Melbourne Institute Working Paper Series

Working Paper No. 18/08

Cyclical Government Spending, Income Inequality and Welfare in Small Open Economies

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Melbourne Institute Working Paper No. 18/08

ISSN 1328-4991 (Print)

ISSN 1447-5863 (Online)

ISBN 978-0-7340-3286-7

September 2008

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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 the type of spending rule makes negligible difference to welfare, in the face of domestic or external shocks. However, pro-cyclical government spending reduces income inequality by more than counter-cyclical spending behavior across different shocks and alternative relative labour intensities.

1 Introduction

This paper examines the effects of pro- and counter-cyclical government spending on welfare and income distribution in an open economy setting. While many economists have noted pro-cyclical spending patterns in emerging market economies, there has been little attention paid to their effects on welfare and income inequality.

Talvi and Végh (1996) have documented the pro-cyclicality of government spending in Latin America. In their model, 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. In a similar study for Africa, Thornton (2008) found that government consumption is more pro-cyclical in those African countries that are more reliant on foreign aid inflows, and less pro-cyclical in countries with unequal income distribution.

Ilzetski and Végh (2008) examine whether pro-cyclicality of fiscal policy (defined as the response of spending to the business cycle) across developing countries is "truth or fiction". They found evidence of pro-cyclical behavior but they also point out that the old adage, "when it rains it pours", should be taken seriously suggesting that a shift in spending from pro-cyclical to a-cyclical or counter-cyclical behavior is a "badge of macroeconomic honor" and a sign that the country in question has joined the exclusive club relying on sound monetary and fiscal policies [Ilzatski and Végh (2008), p. 3].

Lane (2003) examined the cyclicality of fiscal policy in the OECD. He found that cyclicality varies across spending categories and across the OECD. Both volatile output and dispersed political power are the more 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. Alesina, Hausmann, Holmes and Stein (1999) note that pro-cyclicality of government spending is more accentuated in countries with weak budgetary institutions. Finally, as 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), for example, explain pro-cyclical spending patterns as an implication of political constraints on "pork barrel" spending during recessions.

These studies point to the prevalence of pro-cyclical behavior and it is perhaps understandable that fiscal policy would be pro-cyclical. When economic times are good, citizens naturally expect a dividend in terms of higher spending in the form of more and better entitlement programs. When times are bad, they understand the inevitable belt-tightening that must take place.

We ask two questions in this paper. First, how much does pro-cyclicality in government spending matter for overall economic welfare? Second, does pro- or counter-cyclical spending behavior matter for income inequality?

Many studies on fiscal policy and income inequality rely on macro models with heterogeneous agents or overlapping generations [see, for example Heathcote (2005) and Heathcote, Storesletten and Violante (2008)]. We follow the approach put forward by García-Peñalosa and Turnovsky (2007) and Turnovsky and García-Peñalosa (2007), and extend their closed-economy analysis to a small open-economy. In particular, we adopt a stochastic dynamic general equilibrium framework, for an open economy subject to two domestic shocks (to productivity and to interest rates) and two external shocks (to export demand and the terms of trade) and compare the effects of pro- and counter-cyclical government spending on welfare as well as on income distribution.

The paper is organized as follows. Section 2 describes the model. We introduce into the small open economy framework the explicit modelling of heterogenous agents in the household sector to facilitate the computation of income inequality. Since we are interested in exploring the role 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. This specification is chosen to facilitate examination of domestic financial shocks as well as the usual domestic productivity shocks.

Section 3 discusses the calibration and the model is solved using the software DYNARE (see Julliard, 1996 for desciption of method). Section 4 considers the impulse response paths of the aggregate variables, as well as the distribution of welfare for both pro- and counter-cyclical government spending under alternative shock scenarios. It also contains a discussion of the effects of the alternative public spending rules, (again under different shock scenarios) on income inequality as measured by the Atkinson Inequality Index and the Deaton-adjusted Gini coefficients. Concluding remarks are in the final section.

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

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:[1]

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

The parameter θ is the intratemporal elasticity of substitution between the domestically produced non-traded home good C_t^h and the domestically produced export good C_t^x 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

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

good as:

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

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

The domestic goods price index P_t is given by the following formula:[2]

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

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 contraint is:

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

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:

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

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

[2] 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.

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

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

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):

$$Y_t^x = C_t^x + X_t \tag{11}$$

$$\ln(X_t) = \rho^x \ln(X_{t-1}) + (1-\rho^x)\ln(\overline{X}) + \epsilon_t^x, \qquad \epsilon^x \,\tilde{}\, N(0,\sigma^x) \tag{12}$$

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 the export good 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 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.

We further assume that 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 (+ is a depreciation).

