clearing condition (13), the production function (5), and the Euler equation obtained through combining the optimisation of the Ricardian and non-Ricardian household utility:⁹

$$y_{t} = E_{t} \{y_{t+1}\} - \Phi E_{t} \{\Delta \widehat{g}_{t+1}\} - \Phi \Theta_{A} \left(r_{t} - E_{t} \{\pi_{t+1}\} - E_{t} \{\Delta \varepsilon_{t+1}^{b}\}\right) + \Phi \Theta_{B} E_{t} \{\Delta \varepsilon_{t+1}^{a}\} + \Phi \Theta_{C} E_{t} \{\Delta \widehat{t}_{t+1}^{NR}\}$$
(14)
$$\Phi = \frac{\Gamma^{-1}}{\Gamma^{-1} - (1 - \gamma_{g}) [\varphi \lambda (1 + \varphi)]} \Theta_{A} = \gamma_{c} (1 - \lambda) \frac{1}{\sigma} (\varphi (1 + \mu) \gamma_{c} + \sigma (1 - \alpha)) \Gamma \Theta_{B} = \gamma_{c} \varphi \lambda (1 + \varphi) \Gamma \Theta_{C} = \gamma_{c} \varphi \lambda (1 + \mu) \Gamma \Gamma = [\varphi (1 + \mu) \gamma_{c} + \sigma (1 - \alpha) [1 - \lambda (1 + \varphi)]]^{-1}$$

⁹Specifically, the log linear non-Ricardian consumption function is combined with the Ricardian Euler equation to obtain dynamics of aggregate consumption. The resulting equation is a function of future consumption, employment and wages where the latter two can be substituted using the production function and an aggregate labour supply function respectively. A full derivation in a similar model can be found in Galí et al. (2007).

Demand is a function of fiscal and monetary policy, where the extent of each element is dependent upon the share of non-Ricardian households in the economy. When $\lambda = 0$, the expression becomes a simple log linear Euler expression in terms of output, with intertemporal substitution between periods defined through the real interest rate. As λ increases so too does the coefficient Φ , which is a coefficient reflecting that both employment and the real wage rate (which combine to give non-Ricardian households' disposable income) can be expressed as functions of output. Non-Ricardian consumption is a function of output which itself is a function of non-Ricardian consumption which creates a multiplier effect between demand and any initial stimulus.

New Keynesian Phillips curve

The production sector of the economy is independent of the proportion of rule-of-thumb consumers and can be summarised by a typical New Keynesian Phillips curve:

$$\pi_{t} = \beta E_{t} \{\pi_{t+1}\} + \omega \left(mc_{t}^{r} + \varepsilon_{t}^{\mu}\right), \quad \omega = \frac{1 - \alpha}{1 - \alpha + \alpha \epsilon} \frac{(1 - \beta \theta) (1 - \theta)}{\theta}$$
(15)
$$mc_{t}^{r} = y_{t} \left[\frac{\sigma}{1 - \gamma_{g}} + \frac{\varphi + \alpha}{1 - \alpha}\right] - \widehat{g}_{t} \left[\frac{\sigma}{1 - \gamma_{g}}\right] - \varepsilon_{t}^{a} \left[\frac{1 + \varphi}{1 - \alpha}\right]$$

where $E_t \{\pi_{t+1}\}$ is the expectation in the current time period of inflation in the next and mc_t^r represents the (log deviations of) real marginal costs of the monopolistically competitive firms in the current time period. Increases in output increase consumption in the economy and thus reduce labour supply as households substitute consumption for leisure, and increase the demand for labour in order to produce the extra output. Both of these factors push up the real wage and therefore increase the real marginal cost of production, mc_t^r , to firms. The decrease in the labour supply can be muted by increases in government spending as this removes resources from private to public consumption and therefore reduces the substitution effect: increases in government consumption, for a given level of output, reduce real wages.

Exogenous shocks and the closed system

The two equations above illustrate that the four exogenous shocks can be grouped into three separate categories: those which only enter aggregate demand (preference and interest rate shocks); those which only enter the Phillips curve (exogenous movements in the desired markup); and those which enter both (productivity shocks). Preference and interest rate shocks enter the aggregate demand condition because movements in both impact the consumption decisions of Ricardian households. Exogenous increases in the desired markup charged by intermediate firms acts as a cost push shock on the economy, providing additional inflation given a certain level of output. Productivity increases, on the other hand, increase the productive capacity of the economy at no additional cost to inflation and moreover impact the labour demanded by firms. The former impacts the Phillips curve whilst the latter impacts aggregate demand through the consumption of non-Ricardian households.¹⁰ Although the model is too simple to include the vast array of exogenous processes of larger DSGE models, these four shocks provide us with three possibilities that cover many further extensions. It is also important to highlight that the limited number of

¹⁰Bilbiie (2008) also found that technology shocks enter additively in both the aggregate demand condition and New Keynesian Phillips curve.

shocks in this small model makes direct analysis of the recent recession infeasible from an empirical perspective; however, the purpose of this paper is to provide a theoretically robust analysis of general cases. Throughout the paper shocks are assumed to follow a first order autoregressive process with persistence ρ_i and an i.i.d error term η_t^i for $i = \{a, b, l, r\}$.

The system can now be closed through the policy rules (7), (9), (10) and (11) and the non-policy block made up of the aggregate demand condition (14) and the New Keynesian Phillips curve (15). Determinacy of this system, as highlighted by Bilbiie (2008), depends critically on the calibration of λ . From the definition of the coefficients in the aggregate demand condition (14) it is possible to observe that Φ is a rectangular hyperbola in λ , which results in a critical value (denoted in Bilbiie as λ^*) around which the properties of the model are significantly altered. For function (14), this critical value will be given by:

$$\lambda^* = \frac{\varphi(1+\mu)\gamma_c + \sigma(1-\alpha)}{(1+\varphi)\left[\varphi\gamma_c + \sigma(1-\alpha)\right]} \tag{16}$$

With calibrations in the region of $\lambda < \lambda^*$, the Taylor rule ($\varphi_{\pi} > 1$) provides determinacy and 'normal' demand relationships are observed: an increase in interest rates, a reduction in government spending, and an increase in taxes all suppress demand. However, at calibrations of $\lambda > \lambda^*$, demand relationships are inverted and determinacy is only provided with passive or very-aggressive monetary policy. Although this critical value and its implications contributes additional insights, this paper will restrict itself to the case where $\lambda < \lambda^*$: this is empirically appropriate. Independent of the calibration of λ , the fiscal determinacy condition is always required.

