Alternative Government Spending Rules: Effects on Income Inequality and Welfare*

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Abstract

This paper compares the effects of pro and counter-cyclical government spending on income inequality and welfare in a small open economy. We examine the consequences of alternative government spending rules following shocks to productivity, domestic interest rates, terms of trade and export demand. The simulated results show that welfare and income inequality indices can move in opposite directions for government spending rules with countercyclical spending improving welfare and pro-cyclical spending improving income equality.

Key words: cyclical fiscal policy, income inequality, economic welfare

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1 Introduction

The motivation for the paper comes from an empirical observation which appears, on the surface, to be counter–intuitive: the evidence of pro-cyclical fiscal behavior noted in a variety of studies (see Talvi and Végh (1996) for Latin America, Thornton (2008) for Africa, Lane (2003) for the OECD, and Ilzetski and Végh (2008) for developing countries).[1] One could perhaps rationalize the pro-cyclical behavior over the course of a normal cycle as follows: when economic times are good, citizens expect a dividend in terms of higher spending in the form of more and better entitlement programs and when times are bad, they understand the inevitable belt-tightening that must take place.[2] But, a stronger case can be made for counter-cyclical government spending behavior. Pro-cyclical government spending in the expansionary phase of the business cycle could exacerbate inflationary pressures, while pro-cyclical government spending policy during the contractionary phase of the business cycle could be welfare-reducing. In contrast, counter-cyclical fiscal behavior during boom (bust) times could serve as a stabilizing influence on the economy. Why then do we observe pro-cyclical fiscal behavior?

The aim of the paper is to examine whether a case can be made to support pro-cyclical fiscal policy, especially for small open economies. The decision to work with an open rather than closed economy model reflects the increasing importance of global shocks as well as domestic shocks[3] Our analysis assesses

[1] Lane found that cyclicality varies across spending categories and across the OECD. Both volatile output and dispersed political power are the likely causes of pro-cyclicality. During upturns, Lane and Tornell (1998) interpret the rise in government spending in response to a positive shock as the outcome of strategies of powerful lobbying groups.

[2] More politically motivated arguments have been suggested. For example, Alesina, Hausmann, Holmes and Stein (1999) note that pro-cyclicality of government spending is more accentuated in countries with weak budgetary institutions, while Eichengreen and Hausmann (1999) observe, in many countries, mechanisms have not evolved to constrain the strategic, politically motivated use of fiscal policy. In this vein, Battaglini and Coate (2007) explain pro-cyclical spending patterns as an implication of political constraints on "pork barrel" spending during recessions.

[3] In Talvi and Vegh (1996) an important role is played by access to international financial markets, which disappears in the wake of adverse shocks. Thus, sharp fiscal contractions become inevitable during downturns in either productivity or terms of trade. Also Thornton (2008) shows that government consumption is more pro-cyclical in those African countries that are more reliant on foreign aid inflows, and less pro-cyclical in

the implications of cyclical fiscal spending policy for the cases of domestic productivity and interest rate shocks as well as for the cases of external shocks coming from export demand and the terms of trade. We compare the effects of pro- and counter-cyclical government spending[4] on welfare as well as on income distribution.

The focus on income inequality is particularly important for fiscal policy, because changes in fiscal policy have distributional implications (see, for example, Heathcote (2005), Heathcote, Storesletten and Violante (2009) and Kumhof and Laxton (2009)). Like earlier studies, we examine the cyclicality of government spending, but unlike these studies we embed the dynamics of income distribution across agents into a standard dynamic stochastic general equilibrium (DSGE) aggregate open-economy model.[5]

We have two objectives, one methodological and one policy-oriented. The first objective is to expand the use of DSGE models. While DSGE models allows for heterogenous agents, monopolistic firms and capital accumulation, most applications work with a representative agent, single good and single firm and abstract from capital accumulation. One objective of the paper is to show that problems which require explicit modelling of heterogeneity can be made tractable by following the approach put forward by Correia (1999), García-Peñalosa and Turnovsky (2007) and Turnovsky and García-Peñalosa (2007) in their use of Gorman preferences. The second objective is to recognise that policies have welfare and distributional implications. While DSGE models are used to compare welfare, we show that DSGE models may also be used to understand distributional issues.

The advantage of this setup is that the fiscal policy is discussed in a more widely used type of macroeconomic model, namely one with Calvo

countries with unequal income distribution;

[4]We note that using the tax and transfer system would be a more transparent and efficient way to provide direct aid to specific sectors of an economy.

[5]With the exception of Tekin-Bouza and Turnovsky (2009), most of the discussion of income inquality in the macroeconomic context has been with closed-economy models. Their paper employs a two-sector model to examine the effects of foreign aid transfers on income inequality and they find that the effects of aid transfers on inequality depend crucially on how the aid is allocated across sectors as well as on the relative capital intensities of the two sectors. This paper is about the effect of a policy rule for spending, than than transfers, on income inequality and welfare.

pricing and inflation targeting. More importantly, the application extends the usefulness of DSGE models for policy analysis.

The key to the extension lies with the utility function. The benefits of pro-cyclical spending on welfare rest on the assumption that increases in government spending have positive effects on private consumption. Typically DSGE models do not yield this result. Rabanal and Salido (2006) have shown that either non-additively in utility, or non-Ricardian behavior, or both, are needed to deliver a positive response of government spending on consumption. However as Canova and Paustian (2010) note, models like that in Galí, López-Salido, Vallés (2007) with Ricardian and non-Ricardian (rule-of-thumb consumer) households and stickiness in prices or wages, require an "unrealistically large" (over 80 per cent) share of rule of thumb consumers to match empirical data dynamics.

In this paper we model heterogeneity in households, through the convenience of a utility function that satisfies the Gorman polar form. Instead of assuming two classes of households, Ricardian, and non-Ricardian consumers, our specification permits the modelling of a continuum of households. We assume that all households have, to a greater or less extent, limited participation in the financial sector: all make deposits in financial sector institutions, but they have very different initial holdings of wealth in the form of deposits and thus varying access to returns in the financial sector. The Gorman form allows for a distribution of heterogeneous households and avoids the need to prescribe the share of rule of thumb consumers. In short, our model yields results about the effects of cyclical fiscal spending on welfare as well as their effects on income equality within a consistent modelling framework.

The analysis in the paper offers two insights, which we state here. First, we find that counter cyclical government spending rule improves economic welfare by more than pro-cyclical fiscal spending, in the face of domestic or external shocks. Second, we find that pro-cyclical government spending reduces income inequality by more than counter-cyclical behavior across the range of shocks considered and for alternative labour intensities. In other words, we show that welfare and income inequality indices can move in opposite directions for government spending rules. Specifically, countercyclical fiscal spending rules improve welfare while pro-cyclical fiscal spending rules improves income equality. This suggest an important policy trade-off: governments which care more about income inequality relative to economic welfare are more likely to adopt pro-cyclical behaviour.