2.2.2 Non-traded Goods

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 total factor 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 pricing system can be written in a recursive framework with two auxiliary variables, A_t^{num} and A_t^{den}, in the following way:

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

$$A_t^{den} = Y_t^h \left(P_t^h\right)^{\zeta} + \beta\xi A_{t+1}^{den} \tag{21}$$

$$P_t^o = \frac{A_t^{num}}{A_t^{den}} \tag{22}$$

$$P_t^h = \left[\xi \left(P_{t-1}^h\right)^{1-\zeta} + (1-\xi)\left(P_t^o\right)^{1-\zeta}\right]^{\frac{1}{1-\zeta}} \tag{23}$$

$$A_t = \frac{(1 + R_t^n) W_t}{mpl_t} + \frac{S P_t^{m*}}{mpk_t} \tag{24}$$

$$mpl_t = (1-\alpha)\left(Z_t^h\right)^{-\kappa}\left(\frac{Y_t^h}{L_t^h}\right)^{1+\kappa} \tag{25}$$

$$mpk_t = \alpha\left(Z_t^h\right)^{-\kappa}\left(\frac{Y_t^h}{K_t}\right)^{1+\kappa} \tag{26}$$

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 (in other words it 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.

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

$$\frac{S_t P_t^{m*}}{W_t} = \frac{(1-\alpha)}{\alpha} \left(\frac{K_t}{L_t^h} \right)^{1-\kappa} \tag{27}$$

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. 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 :

$$\Phi_t^m = \overline{\Phi}^m + \varphi^m (M_{t-1} - \overline{M}) \tag{28}$$

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:

$$\Phi_t^n = \overline{\Phi}^n + \varphi^n (N_{t-1} - \overline{N}) \tag{29}$$

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:

$$\Phi_t^s = \overline{\Phi}^s + \varphi^s(F_{t-1} - \overline{F}) \tag{30}$$

Again, the steady state international borrowing is given by $\overline{F}$ while $\overline{\Phi}^s$ is the steady-state risk premium.[3] In this flexible exchange rate environment, the balance of payments condition that the amount of foreign debt is equal to net imports plus interest payments on the stock of outstanding assets also holds:

$$S_t F_t = [1 + R_{t-1}^* + \Phi_{t-1}] S_t F_{t-1} + S_t P_t^* K_t - P_t^x C_t^* \tag{31}$$

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:

$$(1 + \Phi_t^n)(1 + R_t) = (1 + R_t^n) \tag{32}$$

$$(1 - \Phi_t^m)(1 + R_t) = (1 + R_t^m) \tag{33}$$

$$(1 + R_t)S_t = (1 + R_t^* + \Phi_t^s)S_{t+1} \tag{34}$$

[3] 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:

$$R_t = \rho^r R_{t-1} + (1-\rho^r)\left[\overline{R} + \rho^\pi(\pi_t - \widetilde{\pi})\right] + \epsilon_t^r, \qquad \epsilon_t^r \tilde{} N(0,\sigma^r) \tag{35}$$

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:

$$\begin{aligned} G_t &= \overline{G} + \phi^g(Y_{t-1} - Y) \\ \phi^g &> 0, \quad \text{pro-cyclical rule} \\ \phi^g &< 0, \quad \text{counter-cyclical rule} \end{aligned} \tag{36}$$

where the business cycle variable Y_t is defined as:

$$Y_t = P_t^h Y_t^h + P_t^x Y_t^x \tag{37}$$

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:

$$B_t = (1 + R_{t-1})B_{t-1} + P_t^h G_t - \tau W_t L_t + Q_t \tag{38}$$

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:[4]

$$(1 + R_{t-1}^n)N_{t-1} - N_t\left(1 + \Phi_t^n + R_t^n\right) - \Phi_t^m M_t = Q_t \tag{39}$$

3 Calibration

The calibration values for the parameters appear in Table I. Many of the parameter values we use are standard in the new open-economy literature. The coefficients are set for an annual frequency.

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

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

Calvo (1983) parameter ξ is low in comparison with most model because we are using annual intervals so 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 behaviour 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.

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 asumption, we also check out an alternative calibration ($\alpha^h = 0.70$; $\alpha^x = 0.30$) which assumes that the export goods sector is more labour-intensive.

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

4 Simulated Results

4.1 Impulse Responses

In the figures to follow, 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.

4.1.1 Domestic Shocks

Figure 1 shows the impulse response paths following a shock to the productivity index Z_t^h for home goods in equation (17). 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. The primary surplus and net exports are positively correlated following the productivity shock. 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 goverment spending is lower but the tax revenue rises along with the rise in output.

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 (35). 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

