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Who is afraid of austerity? The redistributive impact of fiscal policy in a DSGE framework*

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Abstract

This paper presents a comprehensive assessment of fiscal austerity, with special emphasis on its distributional consequences, which are surprisingly ignored in the existing literature. Using a medium scale DSGE model we find that both the aggregate and distributional consequences of fiscal consolidation are shaped by its composition much more than by its speed. A trade-off emerges between efficiency and equality; spending-based austerity leads to smaller net movements in output, incomes and welfare, but also to larger inequality between agents who vary by their access and use of credit markets. Given the severity of the recent downturn in most advanced economies that had adopted austerity, this trade-off between growth and distributional consequences of fiscal consolidation is likely to pose serious challenges to policymakers in many countries.

Keywords: fiscal austerity; welfare; redistribution.

JEL Classification: E65; H2; H3.

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1 Introduction

There has been a great revival of interest in fiscal policy issues in both policy and academic circles following the 2008-09 global financial crisis. Substantial fiscal stimulus packages that were put in place in response to the crisis were followed by much reduced fiscal revenues during the subsequent Great Recession, leading to a clear loss of fiscal discipline, particularly in advanced economies.[1] For example, debt to GDP ratios reached an average of 92.3 per cent in OECD countries with 89 per cent in the UK, 99 per cent in the US, 126 per cent in Italy and 210 per cent in Japan in 2009 (see, for example, OECD; 2012).

Such fiscal sustainability issues that surfaced soon after the adoption of the large fiscal stimulus packages have forced widespread policy reversals. The resulting fiscal consolidation has proved difficult both politically and economically in many countries. Challenges fiscal austerity posed for different sections of the society have been at the top of the political agenda in both the US and the UK since 2010, for example. A key question related to fiscal adjustment is therefore, how the cost of consolidation is distributed. Although the effectiveness of fiscal programs, both stimulus and consolidation, is widely explored in existing work, the distributional impact of fiscal policy is largely ignored.[2] This is somewhat surprising given the clear distributional implications of fiscal austerity, as is evident from the recent policy discussions.[3]

It is also widely acknowledged that austerity programs that are viewed as 'unfair' are unlikely to succeed (see, for example, IMF; 2012). Agnello et al. (2012) and IMF (2012)

[1]The fiscal stimulus programmes were as large as 5.9 per cent of GDP in the US, 3.3 per cent on average in OECD and 4.8 per cent in China in 2008 among many others (see, for example, OECD; 2009).

[2]Due to the the sharp contraction in global economic activity since 2008, recent work has primarily focussed on the output implications of fiscal policy and thus on the size of fiscal multipliers identifying a wide range of values: varying from 1.6 (Romer and Bernstein; 2009) to much smaller figures that are close to zero (Cogan et al.; 2010).

[3]To the best of our knowledge there are two exceptions to this: Drautzburg and Uhlig (2011) and McManus (2012). The former finds that the specific policy of the American Recovery and Reinvestment Act was detrimental to all agents over the lifetime of the policy unless the future is discounted at unfeasibly high rates. Positive impacts of the policy are the main focus of the paper, however, and the normative impacts are not fully considered. The latter finds that counter-cyclical policy, especially those targeting government spending, is to the benefit of credit-constrained agents and the detriment to the unconstrained. However, in contrast to our paper, the latter excludes many empirically relevant instruments within the framework of a smaller model.

present empirical evidence suggesting that periods of fiscal consolidation are associated with increases in income inequality. Moreover, Granados (2005) find that the composition of consolidations play a key role on their consequences for income inequality. Indeed, Woo et al. (2013) show that spending-based consolidations tend to worsen inequality more significantly, as compared with tax-based consolidations.

This paper explores both the aggregate and distributional impact of fiscal austerity by utilizing a dynamic stochastic general equilibrium model (DSGE) with real and nominal frictions. To that end, our framework incorporates heterogeneity of agents regarding access to credit into a medium scale New Keynesian DSGE model. Ricardian consumers own the entire capital stock of the economy and possess access to the financial markets, that are assumed to be complete. Non-Ricardian households, on the other hand, simply consume their total disposable income arising from labour and transfers. Firms produce differentiated goods, choose labour and capital inputs and set prices similar to the method proposed by Calvo (1983). The monetary authority sets the nominal interest rate according to a Taylor rule. The fiscal authority has a set of policy instruments at its disposal with which to respond to the cyclical changes in debt.

This paper makes two distinct contributions. The first is to combine a comprehensive examination of the distributive consequences of fiscal austerity, which has received very little attention in the existing literature, with one which focuses on other macroeconomic outcomes. Our distributional analysis has two dimensions: welfare and income distribution. We examine the normative implications of different fiscal packages for both types of households, and as such shed light on the ranking of policies based on the relative well-being of different groups. We also examine the changes in the relative incomes of the two types of agents, which allows us to relate our results to the existing empirical findings on the income distribution implications of fiscal consolidations. Our second contribution lies in the scope of our fiscal policy analysis; we examine a much richer set of fiscal instruments than has been provided in the existing literature on fiscal consolidations.[4]

[4]One exception is Coenen et al. (2013) who extend the ECB's New Area-Wide Model to include a wide variety of fiscal instruments.

In addition to public consumption, public investment, income and lump-sum taxes that are widely explored in previous work, we incorporate capital taxes, consumption taxes, social security contributions as well as public employment as sources of fiscal adjustment packages. Our choice of this particular set of fiscal instruments is motivated by the actual composition of both the fiscal stimulus and fiscal consolidation packages since 2009.

Our findings can be summarized as follows. First, we find that both the aggregate and the distributional consequences of fiscal austerity are determined by its composition much more than its speed. Specifically, we show that the greater the share of tax-based adjustments, the greater the size of resulting output contraction. Second, the welfare consequences of fiscal consolidations are unevenly distributed among agents with more detrimental impacts on credit-constrained households than those with full access to credit markets. As opposed to its output effects, tax-based austerity leads to more favourable distributional consequences in the form of less skewed welfare and income outcomes. In contrast, spending-based fiscal adjustment tends to worsen income inequality. We also explore the implications of the zero lower bound (ZLB) on the welfare consequences of fiscal consolidations. We find that, inspite of their well-known favourable impact on the effectiveness of fiscal policy, the presence of ZLB doesn't alter the welfare ranking of credit constrained versus unconstrained consumers following fiscal austerity. However, we also show that the composition of consolidations gains more importance at ZLB. Overall, a trade-off emerges between normative equity and positive efficiency effects of fiscal consolidations; spending cuts increase inequality while tax increases generate greater aggregate fluctuations, posing a serious challenge for policymakers in designing appropriate fiscal adjustment programs.

The rest of the paper is organised as follows. Section 2 sets out the benchmark model. Both the positive and the distributive consequences of fiscal austerity are explored in Section 3. An analysis of international consolidation packages and an extension to the monetary zero lower bound are presented in Section 4. Finally, Section 5 provides conclusions and policy implications.