The paper is organized as follows. Section 2 describes the extension of a standard dynamic stochastic general equilibrium small open economy model to allow for heterogenous households with Gorman preferences. Since we explore the effects of fiscal policy under external export and terms of trade shocks, the model contains two production sectors - a tradeable goods sector which draws on natural resources and produces goods for domestic and foreign consumption, and a non-tradeable goods sector which imports intermediate goods and combines them with labour to produce goods for domestic private and public consumption. Prices in the tradeable goods sector are determined globally while prices in the non-tradeable goods sector follow typical Calvo-pricing rules. The model also includes a financial system which accepts deposits from households, borrows internationally, and lends to the government and to domestic firms. We thus combine financial frictions with nominal rigidities. This more extensive specification permits examination of domestic financial shocks as well as the usual shocks to exports, export productivity or terms of trade in the open-economy setting. Section 3 discusses the calibration. The model is solved using the first order[6] perturbation method (see Julliard, 1996).

Section 4 contains two sets of simulated results. The first subsection contains the impulse response paths of the aggregate variables, as well as the welfare results for both pro- and counter-cyclical government spending under alternative shock scenarios. The second subsection discusses the extension of standard DSGE modeling to the case where heterogeneity is explicitly modelled to facilitate the generation of measures of income inequality. We measure inequality in two ways: the Atkinson Inequality Index and the Deaton-adjusted Gini coefficients. This section is devoted to showing the effects of the alternative public spending rules, also under different stochastic scenarios, on income inequality.

[6]Results based on a second-order perturbation method.are not qualitatively different.

2 A Small Open-Economy Model

The model contains heterogenous agents who follow the standard optimizing behavior characterized in dynamic stochastic general equilibrium models. The agents have different initial endowments, but their utility functions are Gorman (1961) functions which imply that the entire group may be modelled as a single, representative agent at the macro-aggregate level.

The model has a production sector which produces two types of goods - tradeables with prices determined globally and non-tradeables with Calvo-style price-setting behavior. The model also includes a monetary authority which sets the interest rate using a simple linear Taylor rule and a financial sector which accepts deposits from households, borrows from foreigners and lends to the public sector and to firms.[7] This specification allows us to examine the effects of the types of shocks which matters for small open economies - domestic shocks to productivity and to interest rates and external shocks to the demand for exports and to the terms of trade.

2.1 Consumption and Labor

The economy has H heterogenous agents and each agent has one unit of time which is divided between work L^i and leisure l^i :

$$L^i + l^i = 1 \tag{1}$$

Following Correia (1999) and Turnovsky and García-Peñalosa (2007), we adopt an isoelastic utility function because it has the Gorman (1961) polar form property[8] which enables a group of utility maximizers to be modelled as a single representative agent.[9] For this reason, this section presents the

[7] We specifiy a financial sector in our model mainly to distinguish the main type of asset held by households (deposits) from assets issued by the authorities and by foreignors which are intermediated through the banking sector.

[8] Other types of utility functions are also amenable to Gorman aggregations. Correia (1999), for example, used the one proposed by Greenwood, Hercowitz, and Huffman (1988): $u(C, l) = C - \chi l^{\varphi}$, $\chi > 0, \varphi > 0$

[9] Note that, in this case, the representative agent is a direct result of the Gorman utility form. In other words, this analysis is based on heterogeneous agents as advocated by An,

results at the aggregate level; the distributional aspects will be discussed in a later section.

The representative agent, at period 0, optimizes the intertemporal welfare function:

$$\max_{C,l,M} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{\eta} (C_t)^{\eta} (l_t)^{\omega\eta} G_t^{\chi\eta} \right) \tag{2}$$

where β is the discount factor, C_t is an index of effective consumption, $1/(1-\eta)$ is the intertemporal elasticity of substitution, ω represents the elasticity of leisure in utility. The parameter χ measures the relative importance of public spending in private utility. Our choice of utility function is influenced by two considerations. First, as Canova and Paustian (2010) point out, typical business cycle models, with only consumption and leisure in the utility function, generally cannot replicate the empirically established positive response of consumption to government spending. We add government spending in the utility function on the assumption that such spending enhances the utility of private spending. Second, the Gorman form adopted here allows us to model a distribution of heterogeneous households and avoids the need to pre-determine the share of Ricardian to rule of thumb consumers.

The agent consumes domestically produced goods C_t which is a composite of non-traded home goods C_t^h and internationally exported goods C_t^x:[10]

$$C_t = \left[(1-\gamma)^{\frac{1}{\theta}} \left(C_t^h\right)^{\frac{\theta-1}{\theta}} + (\gamma)^{\frac{1}{\theta}} \left(C_t^x\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{3}$$

The parameter θ is the intratemporal elasticity of substitution between the domestically produced non-traded home (C_t^h) and export (C_t^x) good and the parameter γ represents the share of export good in the consumption of domestically produced goods. Minimizing expenditures gives the demand for non-traded home good and traded export good as:

$$C_t^h = (1-\gamma) \left(\frac{P_t^h}{P_t} \right)^{-\theta} C_t \tag{4}$$

Chang and Kim (2009), albeit in a straighforward form.

[10]The microfoundations with differentiated goods using the the Dixit-Stiglitz (1977) aggregator have not been spelled out since they are now well known.

$$C_t^x = \gamma \left(\frac{P_t^x}{P_t} \right)^{-\theta} C_t \tag{5}$$

The domestic goods price index P_t is given by the following formula:[11]

$$P_t = \left[(1-\gamma) \left(P_t^h \right)^{1-\theta} + \gamma \left(P_t^x \right)^{1-\theta} \right]^{\frac{1}{1-\theta}} \tag{6}$$

The economic agent receives dividends Π_t, wage payments $W_t L_t$ and pays income taxes $\tau W_t L_t$, where W_t is the economy-wide wage rate and τ is the income tax rate. We assume that savings are held in the bank, as deposits (M_t) which earns interest at the rate R^m. The budget constraint is:

$$(1-\tau)W_t(1-l_t) + (1+R_{t-1}^m)M_{t-1} + \Pi_t = P_t C_t + M_t \tag{7}$$

The representative agent chooses consumption, labor, and deposits to maximize utility subject to the budget constraint. We assume that the agent chooses non-trivial solutions in that $C_t > 0$, $(1-l_t) > 0$, $M_t > 0$. The Lagrangean problem becomes:

$$\mathcal{L} = \sum_{\iota=0}^{\infty} \beta^{\iota} \left\{ \begin{array}{c} U(C_{t+\iota}, L_{t+1}, G_t) \\ -\Lambda_{t+\iota} \left[\begin{array}{c} P_{t+\iota}C_{t+\iota} + M_{t+\iota} - (1+R_{t-1+\iota}^m)M_{t-1+\iota} \\ +(\tau-1)W_{t+\iota}L_{t+\iota} - \Pi_{t+i}^i \end{array} \right] \end{array} \right\}$$