3 Algebraic properties

This section analytically reviews the algebraic relationships between aggregate demand and fiscal policy variables restricted to where $\lambda < \lambda^*$. From the aggregate demand condition (14) it is possible to show, in the region of $0 < \lambda < \lambda^*$, the following three results:

$$\frac{\partial y_t}{\partial \hat{g}_t} > 0, \ \frac{\partial y_t}{\partial \hat{t}_t} < 0, \ \left| \frac{\partial y_t}{\partial \hat{g}_t} \right| > \left| \frac{\partial y_t}{\partial \hat{t}_t} \right|$$
(17)

First, increases in government spending increase aggregate demand: this is true in a fully-Ricardian economy and the magnitude of this (the fiscal multiplier) has been studied extensively in the DSGE literature. Second, tax cuts increase aggregate demand: in a fully-Ricardian economy this would not be true as Ricardian equivalence would hold. The introduction of non-Ricardian households means that taxes are relevant because they impact on these agents' disposable income and subsequently their consumption. Third, the aggregate demand impact of a unit change in government spending is greater than the aggregate demand impact of a unit change in taxes. This is an intuitive result and occurs for two main reasons: first, tax movements only impact the consumption decisions of rule-of-thumb agents because Ricardian agents maximise over their life time and therefore adhere to Ricardian equivalence. The share of rule-of-thumb households is less than one and therefore there are some consumers for which this fiscal action will not impact. Second, government spending movements directly effect demand through direct production. The impact of tax movements on aggregate demand depend on the decisions of households, who can use, say, a tax cut to both purchase more consumption and more leisure: the latter of which will reduce production in the economy. The magnitude to which government spending increases (decreases) dominate tax cuts

(rises) can be algebraically shown to be inversely proportion to the level of asset market nonparticipation, λ . Further, this magnitude can be algebraically shown to be positively related to the level of private consumption in steady state, γ_c , and the mark-up charged by intermediate firms, μ .

Within these relationships, an intuitive key determinant is the proportion of rule-of-thumb agents in the economy, λ . It can be shown that, in the region of $0 < \lambda < \lambda^*$:

$$\frac{\partial \Phi}{\partial \lambda} > 0, \ \frac{\partial^2 \Phi}{\partial \lambda^2} > 0, \ \frac{\partial \Phi \Theta_C}{\partial \lambda} > 0, \ \frac{\partial^2 \Phi \Theta_C}{\partial \lambda^2} > 0 \tag{18}$$

Increases in the fraction of non-Ricardian households increases the impacts that changes in government spending and taxes have on aggregate demand, and does so in a non-linear way: this is an intuitive result. As highlighted above, the more rule-of-thumb agents in the economy the more of an impact tax cuts will have in stimulating aggregate demand because there will be fewer agents adhering to Ricardian equivalence. Likewise, an increase in public consumption will increase labour demand and wages such that it increases disposable incomes. Whereas Ricardian agents see a negative wealth effect to an increase in government spending, therefore cutting their private consumption, non-Ricardian agents simply consume this temporary increase in incomes. The relationships highlighted in (18) are in line with that of Bilbiie (2008) who showed the counter-intuitive relationship that as the proportion of non-Ricardian agents in an economy increases, the agents who do not react to interest rate movements, so too does the effectiveness of monetary policy. This is because of the non-linear feedback mechanism in the economy between aggregate demand components and the level of non-Ricardian households. Any changes in the aggregate demand of the economy consequently impact on wage levels and subsequently the disposable income of all agents. When this occurs, the consumption of rule-of-thumb households deviates and correspondingly this feeds back into additional aggregate demand. This feedback mechanism works on any component in the aggregate demand condition which in this model includes government spending and tax $movements.^{11}$

The existence of non-Ricardian households also means that the relationships found in (17) are sensitive to preference parameters. For example, it can be shown that:

$$\frac{\partial \Phi}{\partial \varphi} > 0, \ \frac{\partial \Phi \Theta_C}{\partial \varphi} > 0 \tag{19}$$

in the region of $0 < \lambda < \lambda^*$. These relationships state that the more disutility agents obtain from labour, the greater the stimulating effect of a government spending increase or a tax reduction. This occurs because in order to stimulate the economy additional labour is required. The higher the disutility agents obtain from labour the bigger an increase in wages required to produce the stimulus. This in turn impacts non-Ricardian income and subsequently demand. Further to these, it can be shown that:

$$\frac{\partial \Phi}{\partial \sigma} < 0, \ \frac{\partial \Phi \Theta_C}{\partial \sigma} < 0$$
 (20)

in the region of $0 < \lambda < \lambda^*$. These relationships state that the less agents gain utility from consumption, the less the stimulating effect of a government spending increase or a tax reduction.

¹¹This non-linear effect can be seen in a number of other papers in the literature (although the cause is not explicitly commented upon) when sensitivity of results in these papers are tested against varying levels of λ . For example see Coenen & Straub (2005), Galí et al. (2007) and Colciago (2011).

This occurs because the response of private consumption to a demand stimulant will be lower the higher the value of σ .

