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**Contents**

**Abstract**

This paper is concerned with how fiscal policy in emerging markets should respond to economic fluctuations. We model the behaviour of a fiscal authority in an emerging market country who can use external borrowing to smooth the effects of exogenous output shocks on domestic agents' private consumption. We focus on the policy implications of the facts that (1) the GDP process in emerging markets is characterised by a relatively volatile trend growth rate, and (2) that policymakers cannot directly observe the output gap or the trend GDP growth rate.

We have two key findings. First, we find that risk-averse policymakers who face EME-style output processes (ie processes dominated by shocks to the trend growth rate) should run tighter fiscal policies, with lower average debt-GDP ratios, than those in industrialised countries, who face different output processes. Second, our baseline parameterisation suggests that EME policymakers should run countercyclical fiscal policies. This result contrasts with other papers which have used optimising frameworks and the features of EME output processes to rationalise the observed procyclicality of EME fiscal policies or external balances.

Simulations suggest that the welfare costs of naively running a fiscal policy that would be appropriate for an industrialised country are around 1% of certainty-equivalent consumption, but this result is sensitive to parameterisation. We find that a simple rule-of-thumb policy that stabilises the debt-GDP ratio in every period entails much smaller welfare losses.

**Summary**

This paper is concerned with how fiscal policy in emerging markets should respond to changes in economic conditions. We model the behaviour of a fiscal authority in an emerging market economy (EME) who can borrow from other countries to smooth the effects of unexpected changes in residents' spending. We focus on the policy implications of (1) Aguiar and Gopinath's (2004a) finding that GDP in emerging markets is characterised by relatively large and persistent shocks to the trend growth rate, and (2) that policymakers cannot directly observe the output gap or the trend GDP growth rate.

We have two key findings. First, we find that risk-averse policymakers who face EME-style output processes (ie changes in output are dominated by shocks to trend growth) should run tighter fiscal policies, with lower average debt-GDP ratios, than those in industrialised countries. This result is robust to agents risk-averseness and dislike of holding debt, as well to the amount of real-time information that the policymaker has on what determines a change in output. In all cases, and particularly when the interest rate is very sensitive to the debt-GDP ratio, we find that the primary fiscal balance (ie excluding net debt interest payments) should respond strongly as the debt-GDP ratio moves above its long-run average. We find that the introduction of moderate shocks to the gross return on debt (eg those due to real-exchange rate shocks if debt is denominated in foreign currency) has little effect on the relationship between the primary fiscal balance and the debt-GDP ratio, unless the shocks happen at the same time as offsetting changes to the trend growth rate.

Secondly, in our baseline 'EME' model, we find that the primary fiscal balance of an optimising policymaker is countercyclical, despite changes in output being driven by shocks to trend growth. This appears to be true irrespective of the amount of information the policymaker has about trend growth and the output gap. This result contrasts with other papers, which have used optimising frameworks and the features of EME output processes to rationalise the observed procyclicality of EME fiscal policies or external balances. The result is somewhat sensitive to assumptions about debt intolerance and risk aversion; in particular, greater debt intolerance makes policy more countercyclical.

Our simulations also suggest that the welfare costs of naively running a fiscal policy that would be appropriate for an industrialised country are around 1% of average consumption. But this result is

sensitive to assumptions about capital markets and risk aversion. We find that a simple rule-of-thumb policy that stabilises the debt-GDP ratio in every period results in smaller welfare losses than if the‘industrialised’ policy is implemented.

## 1 Introduction

Governments in industrialised countries are typically advised to vary borrowing and debt to counteract the economic cycle, cutting borrowing in periods of strong growth or above-trend output and, conversely, borrowing more during downturns. The potential benefits of such policies are clear: they may reduce harmful volatility in tax rates, and perhaps reduce the volatility of output itself. This prescription may be modified when there are doubts about the sovereign's willingness or ability to repay debt: such governments are advised first to reduce debts to a manageable level. But once debt has been reduced and solvency is beyond question, governments should then run countercyclical policies.

Emerging markets, on the whole, may not be following this advice. IMF (2003) notes that fiscal policy was acyclical on average in emerging market economies (EMEs) between 1990-2002, whereas it was countercyclical in industrialised countries.[(1)] Kaminsky, Reinhart and Vegh (2004), with a data set of 104 countries over 43 years, find that OECD fiscal policy is acyclical or countercyclical, while EME fiscal policy is procyclical. However, using instruments to control for the endogeneity of output with respect to fiscal policy, Lee and Sung (2005) find that EME fiscal policy is in fact countercyclical, albeit less so than in OECD countries. And Abiad and Baig (2005), on a panel of 34 EMEs, find that the output gap and the primary surplus are positively correlated. Taken together, the empirical literature tentatively suggests that fiscal policy in EMEs has been generally less countercyclical than in industrialised countries, perhaps to the point of being procyclical.

Yet EMEs differ from industrialised countries in many respects. How do these differences affect optimal fiscal policy? Is it possible that the standard prescription for industrialised countries does not apply to EMEs?

IMF (2003) conjectures that a lack of credibility prevents governments from increasing borrowing during downturns, forcing policy to be acyclical. Relatedly, Riascos and Vegh (2003) establish the stylised fact that government consumption is procyclical among EMEs but acyclical in the G7,[(2)] and rationalise it in an optimising model in which capital markets are incomplete. In their model, an agent with a complete set of Arrow-Debreu securities available at actuarially fair prices

(1) The report measures cyclicality as the sensitivity of the primary balance to the output gap.
(2) They measure cyclicality with correlations between log differences or HP-detrended series.

(which they argue approximates to the industrialised country case) ensures that private and public consumption are invariant across states of nature, and therefore uncorrelated. They characterise the EME case as an economy that only has access to standard non-contingent debt contracts. Neither the private nor the public sector can insure itself against output fluctuations, so government spending must track output to some extent. Aguiar, Amadour and Gopinath (2005) set up a model in which an imperfectly credible policymaker may set capital taxes procyclically, exacerbating the investment cycle, because a countercyclical policy creates excessive incentives to cheat on investors who have already accumulated capital. So borrowing constraints and capital market imperfections – either exogenous limits on the set of available contracts, or endogenous constraints due to a lack of credibility – underpin one possible set of explanations.

An alternative set of explanations appeals to the political economy of the budget process (eg Tornell and Lane (1999)). For example, if the agents that control the budget process do not have social welfare as their objective, they may use the opportunity afforded by strong output and revenues to appropriate more resources.

A third alternative comes from Aguiar and Gopinath (2004a), who focus on the behaviour of the current account (although the logic extends to the fiscal balance). They note that a short-lived positive shock to the level of income raises the current level by more than permanent income. In this case, consumption-smoothing agents should increase saving, improving the current account. In contrast, a persistent positive shock to productivity growth raises permanent income by more than current income, leading consumption-smoothing agents to *reduce* saving, and causing the current account balance to fall.

They establish empirically that EMEs, relative to industrialised countries, face more uncertainty from shocks to the trend growth rate of GDP than from stationary fluctuations around this trend. It follows that their current accounts are likely to be more countercyclical than those in industrialised countries, where trend growth is relatively stable and short-run fluctuations are the main source of uncertainty. This logic might extend from the external balance (the national balance of savings and investment) to the fiscal balance (the public sector analogue).

Crucially, these models assume that agents can directly observe and distinguish between temporary and permanent shocks in real time. In reality, agents may only observe a composite variable – total output or productivity – and be required to infer the temporary and permanent components that underlie it. Suppose, for example, that productivity growth is made up of trend and cyclical components. If the only information one has about the trend is what can be gained by observing total growth, then changes in the trend will take time to filter through to real-time estimates. For example, a positive shock to the trend may initially be mistaken for an increase in the cyclical component. But after several periods of strong growth, the observer will place increasing weight on the hypothesis that the trend has risen. There is evidence to suggest that some agents process data this way: Edge *et al* (2004) show that professional economists' real-time estimates of trend US productivity growth are well approximated by those produced by a Kalman filter, a standard updating algorithm for estimating unobserved variables.

Relatedly, another strand of literature examines how the dynamic responses of investment and consumption to temporary and permanent shocks change if they are unobserved, and must be filtered in this way. Miniane (2004) examines saving and investment responses under such an environment. Investment responds sluggishly as firms need time to infer that the productivity shock is permanent before they are willing to incur the costs of adjusting the capital stock; furthermore, under some parameterisations, saving may initially rise, as households place some weight on the possibility that the shock is temporary. So the current account balance may initially *increase* on impact in response to a positive permanent productivity shock – the opposite of the Aguiar and Gopinath (2004a) result.