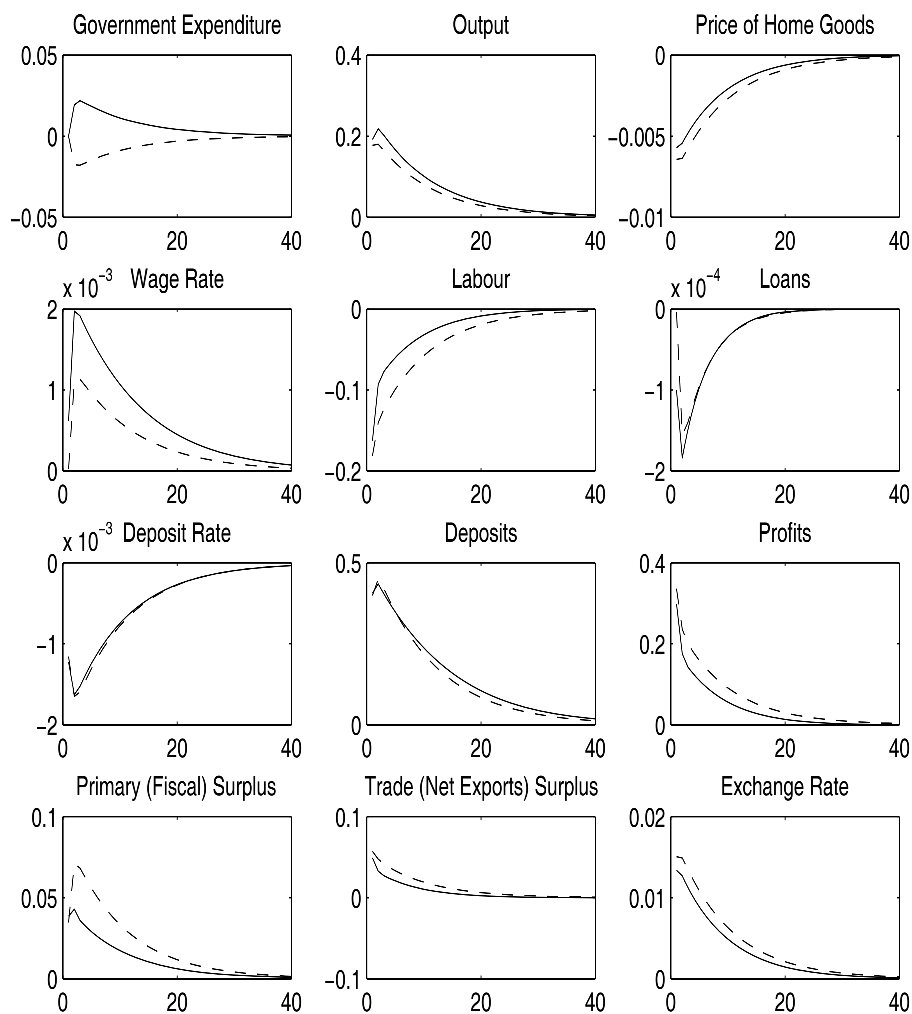

Figure 1: Impulse responses following a shock to productivity: pro-cyclical government spending (solid line) and counter-cyclical government spending (dashed line)

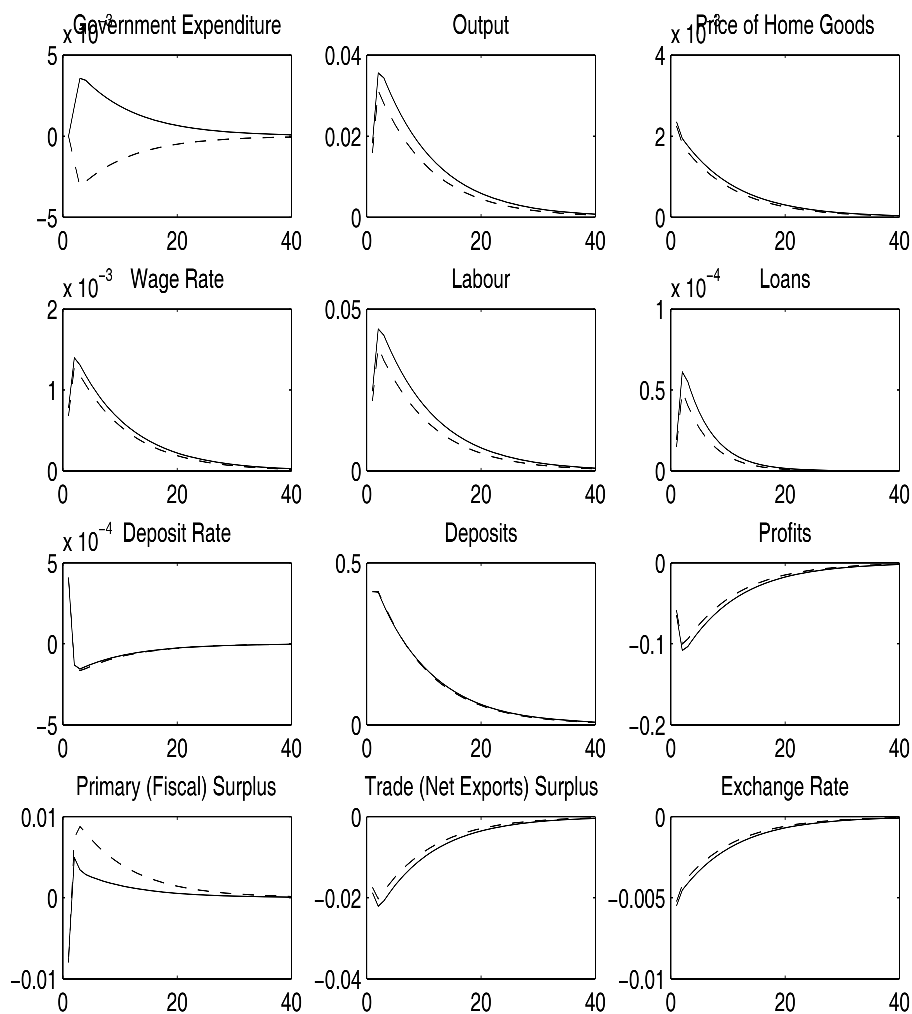

Figure 2: Impulse responses following a shock to the monetary policy interest rate: pro-cyclical government spending (solid line) and counter-cyclical government spending (dashed line)