Substituting out the Λ in the first-order conditions yield the Euler equations:

$$\omega C_t = (1-\tau)\frac{W_t}{P_t} l_t \tag{8}$$

$$\frac{\left[(C_t)^{\eta-1} (l_t)^{\eta\gamma} G_t^{\chi\eta} \right]}{P_t} = \beta \frac{\left[(C_{t+1})^{\eta-1} (l_{t+1})^{\eta\omega} G_{t+1}^{\chi\eta} \right]}{P_{t+1}} (1+R_t^m) \tag{9}$$

2.2 Production and Pricing

There are two types of production and pricing activity, for tradeable and non-tradeable goods. We assume that the same nominal wage rate W_t holds across sectors. The total dividends from firms passed on to households are

[11] This is derived using the definition, $P_t C_t = P_t^h C_t^h + P_t^x C_t^x$, and the two demand equations.

the sum of the dividends from the firms in each sector:

$$\Pi_t = \Pi_t^x + \Pi_t^h \tag{10}$$

We also state, at the outset, that the analysis is concerned with adjustment in the short to medium run. We thus abstract from issues associated with capital accumulation and growth. In particular, production in the export sector is dependent on labor, while production in the non-traded sector is dependent on labor and imported intermediate goods. The sensitivity of the results to alternative labor intensity is reported below.

2.2.1 Export Goods

The export good is a natural resource and inexhaustible. The output Y_t^x is demanded by households C^x and foreigners X_t (exports):

$$\begin{aligned} Y_t^x &= C_t^x + X_t & (11) \\ \ln(X_t) &= \rho^x \ln(X_{t-1}) + (1-\rho^x)\ln(\overline{X}) + \epsilon_t^x, \qquad \epsilon^x \tilde{} N(0,\sigma^x) & (12) \end{aligned}$$

The demand for the export good is assumed to follow an autoregressive process where $\overline{X}$ is the steady-state level of export demand and ϵ^x is a shock term with mean 0 and standard deviation σ^x.

The firm produces what is demanded using labour (L_t^x); we assume a simple production function:

$$Y_t^x = Z^x \left(L_t^x\right)^{\alpha^x} \tag{13}$$

where Z^x is a fixed technological factor. The other factor which is different from capital in the home goods sector is implied.

The export good sells at a price P_t^{x*} which is determined overseas and which is assumed to evolve as follows:

$$\ln(P_t^{x*}) = \rho^p \ln(P_{t-1}^{x*}) + (1-\rho^p)\ln(\overline{P^{x*}}) + \epsilon_t^p, \qquad \epsilon^p \tilde{} N(0,\sigma^p) \tag{14}$$

This sector is subjected to both quantity (export demand) and price (terms of trade) shocks.

The export firm borrows the entire wage bill, $W_t L_t^x$, for which they impute the interest cost $(1+R_t^n)$. In other words, the demand for loans N_t^x by the exporting firm is given by the following equation:

$$N_t^x = W_t L_t^x \tag{15}$$

In this analysis, we assume that the firm runs an overdraft system and can borrow without limits. However, while there are no quantity constraints, the amount of loans affects the cost of borrowing and will be factored into the interest rate R_t^n charged by the financial institution.

The firm remits dividends Π_t^x to households each period:

$$\Pi_t^x = S_t P_t^{x*} Y_t^x - (1+R_t^n) W_t L_t^x \tag{16}$$

where S_t is the exchange rate expressed as domestic currency per foreign dollar (in other words, $P_t^x = S_t P_t^{x*}$)

2.2.2 Non-traded Goods

As is standard in DSGE models, we assume stickiness in pricing. The firm producing non-traded home goods Y_t^h combines labour L_t^h and imported intermediate goods K_t according to a constant elasticity of substitution production function:

$$Y_t^h = Z_t^h \left[(1-\alpha^h) \left(L_t^h \right)^{-\kappa} + \alpha^h \left(K_t \right)^{-\kappa} \right]^{-\frac{1}{\kappa}} \tag{17}$$

The parameter κ is the substitution parameter and α determines the relative factor shares in total output. The symbol L^h denotes the labor services hired by the firms. The term Z_t^h is the productivity factor which is assumed to follow the following autoregressive process:

$$\ln(Z_t^h) = \rho^z \ln(Z_{t-1}^h) + (1-\rho^z) \ln(\overline{Z}) + \epsilon_t^z, \qquad \epsilon^z \,\tilde{}\, N(0, \sigma^z) \tag{18}$$

The market clearing equation is:

$$Y_t^h = C_t^h + G_t \tag{19}$$

which shows that the domestic non-traded output Y_t^h is consumed by households C_t^h and by the government G_t.

The imported intermediate goods are priced at $S_t P_t^{m*}$, where S is the exchange rate and P^{m*} is the internationally determined price, in foreign currency, of these imported goods. We assume that the wage bill (but not the cost of intermediate goods) is similarly funded by borrowing. Total profits are given by the following equation:

$$\Pi_t^h = P^h Y^h - (1 + R_t^n) W_t L_t^h - S_t P_t^{m*} K_t$$

However, in contrast to the export sector where the price of the good is determined overseas, the price of non-traded home goods P_t^h is determined by the familiar Calvo (1983) staggered price system, with each firm given a subsidy to eliminate the effect of a price mark-up. The derivation of the pricing equation is now well-known (see for example Lim and McNelis, 2008). For completeness, the pricing system is stated below:

$$P_t^o = \frac{A_t^{num}}{A_t^{den}} = \frac{Y_t^h \left(P_t^h\right)^{\zeta} A_t + \beta \xi A_{t+1}^{num}}{Y_t^h \left(P_t^h\right)^{\zeta} + \beta \xi A_{t+1}^{den}} \tag{20}$$

$$P_t^h = \left[\xi \left(P_{t-1}^h\right)^{1-\zeta} + (1-\xi)\left(P_t^o\right)^{1-\zeta}\right]^{\frac{1}{1-\zeta}} \tag{21}$$

$$A_t = \left(Z_t^h\right)^{\kappa} \left(\frac{(1+R_t^n)W_t}{(1-\alpha)\left(\frac{Y_t^h}{L_t^h}\right)^{1+\kappa}} + \frac{SP_t^{m*}}{\alpha \left(\frac{Y_t^h}{K_t}\right)^{1+\kappa}} \right) \tag{22}$$

The variable A_t is the marginal cost and the weight ξ in the aggregate price equation represents the fraction of prices which are expected to remain unchanged (i.e.,stays at last period's level P_{t-1}^h). A fraction $(1-\xi)$ of firms are forward-looking with P_t^o determined from maximizing expected profits. Setting $\xi = 0$ implies that prices are fully flexible. In this case all firms are price optimizers and aggregate domestic price P_t^h is equal to the marginal cost, A_t. The terms A_t^{num} and A_t^{den} are auxillary variables, used simply to overcome working with infinite forward sums (see Schmidt-Grohe and Uribe, 2004)

Minimizing total costs subject to the production function (17) yields the usual first-order condition:

$$\frac{S_t P_t^{m*}}{W_t} = \frac{(1-\alpha)}{\alpha} \left(\frac{K_t}{L_t^h} \right)^{1-\kappa} \tag{23}$$

The demand for intermediate goods K_t is assumed to be sourced overseas at an internationally determined price P_t^{m*}.