2 The Model

Our benchmark model shares many features with Smets and Wouters (2003), Christiano et al. (2005) and Bhattarai and Trzeciakiewicz (2012) featuring nominal rigidities in price and wage setting, real frictions in adjustment costs and monopolistic competition and distortionary taxation on labour, capital and consumption. The economy is populated by: a continuum of households indexed by h, a share, $(1-\theta)$, of which have access to capital markets (Ricardian households) and the remainder, θ, do not (non-Ricardian households); two types of firms (final good and intermediate good producing firms); and a fiscal and a monetary authority.

2.1 Households

The utility of each household evolves according to:

$$E_0 \sum_{t=0}^{\infty} \varepsilon_t^b \left(\beta^i\right)^t U \left(\ln\left(C_t^i(h)\right) - \frac{1}{1+\sigma_l} \left(L_t^i(h)\right)^{1+\sigma_l} \right) \tag{1}$$

where E_0 is the expectation operator, $\beta \in (0,1)$ is the discount factor, C_t denotes consumption, L_t denotes labour, σ_l denotes the inverse of the Frisch labour supply elasticity, and ε_t^b represents a first-order autoregressive exogenous shock process to preferences. Superscript i differentiates variables between Ricardian ($i = R$) and non-Ricardian ($i = NR$) households.

2.2 Ricardian Households

Each period Ricardian household, h, faces a budget constraint which states that the household's total expenditure on consumption, C_t^R, investment in physical capital, I_t, and accumulation of a portfolio of riskless one-period contingent claims, B_t, must equal the household's total disposable income:

$$
\begin{aligned}
(1+\tau_t^c)\, C_t^R(h) + I_t(h) + B_t(h) \;=\; & \left(1-\tau_t^l-\tau_t^{ee}\right) w_t\,(h)\, L_t^R\,(h) + div_t\,(h) \\
& + \left[\left(1-\tau_t^k\right) r_{k,t} u_t\,(h) - a(u_t\,(h))\right] \bar{K}_{t-1}\,(h) \\
& + \frac{(1+i_{t-1})B_{t-1}(h)}{\pi_t} + T_t\,(h)
\end{aligned} \tag{2}
$$

where superscript R is used for the Ricardian household, τ_t^c denotes a consumption tax, τ_t^l labour income tax, τ_t^{ee} an employee social security tax, w_t the real wage; div_t dividends paid out of firms profits; τ_t^k capital tax, $r_{k,t}$ the real return on capital services, u_t the capital utilisation rate where the cost of capital utilization is given by $a(u_t)\bar{K}_{t-1}$, $\bar{K}_{t-1}$ the stock of physical capital; i_{t-1} the net nominal interest rate on one-period bonds, π_t the gross inflation rate, and T_t represents a lump sum transfer.[5] Following Christiano *et al.* (2005), we assume complete markets for the state contingent claims in consumption and capital but not in labour. This assumption implies that consumption and capital holdings are the same across households: consequently, $C_t^R(h) = C_t^R$, $K_t^R(h) = K_t$.

In line with most of the existing literature, we maintain that physical capital, $\bar{K}_t$, accumulates in accordance with:

$$
\bar{K}_t = (1-\delta_k)\bar{K}_{t-1} + \left[1 - S\left(\varepsilon_t^i \frac{I_t}{I_{t-1}}\right)\right] I_t \tag{3}
$$

where we follow Schmitt-Grohe and Uribe (2006) and define the cost of investment adjustment function as $S\,(I_t/I_{t-1}) = [(\phi_k/2)(I_t/I_{t-1}-1)^2]$ and ε_t^i is an investment specific first-order autoregressive shock process.[6] Each Ricardian household maximises utility (1) subject to the flow budget constraint (2), the capital accumulation function (3), and the labour demand from the labour unions $L_t(h)$, set out below.

[5] In the steady state there is no unused capital such that $u = 1$.

[6] The adjustment cost function possesses the following properties: $S\,(1) = S'\,(1) = 0$, and $S''\,(1) = \phi_k > 0$: as a result the steady state does not depend on parameter ϕ_k.

2.3 Non-Ricardian households

As discussed above, non-Ricardian households are credit constrained agents who simply consume current after-tax income which comprises of after-tax labour income and transfers.[7] This behaviour can be rationalised in a setting where non-Ricardian households are more impatient than Ricardian households, $\beta^R > \beta^{NR}$, and can default on their debt up to the value of their collateral (see, for example, Iacoviello; 2005). With no durable goods in the non-Ricardian utility function, impatience prohibits the accumulation of collateral and as such non-Ricardians are prevented from engaging in bond and capital markets.[8] The budget constraint of non-Ricardian households is therefore:

$$(1+\tau_t^c)\, C_t^{NR} = \left(1-\tau_t^l-\tau_t^{ee}\right) w_t L_t^{NR} + T_t \tag{4}$$

where C^{NR} and L_t^{NR} denote consumption and employment of non-Ricardian households and all other variables are as defined earlier.[9]

2.3.1 Wage-setting behaviour

As in Erceg et al. (2000), we consider a competitive labour union that transforms households' differentiated labour ($L_t(h)$) into composite labour (L_t), using a CES technology, which is subsequently supplied to private intermediate firms and the public sector. The union takes each household's nominal wage, $W_t(h)$, as given. Profit maximisation of this labour union results in standard demand functions for differentiated labour and a zero profit condition results in a standard wage index. Nominal wages are set in a staggered-price mechanism as in Calvo (1983), where every period, each Ricardian household faces a probability $(1-\varpi_w)$ of being able to adjust the nominal wage. The household then

[7] In what follows the terms 'non-Ricardian', 'rule-of-thumb' and 'credit constrained' are used interchangeably.

[8] Existing literature provides two sources of motivation for introducing rule-of-thumb consumers: first is the lack of evidence for consumption smoothing in the face of income fluctuations (see, for example, Campbell and Mankiw; 1989); and second, the observation that an important fraction of households have near-zero net worth (see, for example, Wolff; 1998; Mankiw; 2000).

[9] With the labour market assumption as set out below, non-Ricardian income and subsequently consumption is homogeneous: $C_t^{NR} = C_t^{NR}(h)$.

sets nominal wages to maximize expected future utility subject to labour demand from firms. Those who cannot reoptimize set wages in accordance with the indexation rule, $W_t = \pi_t^{\gamma_w} W_{t-1}$, where $\gamma_w \in \langle 0, 1 \rangle$ is a parameter that measures the degree of wage indexation.

Following Erceg et al. (2005), we assume that each non-Ricardian household sets its wage equal to the average wage of optimising households. Given that all households face the same labour demand, the labour supply and total labour income of each rule of thumb household are equal to the average labour supply and the average labour income of forward-looking households.

2.4 Production

A competitive final good producer purchases differentiated goods from intermediate producers ($Y_{j,t}^P$) and combines them into a single consumption good (Y_t^P) using a standard CES technology. Profit maximisation of these firms yields standard demand functions for intermediate goods and a zero profit condition results in the standard price index.

