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

G.C. Lim* and Paul D. McNelis†

August 25, 2009

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 specifications for domestic production.

*Melbourne Institute of Applied Economic and Social Research & the Department of Economics, University of Melbourne, Parkville, Australia. Email: g.lim@unimelb.edu.au.
†Department of Finance, Graduate School of Business Administration, Fordham University, 1790 Broadway, New York 10019. Email: mcnelis@fordham.edu

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

JEL Classification: E62, F41
1 Introduction

This paper is motivated by 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 (for examples, 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). These studies point to the prevalence of pro-cyclical behavior. 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. 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—such as reducing income inequality—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 importance of global shocks. This paper

---

1He 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.

2More politically motivated arguments have been suggested. For example, Alesina, Haussmann, Holmes and Stein (1999) note that pro-cyclicality of government spending is more accentuated in countries with weak budgetary institutions, while Eichengreen and Haussmann (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.

3In the model of 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
assesses the implications of cyclical fiscal spending policy for the case of a productivity shock, a domestic interest rate shock as well as for the case of external shocks coming from export demand and the terms of trade.

We compare the effects of pro- and counter-cyclical government spending 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 examples Heathcote (2005), Heathcote, Storesletten and Violante (2009) and Kumhof and Laxton (2009)). Like these studies, we examine the cyclicity of government spending, but we embed the dynamics of income distribution across agents into a standard stochastic dynamic general equilibrium aggregate open-economy model, 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 advantage of this is that the fiscal policy is discussed in a more widely used type of macroeconomic model, namely one with Calvo pricing and inflation targeting.

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 pro-

---

those African countries that are more reliant on foreign aid inflows, and less pro-cyclical in countries with unequal income distribution;
ductivity or terms of trade. Section 3 discusses the calibration. The model is solved using the software DYNARE (see Julliard, 1996 for description of method).

Section 4 contains two sets of simulated results. The first subsection contains 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. 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. 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.

\[4\] We specify 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 foreigners which are intermediated through the banking sector.
2.1 Consumption and Labor

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

$$L^i + l^i = 1$$ (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\(^5\) which enables a group of utility maximizers to be modelled as a single representative agent.\(^6\) 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:

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

where $\beta$ is the discount factor, $C_t$ is an index of effective consumption, $1/(1-\eta)$ is the intertemporal elasticity of substitution, $\omega$ represents the elasticity of leisure in utility. The parameter $\chi$ measures the relative importance of public spending $G_t$ in private utility.

The agent consumes domestically produced goods $C_t$ which is a composite of non-traded home goods $C^{h}_t$ and internationally exported goods $C^{x}_t$:\(^7\)

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

The parameter $\theta$ is the intratemporal elasticity of substitution between the domestically produced non-traded home good $C^{h}_t$ and the domestically produced goods.

\(^5\)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): $u(C,l) = C - \chi l^{\varphi}, \chi > 0, \varphi > 0$

\(^6\)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, Chang and Kim (2009), albeit in a straightforward form.

\(^7\)The microfoundations with differentiated goods using the the Dixit-Stiglitz (1977) aggregator have not been spelled out since they are now well known.
duced export good $C^x_t$ and the parameter $\gamma$ 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:

\[ C^h_t = (1 - \gamma) \left( \frac{P^h_t}{P_t} \right)^{-\theta} C_t \]  

\[ C^x_t = \gamma \left( \frac{P^x_t}{P_t} \right)^{-\theta} C_t \]  

The domestic goods price index $P_t$ is given by the following formula:\(^8\)

\[ P_t = \left[ (1 - \gamma) \left( P^h_t \right)^{1-\theta} + \gamma \left( P^x_t \right)^{1-\theta} \right]^{\frac{1}{1-\theta}} \]  

The economic agent receives dividends $\Pi_t$, 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 $\tau$ is the income tax rate. We assume that savings are held in the bank, as deposits $(M_t)$ which earns interest at the rate $R^m_t$. The budget constraint is:

\[ (1 - \tau)W_t(1 - l_t) + (1 + R^m_{t-1})M_{t-1} + \Pi_t = P_tC_t + M_t \]  