2.3 Financial Activity

In addition to the New Keynesian assumptions implied by the Calvo pricing mechanism, we assume limited participation of households in financial markets. Lahiri, Singh and Végh (2006) have argued that for many emerging market economies, financial frictions are just as important as price rigidities. We follow a framework similar to that of Hendry, Ho and Moran (1993).

Banks accept deposits M_t from households and pay an interest rate R_t^m. They hold reserves as a variable proportion of deposits, Φ_t^m :

$$\Phi_t^m = \overline{\Phi}^m + \varphi^m (M_{t-1} - \overline{M}) \tag{24}$$

where $\overline{M}$ is the steady state level of deposits and $\overline{\Phi}^m$ is the steady-state reserve ratio. The banks lend an amount N_t to firms. We assume that banks face a processing cost for loans equal to $\Phi_t^n N_t$ where Φ_t^n varies depending on the amount of loans processed:

$$\Phi_t^n = \overline{\Phi}^n + \varphi^n (N_{t-1} - \overline{N}) \tag{25}$$

Similar to deposits, $\overline{\Phi}^n$ is the steady-state lending cost and $\overline{N}$ is the steady-state total lending by the financial sector. The term Φ_t^n can also include the cost to the banks from setting aside resources as loan-loss reserves. Banks also lend to the government (through the purchase of government bonds, B_t) and receive a risk-free rate on these bonds given by R_t. Finally, banks can borrow internationally F_t at the international rate R_t^*, but we also assume an asset-elastic foreign interest-rate risk premium term Φ_t^s modelled as:

$$\Phi_t^s = \overline{\Phi}^s + \varphi^s (F_{t-1} - \overline{F}) \tag{26}$$

Again, the steady state international borrowing is given by $\overline{F}$ while $\overline{\Phi}^s$ is the steady-state risk premium.[12] In this flexible exchange rate environment, the balance of payments condition holds (i.e., the amount of foreign debt is equal to net imports plus interest payments on the stock of outstanding assets):

$$S_t F_t = [1 + R_{t-1}^* + \Phi_{t-1}^s] S_t F_{t-1} + S_t P_t^{m*} K_t - P_t^x X_t \tag{27}$$

The bank maximizes the present value of its dividends, subject to the balance sheet identity:

$$\begin{aligned} \Pi_t^b &= (1 + R_{t-1}) B_{t-1} + (1 + R_{t-1}^n) N_{t-1} \\ & \quad -(1 + R_{t-1}^* + \Phi_{t-1}^s) F_{t-1} S_t - (1 + R_{t-1}^m) M_{t-1} \\ s.t &: B_t + (1 + \Phi_t^n) N_t = S_t F_t + (1 - \Phi_t^m) M_t \end{aligned}$$

This expressions tells us that the cash flow of the bank comes from its gross returns from bonds and loans plus new deposits and foreign borrowings, less gross interest on deposits and foreign loans as well as the costs associated with loans and reserve deposits. Optimizing the present value with respect to B_t, N_t, M_t and F_t and substituting out the implied discount factor, yields the familiar interest parity relationship and the spreads between the rates as:

$$(1 + \Phi_t^n)(1 + R_t) = (1 + R_t^n) \tag{28}$$

$$(1 - \Phi_t^m)(1 + R_t) = (1 + R_t^m) \tag{29}$$

$$(1 + R_t) S_t = (1 + R_t^* + \Phi_t^s) S_{t+1} \tag{30}$$

[12] This is an important assumption for closing the open economy (see Schmitt-Grohe and Uribe, 2003).

In this set-up, the deposit rate is always below the risk free government bond rate while the lending rate is always above the risk-free rate. Note that the auditing and deposit insurance costs are incorporated in the deposit and lending rates.

2.4 Fiscal and Monetary Policies

In this model, there is a composite public authority which sets monetary policy according to a Taylor rule and fiscal policy according to a pro- or counter-cyclical spending rule.

2.4.1 Inflation Targeting

The domestic interest rate R_t follows a partial adjustment mechanism for inflation targeting:

$$R_t = \rho^r R_{t-1} + (1-\rho^r)\left[\overline{R} + \rho^\pi(\pi_t - \widetilde{\pi})\right] + \epsilon_t^r, \qquad \epsilon_t^r \tilde{} N(0,\sigma^r) \tag{31}$$

where $\overline{R}$ is the long-run steady state interest rate, π_t is the actual inflation rate, and $\widetilde{\pi}$ is the target inflation rate. The parameter ρ^r reflects the fact that the monetary authority engages in interest-rate smoothing, while the restriction $\rho^\pi > 1$ respects the Taylor principle. The stochastic term ϵ^r represents the exogenous unpredictable component of interest-rate changes. It is distributed normally with mean zero and standard deviation σ^r.

2.4.2 Cyclical government spending

The tax rate levied on wage income τ is fixed, but government spending G_t depends on the stance of fiscal policy. All government spending falls in the home goods sector.

$$\begin{aligned} G_t &= \overline{G} + \phi^g(Y_{t-1} - Y) \qquad (32)\\ \phi^g &> 0, \quad \text{pro-cyclical rule} \\ \phi^g &< 0, \quad \text{counter-cyclical rule} \end{aligned}$$

where the business cycle variable Y_t is defined as:

$$Y_t = P_t^h Y_t^h + P_t^x Y_t^x \tag{33}$$

2.4.3 Government Debt and Liquidity

The Treasury receives taxes and borrows to finance government expenditure so that the evolution of the bonds becomes:

$$B_t = (1 + R_{t-1})B_{t-1} + P_t^h G_t - \tau W_t L_t + Q_t \tag{34}$$

where Q_t is the amount of liquidity injected by the authorities to support its monetary policy. The required liquidity support for this policy is:[13]

$$(1 + R_{t-1}^n)N_{t-1} - N_t(1 + \Phi_t^n + R_t^n) - \Phi_t^m M_t = Q_t \tag{35}$$

2.5 Distribution of Endowments

To obtain insights about the income distributional effects of spending rules, we need to make assumptions about the initial endowments. The base distribution of income is derived by endowing each agent with an initial quantity of money, M_0^i, held in the form of bank deposits. This endowment then determines the share h_i of total profits Π_0 that each agent receives from firms:

$$\Pi_t^i = h^i \Pi_t \tag{36}$$

where Π_t^i represents distributed dividend payments to each agent. Over time, deposits M_t^i and gross nominal income y_t^i of each agent evolves as:

$$M_t^i = (1-\tau)W_t(1-\rho^i l_t) + (1+R_{t-1}^m)M_{t-1}^i + h^i\Pi_t - \frac{\rho^i l_t}{\omega}(1-\tau)W_t \tag{37}$$

$$y_t^i = W_t(1-\rho^i l_t) + (1+R_{t-1}^m)M_{t-1}^i + h^i\Pi_t \tag{38}$$

[13] This variable together with the asset-sensitive interest rates ensure that domestic and foreign debt stabilises following shocks.