The intermediate good production sector is populated by monopolistic firms indexed by j that use the following production function:

$$Y_{j,t}^P = \varepsilon_t^a \left(K_{j,t-1}\right)^{\alpha} \left(L_{j,t}^P\right)^{1-\alpha} \left(K_{j,t-1}^G\right)^{\alpha_G} - \Phi \tag{5}$$

where K_G denotes public capital, Φ represents a fixed cost of production, and ε_t^a represents total factor productivity shock that follows a first-order autoregressive process. Firms rent capital services $K_{j,t-1}$, and incur a cost of labour equal to $(1 + \tau_t^{er}) W_t$ where τ_t^{er} denotes employers social security contributions. As is standard in the new-Keynesian framework, intermediate-good sector firms face three constraints: the production function, a demand constraint, and price rigidity determined by a Calvo (1983) mechanism. Each firm acts to minimise its total costs, $(1+\tau_t^{er})W_t L_{j,t}^P + R_{k,t} K_{j,t-1}$, subject to the production function (5). Intermediate goods producers act as price setters where each period a given firm

faces a constant probability, $(1-\varpi)$, of being able to reoptimise its nominal price. Those who can, maximize expected future profits at these prices. Those who cannot reoptimise set prices subject to an indexing rule, $P_{j,t} = \pi_t^{\gamma_p} P_{j,t-1}$, where $\gamma_p \in \langle 1, 0 \rangle$.

2.5 Macroeconomic policy

The government budget constraint requires that total expenditure on government consumption, G_t, public investment, I_t^G, and public employment, L_t^G be paid through either taxes or transactions in the bond market:

$$\begin{aligned} G_t + I_t^G + (1+\tau_t^{er})\, w_t L_t^G &= \left(B_t(1+\eta_{B,t}) - \frac{(1+i_{t-1})B_{t-1}}{\pi_t} \right) + \tau_t^c C_t + T_t \\ &\quad + \left(\tau_t^l + \tau_t^{ee} + \tau_t^{er}\right) w_t L_t + \tau_t^k r_{k,t} u_t K_{t-1} \end{aligned} \tag{6}$$

where $\eta_{B,t}$ represents an i.i.d. exogenous shock to government borrowing, which can either represent a change in spending, tax revenue, or borrowing conditions, exogenous to the model. This, for example, could take the form of an exogenous rise in spending (e.g. a bank bail out) or a revenue windfall.

Public capital accumulates according to:

$$K_t^G = (1-\delta_k^G) K_{t-1}^G + I_t^G \tag{7}$$

which is equivalent to the accumulation of private capital in (3) but without cost to adjustment and where δ_k^G represents depreciation specific to public capital.

We assume that the nine fiscal instruments in steady state ensure a non-increasing level of debt and out of steady state instruments respond to maintain the solvency condition of the government:[10]

[10]Note that labour income taxes and employees social security contributions enter the model in the same way hence we drop the latter in our simulations and focus on the former.

$$\frac{X_t}{X} = \left(\frac{B_{t-1}}{B}\right)^{\phi_{B,x}} \tag{8}$$

where $X = \left\{\tau^c, \tau^k, \tau^l, \tau^{er}, \tau^{ee}, G, I^G, L^G, T\right\}$, where variables with no time subscript represent relevant steady state values, and where $\phi_{B,x}$ denotes the speed of adjustment. Fiscal instruments only respond to changes in debt and therefore a positive shock to debt initiates fiscal consolidation: a fall in spending instruments and a rise in tax instruments.

As standard in the literature, the monetary authority sets nominal interest rates (R_t) by following a Taylor rule which responds to both output and inflation with some persistence (ρ):

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho} \left[\left(\frac{\pi_t}{\pi}\right)^{\rho_\pi} \left(\frac{Y_t}{Y}\right)^{\rho_y}\right]^{1-\rho} \eta_{R,t} \tag{9}$$

where ρ is the interest rate smoothing parameter, ρ_π and ρ_y denote, respectively, the policy maker's aversion for the deviations of inflation, and output from their relevant steady-state values and $\eta_{R,t}$ represents an i.i.d. shock to the nominal interest rate. All other variables are as defined earlier.

2.6 Market clearing

Total output is the sum of private and public sector output where the equilibrium conditions are given by:

$$Y_t = C_t + G_t + I_t + I_t^G + a(u_t)\bar{K}_{t-1} - (1 + \tau_t^{er})\, w_t L_t^G \tag{10}$$

$$L_t = L_t^P + L_t^G \tag{11}$$

where C_t and L_t denote total consumption and employment which are given by the weighted averages of the consumption and employment of Ricardian and non-Ricardian households. Similarly, the market for capital and bonds are in equilibrium when demand

equals supply.[11]

3 Implications of fiscal austerity

To explore the aggregate and the distributional consequences of fiscal consolidation, we consider a situation where there is a positive shock to government debt ($\eta_{B,t}$) such that debt is exogenously accumulated.[12] We then examine a number of fiscal scenarios corresponding to different fiscal adjustment packages designed towards paying off the additional debt created by this positive debt shock. The reason for making debt repayment as the basis of our fiscal scenarios is the observation that stabilizing debt to GDP ratios has been an important objective of most fiscal consolidation packages since 2010.

Our fiscal consolidation scenarios vary across two dimensions: the composition of fiscal adjustment and the speed of debt repayment. Regarding the composition, we consider two alternative sets of policies. In the first, the burden of debt repayment is shared equally among all fiscal instruments. This takes the form of reductions in all expenditure items (public consumption, public investment, public employment and transfers) and increases in all tax instruments (consumption tax, capital tax, labour income tax and employer social security contributions): in what follows, we refer to this policy as 'all-instruments' fiscal consolidation. Second, we examine fiscal adjustment through either only cutting expenditure or only raising taxes, one at a time. Regarding the speed, for all fiscal scenarios we consider the impact of austerity over a range speeds associated with each consolidation, controlled for by the 'debt aversion' parameters ($\phi_{B,x}$).[13]

[11] The non-stochastic steady state of the model is solved, and the perturbation method in Dynare is used to apply a second-order approximation of the model. The stochastic simulations are also computed using Dynare.

[12] If we were to employ any of the microfounded shock processes to generate debt in the economy, the results would be similar to those from shocking $\eta_{B,t}$, once we removed the effects of the initial shock and only concentrated on repaying the debt.

[13] In order to quantify this speed we present the 'half-life' of consolidation which represents the time (in quarters) for the packages to halve the level of new debt as a result of the shock.

3.1 Calibration and welfare calculation

We follow a calibration procedure in line with the existing literature with common parameters fixed in a standard way, as is listed in Table 1. Steady state tax rates on consumption, capital, labour income and employee and employer social security contributions (τ^c, τ^k, τ^l, τ^{ee} and τ^{er}) are set at 0.2, 0.4, 0.18, 0.05 and 0.07 respectively and the level of government debt in steady state is set at 60 per cent of output. We select a lower value of the depreciation of public capital compared to private capital with $\delta_k^G = 0.02$, and we fix the share of public employment in total employment at 0.15. The elasticity of public capital in the production function, σ_G, is set at 0.02 which is slightly higher than the value calibrated by Straub and Tchakarov (2007) for the US and the euro area. We fix the share of public investment in GDP at 0.02, whereas the share of public consumption at 0.1. This calibration implies the ratio of private investment to GDP is 0.11 whereas private consumption to GDP is 0.65. Finally, the share of non-Ricardian consumers is set equal to 0.3, in line with those in the existing literature.