This paper builds on these insights to examine the optimal cyclicality of fiscal policy in a 'typical' emerging market, where the economy faces temporary and permanent shocks to income but the policymaker cannot necessarily separately identify them. We present a simple model of an emerging market sovereign that can vary taxes with the objective of raising the welfare of the domestic population, which is risk-averse and has no direct access to international capital markets. A key innovation with respect to the aforementioned papers is to allow risk-averse behaviour on the part of the decision-maker; rather than use linearised first-order conditions (and hence produce solutions which are not affected by uncertainty), we use a perturbation method to approximate the risk-averse solution. We use the model to examine the effect of the information structure and the GDP process on how fiscal policy should respond to shocks.

We make two key findings. *First, we find that risk-averse policymakers must tighten fiscal policies* *and run lower debt levels when faced with 'EME' output processes (ie more volatile trend growth rates).* In our baseline parameterisation, uncertainty reduces the average debt-GDP ratio by around 10% in EMEs, whereas the reduction is an order of magnitude lower for the uncertainty in industrialised-country output processes. These results are broadly robust to increases in risk aversion and the precision of information about the components of output, and to varying degrees of 'debt intolerance'. We find that introducing moderate i.i.d. shocks to the gross return on debt (eg from real exchange rate shocks if debt is denominated in foreign currency) have little effect unless they are negatively correlated with trend growth. In all cases, and particularly when the interest rate is sensitive to the debt-GDP ratio, the primary fiscal balance should respond strongly to disequilibria in the debt-GDP ratio, at an increasing rate as the ratio moves further from its steady-state level. In contrast, Abiad and Baig (2005) and IMF (2003) observe econometrically that the primary balance only responds positively to the debt-GDP ratio below a certain threshold in EMEs. So our characterisation of optimal policy does not correspond with the rules that policymakers are actually following.

*Our second main finding is that, unless information about the source of output shocks is very precise, an optimising EME policymaker will initially loosen fiscal policy in response to positive output gap shocks.* This is a combination of two effects. The optimal (procyclical) response to a shock to trend growth is larger in absolute value than the (countercyclical) response to a shock to the cyclical component. Furthermore, in EMEs the latter shocks are typically larger, so when output moves unexpectedly and there is little independent information on which to base inferences about the source of the shock, the policymaker infers that most of the shock is attributable to the permanent component of output. So if there is a positive shock to output, the expected costs of inappropriately loosening fiscal policy (if the shock turns out to be temporary) turn out to be smaller than those of inappropriately tightening policy if in fact the shock is permanent. However, if it becomes clear to the policymaker that she has misread the source of the movement in output, fiscal policy is tightened to correct the resulting imbalance in the debt-GDP ratio. However, stochastic simulations of the baseline model suggest that optimal fiscal policy in EMEs will seem countercyclical to an econometric researcher, when cyclicality is measured as the correlation between detrended output and the primary balance-GDP ratio. This result is sensitive to parameterisation.

We also find that the welfare consequences to an EME of running policies optimal for industrialised-country output process are sensitive to risk aversion and the interest rate function, but can be quite large. In contrast, welfare losses, relative to the optimal policy, from simple suboptimal rules of thumb are generally much smaller.

The rest of the paper is structured as follows. Section 2 presents the model and how it is solved. Section 3 discusses the parameterisation and simulation of the model. Section 4 presents the results: policy functions, impulse response functions, simulated sample correlations and welfare analysis. Section 5 concludes.

## 2 The model

### *2.1 Model setup*

#### *2.1.1 Welfare, consumption and foreign debt*

We assume that social welfare given by the expected present value of a standard CRRA function over the representative agent's private consumption, discounted at factor $\beta$ [(3)]

$$U_t = E_t\left[\sum_{s=0}^{\infty}\beta^s\frac{C_{t+s}^{1-\theta}}{1-\theta}\right] \qquad \textbf{(1)}$$

The domestic private sector is assumed to have no access to international capital markets.[(4)] This assumption is made to provide the government with a simple reason to borrow countercyclically; if the private sector has international capital market access on the same terms as the government (and there are no deadweight costs of taxation) then fiscal policy is Ricardian and there is no reason for the government to borrow. It is clearly unrealistic for most middle-income countries today, but perhaps a better approximation for middle-income countries 25 years ago, or for many low-income countries today. Alternatively, one could re-interpret the decision-maker in the model as a representative private sector agent.[(5)] A similar assumption is made to motivate countercyclical policy in Aguiar, Amadour and Gopinath (2005) and Yue (2005).

(3) The CRRA form implies a restriction between the values of risk aversion and the intertemporal elasticity of substitution. Giuliano and Turnovsky (2002) show that conclusions about behaviour and welfare reached in stochastic optimising models are sensitive to small violations in this restriction, and note that the empirical evidence is ambiguous as to whether this restriction actually holds.

(4) However, domestic private sector agents might borrow and lend among themselves, such that the net borrowing of the private sector is zero.

(5) The Euler equation would require modification (see below): the (atomised) private sector would not internalise the effect of increased borrowing on the national cost of external finance.

One could extend the model by giving some fraction of agents in the private sector access to private capital markets. This would temper the need for the government to stabilise the post-tax income of the private sector. Introducing convex deadweight costs of taxation could have the opposite effect: the government would seek to minimise these costs by smoothing the tax rate.

We abstract from investment and specify output as an exogenous stochastic endowment. In particular, it is not affected by fiscal policy or the level of debt. This strong assumption probably stacks the cards somewhat against countercyclical fiscal policy, although it receives some support from Lee and Sung (2005), who find that the degree of fiscal policy activism has no effect on output volatility in non-OECD countries. There is no money or monetary policy in the model. We interpret the model as describing a dollarised or currency-board regime – ie where monetary policy is not under the control of the authorities – or one in which the economic structure is such that monetary policy has little effect on real variables.

These conditions imply that the representative agent consumes the value of her endowment after taxes $\tau_t$ in each period.(6) Furthermore, we abstract from any non-interest public expenditures,(7) such that taxes and the primary budget surplus $PB_t$ are equal in every period

$$U_t = E_t \sum_{s=0}^{\infty} \beta^s \frac{(Y_{t+s} - PB_{t+s})^{1-\theta}}{1-\theta} \tag{2}$$

When the primary balance is negative, the government is transferring resources to the domestic private sector.

The government's objective is to vary taxes so as to maximise social welfare, balancing cash flows with foreign debt $D_t$. The dynamics of the public debt depend on the primary balance and the effective interest rate on debt:

$$D_{t+1} = (1+\overline{r}_t)D_t - PB_t \tag{3}$$

The marginal interest rate depends on the indebtedness of the economy as follows

$$r_t = r_f \exp(\kappa d_t) + \varepsilon_t^r \tag{4}$$

where $r_f$ is the risk-free rate and $d_t$ is the debt-GDP ratio. $\varepsilon_t^r$ is a shock to the gross return on debt that captures volatility in the return on debt when measured in units of domestic output, both in the

(6) We can think of the government setting a tax rate, the yield of which depends on the size of the economy.
(7) There are no deadweight costs of taxation, so this assumption amounts to a normalisation: some arbitrarily fixed share of government consumption in total income would have no effect on the results. But if the government could vary its own consumption, it would have another lever to affect the welfare of the private sector. Depending on how government consumption entered into the welfare function, this could potentially alter the behaviour of the primary balance.

domestic-currency real interest rate and, when debt is contracted in units of foreign currency, in the real exchange rate. The gross debt return shock is assumed to be an iid process with variance $\sigma_r^2$.

The functional form for $r_t$ is quite similar to that employed by Neumeyer and Perri (2004). This functional form captures the effect of default risk on the interest rate that a country must pay. $\kappa$ is a 'debt intolerance' parameter that governs the semi-elasticity of the interest rate with respect to the level of indebtedness; a higher value of $\kappa$ makes interest rise faster in response to a rise the debt-GDP ratio. However, there is no incidence or account of default in the model. For simplicity we assume that the maturity of debt is one period, such that $\overline{r_t} = r_t$.