where $(1 - \rho^i l_t)$ represents the labor hours and ρ^i is the proportion of total leisure computed from steady state relations based on the Euler equations (8) and (9):

$$\rho_i = \frac{1}{\overline{l}} \frac{\omega}{\omega + 1} \frac{(1-\tau)\,\overline{W} + \overline{R^m} M_s^i + h_i \overline{\Pi}}{(1-\tau)\overline{W}} \tag{39}$$

Figure 1 shows the base distribution of endowments, hours worked, and income for $H = 100$ agents calibrated so that sums of the agents' endowments and incomes equal their respective steady state aggregates.

$$\sum_{i=1}^{H} M_t^i = \overline{M} \tag{40}$$

$$\sum_{i=1}^{H} l_t^i = 100 - \overline{L} \tag{41}$$

The histograms in Figure 1 show a log-normal or Paretian distribution of endowment and income. The point to note is that we assume that lower income agents work more, or enjoy less leisure, than those in the upper income and endowment brackets. All agents hold a positive amount of deposits.

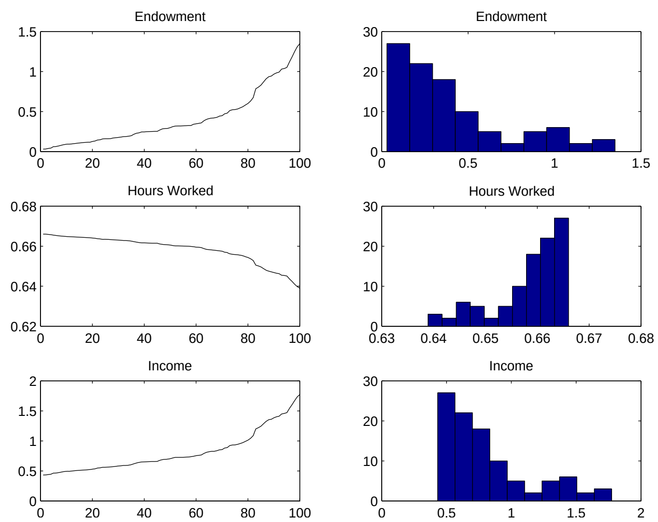

Figure 1: Initial Endowments, Hours worked and Income

3 Calibration

Our analysis is about the effects of government spending rules on income inequality and economic welfare. To that end we work with a calibrated model with parameter values that are standard in the new open-economy literature.[14]. The calibration values for the parameters appear in Table I. The coefficients are set for an annual rather than quarterly frequency, since fiscal spending rules generally operate on an annual budgetary cycle.

The discount factor β is the standard annual value for time preference. The risk aversion coefficient η, labor elasticity ω, and government spending elasticity χ imply that more than half of the time is non-work hours. We allow government spending to affect utility positively in order to account for observed correlations between consumption and government spending in most emerging markets. The utility function adopted here is necessary to facilitate the micro-analysis of income distribution, but the simulated results reported are not sensitive to these calibrated parameters. The share of tradeables γ in consumption and the value for the intratemporal elasticity of substitution θ are typical.

The risk premium parameters are set to allow for some sensitivity. The Calvo (1983) parameter ξ is low in comparison with most model. Since we are using annual intervals, we assume that most forms of price stickiness do not last beyond one year. The elasticity of substitution of differentiated goods ζ is common to these open economy models. We set the shock processes with a high degree of persistence and we set the standard deviations at a value to facilitate a 1% change in the shocked variable. The frictions introduced into the financial system and the inertia introduced into the shock processes and price setting behavior affects the dynamics but not the essential insights from the simulations.

The monetary policy (Taylor) coefficients are typical, while the government spending coefficients allow for some sensitivity to pro- and countercyclical fiscal policies.

[14] See, especially Smets and Wouter (2002)

Table 1: Parameter Definitions and Calibrated Values

Parameters	Definitions	Calibrated Values
β	discount factor	0.96
η	relative risk aversion	-1.5
ω	labor supply elasticity	0.5
χ	government spending in utility	0.15
γ	share in consumption	0.3
θ	intratemporal substitution elasticity	1.5
$\varphi^m, \varphi^n, \varphi^s$	risk premium parameters	0.01
ξ	Calvo persistence coefficient	0.15
ζ	substitution elasticity for differentiated goods	6
ρ^z, ρ^x, ρ^p	autoregressive terms for shock processes	0.9
$\sigma^z, \sigma^x, \sigma^p, \sigma^r$	standard deviation for shocks in Z, X, P^{x*}, R	0.01
ϕ^g	government spending rule, pro (counter)	0.1 (-0.1)
τ	tax rate	0.2
ρ^r, ρ^π	Taylor coefficients	0.9, 1.5
κ	CES substitution parameter in production	-0.1
Case when the non-tradeable sector is more labour intensive		
α^h	coefficient of intermediate capital in CES function	0.15
α^x	coefficient of labour in production function of non-tradeables	0.85
Case when the tradeable sector is more labour intensive		
α^h	coefficient of intermediate capital in CES function	0.70
α^x	coefficient of labour in production function of non-tradeables	0.30

The dynamic stochastic general equilibrium model applied here has many features which are standard in the literature, but there is one important calibrated feature which may affect the results; namely the degree of relative labor intensity in the traded-goods and non-traded goods sector. For this reason, we consider two sets of production parameters. The first case assumes that the home goods sector is more labor-intensive ($\alpha^h = 0.15$; $\alpha^x = 0.85$), that is more of the labor force are employed in the sector producing non-tradeables. This is the case for many small open economies, but to test the sensitivity of the results to this assumption, we also check out an alternative calibration ($\alpha^h = 0.70$; $\alpha^x = 0.30$) which assumes that the export goods sector employs more of the labour force.

The model is solved using DYNARE.[15] Briefly, the equations are log-linearized and simulated variables are generated as deviations from their steady states. This means that the analysis is not dependent on initial values and the effects of various shocks can be consistently compared. The results for welfare and income inequality are based on the generated impulses associated with the various shocks.

4 Simulated Results

4.1 Impulse Responses

The impulses for the four shocks.are shown in Figure 2 where the solid lines are the paths generated under the pro-cyclical spending rule while the dashed lines are the corresponding paths for the counter-cyclical spending rule. Since the model is expressed in log-linearised form, the impulses represent deviations from the zero baseline.

- Productivity Shock

The first column in Figure 2 shows the impulse response paths following a shock to the productivity index Z_t^h for home goods in equation (17).