Our welfare calculations are performed by deriving a welfare criterion based on a second order Taylor series expansion of the utility function around the non-stochastic 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. The resulting expression for welfare is of the following form:

$$\begin{aligned} W^i &= E_0 \sum_{t=0}^{\infty} \beta^t \left(c_t^i + \frac{1-\sigma_c}{2} \left(c_t^i\right)^2 \right) \\ &\quad - \frac{1-\alpha}{1+\tau^{er}} \frac{1}{\mu^w} \frac{1-\tau^l-\tau^{ee}}{1+\tau^c} \frac{Y}{C^i} E_0 \sum_{t=0}^{\infty} \beta^t \left(n_t^i + \frac{1+\sigma_l}{2} \left(n_t^i\right)^2 \right) \end{aligned} \tag{12}$$

where i denotes the type of the consumer. In (12) lowercase variables represent log-deviations of their uppercase counterparts and $\mu^w = \nu/(\nu-1)$, where ν is the elasticity

Table 1: Calibration

Share/parameter	Description	Value
Expenditure shares		
C/Y	Private consumption to GDP	0.65
G/Y	Public consumption to GDP	0.1
I/Y	Private investment to GDP	0.11
I^G/Y	Public investment to GDP	0.02
Preferences		
β^R	Discount factor Ricardian	0.99
β^{NR}	Discount factor non-Ricardian	0.973
σ_l	Inverse Frisch elasticity	2
θ	Share of non-Ricardian households	0.3
Technology		
δ_k	Depreciation rate: private capital	0.025
δ_k^G	Depreciation rate: public capital	0.02
α	Share of capital in production	0.31
ϕ_k	Investment adjustment cost parameter	5
κ	Capital utilisation adjustment parameter	0.6
ϖ	Stickiness in prices	0.75
ϖ_W	Stickiness in wages	0.5
γ_p	Price indexation	0.15
γ_w	Wage indexation	0.15
s	Elasticity of substitution in consumption	6
ν	Elasticity of substitution in labour	6
Φ	Fixed costs in production	0.15
Monetary policy		
ρ	Monetary policy persistence	0.8
ρ_π	Inflation Taylor rule weight	1.5
ρ_y	Output Taylor rule weight	0.125
Fiscal policy		
τ^c	Steady state consumption tax	0.2
τ^k	Steady state capital tax	0.4
τ^l	Steady state labour income tax	0.18
τ^{ee}	Steady state employee social security tax	0.05
τ^{er}	Steady state employer social security tax	0.07
b/Y	Government debt to annual GDP	0.6
α_G	Elasticity of public capital in production	0.02
wL^G/Y	Share of public to total employment	0.15

of labour among the differentiated labour inputs. This criterion provides disaggregate calculations for each set of households in the economy.

3.2 Fiscal adjustment and macroeconomic outcomes

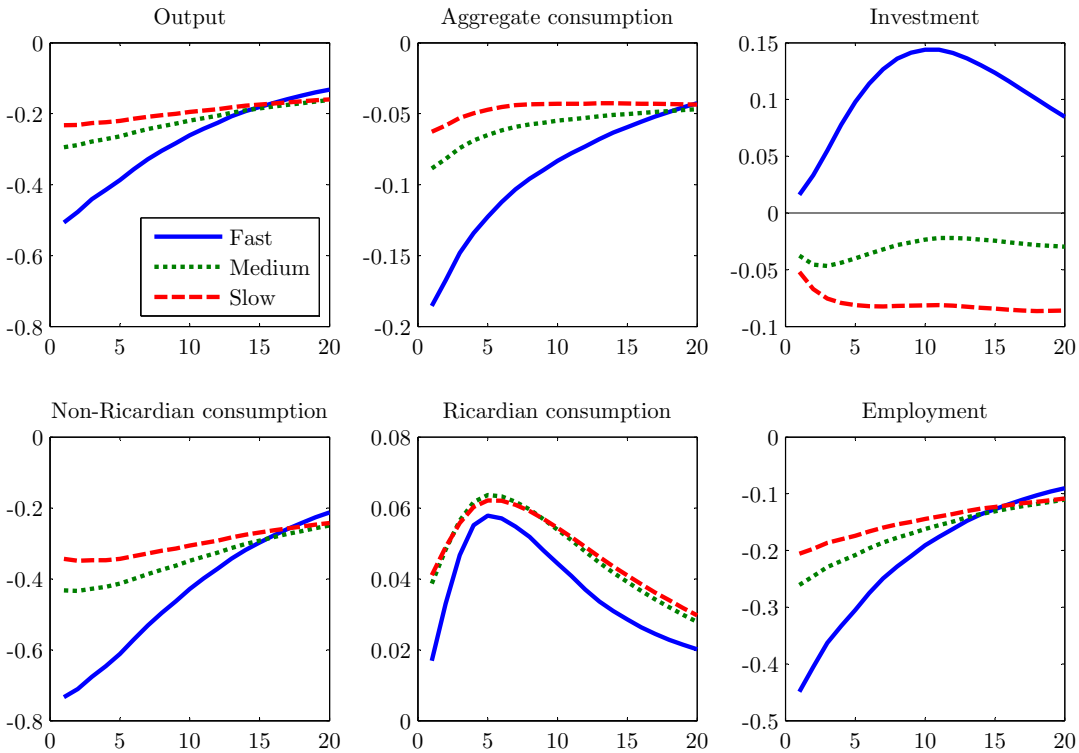
Figure 1 illustrates the economy's response to a 3 per cent rise in the debt-to-GDP ratio where all fiscal instruments contribute equally towards the resulting debt repayment.[14] Consolidations have a negative effect on output, arising from both lower private demand (due to lower incomes and higher taxes) and lower government demand (as part of the austerity package). The magnitude of the fall in output as well as the profile of recovery vary with the speed of adjustment; both output and employment are initially lowest with fastest fiscal adjustment. However, although short sharp episodes have the biggest initial impact on GDP in the short run, they also mean that over the medium run output can converge back to normal levels quicker.

Consolidations also reduce aggregate consumption, but by less than output since the cuts in government spending elicit some crowding-in of both consumption and investment. This small reduction in aggregate consumption, however, hides a disparity across households where non-Ricardian consumption falls and Ricardian consumption rises. This is because Ricardian agents can smooth their consumption whereas non-Ricardian households are fully exposed to the fall in labour demand and, thus, in wages. Moreover, lower interest rates and lower government spending further contribute to increasing Ricardian consumption.

Figure 1 also portrays an interesting investment profile. There are two channels through which fiscal adjustment impacts on investment: through its effect on interest rates and through its effect on the return on capital (net of capital taxes). A fiscal consolidation leads to a fall in interest rates leading to a rise in interest-sensitive investment. On the other hand, fiscal adjustment also raises capital taxes leading to a fall in net

[14] This size of debt shock is in line with the scale of fiscal stimulus packages put in place in 2009 which had be paid for subsequently: the OECD average stood at 3.3 per cent of GDP.