4 Dynamic simulations

4.1 Calibration

For dynamic simulation, the following calibration of parameters will be applied: sensitivity to these will be performed throughout. Each unit of time is a quarter and the discount factor, β , is set at 0.99 which corresponds to a steady state rate of return to bonds of 4%. The preference parameters are set such that $\sigma = 1$, which represents log utility with respect to consumption, and $\varphi = 0.2$, the inverse elasticity of work with respect to the real wage. The degree of decreasing returns to labour in the production function, α , is set to equal 1/3 and the steady state mark-up, μ , is calibrated to 0.2; this value of mark-up corresponds to a elasticity of substitution across the intermediate goods, ϵ , of 6. The parameter governing the stickiness of prices, θ , is set at 0.75 leading to the average price duration for a given firm to be four quarters. Steady state levels of production are shared by private and public consumption at a ratio of 4 : 1 leading to a calibration of $\gamma_c = 0.8$ and $\gamma_g = 0.2$. The Taylor rule parameters are set such that $\varphi_{\pi} = 1.5$ and $\varphi_y = 0.125$. The persistence of the shock parameters are set equal to 0.8 to make comparisons across the results for different shocks.

This calibration follows closely that of Galí et al. (2007), which has been criticised for its low value of the inverse of the wage elasticity of employment.¹² As demonstrated in equation (16), if it is required that $\lambda < \lambda^*$, there are six parameters to calibrate and only five degrees of freedom: the choice of calibration of one parameter needs to be sacrificed to the model and not to the data. Through setting $\varphi = 0.2$ a calibration of $\lambda = 0.5 < \lambda^*$ is achievable ($\lambda = 0.5$ is reflective of empirical observations and is the calibration used in Galí et al. (2007)): φ is sacrificed to allow a reasonable calibration of λ . A similar strategy as adopted in Galí et al. is adopted here by using the same calibration. The value of λ^* with other parameters at reasonable calibrations is too low, and this is primarily due to the simplicity of the model. It has been implicitly shown that through including further rigidities such as fixed capital accumulation, habit persistence, Kimball demand curves and firm specific capital the values of λ^* increase.¹³ It is a preference to not overcomplicate the model in order to allow for more algebraic understanding of the transmission mechanisms. Moreover, it is desired that the share of the two types of households are approximately equal to their empirical share because the paper reviews welfare and with appropriate proportions for each household comes appropriate weighted average population calculations. Sensitivity of the results to the calibrations of φ and λ parameters, amongst others, will be performed.

4.2 The positive consequences of fiscal policy

An a-cyclical fiscal response

As a benchmark, the dynamics of an economy with no active fiscal policy will be considered. It will be against these results that the impact of fiscal interaction will be analysed. For brevity the results for an exogenous adverse monetary policy shock will be considered: sensitivity of the

 $^{^{-12}}$ In particular these two calibrations have been questioned in Furlanetto & Seneca (2009) and Colciago (2011).

¹³Although this cause and effect is not explicitly shown, it is highlighted through sensitivity analysis in different papers varying the level of λ . For the examples provided above see Galí et al. (2007) and Furlanetto & Seneca (2009).

results to other shocks will be discussed. An exogenous positive monetary policy shock leads to a fall in output in the economy as Ricardian consumers postpone consumption due to the higher rates of returns on savings, and non-Ricardian consumers respond to the decline in the economy and subsequent drop in their disposable income. As a result, both aggregate consumption and employment fall in general equilibrium. These results are also true of a fully-Ricardian economy although the initial impact of the shock increases with the level of asset market non-participation, λ , due to the non-linear feedback mechanism discussed above; in this calibration, output initially falls by approximately 2% from it's steady state level but this diminishes over time as the impact of the shock reduces.

Figure 1 illustrates the dynamics of an economy hit by the same shock under the circumstances of a-cyclical fiscal policy and the two fiscal experiments: the above results are observed for the aggregate economy. Moreover, the disaggregated impacts that are expected are illustrated in the diagram. Both Ricardian and non-Ricardian consumption falls as a consequence of the shock; the former due to higher nominal interest rates and the latter due to both the fall in real wages in the economy, driven by lower labour demand, and lower levels of employment both contributing to reduce disposal income. However, the fall in consumption for the rule-of-thumb agents is greater than that of their Ricardian counterparts: in this calibration the fall in the former is 37% greater than that of the latter. This is an intuitive result that occurs for all time periods. The Ricardian households are less constrained than the non-Ricardian households and have an additional smoothing resource at their disposal: capital markets. Rule-of-thumb households (by assumption) are unable to use these and the only decision they can respond with to alleviate the impact of the shock is through their labour market decisions: their supply of labour. In the presence of an adverse shock, these credit constrained agents supply more labour to the market compared to Ricardian households in order to increase their disposable income and therefore consumption. However, the result of this increase in labour supply, and the overall reduction in output leads to a fall in wages and therefore, even though their employment has increased compared to steady state levels, the consumption of non-Ricardian households still falls. These agents are supplying more labour to the market, therefore increasing aggregate output, but they are unable to consume all of this additional production; the surplus is consumed by the Ricardian households who are being insulated as a result of the actions of the credit constrained agents. They are able to purchase this surplus through greater dividends in general equilibrium brought about by the supply of cheap labour. Overall, income of Ricardian households dominates that of non-Ricardian households despite the fall in the former's labour supply and the rise of the latter's. Ricardian households both consume more and work less than their non-Ricardian neighbours. This is illustrated in Figure 1 for an adverse monetary policy shock, but this intuitive transmission mechanism is not sensitive to the original source of disequilibrium and similar results for other shocks can be observed (although the aggregate dynamics underlying these will differ).