[15] Dynare is a software platform for handling a wide class of economic models, in particular dynamic stochastic general equilibrium (DSGE); see http://www.dynare.org/

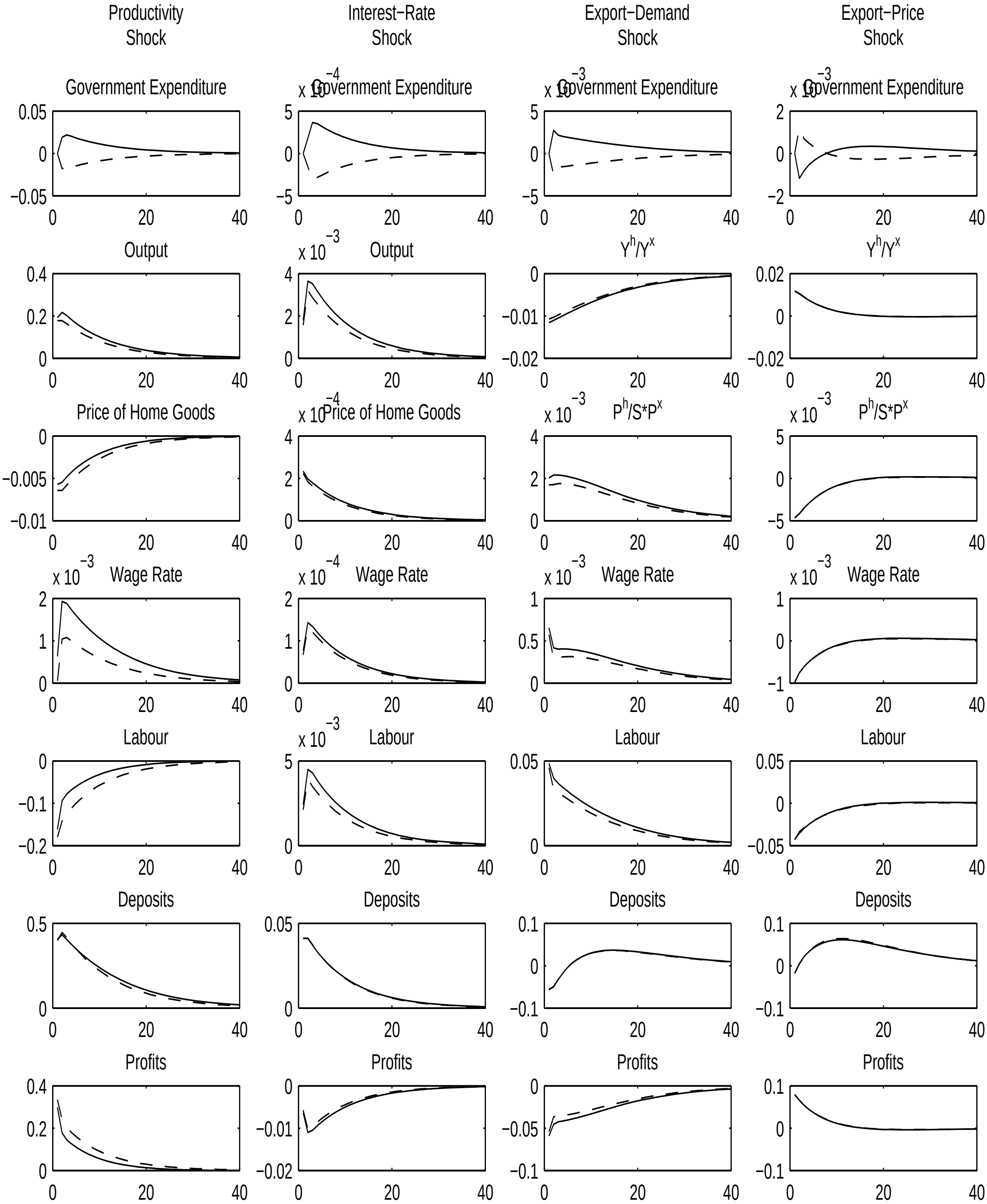

Figure 2: Impulse Responses following shocks: pro-cyclical government sepnding (solid line) and counter-cyclical spending (dashed line)

We see under both spending rules that output and wages rise, while labor falls (implying an increase in leisure). Deposits also increase, due to the higher income available to households. The price of home goods and the overall price index fall, so that interest rates on deposits fall. This leads to a depreciation of the exchange rate. In turn the trade surplus rises. The primary fiscal balance (taxes less government spending only) also rises due to the increased tax revenue. In the case when government spending is counter-cyclical, the direction of effects for the macroeconomic variables are the same, but the magnitudes are somewhat moderated. The main difference is in the primary surplus which is larger since government spending is lower but the tax revenue rises along with the rise in output.

- Interest Rate Shock

The second column in Figure 2 shows the impulse response paths for a shock to the domestic financial system, in terms of an unexpected increase in the domestic interest rate, represented by ϵ^r in equation (31). The higher interest rate triggers an increase in marginal costs for firms, and the price of goods increases which in turn puts pressure on the monetary authority to increase interest rate to reduce inflation. Deposits increase and the wealth effect stimulates consumption which in turn leads to higher output, employment and wages. Profits of firms fall. The exchange rate appreciates, due to the higher home interest rates, while the trade surplus falls as net exports decline. There is an initial fall in the primary surplus as the price of non-traded government spending rises relative to tax revenue, but it soon increases as the higher tax revenue from higher labor income overtakes the higher costs of government spending on home goods. As in the case of the productivity shock, the main noticeable difference generated by the different spending rules is for the primary surplus, with, in this case, the pro-cyclical rule moderating the rise in this variable.

- Export Demand Shock

The third column in Figure 2 shows the impulse response paths following a shock to export demand X, see equation (12). The increase in overall demand triggers a rise in wages and labour and the price of non-tradeables which in turn leads to a rise in the interest rate and an appreciation of the exchange rate. Deposits initially fall, due to the increased costs of home consumption goods. Overall, profits fall with the shift away from the demand for non-tradeables. However, the increase in tax revenue improves the primary surplus while the increased export demand improves the trade surplus. As in the case of the domestic shocks, the only noticeable difference in the impulse-response paths appears to be in the adjustment path of the primary surplus.

- Terms of Trade Shock

The fourth column in Figure 2 shows the impulse response paths for an increase in the price of the export good, given by P_t^{x*} in equation (14). Since the export price shock is a component of the overall price index, the shock also leads to a rise in domestic interest rates and an increase in deposits. As consumption falls, wages, labour and the price of tradeables fall. Overall, we see a switch to the production of non-tradeables with an increase in profits. With the increase in the interest rate, the exchange rate appreciates. The fall in labor income results in a fall in the primary surplus, while the increased export price induces a rise in the value of net exports. We also see that unlike the other cases, that there is practically no difference in the impulse-response paths for the two types of spending rules.