### *2.1.2 Income and information*

The log-level of income $y_t = \log(Y_t)$ evolves according to the following exogenous process:

$$\begin{aligned} \Delta y_t &= g_t + \Delta\varepsilon_t \\ \varepsilon_t &= \rho_\varepsilon \varepsilon_{t-1} + \eta_t^\varepsilon \\ g_t &= \overline{g}(1-\rho_g) + \rho_g g_{t-1} + \eta_t^g \end{aligned} \tag{5}$$

where $\{\eta_t^\varepsilon, \eta_t^g\}$ are iid shocks. That is, output growth is the sum of two components: $g_t$, which we can interpret as trend growth, and the change in $\varepsilon_t$, the output gap or some other stationary component of the income process (eg a commodity-price cycle). We assume that the policymaker knows the structure and parameters of this model, thereby sidestepping important but unresolved questions in the literature on how to set policy under parameter/model uncertainty (see eg Levin and Williams (2003), Hansen and Sargent (2003)).

The policymaker observes $\Delta y_t$, but not the underlying state vector $\xi_t = \begin{pmatrix} \varepsilon_t & \varepsilon_{t-1} & g_t \end{pmatrix}'$. However, she observes $e_t$, a noisy signal of $\varepsilon_t$

$$e_t = \Delta\varepsilon_t + \eta_t^e \tag{6}$$

We interpret $e_t$ as a noisy measure of the stationary component of output obtained from some other variables or model (eg the unemployment rate, inflation). We can alter the variance of the signal error $\sigma_e^2$ to examine the effect of the information structure on optimal policy.

We can represent this system in state-space form with standard equations: a 'signal' equation **(7)** that governs the variables the policymaker sees, and a 'state' equation **(8)** which describes the dynamics of the unobserved variables:

$$x_t = H^T \xi_t + w_t \qquad \textbf{(7)}$$

$$\xi_t = F\xi_{t-1} + v_t \qquad \textbf{(8)}$$

where $x_t = \begin{pmatrix} \Delta y_t & e_t & \varepsilon_t^r \end{pmatrix}'$, $H = \begin{bmatrix} 1 & 1 & 0 \\ -1 & -1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$, $w_t = \begin{pmatrix} 0 \\ \eta_t^e \\ \varepsilon_t^r \end{pmatrix}$, $F = \begin{pmatrix} \rho_\varepsilon & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & \rho_g \end{pmatrix}$ and $v_t = \begin{pmatrix} \eta_t^\varepsilon \\ 0 \\ \eta_t^g \end{pmatrix}$. We assume that the policymaker knows $F$,the covariance matrix of signal equation shocks $R = \begin{bmatrix} 0 & 0 & 0 \\ 0 & \sigma_e^2 & 0 \\ 0 & 0 & \sigma_r^2 \end{bmatrix}$ and the covariance matrix of state-equation shocks $Q = \begin{bmatrix} \sigma_{\eta^\varepsilon}^2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \sigma_{\eta^g}^2 \end{bmatrix}$ (they can be estimated from observable data).

The policymaker infers real-time estimates of the state vector $\xi_{t|t}$ (8) from the behaviour of the observed variables $x_t$, using the following recursive algorithm given by the Kalman filter:

$$\widehat{\xi}_{t|t} = F\widehat{\xi}_{t-1|t-1} + PH(H^T PH + R)^{-1}(x_t - x_{t|t-1}) \qquad \textbf{(9)}$$

where $x_{t|t-1}$ are one period ahead forecasts of the observed variables

$$x_{t|t-1} = H^T F\widehat{\xi}_{t-1|t-1} \qquad \textbf{(10)}$$

and $P$ is the covariance matrix of one step ahead state-variable forecast errors.[9]

(8) Question: The Kalman filter is optimal in the sense that it yields the minimum-variance unbiased estimates. However, the agent is not a mean-variance optimiser. Is the Kalman filter still optimal in the sense that it provides estimates that minimise utility losses from filtering errors for agents with our (CRRA) utility function?

(9) $P$ is the solution to equation $P = F\left[P - PH(H^T PH + R)^{-1}H^T P\right]F^T + Q$ where $Q = \begin{bmatrix} \sigma_{\eta^\varepsilon}^2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \sigma_{\eta^g}^2 \end{bmatrix}$ (the covariance matrix of state-variable shocks).
Here we implicitly assume that the policymaker has observed a sufficiently long history of the economy for the Kalman gain coefficients to have converged to their steady-state values. It would be interesting as an extension to

The intuition behind these equations is as follows. The first equation says that the best guess of this period's (unobserved) state variables is what one would expect from the best guess about last period's value combined with what we know about the dynamics of the state variables (the first term), plus a term that depends on how surprising this period's data are, and how much weight one should optimally put on such surprises. Today's best guess about next period's observed variables depends only on what we believe today's state variables to be (because the shocks $\{w, v\}$ are i.i.d, so our best forecast of them is always zero).

For example, suppose the policymaker thought that this period's (unobserved) output gap was positive, while trend growth is at its long-run value. Assuming $\rho_{\varepsilon} \in (0, 1)$, she would expect some of the output gap to decay in the next period, and therefore to observe below-trend growth. If growth in the next period turns out to be faster than expected, this could be due to a positive shock to either trend growth or the output gap, or an error about past variables – it may be that last period the output gap was lower or trend growth faster than the agent had assumed. If the output gap is relatively variable, she will assume that it is this which is responsible for most of the observed movements in output.

The agent will take time to identify shocks that hit the system. Charts 1 and 2 show the effect of individual shocks to the output gap and trend growth on the path of total output (ie impulse response functions), and how the best guess produced by the Kalman filter converges on the right answer. In a simulation, the system is constantly being hit by shocks, so it will never look like this.

### *2.2 Solution*

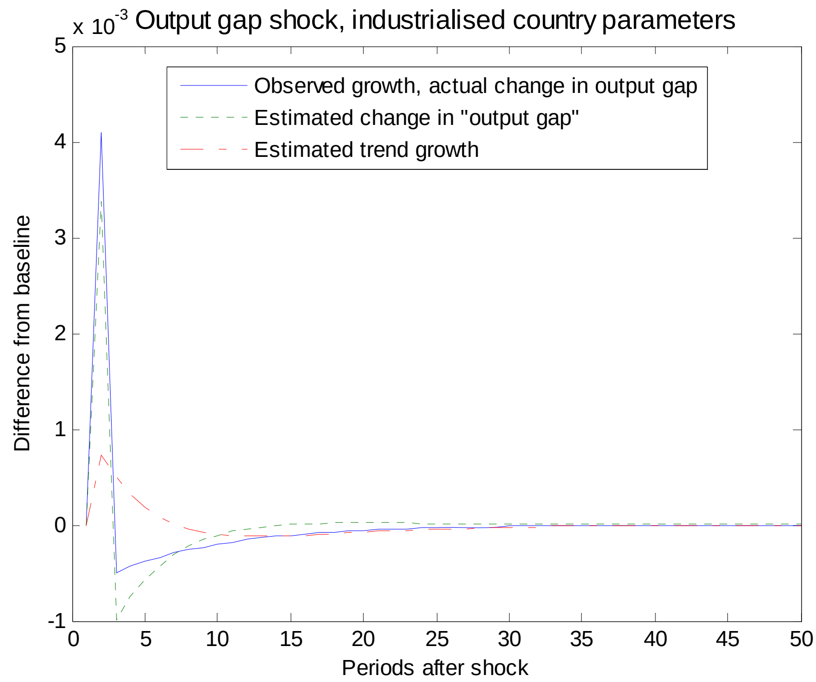
The dynamic equations that describe the model consist of the transition equation for debt **(3)**, the signal and state equations **(7)** and **(8)**, and the updating equations **(9)** and **(10)**. Furthermore, at the optimum, the Euler equation **(11)** will hold

$$Y_t^{-\theta}(1 - pb_t)^{-\theta} = \beta E_t\left[Y_{t+1}^{-\theta}(1 - pb_{t+1})^{-\theta}\left[1 + r_f \exp(\kappa d_{t+1}) + d_{t+1}\kappa r_f \exp(\kappa d_{t+1})\right]\right] \quad \textbf{(11)}$$