The impact of fiscal policy

Figure 1 also presents the impact of the two policy experiments to the aggregate and disaggregate economy. As predicted by the algebraic analysis in Section 3 in both experiments aggregate demand, and subsequently output, initially increases. In policy experiment 1, where spending increases in the short term are funded by future spending cuts, this increase in demand comes directly from the government. Aggregate private consumption initially falls in the economy, it is 'crowded out' by the fiscal action, however this aggregate movement hides disparity across agents; non-Ricardian



Figure 1: Dynamics under different fiscal experiments

Dynamics achieved through using the calibration described in Section 4.1 and with a 1% monetary policy shock (η_t^r) in period t = 1. The x-axis represents the number of quarters and the y-axis the percentage deviation of the variable from steady state levels. A-cyclical policy is when all fiscal parameters are set to zero; 'PE1' represents policy experiment 1 with calibration $\varphi_g = -3$ and $\varphi_{b,g} = -0.1$; 'PE2' represents policy experiment 2 with calibration $\varphi_t = 3$ and $\varphi_{b,t} = 0.1$. These fiscal parameters are arbitrarily set for the purposes of demonstration in the figure. Note, debt aversion parameters equal to 0.1 in modulus relate to an expected haffile of debt of two years.

consumption increases and Ricardian consumption falls, compared to the a-cyclical benchmark. This rise in rule-of-thumb consumption is driven by an increase in real wages as labour demand in the economy rises due to the increase in output. Ricardian households, on the other hand, substitute leisure for consumption as the increase in labour demand increases their employment levels: they optimise by reducing their consumption. In policy experiment 2, where tax cuts today are funded by future tax rises, this rise in aggregate demand and subsequently output comes entirely through private consumption. Non-Ricardian consumption increases and Ricardian consumption falls, however the increase in the latter is much greater than that of the former. Rule-of-thumb consumption increases as a result of both the tax cut which directly increases disposable income, and also through an increase in wages as labour demand in the economy increases. In a fully-Ricardian consumption would remain unchanged. However, with $\lambda > 0$, a small short term fall in Ricardian consumption is observed, compared to the acyclical benchmark, as a result of increasing Ricardian employment leaving them with a preference to substitute consumption for leisure.

The effectiveness of policy experiment 1 over policy experiment 2 with respect to aggregate output, as predicted in (17), is illustrated in Figure 1. In both cases output initially dominates the a-cyclical benchmark but the direct government injection of public spending is more effective than private tax cuts as the latter are used (partially) to purchase more leisure. Over longer horizons the fiscal policy actions need to be repaid and as such the stimulating impact is reduced until output falls below that of the a-cyclical benchmark; in this calibration this occurs after 12 and 15 quarter for policy experiments 1 and 2 respectively.

From a disaggregate perspective clear results are presented as a consequence of the fiscal experiments. Compared to the a-cyclical benchmark, consumption rises and employment falls initially for rule-of-thumb households with the reverse results for Ricardian households: unambiguous gains and loses in welfare. However, these results are only immediate consequences of the policy and as the fiscal authority starts to repay the debt these dynamics are reversed.

4.3 The normative consequences of fiscal policy

This section reviews whether there is a normative justification to fiscal policy by evaluating the different agent's welfare under the policy experiments discussed above. This is performed by deriving a welfare criterion based on a second order Taylor series expansion of the utility function around the non-stochastic, zero debt, zero inflation, steady state values. This procedure provides a criterion expressed as the equivalent one period consumption loss, as a proportion of steady state consumption, that leaves the agent indifferent between living through the shock or the one period consumption loss. When the necessary calculations have been performed this criterion take the following form:

$$W^{i} = E_{t} \sum_{t=0}^{\infty} \beta^{t} \left(c_{t}^{i} + \frac{1-\sigma}{2} (c_{t}^{i})^{2} \right) - \frac{(1-\alpha)}{\mu \gamma_{c}} E_{t} \sum_{t=0}^{\infty} \beta^{t} \left(n_{t}^{i} + \frac{1+\varphi}{2} \left(n_{t}^{i} \right)^{2} \right)$$
(21)

This criterion provides disaggregate calculations for the two different households in the economy and with this any political frictions to fiscal policy can be observed.

An a-cyclical fiscal policy response

The top row of Figure 2 presents welfare valuations of the two policy experiments when the economy is struck by the same 1% adverse monetary policy shock discussed above, for differing values of the cyclical-response parameters; the vertical lines represent a-cyclical policy ($\varphi_q = \varphi_t = 0$). The results show the intuitive result from the disaggregated dynamics presented above; in the absence of fiscal policy Ricardian welfare dominates non-Ricardian welfare as the former both consumer more and work less. The resulting dynamics mean that these unconstrained agents *qain* welfare as a result of the shock; their fall in employment provides enough of a utility reward to compensate for the penalty of a fall in consumption. These results are in stark contrast to the non-Ricardian agents who see significant a fall in welfare as a result of both the shock and the lack of access to credit in order to insulate themselves. In aggregate the welfare reduction is minimal as the gains of the Ricardian agents (6% of steady state consumption) net off against the loses of the non-Ricardian agents (11%) of steady state consumption); this is in line with the analysis of Lucas (2003) but shows that this aggregation hides significant differences in experiences. There is a redistribution of welfare from non-Ricardian to Ricardian agents as a result of the adverse shock. This is not sensitive to the type of shock causing the deviations and the intuitive transmission mechanism is maintained.

The impact of fiscal policy

Figure 2 presents the normative consequences of fiscal policy: as discussed above, the first row illustrates the movement in welfare when the cyclical-response parameters (φ_g and φ_t) are varied whilst the debt aversion parameters are fixed ($\varphi_{b,g}$ and $\varphi_{b,t}$); the second row reverses this, varying the debt aversion parameters whilst fixing the cyclical response parameters. From these figures four clear results emerge. First, non-Ricardian households gain welfare and Ricardian households loose welfare as a result of counter-cyclical fiscal policy: this is an intuitive result. Counter-cyclical policy stabilises the economy by reducing the impact of the exogenous shock. This stabilising role reduces the need to use capital markets to smooth consumption and therefore reduces the welfare losses associated to not being able to do this. However, because the stabilisation policy is insulating the economy, the increase in the rule-of-thumb labour supply is reduced and as such, the gains from the shock that the Ricardian agents experience are reduced through counter-cyclical policy. There is a clear divergence of preferences between the two households and a resulting divisive political friction to fiscal policy.