Figure 1: Dynamics - all instruments



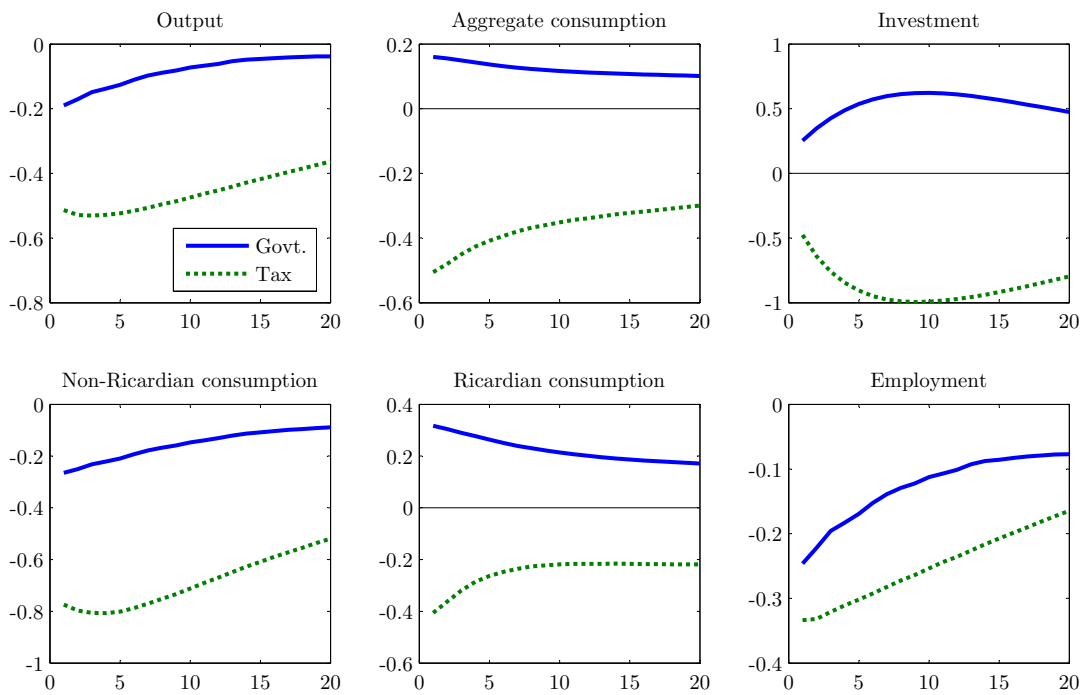
Note: Dynamics are achieved through shocking debt by 3% of its steady state level: x-axis represents time in quarter, and y-axis represents percentage deviations from steady state. Half-life of debt represents the time for debt to be reduced by 50%; under 'Fast' this is 10 quarters, 'Medium' 20 quarters, and 'Slow' 40 quarters.

return to capital, reducing incentives to invest. The higher the pace of consolidation, the greater the likelihood of the first effect dominating the second, due to the fact that the faster the pace of fiscal adjustment, the sharper the response of the monetary authority.

The composition of adjustment We now turn to an analysis of spending versus tax-based fiscal adjustments where the outstanding debt is repaid only through reducing government spending in the former and only through tax increases in the latter. Macroeconomic outcomes under the two types of consolidation programs are displayed in Figure 2.

It is clear that tax-based consolidations lead to sharper responses compared with spending-based ones in all variables, with the greatest fall in non-Ricardian consump-

Figure 2: Dynamics - government spending instruments versus tax instruments



Note: Dynamics are achieved through shocking debt by 3% of its steady state level: x-axis represents time in quarters, and y-axis represents percentage deviations from steady state. For both experiments the half-life of debt is calibrated to 20 quarters.

tion. Two other features are evident from Figure 2. First, Ricardian consumption rises in the wake of spending-based consolidations in contrast to tax-based austerity where the opposite is the case. This is due to the crowding in of Ricardian consumption in response to a cut in government spending, which in turn drives the movement in aggregate consumption. Second, private investment also rises following spending cuts, as opposed to following tax increases. This is because tax-based consolidations raise the marginal cost of production through increases in both capital and labour taxes, while spending cuts bring about lower real interest rates.

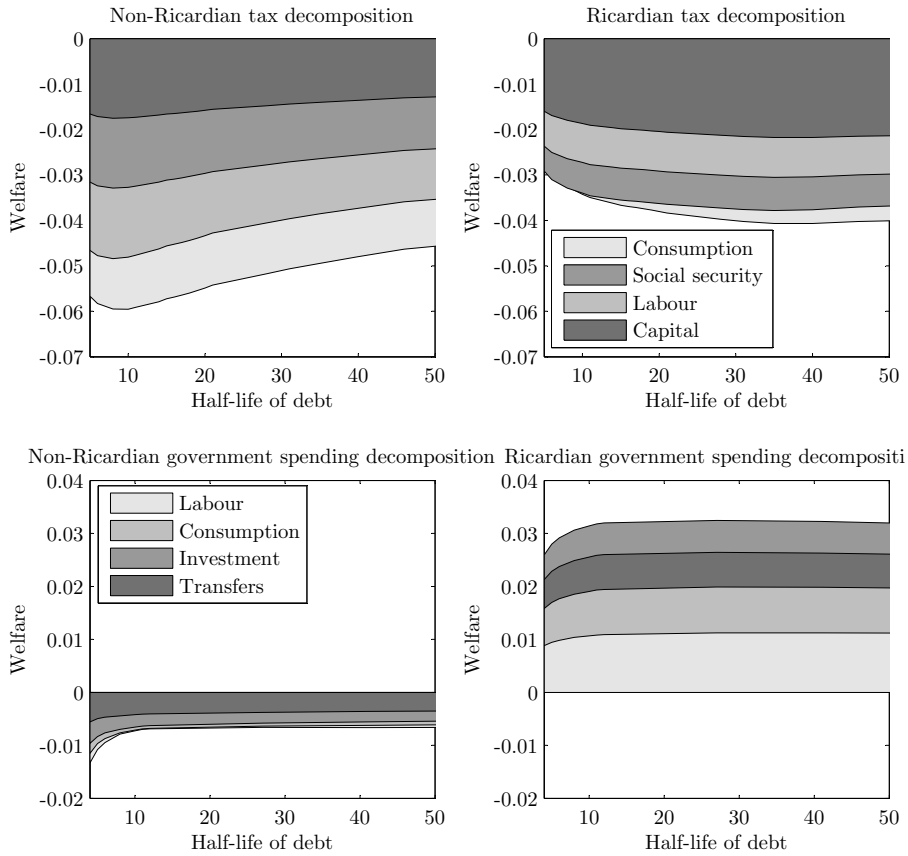
Overall, tax-based fiscal adjustment produces lower output (combining both lower consumption and lower investment) and lower employment than spending-based adjustment programs. Existing empirical work on fiscal adjustment programs indicates that this has indeed been the profile of the macroeconomic responses to fiscal adjustment programs

in practice (see, for example, Agnello et al.; 2012; IMF; 2012; Woo et al.; 2013).

3.3 Fiscal austerity and welfare

We now turn to the welfare implications of fiscal consolidations. Figure 3 plots the welfare of the two types of households against the speed of fiscal adjustment for the two consolidation packages focusing on just tax and just spending instruments, respectively.