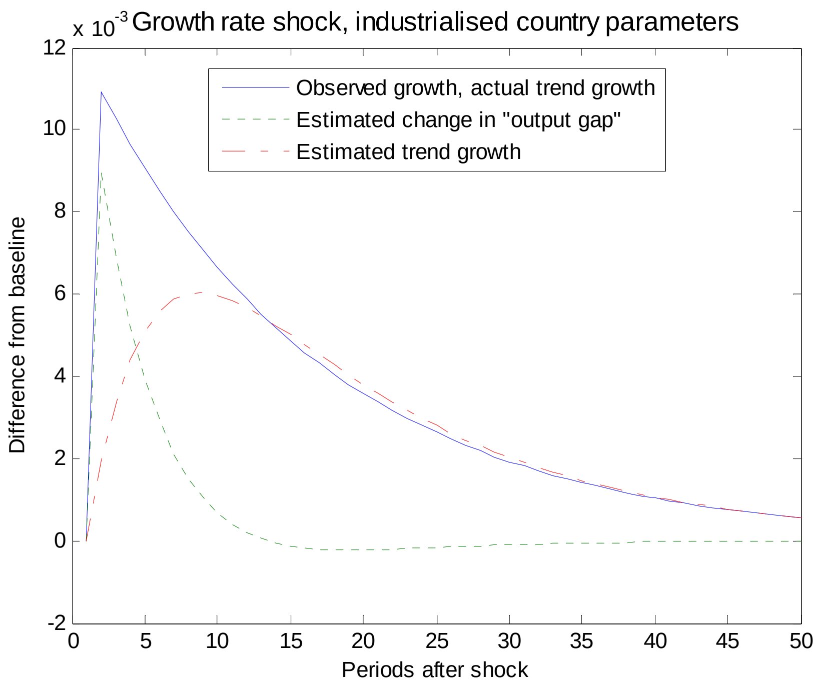
This has a familiar interpretation. On the left-hand side is the utility benefit of reducing the primary balance (ie increased consumption) today. On the right-hand side is its cost: the discounted utility cost of one unit less of consumption tomorrow, times the number of units

examine the case in which the relevant economic history is short (eg shortly after a substantial economic reform), such that the gain matrix has not yet converged to its steady-state value.

## Chart 1: Filtering an output gap shock




## Chart 2: Filtering a trend growth shock



tomorrow's consumption would have to fall to keep the future beyond tomorrow unaffected (ie one unit, plus the interest payments, plus the effect on total interest payments of the increase in the interest rate due to greater indebtedness). Note that the Kalman filter and utility-maximisation parts of the problem can be considered separately, because the former is only concerned with forming expectations of exogenous variables, whereas the latter takes these expectations as given and embeds them in the constraints of the problem.

We seek a policy function that maps the state variables the policymaker can see (the debt-GDP ratio, the signal vector and the estimated state vector, which we collectively denote $\chi \equiv \{\overline{d}, \overline{x}, \overline{\xi}\}$) to the optimal choice of primary balance. Given the structure of the model (in particular, of the utility function), there is no known analytical solution to this problem. We therefore obtain a second-order approximation to the true policy function

$$\widehat{pb}_t = f\left(\chi_t; \sigma\right) \tag{12}$$

(where $\sigma$ is a parameter proportional to the size of the shocks in the model) around the non-stochastic steady state $\overline{\chi}$ using the method developed by Schmitt-Grohe and Uribe (2004). Note that a first-order approximation would omit the impact on the decision rules of uncertainty about both the current state variables and future shocks to them – the key focus of our investigation.

To employ their method, the model must be expressed as a system of two-period intertemporal equilibrium conditions exactly equal to zero in expectation: in our case, an Euler equation linking marginal utility today and tomorrow, a debt accumulation equation, and the equations **(7)**, **(9)** and **(10)** that describe the motion of the exogenous variables from the point of view of the policymaker. The Kalman filter algorithm does not depend on the nature of the optimisation problem or the way in which it is solved, because it is concerned solely with exogenous variables. The Schmitt-Grohe and Uribe procedure yields derivatives of the policy function around the non-stochastic steady state, around which we can construct an equation of the form

$$\widetilde{\widehat{pb}}_t = f\left(\overline{\chi}; 0\right) + f_\chi\left(\overline{\chi}; 0\right)\left(\chi_t - \overline{\chi}\right) + \frac{1}{2}\left(\chi_t - \overline{\chi}\right)' f_{\chi\chi}\left(\overline{\chi}; 0\right)\left(\chi_t - \overline{\chi}\right) + \frac{1}{2}\sigma^2 f_{\sigma\sigma}\left(\overline{\chi}; 0\right) \tag{13}$$

(Schmitt-Grohe and Uribe show that $\left\{f_\sigma,\ f_{\sigma\chi}\right\} = 0$).

## 3 Parameterisation and simulation

Aguiar and Gopinath (2004a) estimate the variability and persistence of temporary and permanent shocks to productivity for Canada and Mexico, as notionally 'typical' output processes of industrialised and emerging market economies respectively. Our model is an endowment economy, so we use these parameters directly in the $\{F, Q\}$ matrices that govern our output process. We employ the 'Mexico' parameters as our baseline, and compare them to the 'Canada' parameters solely to examine the effect that having an 'EME-like' income process has on optimal fiscal policy. We do not suggest that our results have particular relevance for these countries, but rather interpret them as illustrating the policy implications of a stylised difference between emerging market and industrialised economies.

The familiar parameters $\{r_f, \beta, \overline{g}\}$ are set at standard values from the literature. We experiment with different values of the non-standard parameters $\{\kappa, \sigma^2_{\eta^e}\}$,[10] and check the sensitivity of results with respect to $\theta$. Values for all parameters, and the resulting non-stochastic steady-state values of $\{d, pb\}$ are shown in Appendix A.We generate the impulse response functions with the following procedure. First, we set a value for the initial impulse vector $\upsilon_1$ and generate associated series for the observable exogenous variables $\{x_t\}_{t=1}^T$ with equations **(7)** and **(8)**. Second, using $\{x_t\}_{t=1}^T$, we generate $\left\{x_{t|t-1}, \widehat{\xi}_{t|t}\right\}_{t=1}^T$ with equations **(10)** and **(9)**. Finally, we use $\left\{x_{t|t-1}, \widehat{\xi}_{t|t}\right\}_{t=1}^T$, the debt transition equation **(3)** and the approximated policy function **(13)** to generate the remaining elements of $\left\{pb_t, \chi_t\right\}_{t=1}^T$. With random draws of $\{\upsilon_t, w_t\}_{t=1}^T$, this method produces simulations from which we can calculate simulated sample moments.

## 4 Results

Our results consist of policy functions, impulse response functions, simulated sample moments and welfare analysis. We discuss each in turn.

(10) The baseline value for $\kappa$ was chosen to yield a steady-state debt level under the 'safe' debt limit determined in Reinhart *et al* (2003) within the range of risk-aversion parameters we consider.

### *4.1 Policy functions*

In terms of equation **(13)**, the baseline policy rule is calculated to be

$$
\begin{aligned}
\widetilde{\widetilde{pb}}_t \quad = \quad & 0.0043 + \left(\chi_t - \overline{\chi}\right)' \begin{pmatrix} 0.32 \\ -0.03 \\ 0 \\ 0.03 \\ 0.16 \\ 0 \\ -1.24 \end{pmatrix} \\
& + \frac{1}{2}\left(\chi_t - \overline{\chi}\right)' \begin{pmatrix} 0.79 & -0.28 & 0 & 0.28 & -0.16 & 0 & 1.00 \\ -0.28 & 0.01 & 0 & -0.01 & 0.02 & 0 & -0.14 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.28 & -0.01 & 0 & 0.01 & -0.02 & 0 & 0.14 \\ -0.16 & 0.02 & 0 & -0.02 & 0.11 & 0 & -0.44 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1.00 & -0.14 & 0 & 0.14 & -0.44 & 0 & 1.99 \end{pmatrix} \left(\chi_t - \overline{\chi}\right) \\
& + \frac{1}{2}\sigma^2 (0.00555)
\end{aligned}
\qquad \textbf{(14)}
$$

Table A shows the how the non-stochastic steady-state debt-GDP ratio depends on the parameters $\{\theta, \kappa\}$, for which our baseline values are 2 and 5 respectively. The table shows that $d^*$ is increasing in $\theta$ – a higher $\theta$ implies a lower intertemporal elasticity of substitution – and decreasing in $\kappa$, because a higher $\kappa$ raises both the level and the sensitivity of the interest rate at a given level of the debt-GDP ratio, such that current and future marginal utilities of consumption are balanced at a lower debt level. By definition, it is invariant with respect to the parameters $\left\{F, Q, \sigma^2_{\eta^e}\right\}$.

Table B shows the computed derivatives of the policy function (ie the optimal primary balance) with respect to the debt-GDP ratio $d$. The positive first derivative indicates that the primary balance rises in response to positive shocks to the debt-GDP ratio. The positive second derivatives

**Table A: Non-stochastic steady-state debt-GDP ratio**

| $\theta$ | $\kappa$ | $d^*$ |
|---|---|---|
| 2 | 1 | 69.2% |
| **2** | **5** | **13.8%** |
| 6 | 1 | 128.2% |
| 6 | 5 | 25.6% |

show that reactions become increasingly aggressive the further debt strays above $d^*$; below $d^*$, the optimal policy reaction is weaker. Policy reaction is much stronger for high values of the debt intolerance parameter $\kappa$, whereas the effect of $\theta$ seems to be small and ambiguous (ie it depends on the values of other parameters).