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:

\[ \mathcal{L} = \sum_{t=0}^{\infty} \beta^t \left\{ -\Lambda_{t+1} \left[ U(C^h_{t+1}, L_{t+1}; G_t) \right. \right. \\
\left. \left. P_{t+1} C^h_{t+1} + M_{t+1} - (1 + R^m_{t-1})M_{t-1+1} \right. \right. \\
\left. \left. + (\tau - 1)W_{t+1}L_{t+1} - \Pi^i_{t+1} \right] \right\} \]  

\(^8\)This is derived using the definition, $P_tC_t = P^h_tC^h_t + P^x_tC^x_t$, and the two demand equations.
Substituting out the $\Lambda$ in the first-order conditions yield the Euler equations:

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

$$\frac{[(C_t)^{\eta - 1} (l_t)^{\eta_1} G_t^{\chi_1}]}{P_t} = \beta \frac{[(C_{t+1})^{\eta - 1} (l_{t+1})^{\eta_0} G_{t+1}^{\chi_0}]}{P_{t+1}} (1 + R_t^m)$$  (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 the sum of the dividends from the firms in each sector:

$$\Pi_t = \Pi_t^x + \Pi_t^h$$  (10)

#### 2.2.1 Export Goods

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

$$Y_t^x = C_t^x + X_t$$  (11)

$$\ln(X_t) = \rho^x \ln(X_{t-1}) + (1 - \rho^x) \ln(\overline{X}) + \epsilon_t^x, \quad \epsilon_t^x \sim N(0, \sigma^x)$$  (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 $\epsilon_t^x$ is a shock term with mean 0 and standard deviation $\sigma^x$.

The firm produces the export good using labour ($L_t^x$); we assume a simple production function:

$$Y_t^x = Z^x (L_t^x)^{\alpha^x}$$  (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 $P_{t}^{xx}$ which is determined overseas and
which is assumed to evolve as follows:

\[
\ln(P^x_t) = \rho P \ln(P^x_{t-1}) + (1 - \rho P) \ln(P^x) + \epsilon^p_t, \quad e^P \sim N(0, \sigma^P)
\]  

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, \(W_t L^x_t\), for which they impute the interest cost \((1 + R^n_t)\). In other words, the demand for loans \(N^x_t\) by the exporting firm is given by the following equation:

\[
N^x_t = W_t L^x_t
\]

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 \(R^n_t\) charged by the financial institution.

The firm remits dividends \(\Pi^x_t\) to households each period:

\[
\Pi^x_t = S_t P^x Y^x_t - (1 + R^n_t) W_t L^x_t
\]

where \(S_t\) is the exchange rate expressed as domestic currency per foreign dollar.

### 2.2.2 Non-traded Goods

The firm producing non-traded home goods \(Y^h_t\) combines labour \(L^h_t\) and imported intermediate goods \(K_t\) according to a constant elasticity of substitution production function:

\[
Y^h_t = Z^h_t \left[ (1 - \alpha^h) (L^h_t)^{-\kappa} + \alpha^h (K_t)^{-\kappa} \right]^{-\frac{1}{\kappa}}
\]

The parameter \(\kappa\) is the substitution parameter and \(\alpha\) determines the relative factor shares in total output. The symbol \(L^h\) denotes the labor services hired by the firms. The term \(Z^h_t\) is the total factor productivity factor which is
assumed to follow the following autoregressive process:

\[ \ln(Z^h_t) = \rho^z \ln(Z^h_{t-1}) + (1 - \rho^z) \ln(Z^h) + \epsilon^*_t, \quad \epsilon^* \sim N(0, \sigma^z) \]  

(18)

The market clearing equation is:

\[ Y^h_t = C^h_t + G_t \]  

(19)

which shows that the domestic non-traded output \( Y^h_t \) is consumed by households \( C^h_t \) and by the government \( G_t \).