Second, rule-of-thumb households have a preference for counter-cyclical measures which increase government spending over those that reduce taxes in response to a recessionary shock. It was observed in equation (17) that the former have a greater impact on the aggregate economy than the latter and this was demonstrate in Figure 1. The normative results imply that rule-of-thumb agents benefit more from general increases in aggregate demand than through direct injections into their disposable income. This result occurs using a lifetime horizon for the welfare calculation; as can be seen in the disaggregated dynamics of the two policies, the results for rule-of-thumb households in policy experiment 2 dominate those of policy experiment 1, but over the long term, there is more pain to these agents repaying the tax policy than the government spending policy. The top row of Figure 2 demonstrates that welfare converges quicker to higher levels of welfare for credit-constrained agents in policy experiment 1 than 2.¹⁴ Similarly, Ricardian households prefer

¹⁴The converging property of the figure comes from the diminishing impact policy has due to the way the fiscal



Figure 2: Welfare consequences of policy experiments

Dynamics achieved through using the calibration described in Section 4.1 with a 1% monetary policy shock (η_t^v) in period t = 1. In the top left pane φ_g is varied whilst $\varphi_{b,g} = -0.1$; in the top right pane φ_t is varied whilst $\varphi_{b,t} = 0.1$; in the bottom left pane $\varphi_{b,g}$ is varied whilst $\varphi_g = -3$; and in the bottom right pane $\varphi_{b,t}$ is varied whilst $\varphi_t = 3$. Note, debt aversion parameters equal to 0.1 in modulus relate to an expected halflife of debt of two years. Vertical lines represent a-cyclical fiscal policy. Welfare movement is expressed as the equivalent one period consumption loss, as a proportion of steady state consumption, that would leave the household indifferent between living through the shock, or this one period sacrifice.

authority's actions have been modelled. As φ_g or φ_t increases, rational agents in the economy expect the impact of shocks to be less which leads to a reduction in the movements in y_t resulting from the shock and thus less of an automatic response from the government. If fiscal responses were modelled through a shock process, then the impact of an increase in the size of this shock on the welfare consequences would be linear and the dominance of welfare

counter-cyclical measures which cut taxes over those that increase spending because they have less of a stabilising role and therefore maintain their improved position as a result of the shock; the political frictions from the model do not only come from the cyclical response of the fiscal authority but moreover from the policy mix.

Third, high degrees of debt aversion lead to lower movements in relative welfare as a result of policy (the second row in Figure 2). This occurs because the initial impact of the intervention is shortened as the repayment for the policy is accelerated in the economy.¹⁵ Therefore, the results from above are maintained, rule-of-thumb agents benefit from counter-cyclical fiscal policy, and that Ricardian households loose, and moreover, rule-of-thumb agents would prefer that such policy be repaid slowly, when the impact of the shock on the economy has passed. This further contributes to the austerity versus stimulus debate. In many respects the expression 'debt aversion' could be replaced with 'austerity preference'. Many western economies performed an initial fiscal stimulus as a result of the financial crash in 2008, with limited controversy. When the downturn persisted the austerity versus stimulus debate ignited with the austerity camp looking to repay the initial stimulus quickly with the counter-argument that such repayment was inappropriate whilst the economy was still struggling. These results provide a further political friction to the conduct of fiscal policy.

Finally, there is a normative aggregate justification for counter-cyclical fiscal measures but these are quantitatively small: this result is in line with Lucas (2003). The real normative justification comes from the redistributional consequences of policy because it reduces the inequality of sacrifice between the two households as a result of the shock. Through having a stabilising influence on the economy, the counter-cyclical policy limits the impact of the adverse shocks and in so doing reduces the redistribution of welfare associated with the shock. The fact that aggregate welfare gains as a response of fiscal intervention are small is the cause of the political frictions in the model: as one agent gains welfare, the other agent loses. These frictions lie in all dimensions presented by model with respect to the cyclical response, the degree of debt aversion and the policy mix preferences of the two types of agents.

Other shock processes

The same analysis as presented in Figures1 and 2 can be performed for when the initial disequilibrium shock originates from any of the other microfounded shock processes. The redistribution of welfare, in the presence of the adverse shock and acyclical fiscal policy, from non-Ricardian to Ricardian households is observed whereby the former agents' labour market decisions, due to the lack of access to capital markets, improves welfare for the latter agents over their steady state levels. From this benchmark, fiscal policy interacts with the economy in a similar way as to those presented for adverse nominal interest rate shocks, and the disaggregated welfare experiences of the two households also follow similar paths. This consistency of results is due to the way fiscal policy interacts within the economy through the aggregate demand condition.

between households could be reversed.

¹⁵Similar affects of the impact of lower debt aversion on the impact of both aggregate and disaggregate variables are found in Bilbiie & Straub (2004).

4.4 Discussion

The results observed from the theoretical model are simple, intuitive and reassuringly reflective of empirical debates. Clear political economies to fiscal policy are predicted where policies affect heterogeneous households differently, in divisive and polarising ways. Rule-of-thumb agents have preferences for strong counter-cyclical fiscal policy that favour government spending increases over tax cuts which are paid back slowly over the medium term. Ricardian agents, on the other hand, prefer an acyclical response of fiscal variables to the business cycle with limited government intervention. If there are to be stimulating actions, these agents prefer measures which cut taxes and raise them in the future, where the latter is performed quickly in order to pay for the tax reductions.¹⁶ These two sets of preferences are reflected in real world debates. Two clear camps appear in these political discussions whose arguments follow similar lines to those predicted by the model: this is with respect to the cyclical nature of the fiscal response, policy mixes and the degree of debt aversion. We proposed that the rule-of-thumb agents will come predominantly from those in the lower end of the income distribution; this proposition is coherent with the preferences outlined above because it is the political left wing who argue for policy measures similar to those desired by the non-Ricardian agents and the political right wing who argue for those preferences observed for the Ricardian households. This alignment of preferences from the model to the empirical debates provides support for not only the model but also the hypothesis about the identification of the two types of agent. Moreover, it provides further evidence towards the preferences over the policy mix as with a progressive tax system (not assumed in the model) it will be the Ricardian agents paying the majority of the taxes in the economy, therefore receiving the majority of any cuts further reducing the aggregate impact of these and diminishing the welfare gains of counter-cyclical policy to rule-of-thumb agents. Although the modelling assumption is a crude division of an otherwise more diverse population, its ability to predict the real world polar fiscal debates is persuasive. Beyond this segregation of agents the implied intuition is clear; if some agents gain and others lose during different phases of the business cycle, the former have an incentive to prolong the conditions from which they are benefiting and are adverse to policy measures that prohibit this.