**Table B: Derivatives of policy function with respect to the debt-GDP ratio**

| $\theta$ | $\kappa$ | $f_d$ | $f_{dd}$ |
|---|---|---|---|
| 2 | 1 | 0.15 | 0.07 |
| **2** | **5** | **0.32** | **0.79** |
| 6 | 1 | 0.15 | 0.08 |
| 6 | 5 | 0.29 | 0.73 |

The derivatives of the policy function with respect to $\sigma$, the parameter that indexes the size of the shocks in model, show how the introduction of uncertainty affects the average level of the primary balance. Schmitt-Grohe and Uribe show that the first derivative $f_\sigma$ must be zero (ie uncertainty has no effect on the first-order approximation of a policy function), but that the second derivative $f_{\sigma\sigma}$ may be non-zero.(11) The result that first-order approximations omit the effect of uncertainty on policy functions is familiar.

Table C shows that these derivatives are in general positive in our model – other things equal, uncertainty requires fiscal policy to be tightened.(12) For example, with Mexican output parameters and other parameters at baseline values, the effect of uncertainty is to tighten the quarterly primary balance by 0.6% of annual GDP (2.4% of GDP in annualised terms), other things equal. Table D quantifies this effect in terms of the resulting percentage reduction in the steady-state debt-GDP ratio. It is noteworthy that adding volatility to the gross return on debt

(11) The cross-partial derivatives $f_{\sigma x}$ are also zero so, up to a second-order approximation, introducing uncertainty has no effect on the optimal response to the state variables.
(12) Simulations in which the signal noise is set very low (effectively zero) illustrate the case where the only source of uncertainty are the standard shocks to growth and interest rates, with virtually no uncertainty about the contemporaneous states.

appears to make only a very small difference to this effect. The tightening required is 2-3 many times larger for the higher value of the risk-aversion parameter $\theta$, but about two thirds smaller for the higher value of the debt-intolerance parameter $\kappa$. This may be due to the higher non-stochastic steady-state value of $d$ at high $\theta$, low $\kappa$ configurations.

**Table C: Derivatives of policy function with respect to uncertainty**

| | | | Mexico | Canada | Mexico | Canada |
|---|---|---|---|---|---|---|
| $\theta$ | $\kappa$ | $\sigma_e$ | $\sigma_r = 0$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ | $\sigma_r = 5\%$ |
| 2 | 1 | 0.1% | 1.6% | 0.2% | 1.7% | 0.3% |
| **2** | **5** | **0.1%** | **0.6%** | **0.1%** | **0.6%** | **0.1%** |
| 2 | 1 | 10% | 1.6% | 0.2% | 1.7% | 0.3% |
| **2** | **5** | **10%** | **0.6%** | **0.1%** | **0.6%** | **0.1%** |
| 6 | 1 | 0.1% | 5.0% | 0.5% | 5.5% | 1.0% |
| 6 | 5 | 0.1% | 1.6% | 0.2% | 1.7% | 0.2% |
| 6 | 1 | 10% | 5.1% | 0.7% | 5.5% | 1.2% |
| 6 | 5 | 10% | 1.7% | 0.2% | 1.7% | 0.3% |

**Table D: Effect of introducing uncertainty on the steady-state debt-GDP ratio**

| | | | Mexico | Canada | Mexico | Canada |
|---|---|---|---|---|---|---|
| $\theta$ | $\kappa$ | $\sigma_e$ | $\sigma_r = 0$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ | $\sigma_r = 5\%$ |
| 2 | 1 | 0.1% | 91% | 99% | 91% | 99% |
| **2** | **5** | **0.1%** | **93%** | **99%** | **93%** | **99%** |
| 2 | 1 | 10% | 91% | 99% | 91% | 98% |
| **2** | **5** | **10%** | **93%** | **99%** | **93%** | **99%** |
| 6 | 1 | 0.1% | 79% | 98% | 77% | 96% |
| 6 | 5 | 0.1% | 86% | 99% | 86% | 98% |
| 6 | 1 | 10% | 79% | 97% | 77% | 95% |
| 6 | 5 | 10% | 86% | 98% | 86% | 98% |

A key result here is that the uncertainty in the ‘EME’ output process necessitates a tightening of fiscal policy several times greater than that in the ‘industrialised country’ process. This result appears to be attributable to the greater volatility of trend growth shocks in EMEs; calculating $f_{\sigma\sigma}$ for different configurations of $\{F, Q, R\}$ suggests that increasing the size and persistence of trend growth shocks has a much larger effect on $f_{\sigma\sigma}$ than similar increases in the corresponding ‘output gap’ parameters. The intuition for this result is that growth-rate shocks affect the location of the stochastic trend of output, and therefore have a much larger effect on permanent income uncertainty than output gap shocks.

It is noteworthy that increases in the signal noise and the variability of the gross return on debt seem to require only a small reduction in the debt-GDP ratio. Table E shows that $\varepsilon^r$ shocks cause a somewhat larger reduction in the debt-GDP ratio if they are negatively correlated with the $\eta^g$ trend growth shocks (which is plausible), particularly if risk aversion is high and debt intolerance low; any correlation between $\eta^y$ output gap and $\varepsilon^r$ shocks has a much smaller effect.[(13)]

**Table E: Effect of correlation between real exchange rate shocks and output growth components**

| | $Corr\ [\varepsilon^r, \varepsilon^y]$ | $Corr\ [\varepsilon^r, \varepsilon^g]$ | $\boldsymbol{\theta = 2}$ $\boldsymbol{\kappa = 5}$ | $\theta = 2$ $\kappa = 1$ | $\theta = 6$ $\kappa = 5$ | $\theta = 6$ $\kappa = 1$ |
|---|---|---|---|---|---|---|
| $\sigma_r = 0$ | 0 | 0 | **-6.7%** | -8.8% | -13.7% | -21.1% |
| $\sigma_r = 5\%$ | 0 | 0 | **-6.8%** | -9.2% | -14.1% | -23.2% |
| | -0.8 | 0 | **-6.8%** | -9.4% | -14.3% | -23.9% |
| | 0.8 | 0 | **-6.6%** | -9.0% | -13.6% | -22.1% |
| | 0 | -0.8 | **-7.0%** | -11.1% | -15.8% | -31.5% |
| | 0 | 0.8 | **-6.6%** | -7.4% | -12.4% | -15.0% |

The derivatives of the policy function with respect to the state variables other than debt are harder to interpret in this fashion. For example, a shock to the output gap will affect both $\Delta y$ and $\widehat{\xi}_{t|t}$, so the initial policy reaction to the shock will be some combination of the respective elements of $f_\chi$ that will depend on the algorithm for updating $\widehat{\xi}_{t|t}$.

### *4.2 Impulse response functions*

To illustrate the basic properties of the model, Chart 3 shows the response of the primary balance to a 5 percentage points shock to the debt-GDP ratio for different values of the debt-intolerance and risk-aversion parameters. As we would expect, the corrective response is sharper when ‘debt intolerance’ is higher.

Chart 4 shows the response of the primary balance to a shock to the measurement error on the output gap. The policymaker initially tightens fiscal policy, as her signal suggests that the output gap has increased. When it becomes clear that this is not the case, policy is relaxed, relative to the baseline, to bring the debt-GDP ratio back to its steady-state level. As one would expect, the magnitude of the response is decreasing in the variance of the measurement error shock.

(13) In the table we have set $\sigma^e = 1\%$.