The imported intermediate goods are priced at \( S^h_t P^m \), 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:

\[ \Pi^h_t = P^h_t Y^h_t - (1 + R^n_t)W_t L^h_t - S^h_t P^m \]  

However, in contrast to the export sector where the price of the good is determined overseas, the price of non-traded home goods \( P^h_t \) 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, \( A^\text{num}_t \) and \( A^\text{den}_t \), in the following way:

\[ A^\text{num}_t = Y^h_t (P^h_t)^\zeta A_t + \beta \xi A^\text{num}_{t+1} \]  

(20)

\[ A^\text{den}_t = Y^h_t (P^h_t)^\zeta + \beta \xi A^\text{den}_{t+1} \]  

(21)

\[ P^\ell_t = \frac{A^\text{num}_t}{A^\text{den}_t} \]  

(22)

\[ P^h_t = \left[ \xi (P^h_{t-1})^{1-\zeta} + (1 - \xi) (P^\ell_t)^{1-\zeta} \right]^{\frac{1}{1-\zeta}} \]  

(23)
\[ A_t = \frac{(1 + R^n_t)W_t}{mpl_t} + \frac{SP^{ms}_t}{mpk_t} \tag{24} \]

\[ mpl_t = (1 - \alpha) \left( Z^h_t \right)^{-\kappa} \left( \frac{Y^h_t}{L^h_t} \right)^{1+\kappa} \tag{25} \]

\[ mpk_t = \alpha \left( Z^h_t \right)^{-\kappa} \left( \frac{Y^h_t}{K_t} \right)^{1+\kappa} \tag{26} \]

The variable \( A_t \) is the marginal cost and the weight \( \xi \) 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 \( P^{h}_{t-1} \)). A fraction \( (1-\xi) \) of firms are forward-looking with \( P^o \) 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 \( P^h_t \) is equal to the marginal cost, \( A_t \).

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

\[ \frac{S_tP^{ms}_t}{W_t} = \frac{(1 - \alpha)}{\alpha} \left( \frac{K_t}{L^h_t} \right)^{1-\kappa} \tag{27} \]

The demand for intermediate goods \( K_t \) is assumed to be sourced overseas at an internationally determined price \( P^{ms}_t \).

### 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 \( R^m_t \). They hold reserves as a variable proportion of deposits, \( \Phi^m_t \):

\[ \Phi^m_t = \Phi^n_m + \varphi^m (M_{t-1} - M) \tag{28} \]
where $\bar{M}$ is the steady state level of deposits and $\Phi^m$ 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 $\Phi^n_t N_t$ where $\Phi^n_t$ varies depending on the amount of loans processed:

$$\Phi^n_t = \Phi^n + \varphi^n (N_{t-1} - \bar{N})$$ (29)

Similar to deposits, $\Phi^n$ is the steady-state lending cost and $\bar{N}$ is the steady-state total lending by the financial sector. The term $\Phi^n_t$ 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 $\Phi^s_t$ modelled as:

$$\Phi^s_t = \Phi^s + \varphi^s (F_{t-1} - \bar{F})$$ (30)

Again, the steady state international borrowing is given by $\bar{F}$ while $\Phi^s$ is the steady-state risk premium. 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:

$$S_t F_t = [1 + R^*_t - \Phi^s_{t-1}] S_t F_{t-1} + S_t P^*_t K_t - P^*_t C^*_t$$ (31)

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

$$\Pi^b_t = (1 + R_{t-1}) B_{t-1} + (1 + R^n_{t-1}) N_{t-1} - (1 + R^*_t + \Phi^s_{t-1}) F_{t-1} S_t - (1 + R^m_{t-1}) M_{t-1}$$

s.t. : $B_t + (1 + \Phi^m_t) N_t = S_t F_t + (1 - \Phi^m_t) M_t$

---

9This is an important assumption for closing the open economy (see Schmitt-Grohe and Uribe, 2003).
This expression 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:

\begin{align*}
(1 + \Phi^m_t) (1 + R_t) &= (1 + R^m_t) \\
(1 - \Phi^m_t) (1 + R_t) &= (1 + R^m_t) \\
(1 + R_t) S_t &= (1 + R^*_t + \Phi^*_t) S_{t+1}
\end{align*}