5 Further extensions

5.1 Fiscal policy at the zero lower bound

A characteristic that has been prevalent in the recent recession, and for which has received much academic attention, is that monetary policy has been operating at its' lower bound: where nominal interest rates reach, or are close to, zero. Under such a scenario fiscal multipliers are shown to increase as the deflationary impact of higher interest rates associated with higher levels of output are removed: see for example Christiano et al. (2011). When nominal interest rates reach zero the expansionary impact of a cut in these rates is no longer possible and as such the impact of shocks that take the economy below this point become progressive larger as the monetary authority has lost its ability to stabilise the economy: this increases the scope for fiscal policy.

To see how the results are altered when the nominal interest rate is at it's lower bound the economy above is exposed to a preference shock such that interest rates are zero for 14 periods in the presence of acyclical fiscal policy: from this benchmark the impact of fiscal policy on the

¹⁶These results are also in line with the empirical observations in IMF (2012) which observes a rise in income inequality from fiscal consolidations, especially those which favour spending cuts over tax rises.

welfare outcomes of the two agents are illustrated in Figure 3.¹⁷ In the presence of acyclical policy the amplification of the impact of the shock leads to an amplification in the welfare consequences resulting: non-Ricardian losses and Ricardian gains are increased where the former are greater than the latter leading to an increase in the weighted average welfare losses of the economy. From this benchmark fiscal policy has more scope to rebalance this larger redistribution of welfare. As from before the weighted average movements from policy are not large, although are larger, and as such any improvements to non-Ricardian households from countercyclical policy are at the expense of Ricardian households. Sufficiently countercyclical policy in experiment 2 can lead to non-Ricardian households' welfare dominating that of Ricardian households. This occurs because the asymmetry in the behaviour of monetary policy means the period when the lower bound is binding is of more importance than when it is not because these impacts are amplified. As is illustrated in Figure 1 countercyclical policy experiment 2 leads to significant short term utility losses of Ricardian agents whose benefits from the policy accrue over the medium and long term. If this initial period is amplified and fiscal policy is sufficiently countercyclical this can result in these agents losing welfare as a result of the shock and non-Ricardian agents gaining welfare. Although this analysis has shown that the conclusions above are robust to when monetary policy is at it's lower bound, it does show that the conflict between the two agents is amplified by this empirically relevant scenario.



Dynamics achieved through using the calibration described in Section 4.1 with $\eta_t^b = 0.05$ in period t = 1. The algorithm used in Holden & Paetz (2012) was applied in order to derive the results. In the top left pane φ_g is varied whilst $\varphi_{b,g} = -0.1$; in the top right pane φ_t is varied whilst $\varphi_{b,t} = 0.015$ where this latter calibration was necessary to secure results from the algorithm. Benchmark results are presented for an economy subjected to the same shock but where no zero lower bound is imposed ('No ZLB').

¹⁷The algorithm designed in Holden & Paetz (2012) is applied which provides a shock to interest rates whenever their dynamics are below zero to increase them to this lower bound.

5.2 The conduct of fiscal policy over the business cycle

The above analysis has been performed considering only adverse shocks, defined as those leading to a negative output gap. This restriction was made for two main reasons: first, to consider the conduct of fiscal policy in the current recession; and second, because it was argued that restricting access to capital is more relevant in downturns when agents want to borrow. The model is linear and therefore the results above would be reversed in the presence of non-adverse shocks: Ricardian households benefit from countercyclical fiscal policy in boom times when the redistribution of welfare operates in the other direction. This result breaks economic logic, to some extent, as those agents who are more constrained are achieving higher levels of utility than those who are less constricted: at least with acyclical fiscal policy. However, it could be argued that such behaviour over the course of the business cycle leads to lower levels of welfare as the linear impacts net off but the variance in consumption will be higher for credit constrained agents.

To consider the conduct of fiscal policy over the whole business cycle simulations of the model are made with a mixed fiscal strategy where $-\varphi_{b,g} = \varphi_{b,t} = 0.05$ and where the cyclical response parameters are varied but set equal to each other in absolute terms ($-\varphi_g = \varphi_t$). The results are not sensitive to this mixed strategy and the remainder of calibrated parameters are as set out in Section 4.1. Simulations are run with equal weights for demand, cost push and productivity shocks and key statistics observed and documented in Figure 4.

A countercyclical fiscal response to the business cycle leads to a fall in the variance of non-Ricardian consumption and a rise in the variance of Ricardian consumption compared to an acyclical benchmark (the first pane of Figure 4). The fall in the variance of non-Ricardian consumption arises because the fiscal action acts to stabilise disposable income either directly through taxation or indirectly through government demand. For Ricardian households, the insulating actions of their non-Ricardian neighbours are more effective than those of the fiscal authority and the countercyclical conduct of the latter therefore leads to a rise in the variance of their consumption. To these agents, movements in government spending raises their consumption variance as they substitute consumption for leisure, and movements in taxes are ignored, at least in partial equilibrium. Therefore, over the course of the business cycle countercyclical fiscal policy works to the advantage of non-Ricardian households at the expense of Ricardian households. This can get to such a level whereby the variance of Ricardian household consumption exceeds that of non-Ricardian households; this is demonstrated in the second pane of Figure 4. These results are not sensitive to the calibration used, in particular with respect to λ , φ , and fiscal parameters or changing the weights on different standard deviation of shocks. Moreover, they are not sensitive to the labour market assumed (see below for a different labour market application). However, when more frequently applied modelling assumptions and calibrations are used the point at which non-Ricardian consumption variance is lower than that of Ricardian consumption variance is significantly extended. This is particularly true of a more restrictive labour market and a higher calibrated value of φ .