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. We also see in Figure 2 that during the adjustment process the primary fiscal surplus and net exports are negatively correlated. 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.

4.1.2 External Shocks

Figure 3 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.

Figure 4 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 and 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. Thus the two accounts are negatively correlated during the adjustment process. 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.

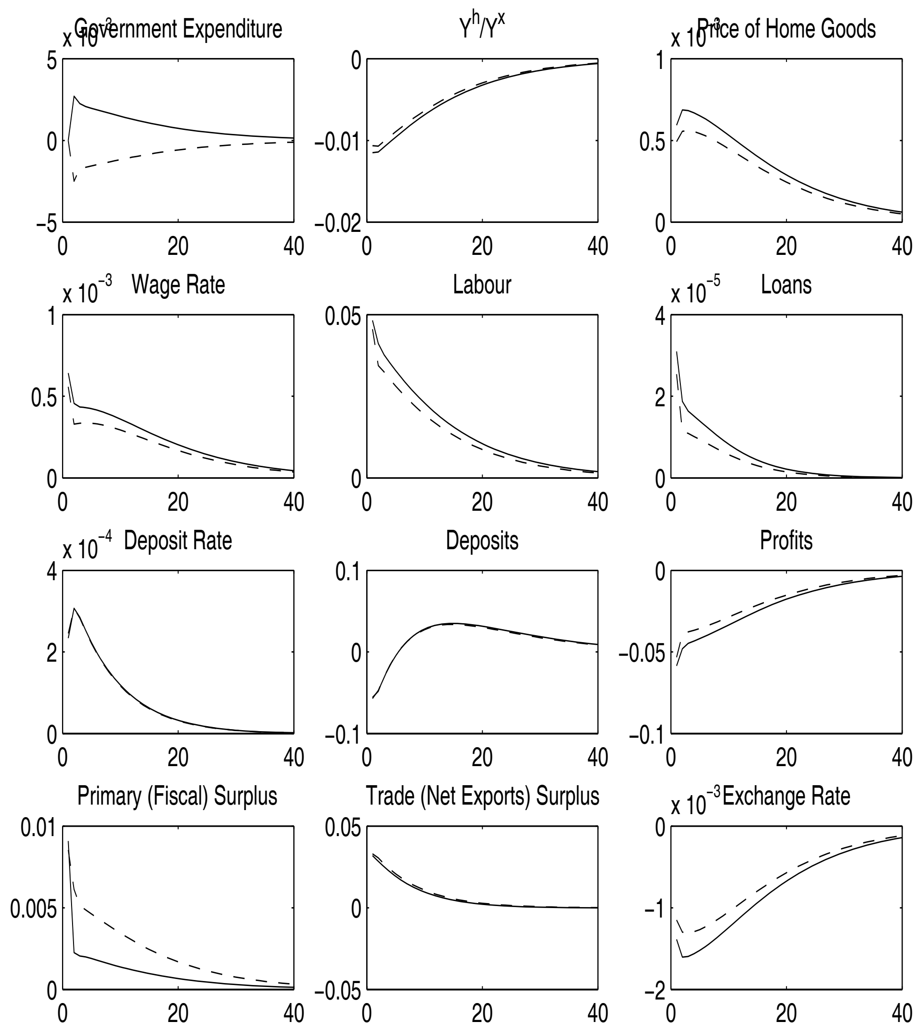

Figure 3: Impulse responses following a shock to export demand: pro-cyclical government spending (solid line) and counter-cyclical government spending (dashed line)