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:

$$R_t = \rho^\pi R_{t-1} + (1 - \rho^\pi) \left[ \bar{R} + \rho^\pi (\pi_t - \bar{\pi}) \right] + \epsilon_t^\pi, \quad \epsilon_t^\pi \sim N(0, \sigma^\pi) \quad (35)$$

where $\bar{R}$ is the long-run steady state interest rate, $\pi_t$ is the actual inflation rate, and $\bar{\pi}$ is the target inflation rate. The parameter $\rho^\pi$ 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 $\epsilon^\pi$
represents the exogenous unpredictable component of interest-rate changes. It is distributed normally with mean zero and standard deviation $\sigma^r$.

2.4.2 Cyclical government spending

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

$$G_t = \bar{G} + \phi^g(Y_{t-1} - Y)$$  \hfill (36)

$\phi^g > 0$, pro-cyclical rule

$\phi^g < 0$, counter-cyclical rule

where the business cycle variable $Y_t$ is defined as:

$$Y_t = P^h Y^h_t + P^x Y^x_t$$  \hfill (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:

$$B_t = (1 + R_{t-1})B_{t-1} + P^h_t G_t - \tau W_t L_t + Q_t$$  \hfill (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:10

$$(1 + R^m_{t-1})N_{t-1} - N_t (1 + \Phi^m_t + R^m_t) - \Phi^m_t M_t = Q_t$$  \hfill (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.

10This variable together with the asset-sensitive interest rates ensure that domestic and foreign debt stabilises following shocks.
The coefficients are set for an annual frequency.

The discount factor $\beta$ is the standard annual value for time preference. The risk aversion coefficient $\eta$, labor elasticity $\omega$, and government spending elasticity $\chi$ 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 $\gamma$ in consumption and the value for the intratemporal elasticity of substitution $\theta$ are typical.

The risk premium parameters are set to allow for some sensitivity. The Calvo (1983) parameter $\xi$ 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 $\zeta$ 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 counter-cyclical 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 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.

Table 1: Parameter Definitions and Calibrated Values

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Definitions</th>
<th>Calibrated Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>discount factor</td>
<td>0.96</td>
</tr>
<tr>
<td>$\eta$</td>
<td>relative risk aversion</td>
<td>-1.5</td>
</tr>
<tr>
<td>$\omega$</td>
<td>labor supply elasticity</td>
<td>0.5</td>
</tr>
<tr>
<td>$\chi$</td>
<td>government spending in utility</td>
<td>0.15</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>share in consumption</td>
<td>0.3</td>
</tr>
<tr>
<td>$\theta$</td>
<td>intratemporal substitution elasticity</td>
<td>1.5</td>
</tr>
<tr>
<td>$\varphi^m, \varphi^n, \varphi^s$</td>
<td>risk premium parameters</td>
<td>0.01</td>
</tr>
<tr>
<td>$\xi$</td>
<td>Calvo persistence coefficient</td>
<td>0.15</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>substitution elasticity for differentiated goods</td>
<td>6</td>
</tr>
<tr>
<td>$\rho^z, \rho^x, \rho^p$</td>
<td>autoregressive terms for shock processes</td>
<td>0.9</td>
</tr>
<tr>
<td>$\sigma^z, \sigma^x, \sigma^p, \sigma^r$</td>
<td>standard deviation for shocks in $Z, X, P^x*, R$</td>
<td>0.01</td>
</tr>
<tr>
<td>$\phi^g$</td>
<td>government spending rule, pro (counter)</td>
<td>0.1 (-0.1)</td>
</tr>
<tr>
<td>$\tau$</td>
<td>tax rate</td>
<td>0.2</td>
</tr>
<tr>
<td>$\rho^s, \rho^n$</td>
<td>Taylor coefficients</td>
<td>0.9, 1.5</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>CES substitution parameter in production</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Case when the non-tradeable sector is more labour intensive

- $\alpha^h$: coefficient of intermediate capital in CES function 0.15
- $\alpha^x$: coefficient of labour in production function of non-tradeables 0.85

Case when the tradeable sector is more labour intensive

- $\alpha^h$: coefficient of intermediate capital in CES function 0.70
- $\alpha^x$: 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 Productivity Shock

Figure 1 shows the impulse response paths following a shock to the productivity index $Z_h$ 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 government spending is lower but the tax revenue rises along with the rise in output.