These results are of particular significance because they contribute to the literate that observes fiscal policy to be frequently procyclical, especially in developing nations: see for example Kaminsky et al. (2004). In this model it is hypothesised that different agents have different preferences over the conduct of fiscal policy depending on the phase of the business cycle, but that in aggregate Ricardian households benefit from procyclical policy and non-Ricardian households from countercyclical policy.



Figure 4: Fiscal policy and consumption variance through the business cycle

Dynamics achieved through using the calibration described in Section 4.1 with equal standard deviation weights for demand, cost push and productivity shocks (where demand shocks are shared across both interest rate and preference shocks); the results are not sensitive to this equal weighting. A simulation period of 1,000 quarters is used where the first 200 observations were dropped from the analysis. Debt aversion parameters are set such that $-\varphi_{b,g} = \varphi_{b,t} = 0.05$ and where cyclical response parameters are varied but set such that $-\varphi_g = \varphi_t$. The left hand pane measures the variance in disaggregated consumption compared to an acyclical fiscal policy benchmark and the right hand pane compares absolute values of disaggregated consumption by normalising by the variance of total consumption.

5.3 Distortionary taxation

The analysis above has been performed using lump sum taxation however were distortionary taxes to be included we derive similar results. From the structure of the model it is possible to include taxes on consumption, employment income and employment by firms such that these rates react to the business cycle and the level of debt similar to (10). If these are included similar results as those presented for lump sum taxes are derived: countercyclical policy is to the advantage of non-Ricardian households and the expense of Ricardian households. Consumption and employment income taxes are more effective at rebalancing these welfare impacts compared with employer social security contributions as the latter accrue to Ricardian agents through dividends; however a countercyclical response of these taxes leads to an incentive to increase employment today. This leads to a stabilisation of the economy and as such a lower response from rule-of-thumb agents: fiscal policy is still played in a near zero sum game.

6 Sensitivity

The sensitivity of the results above have already been tested against the cyclical response of the fiscal authority (φ_g and φ_t), the degree of debt aversion ($\varphi_{b,g}$ and $\varphi_{b,t}$), as well as the initial source of disequilibrium. In all cases small changes to the quantitative results were observed but not to those of the qualitative messages from the analysis. This section performs further robustness tests of the results.

6.1 Multipliers

A potential critique of the above results is that through introducing a proportion of non-Ricardian agents the model is implicitly generating large fiscal multipliers through increasing the private consumption response to stimuli over the traditional RBC model. However, as can be observed in Figure 1 government spending, in the calibration used, crowded-out private consumption leading to lower than unity multiplier in policy experiment 1. To further address this issue, the model can be manipulated to find fiscal policy multipliers associated with the different experiments. The response functions (9) and (10) can be adapted to include shocks to fiscal parameters. This is performed because the resulting multiplier calculations from using the above analysis are sensitive to the arbitrary calibration of the cyclical response parameters: they are not sensitive under the new specification.¹⁸ Table 1 presents the results from this analysis.

Table 1: Fiscal multip	pliers of p	olicy experii	ments
	Multiplier		
	Impact	One Year	
Experiment 1	1.16	1.01	
Experiment 2	0.24	0.24	

The 'Impact' multiplier is calculated using $y_t/\hat{g_t}$ in policy experiment 1 and $y_t/|\hat{t}_t|$ in policy experiment 2. The 'One Year' multiplier is calculated using $\sum_{t=1}^{t=4} y_t/\hat{g_t}$ in policy experiment 1 and $\sum_{t=1}^{t=4} y_t/|\hat{t}_t|$ in policy experiment 2. Multipliers achieved through shocking either government spending or taxes: the calibration is as that set out in Section 4.1. Debt aversion parameters are set with $\varphi_{b,g} = -0.1$ and $\varphi_{b,t} = 0.1$. Given the way the fiscal policy has been modelled, the multiplier figures for the two experiments can be seen as the stimulus to output achieved by an equal path of government debt. A positive multiplier for tax shocks corresponds to the rise in output as a result of a fall in taxes.

As demonstrated by the table, even with the inclusion of the rule-of-thumb households the model does not produce large aggregate multipliers from fiscal actions, because there are few other rigidities in the model: the model is too simple to derive these large multipliers. The analysis is different from above and under this specification for the fiscal authority there is a slight crowding in of private consumption from government spending increases but even with this design the multipliers are within modest empirical estimates. Therefore, the model is providing the results despite the multipliers associated with it, not because these are being amplified through the inclusion of non-Ricardian households. This is somewhat by design: the paper is researching if DSGE models can

¹⁸They will be sensitive to these cyclical response parameters because the higher the value them the lower the impact of the shock will be under rational expectations. This will lead to a lower fiscal response to the shock and therefore the policy is becoming more effective despite the quantitative response being smaller.

present political frictions to fiscal policy and whether these shed light on the current austerity versus stimulus debate. It is not trying to provide a positive aggregate justification to fiscal policy but a normative disaggregate justification. Increasing the multipliers generated by the model would do both, but even without these the analysis provides clear, intuitive and robust results. There is a normative justification to counter-cyclical fiscal policy, even in the absence of a significant positive one.

The modelling procedure used to find multiplier figures can also be used to test for the results if fiscal policy was conducted through shock processes rather than automatic rules. If this was performed, similar conclusions as those reached above would be reached; the analysis is not sensitive to the way the fiscal authority was modelled.

6.2 Labour market assumption

A key assumption for all results has been that of the perfectly competitive labour market, because it is through the labour market that non-Ricardian households perform their constrained optimisation and through these dynamics from which the redistribution of welfare results. Therefore the design and assumptions of this market and how it operates is important to the analysis. If the model were adapted to include imperfectly competitive labour markets similar to those in Galí et al. (2007), where a continuum of trade unions bargain to add a mark up on wages by aggregating individual preferences to create a weighted average labour supply function, the results remain qualitatively unchanged as those presented above. There is a redistribution of welfare observed in the presence of an adverse shock and this can be reduced through counter-cyclical fiscal measures. However, the quantitative results are amplified as the scope of fiscal policy is extended by this additional rigidity in the market; larger multipliers are also observed from fiscal actions. Although the model presented provides a simple intuitive framework from which to consider the heterogeneous impacts of shocks and subsequent policy, the results obtained are not sensitive to the labour market assumption.