4.2 Welfare

Unlike studies using first or second approximations, welfare is calculated directly as the discounted value of the stream of consumption, labour and government expenditure (using equation (2)) for the various shocks. Since the values of the welfare are not meaningful, we present the percentage difference between welfare for the pro- and counter-cyclical government spending cases. Table 2 shows the very small welfare gain from counter-cyclical government spending compared to welfare from pro-cyclical government spending.[16]

Also as shown, shocks to productivity yield higher welfare gain than shocks to the interest rate, to export demand or to the terms of trade. The reason for this is that the productivity shocks directly affect wage income which has an immediate effect on the components of utility - consumption and leisure. Interest rate shocks affect deposits, which have a smaller effect on consumption while shocks to export demand and export price affect the composition of consumption between tradeables and non-tradeables.

Table 2: Welfare Comparisons (per cent)
(counter-cyclical relative to pro-cyclical spending)

Shocks			
productivity	interest rate	export demand	export price
0.1758	0.0296	0.0531	0.0209

4.3 Income Distributions

If counter-cyclical spending rules have a greater effect on the welfare consequences of domestic or external shocks impinging on the economy, why do some countries engage in pro-cyclical rather than counter-cyclical spending? In this section, we explore this question by examining the effects of the different shocks on two measures of income inequality, under the two spending rules.

Two measures of income inequality are used. The first is by Atkinson (1970):

$$AI = 1 - \frac{1}{\overline{y}} \left(\prod_{i=1}^{H} y_i \right)^{1/H}$$

where y_i is individual income for $i = 1, 2, ...H$, with H representing the

[16]The numeric values of welfare will be a function of the deep parameters in the utility funcion. Using alternative values, such as in Turnovsky (2004); $\omega = 1.75$ and $\chi = 0.3$ gives.similar results

population size, and $\overline{y}$ is the mean income.[17] The second measure is the Deaton (1997) modified Gini coefficient, DG :

$$DG = \frac{H+1}{H-1} - \frac{1}{H(H-1)\overline{y}} \sum_{i=1}^{H} p^i y_i$$

where p^i is the income rank of person i, with the richest person having a rank of 1 and the poorest person having a rank of H.[18]

Figure 3 contains the paths of the Deaton modified Gini coefficient and the Atkinson inequality index for different shocks under the two government spending rules. The solid lines are the dynamic paths under pro-cyclical spending rules while the dashed lines are for the counter-cyclical spending rules. To facilitate comparison, the shocks are normalized to increase the shocked variables - productivity index (Z), interest rate (R), export demand (X) and export price (P^x) - by 1 percent and such that the implied trajectory of deposits rises and remains at a sustained higher level.

Income inequality falls for three of the shock scenarios and the degree to which inequality is affected depends on the relative impact of wage and interest rate changes. Productivity gains has the greatest impact on wages which in turn has the greatest potential to reduce income inequality by increasing the income of the group with the higher hours worked. Higher interest rates favour the group with the greater endowment but the interest gains are widespread. For the export demand shock, the gains in wage income is muted by the loss in profits.

In the case of an export price shock, inequality for both indices rises. The reason why the export price shock has a positive effect on inequality, while the other shocks have negative effects, is due to the distribution of profits which favor those agents with higher initial endowments. Recall, that the

[17] Another version imposes an inequality aversion parameter ϵ to weight the incomes: $A = 1 - \frac{1}{\overline{y}} \left[\frac{1}{H} \sum_{i=1}^{H} y_i^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}}$, where as ϵ approaches ∞ (0), the index becomes more sensitive to changes at the lower (upper) end of the income distribution. For this paper, we have used the formula for the case when $\epsilon = 1$.

[18] As an aside, the Deaton-adjusted Gini coefficient for the base income distribution is about 0.44 compared to the reported Gini coefficients for most industrialized countries, for example 0.36 for the United States.

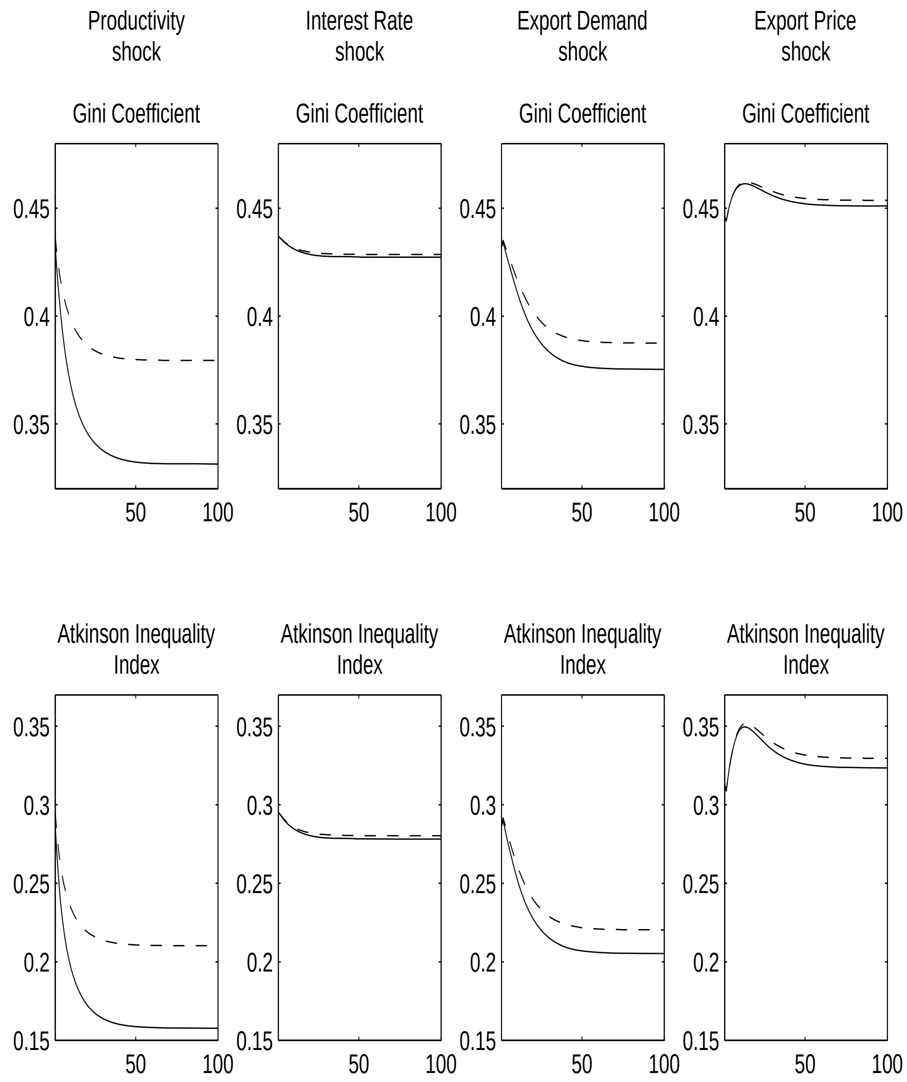

Figure 1: Measures of Income Inequality when the Non-traded Goods Sector is more Labor Intensive

price shock generates an immediate jump in profits.

Overall we see for all shock scenarios, that pro-cyclical spending reduces inequality by more than counter cyclical spending.