**Chart 3: Response of primary balance to debt-GDP ratio shock**

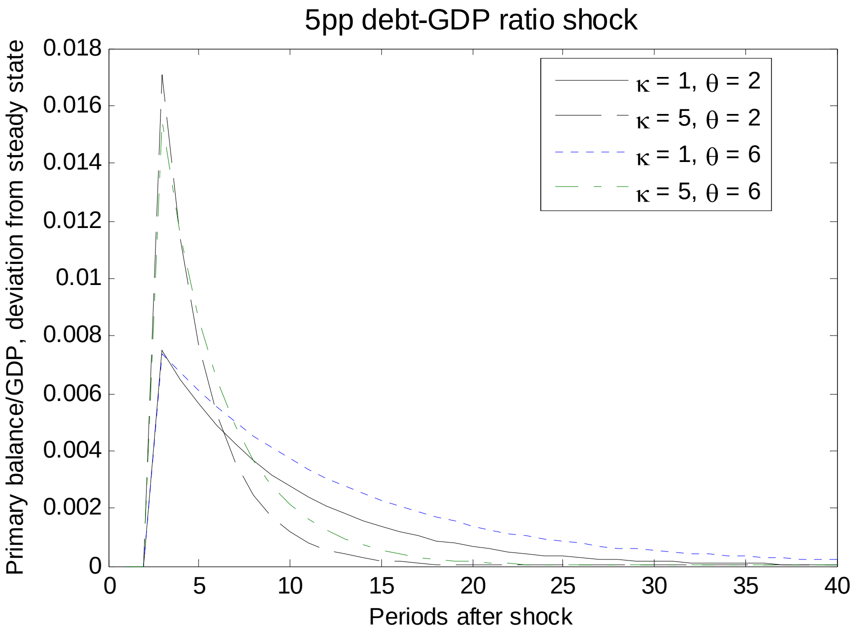



**Chart 4: Response of primary balance to measurement error shock**

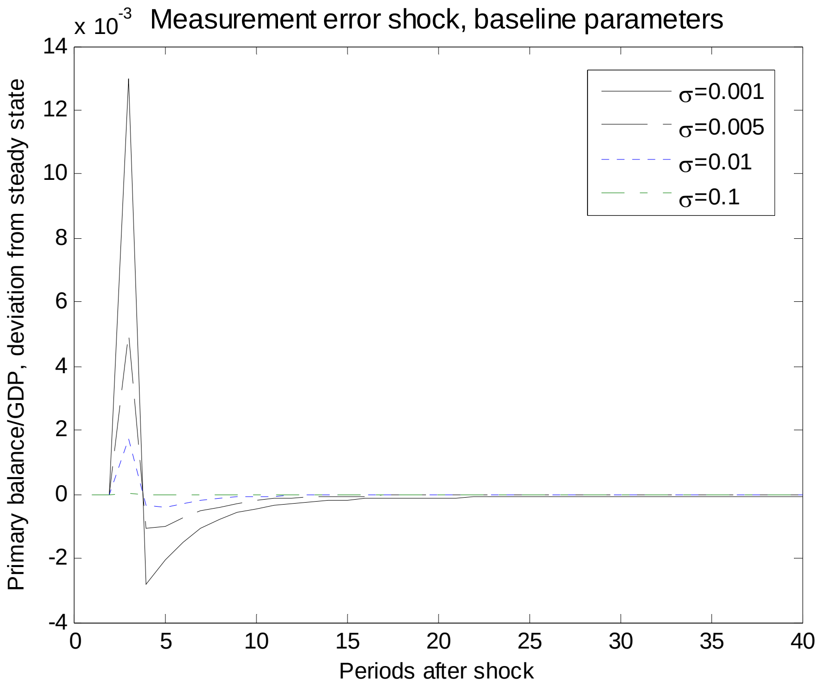
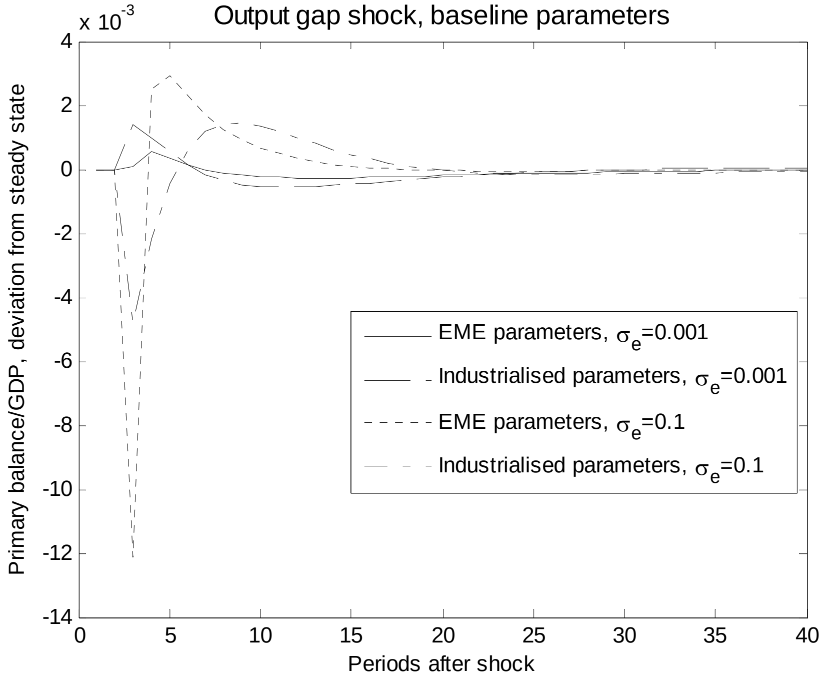


**Chart 5: Impulse response of primary balance, output gap parameters, baseline parameters**

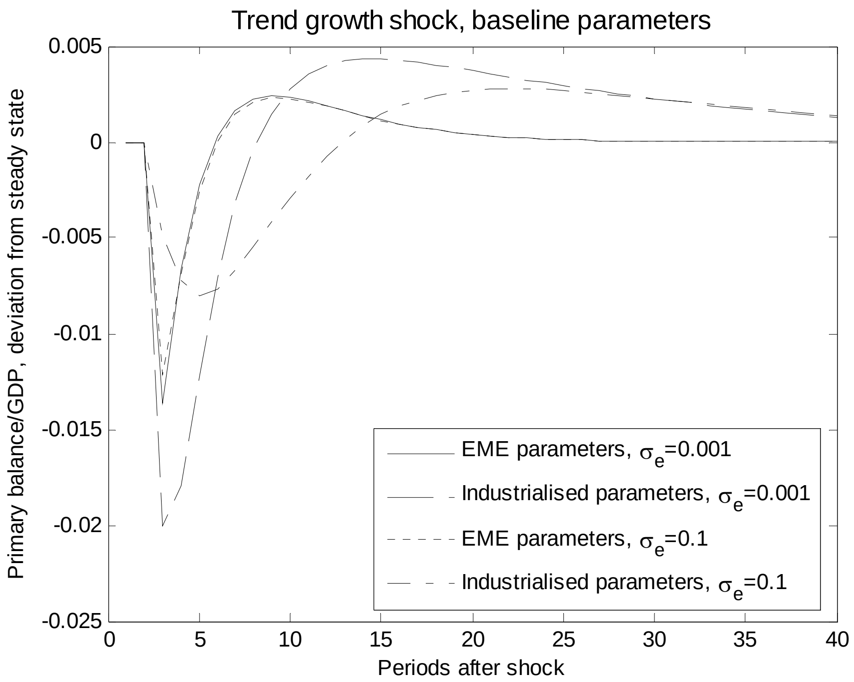



Our main exercise here is to compare optimal fiscal policy responses to 'output gap' and growth shocks, and examine how these responses vary when the information available to the policymaker changes. Chart 5 shows the optimal responses to 1% positive shock to the stationary component of output,[14] for varying degrees of information precision. We see that, in all but the lowest signal noise case, a positive shock to the output gap initially generates a relaxation in fiscal policy: the policymaker assumes that part of the movement in output reflects higher trend growth, and the resulting impulse to relax fiscal policy dominates the motivation to tighten it in response to the part that is attributed to the positive output gap. As time passes and the policymaker realises that trend growth has in fact not increased, she moves to tighten fiscal policy in order to save the temporarily high output and to return the debt-GDP ratio back to its target level. Chart 6 shows that a positive growth-rate shock causes a relaxation in fiscal policy, however precise the policymaker's information is.

These results are robust to changes in the risk-aversion and 'debt-intolerance' parameters: increasing $\theta$ to 6 makes essentially no difference to the impulse response functions, whereas reducing $\kappa$ to unity makes policy conditional on both shocks a little more countercyclical. So it

(14) That is, output rises 1% above the stochastic trend.

**Chart 6: Impulse response of primary balance, trend growth shock, baseline parameters**




seems that, under the EME parameterisation, the costs of observing fast growth, assuming it to be a stationary shock when in fact it is higher trend growth, and erroneously tightening fiscal policy outweigh the costs of the converse error. These results are not sensitive to $\sigma_r$, the volatility of the gross return on debt (the shock $\varepsilon^r$ affects only $d_t$ among the state variables, and $f_{\chi\sigma}$ is zero so the policy response to other state variables is unchanged). Note that an $\varepsilon^r$ shock will have the same effect as an appropriately scaled shock to the debt-GDP ratio.