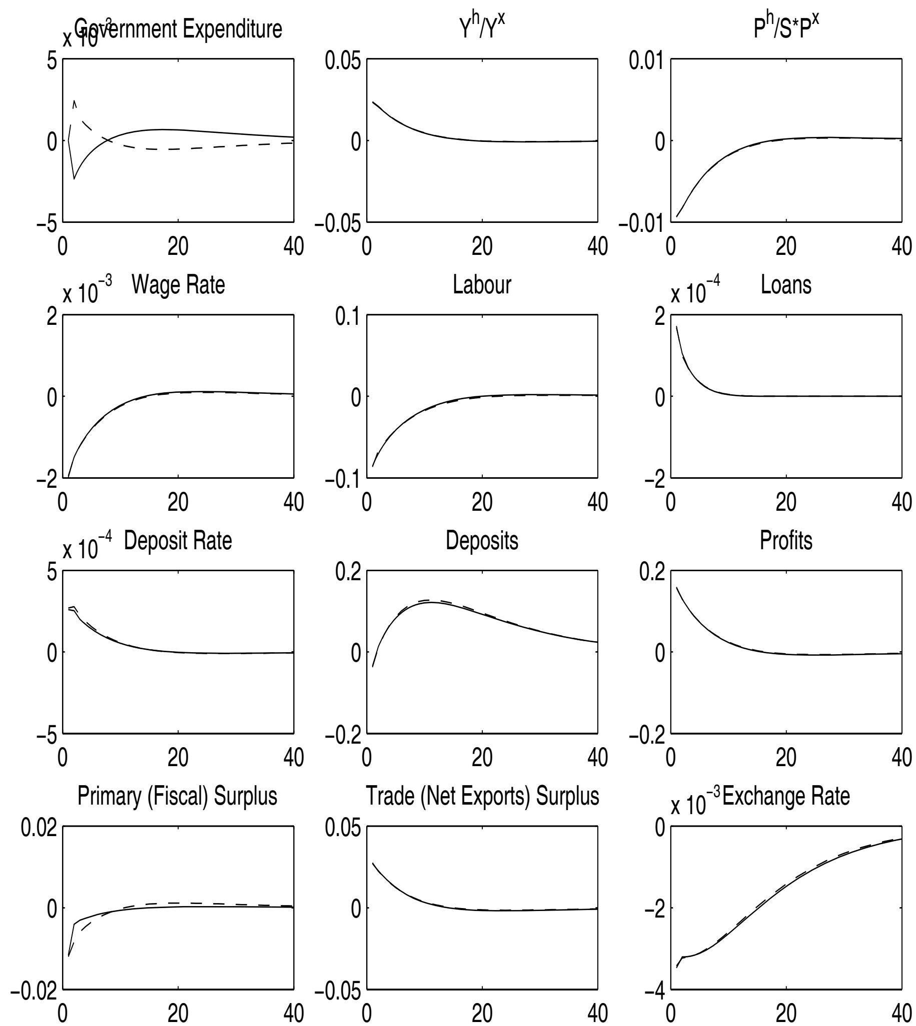

Figure 4: Impulse responses following a shock to the export price: pro-cyclical government spending (solid line) and counter-cyclical government spending (dashed line)

4.2 Welfare Distributions

Figure 5 shows the distributions of the welfare index (using equation (2) for the various shocks (based on 100 stochastic simulations of sample size 100). As shown, shocks to productivity generate a wider dispersion in welfare than shocks to the interest rate, to export demand or to the terms of trade. The reason for this is that the productivity shocks 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.

However, Figure 5 shows that the mean and dispersion of welfare do not change very much if government spending is pro or counter-cyclical. The dispersion of the percentage differences in welfare of the two spending rules is very small - less than 0.01 per cent. There is no clear cut positive or negative effect on welfare based on the spending rule of the government.

4.3 Income Distributions

If pro and counter-cyclical spending rules have little or no effect on the welfare consequences of domestic or external shocks impinging on the economy, why do less developed or emerging-market countries engage in pro-cyclical rather than counter-cyclical spending? In the words of Ilzetski and Végh (2008), why have they not opted for the macroeconomic badge of honor by adopting counter-cyclical spending rules? To answer this question, we examine the effects of the different shocks on two measures of income inequality, under the two spending rules.

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:

$$\Pi_t^i = h^i \Pi_t$$

where Π_t^i represents distributed dividend payments to each agent. Over

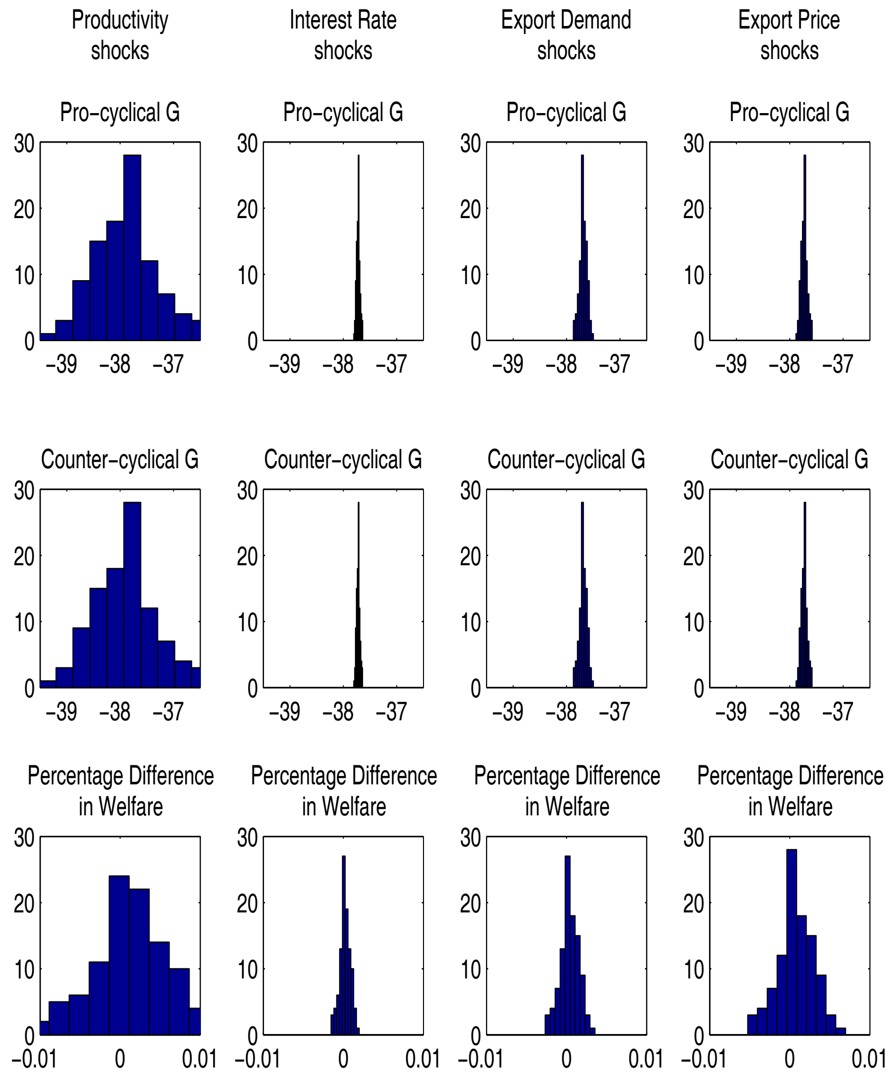

Figure 5: Welfare Comparisons for Pro- and Counter-Cyclical Fiscal Spending under Different Shock Scenarios

time, the deposits M_t^i and gross nominal income y_t^i of each agent evolves as follows:

$$\begin{aligned} M_t^i &= (1-\tau)W_t(1-\rho^i l_t) + (1+R_{t-1}^m)M_{t-1}^i + h^i\Pi_t - \frac{\rho^i l_t}{\omega}(1-\tau)W_t \\ y_t^i &= W_t(1-\rho^i l_t) + (1+R_{t-1}^m)M_{t-1}^i + h^i\Pi_t \end{aligned}$$

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):

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

Figure 6 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.

$$\begin{aligned} \sum_{i=1}^{H} M_t^i &= \overline{M} \\ \sum_{i=1}^{H} l_t^i &= 100 - \overline{L} \end{aligned}$$

The histograms in Figure 6 show a log-normal distribution of endowment and income. The main point to note is that we assume that the 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.

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 population size, and $\overline{y}$ is the mean income.[5] The second measure is the