4.4 Alternative Labor Intensity

Since we are operating under the assumption that government spending falls on the non-traded sector of the economy, the spending rule may have different effects on income distribution, depending on the degree of labor intensity in the non-traded sector and, by implication the relative share of total labor employed in the two sectors.[19] Figure 4 presents the measures of income inequality for the case when the non-traded sector is highly capital intensive and more of the labour force are employed in the export good sector. As expected, shocks to the export sector have a bigger impact on income inequality, compared to the results discussed earlier.

An increase in the demand for the export goods initially reduces income inequality following a rise in wage income, but as profits improve, inequality worsens as those with higher endowments receive a bigger share of the profits. When the non-traded sector is highly capital intensive (and hence more of the labour supply is employed in the traded sector), pro-cyclical spending has the effect of increasing returns to owners of capital, which is less equally distributed. A similar pattern of inequality occurs with counter-cyclical spending, but the effect on inequality is less. In the earlier case, when the non-traded sector was more labour intensive (and hence employed more of the total labour supply in the economy), spending in a boom increases returns to labor which promotes income equality.

For the case of an export price shock, income inequality initially rises but it eventually falls because wage incomes have to rise to attract more labor to the traded goods sector which employs more of the total labour supply. Overall, in three of the four shock scenarios considered, increasing the intensity of capital in the non-traded sector and hence by implication

[19] The results are not sensitive to the parameters that drive the dynamics nor to the deep household behavioural parameters; alternative simulated results for welfare and income inequality are available on request.

increasing the relative share of total labour employed in the export sector did not change the result that pro-cyclical government spending yielded lower income inequality.

5 Concluding Remarks

The aim of the paper was to propose a tractable extension of a standard DSGE model to analyze income inequality and welfare for alternative government spending rules. The key to the extension lies with the utility function which facilitates the modelling of a distribution of households. The model permits the study of welfare and income inequality in a consistent DSGE framework with standard assumptions about stickiness and monopolistic competition.

Using a calibrated DSGE model, we find that counter cyclical government spending rules improves economic welfare by more than pro-cyclical fiscal spending, in the face of domestic or external shocks. In other words, when households derive some utility from government spending, there does appear to be a reason for favouring a counter-cyclical government spending rule.

However, the simulations also show that pro-cyclical government spending reduces income inequality by more than counter-cyclical behavior across the range of shocks considered and for alternative labour intensities. The simulated results are robust and they provide support for the observed pro-cyclical spending behavior of governments, especially in economies where more of the total supply of labour is employed in the non-traded sector.

We thus show that welfare and income inequality indices can move in opposite directions for government spending rules: countercyclical fiscal spending improves welfare while pro-cyclical fiscal spending improves income equality. Our results offer a rationale for this trade-off, and why spending rules, pro- or counter-cyclical, varies by category and across time, for particular countries. In some instances, welfare issues matter more than inequality, while in other times, inequality issues outweigh welfare concerns.

Our results show the importance of studying the dynamics of distributions (i.e., heterogeneity) as well as aggregates in macro models. While the

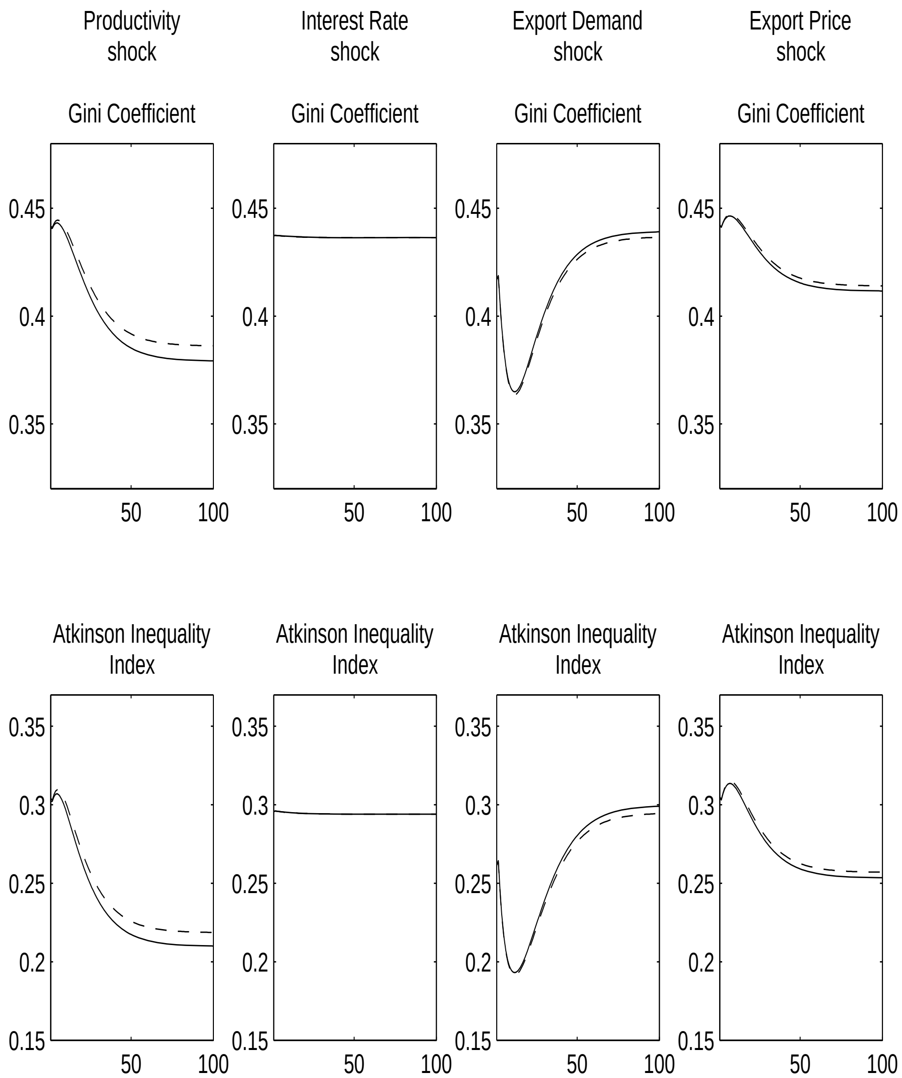

Figure 2: Measures of Income Inequality when the Traded Goods Sector is more Labor Intensive

simulation analysis is not designed to study a specific economy with a specific initial distribution of income and wealth among agents, it does provide a framework to consider the broader political-economy objective of promoting income equality by fiscal authorities through spending rules.

In concluding this paper we note that we have treated all government spending as public consumption spending and that returns to owners to capital are less equally distributed than returns to labor. Further analysis of the role of government investment spending (such as public infrastructure) on income distribution, with more varied sources of inequality among agents, would give a fuller picture of the effects of fiscal spending rules on income distribution.[20]

[20] In this regard, we note a recent paper by Chatterjee and Turnovsky (2010) which considers the distributional effects of public investment on the distributions of wealth, income and welfare, using an endogenous growth model. Future research would extend this research within the DSGE framework.

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