It is interesting to see how these results vary when we change the output process to resemble that of a 'typical' industrialised country – that is, a process with less conditional volatility in the trend growth rate (although also with a little less persistence in the output gap and more in the growth rate). Charts 5 and 6 present the analogous impulse response functions for this case. We see that responses to output gap shocks are generally more countercyclical for any given degree of information precision: with very precise information, a strongly countercyclical response is elicited, whereas responses are more procyclical with less precise information. Conversely, a growth-rate shock elicits a even stronger procyclical response than in the EME case, because the growth rate is more persistent. With less precise information, the procyclical response is more cautious: relative to the EME case, the policymaker places greater weight on the possibility that the shock is temporary.

What can we conclude from this? When the policymaker can distinguish between output gap and trend growth shocks, she responds countercyclically to the former and procyclically to the latter, as we would expect. As we weaken the direct signal that the policymaker receives about the output gap, the policymaker cannot perfectly identify the source of the shock to growth, and assumes that it is a bit of both. Given this uncertainty, the motivation to bring forward what may be higher permanent income from potentially faster trend growth outweighs the desire to save from what may be temporarily high output.

All the above impulse responses correspond to perturbations from the steady state. Does the cyclical response of fiscal policy differ when the debt-GDP ratio is away from the steady state? Charts 9, 10 and 11 compare the marginal policy response close to the steady state to the case where the debt-GDP ratio starts 5 percentage points above the steady state.

Chart 9 suggests that, when information is precise, the countercyclical response to an output gap shock is attenuated if debt is above the steady state. But Chart 10 indicates that the response to a trend growth rate shock is little changed. Chart 11 shows that, if information is imprecise, the response to an output gap shock is also little changed; as above, this response is intially dominated by the optimal response to a trend growth shock, which is seen to be little different between the two cases. This suggests that if debt is above the steady state, policy should be less countercyclical in response to output gap shocks, if they can be correctly identified.

### *4.3 Simulated sample moments and welfare analysis*

In light of the above results, we might expect policy to be more procyclical (in the sense that the primary balance should be negatively correlated with ‘good times’) in economies with EME output processes than policy in economies with ‘industrialised’ output processes. To check this, we simulate the model and examine sample moments. Table F shows that the covariance between the primary balance and output growth is indeed more negative for the EME output process, and broadly increasing in the imprecision of direct information about the output gap.

However, a better measure of the cyclicality of fiscal policy is the correlation between the primary

**Chart 7: Impulse response of primary balance, output gap shock and industrialised country parameters**

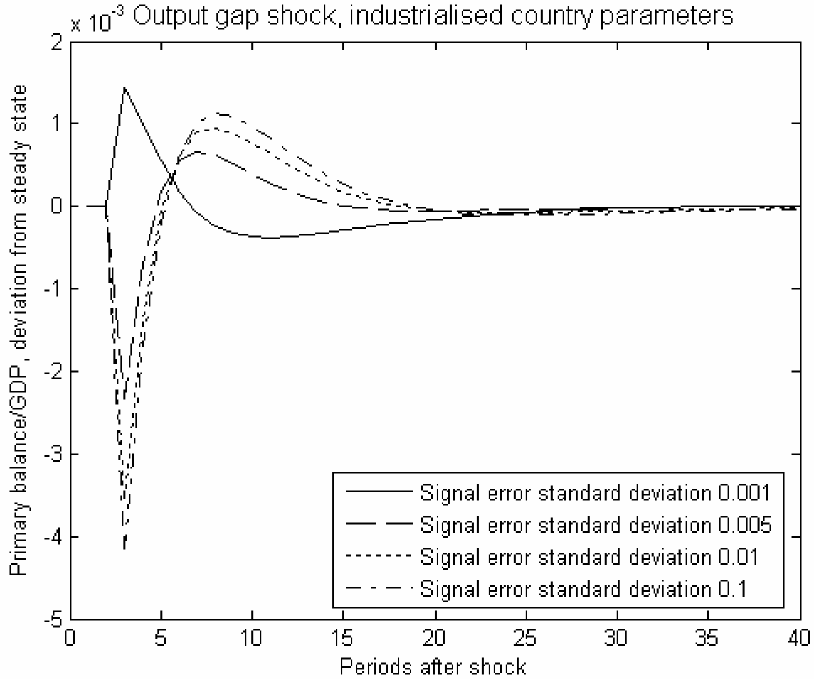
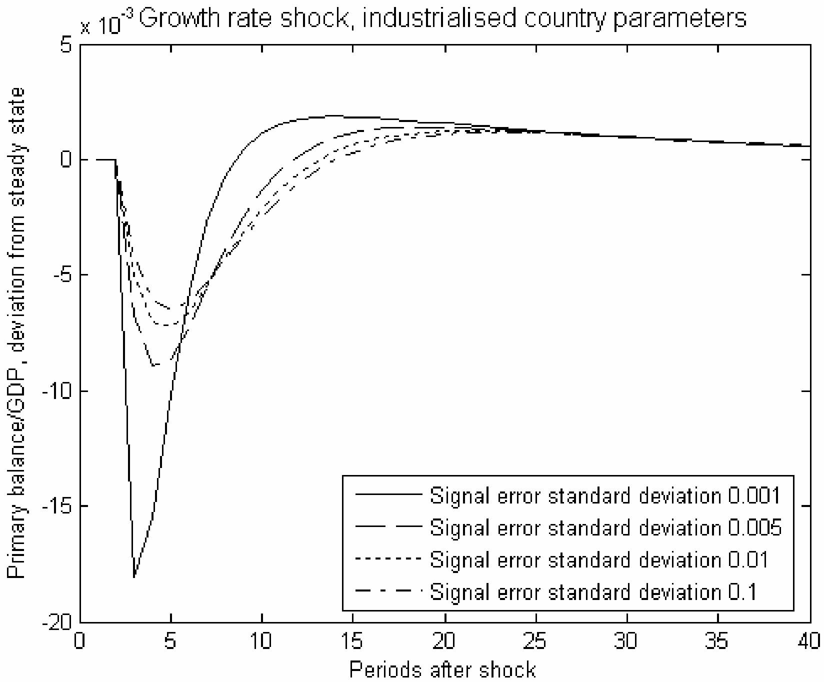
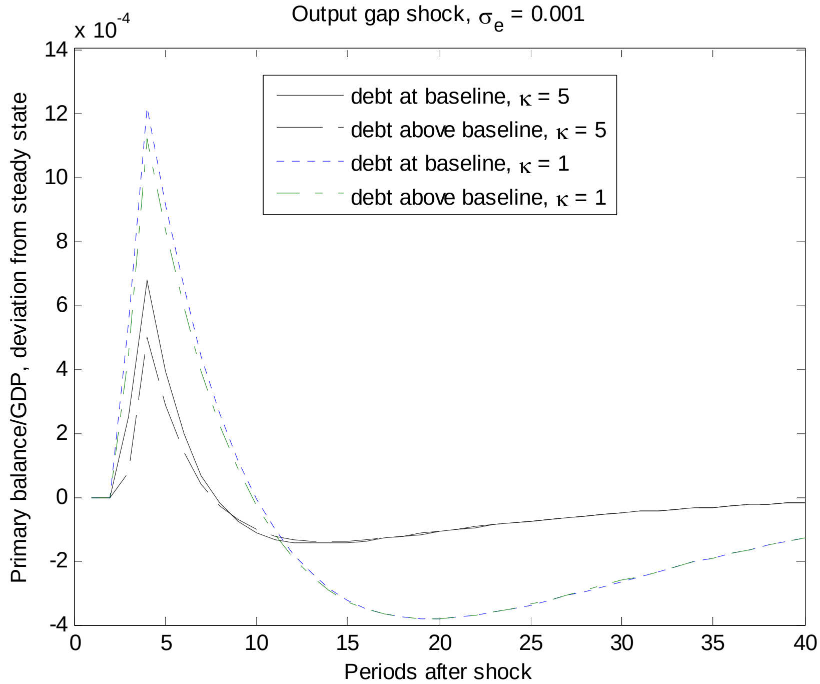