[5] 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,

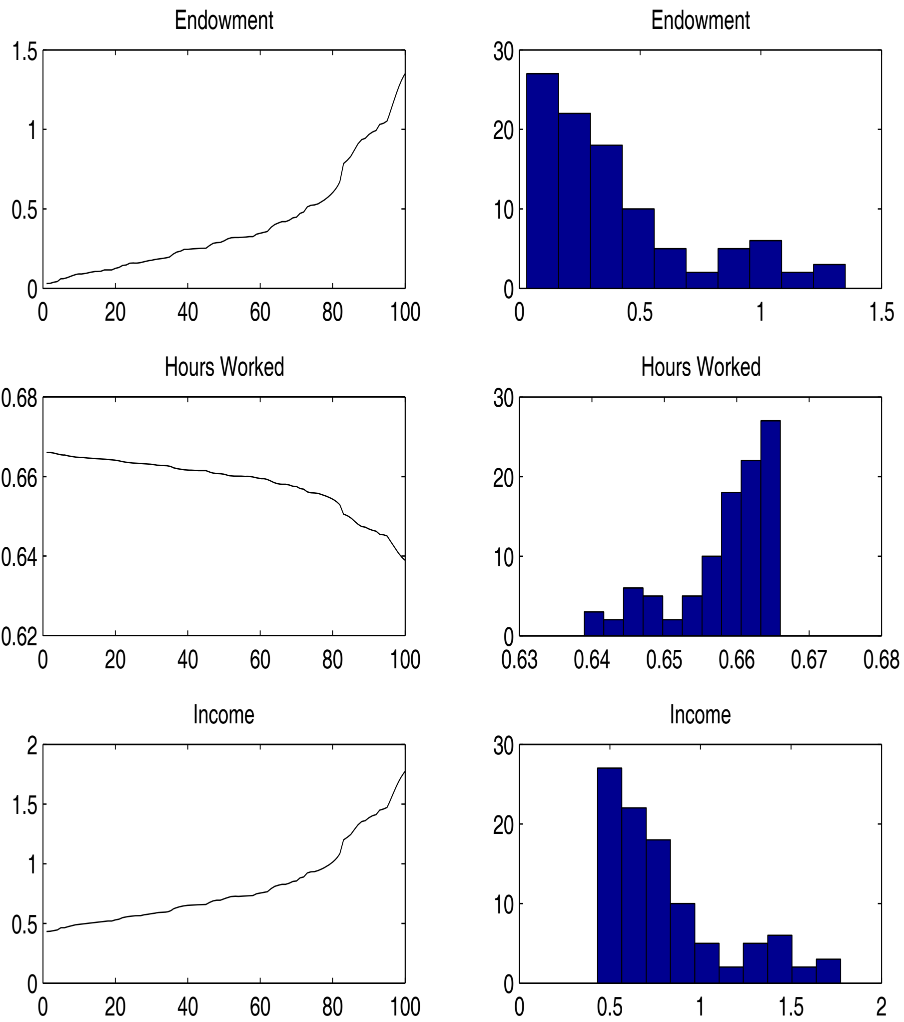

Figure 6: Initial Endowments, Hours worked and Income

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.[6]

Figure 7 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 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.

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we have used the formula for the case when $\epsilon = 1$.

[6] 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.

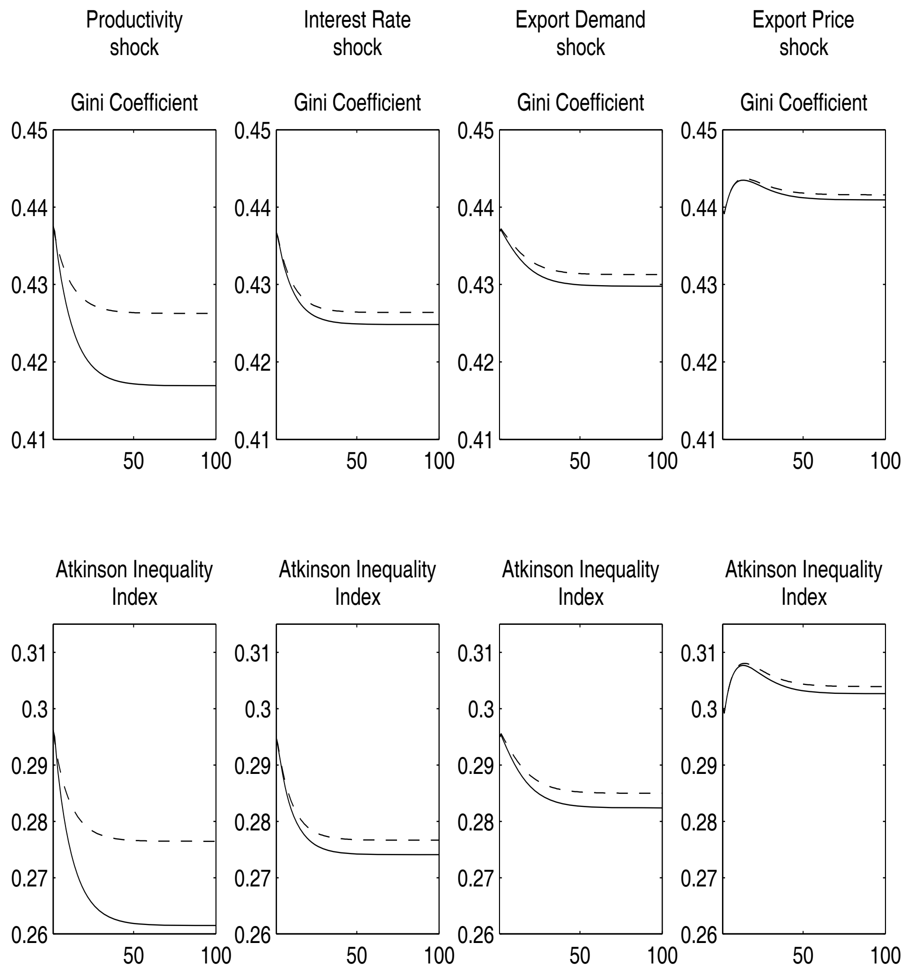

Figure 7: Measures of Income Inequality when the Non-traded Goods Sector is more Labor Intensive

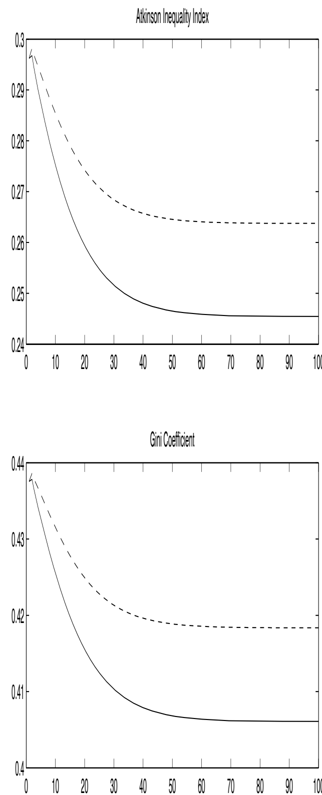

Figure 8: Measures of Inequality: Case of Multiple Shocks

4.4 When It Rains: Response to Multiple Shocks

Generally, emerging market economies subject to positive terms of trade shocks and export demand shocks also experience positive shocks to domestic productivity. The increase in demand then triggers an increase in prices and a rise in interest rates by the central bank.