Figure 3: Welfare effects



Note: Welfare results are expressed as the equivalent of one-period of steady state consumption that would leave the agent indifferent between living through the shock or forgoing the one period loss. The bottom line represents the aggregate impact where shaded areas represent the decomposition of this aggregate into component fiscal instruments. The top row represents welfare from just using tax instruments and the bottom row just from spending instruments; the left column depicts results for non-Ricardian households and the right column for Ricardian households.

In Figure 3, the bottom line represents the aggregate impact where shaded areas represent the composition of this aggregate in individual fiscal instruments that are com-

ponents of the fiscal package in each case. As is seen from the first column in Figure 3, austerity reduces non-Ricardian welfare in all cases and the scale of this reduction is greater the quicker the speed of consolidation. This is due to the fact that non-Ricardian agents are exposed to austerity through their dependence on the overall health of the economy through wages and employment, both of which decline in response to austerity. Moreover, higher labour and consumption taxes and lower transfers (under the tax-based fiscal adjustments) decrease the disposable income and subsequently the consumption of the credit-constrained agents.

As is also seen from the bottom right pane of Figure 3, in contrast, spending-based consolidations result in Ricardian consumers being better off, irrespective of the speed of adjustment, due to both higher levels of consumption and lower levels of employment. Consumption is improved following the reductions in interest rates and government spending. Households in the model are assumed not to gain utility from government consumption and public employment and reductions of these, from the perspective of Ricardian agents, leads to welfare improvements as they can crowd in private consumption and investment. Both consumers are worse off under tax-based consolidations, though Ricardian welfare dominates that of non-Ricardians unless debt is repaid over long time horizons. Ricardian agents do not directly respond to movements in transfers and are therefore less affected by cuts in these than their non-Ricardian neighbours. Overall, the welfare consequences are unevenly shared by the two types of agents; austerity tends to harm non-Ricardian households more than the Ricardian households.

An interesting question related to the welfare implications of spending and tax-based austerity is whether the welfare outcomes vary significantly between adjustments based on individual instruments. Figure 3 also presents a decomposition of total welfare implications of austerity, highlighting the contribution made by each fiscal instrument. The worst case scenario for both households is fiscal adjustment by increases in capital taxes, resulting in the lowest welfare for each household as it both reduces incomes in the short run, and impacts on the productive capacity of the economy over the medium term.

However, it must also be noted that rises in capital taxes exert a bigger impact on Ricardian households who directly pay this tax. For similar reasons, increases in labour taxes have large negative normative consequences for non-Ricardian households for whom a rise directly reduces disposable income. In contrast, austerity through cuts in government consumption and government employment produces the two best welfare outcomes. Figure 3 once again confirms that austerity always harms the constrained households while the unconstrained are either better off (under spending-based adjustment) or less worse off than the constrained household (under the tax-based adjustment).

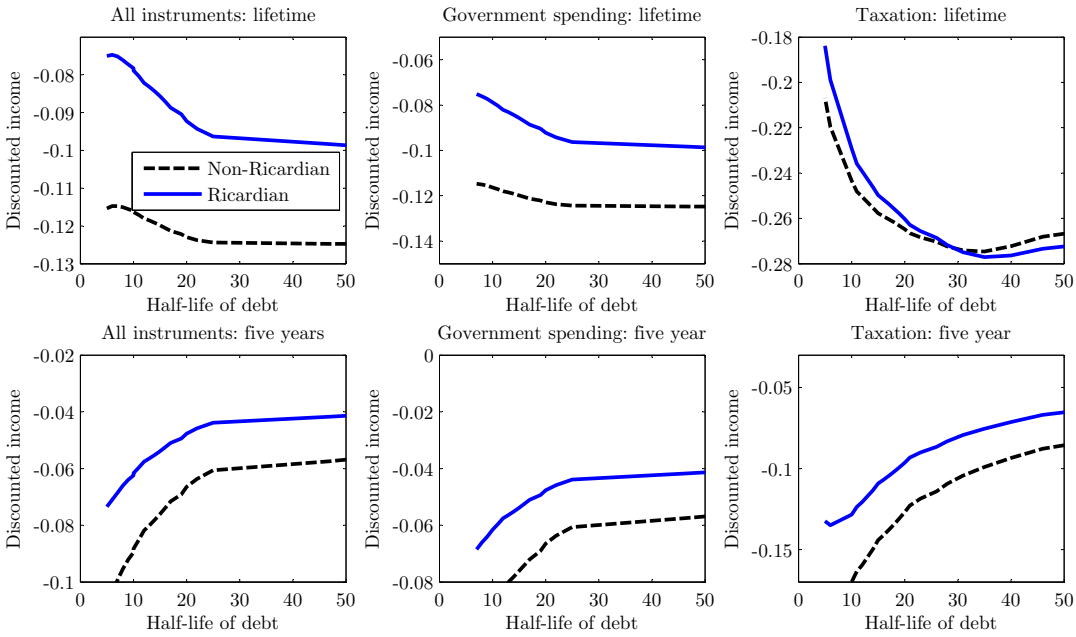
3.4 Fiscal austerity and income distribution

An important aspect of distributional outcomes arising from fiscal policy changes is related to their implications for income distribution. This is important for two reasons. First, as is widely recognized, income distribution plays a key role in political and economic stability and thus has a wider significance (see, for example, Alesina and Perotti; 1996). Second, income distribution outcomes are more easily measurable than welfare ones, which enables us to put our results in perspective in light of the existing empirical findings on the income distribution implications of fiscal adjustment programs.

Figure 4 presents discounted incomes of both households in the face of all three types of fiscal consolidation packages. The top row considers income movements over the whole lifetime of the experiment, whereas the bottom row considers a shorter five year horizon. Clearly, non-Ricardian income is most exposed to austerity both in the short and long term, leading to a widening of inequality in the economy. The second and third columns of Figure 4 confirms the welfare results presented in Figure 3; spending-based consolidations tend to worsen income inequality more than tax based-ones, a finding supported by recent empirical evidence (see, for example, Woo et al.; 2013). However, it has also been shown that tax-based fiscal adjustments are less likely to be longer-lasting than those based on spending ones (see, for example, Alesina and Perotti; 1996). Our findings point to a source of such reduced longevity for tax based adjustment programs; they do not only

reduce the welfare of both types of households, they also bring about greater aggregate fluctuations.

Figure 4: Income effects



Note: Discounted income effects under consolidation packages using 'all instruments', just 'Government spending' instruments' and 'Taxation' instruments, calculated over the whole lifetime of the experiment (the top row), and over the first five years of the experiment (the bottom row): future periods are discounted by relative discount factors.