4.1.2 Interest Rate Shock

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

4.1.3 Export Demand Shock

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.

4.1.4 Terms of Trade Shock

Figure 4 shows the impulse response paths for an increase in the price of the export good, given by \(P^x_t\) 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
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)
Figure 3: Impulse responses following a shock to export demand: pro-cyclical government spending (solid line) and counter-cyclical government spending (dashed line)
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.

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 directly affect wage income, which, in turn, 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 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.

The base distribution of income is derived by endowing each agent with an initial quantity of money, $M_0$, held in the form of bank deposits. This endowment then determines the share $h_i$ of total profits $\Pi_0$ that each agent
Figure 4: Impulse responses following a shock to the export price: pro-cyclical government spending (solid line) and counter-cyclical government spending (dashed line)
Figure 5: Welfare Comparisons for Pro- and Counter-Cyclical Fiscal Spending under Different Shock Scenarios
receives from firms:

\[ \Pi^i_t = h^i \Pi_t \]

where \( \Pi^i_t \) represents distributed dividend payments to each agent. Over time, the deposits \( M^i_t \) and gross nominal income \( y^i_t \) of each agent evolves as follows:

\[
M^i_t = (1 - \tau)W_t(1 - \rho^i_l) + (1 + R^m_t)M^i_{t-1} + h^i \Pi_t - \frac{\rho^i_l}{\omega}(1 - \tau)W_t
\]

\[
y^i_t = W_t(1 - \rho^i_l) + (1 + R^m_t)M^i_{t-1} + h^i \Pi_t
\]

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

\[
\rho^i = \frac{1}{1 + \frac{(1 - \tau)W + R^m M^i_s + h^i \Pi}{\omega(1 - \tau)W}}
\]

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.

\[
\sum_{i=1}^{H} M^i_t = M
\]

\[
\sum_{i=1}^{H} y^i_t = 100 - T
\]

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):

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

where \( y_i \) is individual income for \( i = 1, 2, \ldots H \), with \( H \) representing the
Figure 6: Initial Endowments, Hours worked and Income
population size, and $\overline{y}$ is the mean income. The second measure is the Deaton (1997) modified Gini coefficient, $DG$:

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

where $p_i^i$ is the income rank of person $i$, with the richest person having a rank of 1 and the poorest person having a rank of $H$.\(^{12}\)

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\(^{11}\)

---

\(^{11}\)Another version imposes an inequality aversion parameter $\epsilon$ 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 $\epsilon$ approaches $\infty$ (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 $\epsilon = 1$.

\(^{12}\)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
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. Figure 8 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 thus 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.
Figure 8: Measures of Income Inequality when the Traded Goods Sector is more Labor Intensive
5  Concluding Remarks

Using a calibrated dynamic stochastic general equilibrium model, we find that alternative government spending rules make 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, the simulations 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. In other words, the simulated results appear to be robust and they provide support for the observed pro-cyclical spending behavior of governments, especially in emerging market countries, where more of the total supply of labour is employed in the non-traded sector.

Our results show the importance of studying the dynamics of distributions as well as aggregates in macro models. While the simulation analysis is not designed to study a specific economy with an initial distribution of income and wealth among agents, the analysis does show that a case can be made to support the pro- rather than counter-cyclical government spending rules observed in many emerging and developing countries when we consider the broader political-economy objective of promoting income equality by fiscal authorities.

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, as well as modelling agents with more varied sources of inequality, such as access to financial markets, would give a fuller picture of the effects of fiscal spending rules on income distribution.
References