Figure 8 shows the adjustment of the Deaton-adjusted Gini coefficient and the Atkinson inequality index for the case when the economy is subjected to all shocks. We see that both indices fall, but again the fall in inequality is greater under pro-cyclical spending. The message from these simulations seems to be that pro-cyclical government spending generates more favorable outcomes for income distribution without generating any significant decrease in economic welfare.

4.5 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 distribution, given the relative labor intensities of each sector. Figure 9 presents the measures of income inequality for the case where 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. In this scenario, counter-cyclical government spending is associated with marginally lower income inequality.

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 more labor intensive traded goods sector. Overall, in three of the four shock scenarios considered, increasing the relative share of labour in the export sector did not change the result that pro-cyclical government spending yielded lower income inequality.

5 Concluding Remarks

Using a calibrated dynamic stochastic general equilibrium model, we find that the government spending rule makes little or no difference to overall economic welfare, in the face of domestic or external shocks. In other words, in terms of the typical welfare measure based on discounted utility, there does not appear to be any reason for favouring a pro- or a counter-cyclical government spending rule.

However, pro-cyclical government spending reduces income inequality by more than counter-cyclical behavior across the range of shocks considered and for alternative labour intensities. These simulated results appear to be robust and they provide support for the observed pro-cyclical spending

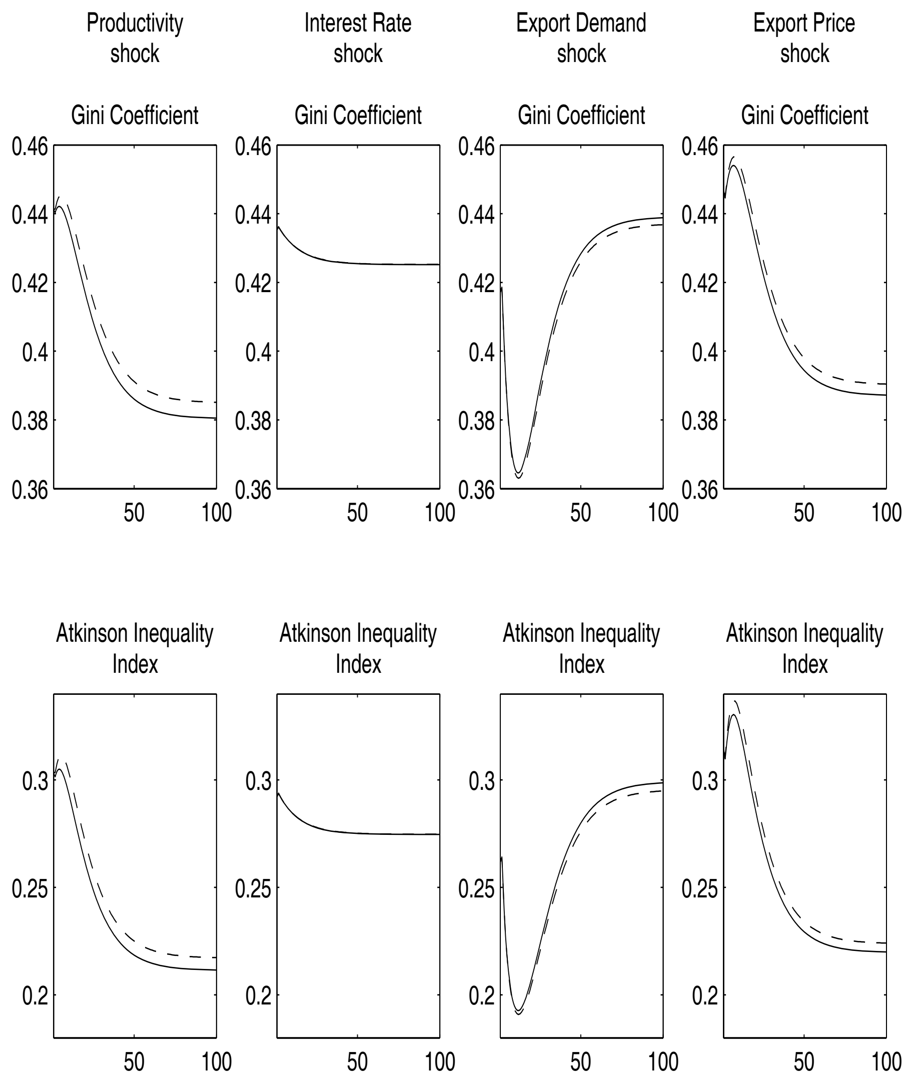

Figure 9: Measures of Income Inequality when the Traded Goods Sector is more Labor Intensive

behavior of governments, especially in emerging market countries; i.e., they show that pro-cyclical government spending is appropriate when we consider the objective of promoting income equality.

In concluding, in this paper we have treated all government spending as public consumption spending, with a direct effect on utility. Further analysis of the role of government investment spending on income distribution would give a fuller picture of the effects on income distribution.

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