4 Further extensions

4.1 International consolidation packages

The above results consider the aggregate and distributional impact of fiscal consolidations in a range of benchmark calibrations. In order to obtain a direct perspective on the austerity measures implemented in recent times, we simulate our model using actual composition of fiscal packages based on international data (IMF; 2013, 2014), as summarised in Table 2.[15]

[15]Specifically, we obtain information on the size of fiscal adjustments between 2009 and 2013 from both revenue and expenditure measures from IMF Fiscal Monitor (2013: Figure 2) and combine this

Table 2: International consolidation data

	Debt to GDP			Proportions	
	2007	2013	Consolidation	Revenue	Expenditure
GRC	95.6	173.8	17.8	26%	74%
IRL	24.9	122.8	7.6	9%	91%
PRT	63.6	128.8	7.4	48%	52%
ESP	36.1	93.9	6.9	38%	62%
GBR	44.1	90.1	6.2	40%	60%
NLD	45.5	74.9	4.6	49%	51%
USA	62.1	104.5	4.3	61%	39%
FRA	35.2	93.9	3.0	124%	-24%
BEL	82.8	99.7	2.2	135%	-35%
AUT	59.5	74.2	1.0	65%	35%
DEU	65.0	78.1	0.9	-81%	181%

Note: 'Consolidation' represents the sum of both revenue and expenditure based fiscal adjustments, expressed as the proportion of potential GDP on cyclically adjusted data (obtained from IMF fiscal monitor); and 'Revenue' and 'Expenditure' represent the individual proportions of this overall consolidation figure.

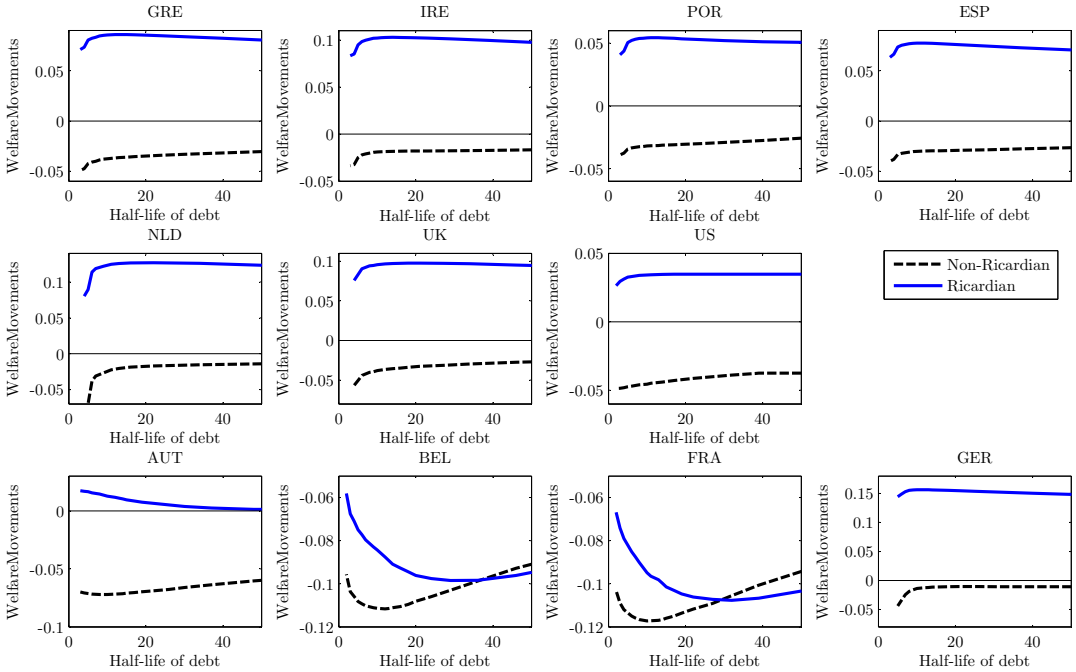
Comparing the debt to GDP ratios in 2007 to those in 2013 reveals that there were significant increases in indebtedness in most countries, where doubling of the debt ratio is observed in nearly half of the sample. The rise in debt ratios, in turn, required substantial fiscal adjustment, as large as 17.8 per cent of GDP in Greece, 7.6 per cent in Ireland and 7.4 per cent in Portugal. An interesting aspect of these consolidation packages has been the wide variation in their composition. Table 2 suggests that countries that have carried out substantial adjustment packages such as Greece, Ireland, Portugal and Spain carried out most of this adjustment through expenditure-based measures while those with smaller consolidation, with the notable exception of Germany, adopted mostly taxed-based adjustment.

We employ the same empirical composition of consolidation packages currently in place in each country and impose the same 3 per cent shock to steady-state government debt as above over a variety of speeds of repayment. Figure 5 groups the countries into

with data on individual spending measures (IMF; 2014, Figure 2.2) and tax measures (IMF; 2014, Table 9).

high consolidators (Greece, Ireland, Portugal and Spain), medium consolidators (UK, Netherlands and US), and low consolidators (France, Belgium, Austria and Germany) and presents predicted welfare movements, and Figure 6 presents the sum of discounted output (using β^R) from the model.

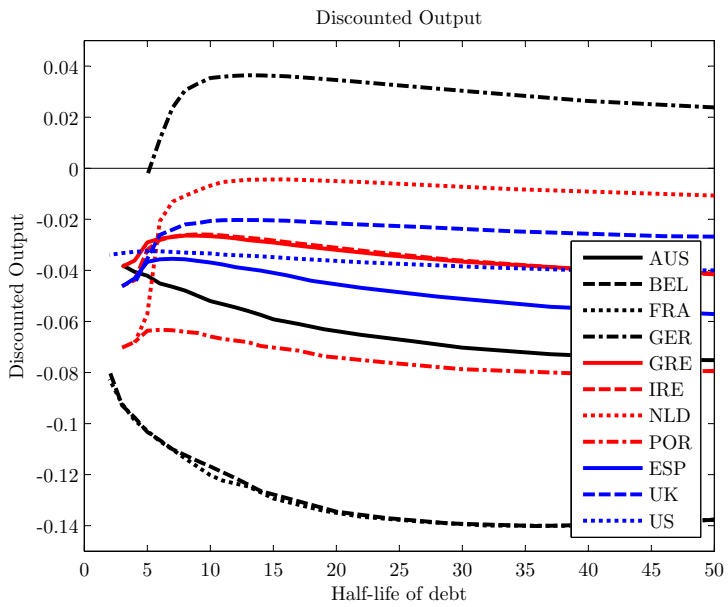
Figure 5: International comparison: welfare movements



Note: Results are obtained by utilizing IMF Fiscal Monitor data on the composition of current fiscal adjustment packages and assuming a similar composition for future consolidation, and through the same shock of 3% of steady state debt to aid comparisons. The calibration is as that of Table 1 but where the fiscal parameters are calibrated differently for the EU countries (where we use Coenen et al.; 2013), the UK (where we use Bhattarai and Trzeciakiewicz; 2012) and the US (where we use Leeper et al.; 2010).