6.3 The share of non-Ricardian households

As was discussed above, the greater the share of non-Ricardian households the greater the impact of a shock on the aggregate economy due to the non-linear feedback mechanism between any exogenous movement and aggregate demand. From a disaggregate perspective three factors are influencing the welfare of individual agents: first, the increased aggregate impact of the shock is leading to a larger labour supply reaction by rule-of-thumb agents; second, as the proportion of rule-of-thumb households increase, the proportion of Ricardian households is decreasing, and therefore so too are the agents who can take advantage of the additional employment and dividends in the economy; and third, an increase in the share of non-Ricardian agents leads to a greater effectiveness of fiscal policy as is demonstrated in condition (18). These combine to lead to a greater quantitative impact of exogenous shocks on agents at higher levels of λ which is particularly true of Ricardian households who are now sharing surplus production across fewer agents. However, the interaction of fiscal policy with the aggregate and disaggregate economy remains qualitatively unchanged: countercyclical policy is to the benefit of non-Ricardian agents at the expense of Ricardian agents.

It should also be highlighted that there is a normative justification for fiscal policy even in a fully-Ricardian economy ($\lambda = 0$). Counter-cyclical policy in experiment 1 increases welfare for the Ricardian agents when no rule-of-thumb households are present because of its stabilising impact.

However, the welfare losses of any adverse shocks are small and subsequently improvements on these will also be small.

We can also remove the assumption that both types of agent consume and work the same amounts in steady state. The only impact this would have on the model would be to change the aggregate consumption condition to:¹⁹

$$c_t = \chi c_t^{NR} + (1 - \chi) c_t^R$$

where $\chi = \lambda C^{NR}/C$. Empirical studies on rule-of-thumb behaviour, for which the calibration of λ is based, are effectively finding χ as they are estimating the share of income accruing to credit constrained households. Therefore, if the proposition that these agents will come from the lower end of the income distribution is believed, this will mean that there are more non-Ricardian households than their share of total income. The only impact that this will have on the above results is to change the weighted average welfare results.

6.4 Other parameters

The calibration used, which follows closely that of Galí et al. (2007), has been criticised for its low value of the inverse elasticity of work with respect to the real wage, φ , and its high value of price stickiness, θ : see for example Furlanetto & Seneca (2009). Higher values of the former lead to a greater aggregate impact of shocks for two reasons: first, through increasing the disutility from work the labour supply response of rule-of-thumb agents will be reduced; and second, a higher value of φ leads to a lower value of λ^* thus increasing the impact of the shock. Similarly, with the exception of movements in the desired markup of intermediate good firms, higher values of price stickiness lead to a higher impact from exogenous shocks as they are propagated for longer in the economy. These both lead to an increase in the scope of fiscal policy to rebalance the bigger redistribution of welfare associated with higher calibrations of both. Again however, although there are small quantitative changes in absolute welfare from these calibrations the impact of fiscal policy on relative welfare remains unchanged: countercyclical policy is to the benefit of non-Ricardian households at the expense of Ricardian households.

7 Conclusions

The aim of this paper was to perform a normative assessment of fiscal policy in the presence of adverse shocks in a DSGE model. This was done using a model that included heterogeneous households, the inclusion of which has been shown to be ex-ante and ex-post justified, and provides an avenue for political frictions to emerge within the model. The findings are intuitive and representative of that observed in the real world. Adverse shocks to an economy impact constrained non-Ricardian households more than their unconstrained counterparts. This occurs because whereas Ricardian households are able to use capital markets to insulate themselves against the impact of any adverse shock, the non-Ricardian households cannot. In aggregate the welfare loss from such actions are small, but this hides a big loss of rule-of-thumb agents netting off gains of their Ricardian neighbours. When fiscal policy is allowed to interact with the business cycle key themes

¹⁹Note that the remaining areas where disaggregate steady state levels arise in the derivation of the model (the welfare criterion and the log linear non-Ricardian consumption function) require the ratio of these variables (N^i/C^i) which given the assumed identical period utility function will be equal in steady state.

and intuitive results are observed. Rule-of-thumb agents have a preference towards counter-cyclical fiscal policy that favours government spending increases and is repaid over a long time horizon. Ricardian households, on the other hand, have opposing preferences wanting a-cyclical policy to maintain their position; if fiscal policy is to be counter-cyclical these agents prefer measures that favour tax cuts and that are repaid quickly. In effect, these fiscal decisions are played in a virtual zero-sum game where the gains of one household are netted off against the losses of the other and this is the source of political frictions in the model. These frictions are coherent with those observed in the real world and the intersection of preferences to empirical debates is compelling. This paper hypothesised that rule-of-thumb agents are those in the lower end of the income distribution and this identification collaborates with the current political stances: this both provides support for the model but moreover support for the hypothesis. With regards to the current austerity versus stimulus debate, the model predicts its existence, predicts those involved on the two sides of the debate, and predicts the current political swing from those parties supporting the former (austerity) to those supporting the latter (stimulus) when it is observed that more agents are prohibited from credit as the current recession continues; moreover, the model predicts the debate is of greater significance when monetary policy is at the zero lower bound. These results come from a model which assumes away progressive taxes and one with modest multipliers. The normative justification comes despite the lack of a significant positive one.

The importance of this research is that it broadens the scope of DSGE models to not only comment on the positive and normative consequence of shocks and policy from an aggregate perspective, but also from a disaggregate perspective. Such analysis complements the current literature because it provides further understanding behind various policy implications but moreover, provides a commentary of potential political frictions policy makers face which may prohibit certain actions. Given that models which include heterogeneity in the actions of households are now commonplace, the methods and procedures applied here are easily tractable into this current research. The potential extensions of this research are vast and include extending the model developed here for further rigidities and fiscal instruments, but moreover, include adopting the procedures performed here to other policy scenarios and other methods of diversifying individuals.

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