Figures 5 and 6 enables us to make a number of observations. First, the composition of consolidation is of far more importance to its positive results, compared to with the speed of consolidation. In line with our earlier results, those policies which target government expenditure have the lowest impact on output, and as in the case of Germany, spending cuts to finance some tax cuts can have a beneficial impact to output. Similarly, Figure 5 reveals that the composition of consolidation is also of much more importance to its distributive outcomes than its speed; specifically, consolidations which focus on tax

Figure 6: International comparison: discounted output



Note: Results are obtained by utilizing IMF Fiscal Monitor data on the composition of current fiscal adjustment packages and assuming a similar composition for future consolidation, and through the same shock of 3% of steady state debt to aid comparisons. The calibration is as that of Table 1 but where the fiscal parameters are calibrated differently for the EU countries (where we use Coenen et al.; 2013), the UK (where we use Bhattarai and Trzeciakiewicz; 2012) and the US (where we use Leeper et al.; 2010).

revenues as opposed to spending cuts have the most equitable normative effects, as is seen above, and is supported by cross-country simulated evidence. For example, in countries where fiscal adjustment is carried out mostly through expenditure related measures, as was the case in high consolidation countries (the top row), the outcome is the substantial gap in the welfare of the constrained and unconstrained households. This gap is clearly smaller in low consolidation countries such as Austria, Belgium and France who mostly utilized tax-based instruments. France is the best example of this with the only consolidation package where non-Ricardian welfare can dominate Ricardian welfare (beyond 30 quarters for the half-life of debt).

Interestingly, the greatest gap between the welfare of the constrained and the unconstrained households is in Germany who have enacted cuts to transfers, government consumption and government employment to pay for cuts in income taxes and social

security contributions and increased public investment. Germany's composition also has a positive impact on output, the only one to do so.

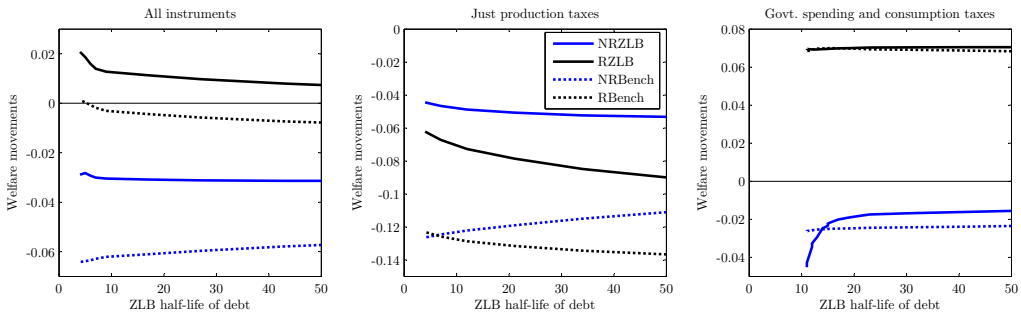
Overall, the trade-off between equity and positive efficiency of fiscal adjustment programs found above is maintained. Whereas spending-based consolidations can lead to lower overall effects with respect to output, incomes and welfare, tax-based austerity is associated with more equality of sacrifice whereby all agents lose more, but do so together. Although non-Ricardian agents tend to lose less in absolute terms with spending based programmes than in tax-based ones, the relative welfare considerations carry great significance in practice. This is illustrated by the political consequences of austerity over recent years, especially in the high consolidation countries, those which rely more on cuts in spending; all three countries Greece, Spain and Portugal have witnessed greatest anti-austerity protests observed across Europe following the adoption of fiscal consolidation.

4.2 Austerity at the zero lower bound

A key distinguishing feature of the recent recession, for which it 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 contractionary impact of higher interest rates associated with higher levels of output are removed: see, for example, Eggertsson (2011), Christiano et al. (2011) and Hall (2011). An interesting question is whether the presence of the zero lower bound (ZLB) has any impact on the welfare consequences of fiscal consolidation.

Figure 7 presents the welfare movements in three fiscal scenarios: where all fiscal instruments are used; when only the three production taxes (labour, capital and employer social security) are used; and when all government spending instruments are used, as well as consumption taxes. As is clear in Figure 7, the ZLB doesn't alter the welfare outcomes to a strong degree. However, at the monetary ZLB the composition of consolidation becomes more important: if austerity is executed through increases in production taxes then one can have a more fruitful consolidation as these rises have an expansionary

Figure 7: Welfare effects at the zero lower bound



Note: Welfare results are expressed as the equivalent of one-period of steady state consumption that would leave the agent indifferent between living through the shock or forgoing the one period loss. The three panes represent the three different experiments from using 'all instrument' from using only 'production taxes' (labour, capital and employer social security contribution) and from using all spending instruments and consumption taxes. 'NR' and 'R' in the legend represent results for non-Ricardian and Ricardian households respectively and 'Bench' represents benchmark results from when the monetary zero lower bound is not binding.

effect due to the inflationary pressures they provide the economy, thus lowering the real interest rate: this is a result highlighted in Eggertsson (2011). However, spending based consolidations, or those focussing on consumption taxes, are worse when conducted at the ZLB.

However, these results do hide a timing disparity, whereby during the period of the zero lower bound (which is what Europe, the UK and the US has been of late) the impact is heightened. Therefore, consolidations based on spending cuts and front loaded will be felt much worse. It is interesting to note that those high consolidating countries such as Greece, Ireland and Spain performed the significant majority of their austerity through spending cuts and in a front-loaded fashion. Over the whole period of consolidation, however, when the initial phase is averaged out, these effects look smaller.

4.3 Sensitivity analysis

We have simulated our model, both for the positive and normative implications, across a wide range of parameter values of wage and price stickiness, the proportion of credit-constrained consumers, Taylor rule parameters as well as the horizon of welfare calcula-

tions to better reflect the shorter political horizon. We find that varying these parameter values has a negligible qualitative and quantitative impact on the results (not reported).

5 Conclusions

This paper explored the aggregate and the distributional impact of fiscal austerity by utilizing a medium scale DSGE model with a rich set of fiscal instruments. We examine aggregate, welfare and the income distribution outcomes in different types of fiscal adjustment that vary with its composition and the speed of adjustment.

Our main results are as follows. First, we find that fiscal austerity gives rise to a variety of distributional outcomes, determined predominantly by the composition of fiscal adjustment. In almost all cases, austerity tends to harm credit constrained households more than those with full access to capital markets. We find that spending-based fiscal adjustment improves Ricardians' welfare while non-Ricardians lose out. In contrast, tax-based fiscal consolidations reduce welfare of both types of households but disproportionately more of non-Ricardians. In addition to making everyone worse off, tax based consolidations also bring about greater contractions in output and employment. These two aspects of tax-based consolidations versus spending-based ones may have important implications for the continuity of these programs. Indeed, existing empirical literature on fiscal adjustments presents evidence for tax based consolidations to be shorter lived than spending based ones.

We also examined the implications of the ZLB on the welfare consequences of fiscal consolidations. We find that, inspite of their well-known favourable impact on the effectiveness of fiscal policy, the presence of the ZLB doesn't alter the welfare ranking across different set of consumers following fiscal austerity. However, we also show that the composition of consolidations gains more importance at the ZLB. For example, we find that fiscal adjustment through capital taxes are less bad in welfare terms at ZLB, in contrast to adjustment through government spending or consumption taxes where the

opposite is true.

Overall, our findings also point to a clear trade off between the efficiency and the equity aspects of austerity. Policies that lead to greater aggregate fluctuations (tax-based) are also those that generate smaller inequality both in terms of welfare and income distribution. Given the severity of the recent downturn in most advanced economies that have adopted austerity, and the resulting preoccupation with GDP figures, this trade-off between growth and distributional consequences of fiscal consolidation is likely to pose serious challenges to policymakers in many countries.

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