**Chart 8: Impulse response of primary balance, growth rate shock and industrialised country parameters**



## Chart 9: Output gap shocks, low signal noise




## Chart 10: Trend growth shocks, low signal noise

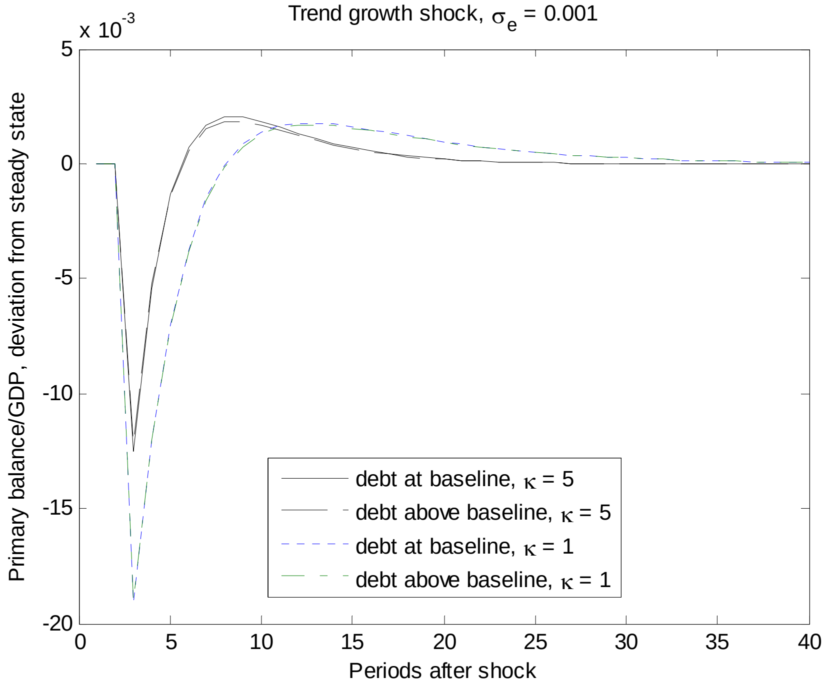


**Table F: Correlation of primary balance with output growth**

| | EME | | Industrialised | |
|---|---|---|---|---|
| $\sigma_e$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ |
| 0.1% | -0.70 | -0.71 | -0.05 | -0.05 |
| 1% | -0.75 | -0.74 | -0.66 | -0.51 |
| 10% | -0.77 | -0.76 | -0.72 | -0.56 |

balance-GDP ratio and detrended output.[15] The statistics reported in Table G shows that this is positive (ie optimal fiscal policy would appear countercyclical to an econometrician) under the baseline parameterisation, albeit marginally less so than under an industrialised country output process. Reducing the precision of information available to the policymaker makes 'EME' policy somewhat less countercyclical, but dramatically less so for the 'industrialised country' parameters. At first sight, these results seem to conflict with the impulse response functions presented above, which show a large procyclical response to trend growth shocks and, at most, a small countercyclical response to output gap shocks. However, detrending output with a Hodrick-Prescott filter removes much of the fluctuation in the stochastic trend from the data, leaving the detrended correlation dominated by the countercyclical policy response to the output gap.

**Table G: Correlation of primary balance with detrended output – summary table**

| | EME | | Industrialised | |
|---|---|---|---|---|
| $\sigma_e$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ |
| 0.1% | 22.0% | 20.7% | 28.3% | 27.6% |
| 1% | 18.4% | 19.7% | -2.5% | -7.5% |
| 10% | 17.2% | 17.6% | -32.1% | -23.1% |

Table H reports the results for a variety of parameterisations. Reducing debt intolerance makes policy more procyclical: it may be that when interest rates are lower and less sensitive to indebtedness, it is less costly to bring forward the higher permanent income resulting from a growth-rate shock, so policy would respond more. Higher risk aversion (or equivalently a lower intertemporal elasticity of substitution) seems to reduce the countercyclicality (drastically so in the industrialised-country case). In each case, the varability in the statistics across simulations is high, with the 5th and 95th percentiles as much as 20 percentage points away from the reported mean

(15) Output is detrended with an HP filter, so our measure of the trend depends only on observable variables. The smoothing parameter set at the standard value $\lambda = 1600$.

value for any given parameterisation; this is the essence of the result in Aguiar and Gopinath (2004a).[16] Simulating the system with only a first-order approximation to the policy function generally raises the correlation by around 3-5 percentage points (see table in Appendix B); this suggests that omitting second-order terms from the policy function biases the results towards countercyclicality.

**Table H: Correlation of primary balance with detrended output**

| | | | EME | | Industrialised | |
|---|---|---|---|---|---|---|
| $\theta$ | $\sigma_e$ | $\kappa$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ | $\sigma_r = 0$ | $\sigma_r = 5\%$ |
| 2 | 0.1% | 1 | -0.9% | 0.9% | 23.5% | 18.9% |
| **2** | **0.1%** | **5** | **22.0%** | **20.7%** | **28.3%** | **27.6%** |
| 2 | 10.0% | 1 | -5.1% | -3.2% | -47.6% | -32.3% |
| **2** | **10.0%** | **5** | **17.2%** | **17.6%** | **-32.1%** | **-23.1%** |
| 6 | 0.1% | 1 | -6.4% | -7.9% | 15.6% | 8.3% |
| 6 | 0.1% | 5 | 20.2% | 17.1% | 29.4% | 20.2% |
| 6 | 10.0% | 1 | -12.1% | -12.0% | -46.4% | -22.9% |
| 6 | 10.0% | 5 | 15.3% | 15.9% | -33.0% | -24.6% |

Changing the nature of the output process and the precision of information both appear to have a significant effect on the impulse response function. But are these effects significant in utility terms? Put another way, what are the welfare costs if the policymaker follows the wrong policy? To quantify this, we simulate the model for 400 periods, 100 times, calculate average realised utility and express it in units of certainty-equivalent consumption.[17] To get an idea of how material the difference between the 'EME' and 'industrialised' policies is, we calculate the welfare loss to the EME of running the policy that would be appropriate if it had the industrialised-country output process. The results, shown in Table I, suggest that at baseline parameter values for risk aversion and the interest rate function, welfare costs of running the wrong policy are a little below 1% of certainty-equivalent consumption. These costs are roughly tripled if we increase the coefficient of relative risk aversion from 2 to 6.[18] The combination of high risk aversion and an inelastic interest rate function increases the utility costs of this inappropriate policy further.

(16) Their model includes net exports, and focuses on net exports (external balance less factor payments) rather than the primary balance (public sector balance less factor payments).

(17) That is, the constant stream of consumption that yields the same utility. The utility function is $U_t = \frac{1}{1-\theta} \Sigma_{s=0}^{\infty} \beta^s C_{t+s}^{1-\theta}$ so for average realised utility $\overline{U}$ we calculate $C_{equiv} = \left( \frac{\overline{U}(1-\theta)}{\Sigma_{s=0}^{\infty} \beta^s} \right)^{\frac{1}{1-\theta}}$. We place a ceiling of 80% on the primary balance to GDP ratio to proxy for a subsistence level of consumption when realisations are adverse enough to cause default.

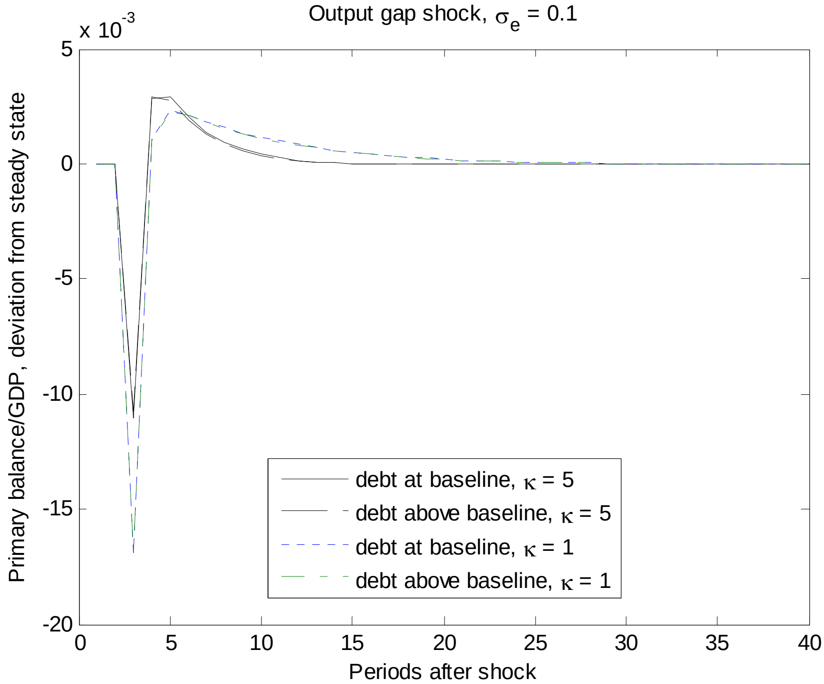
(18) This experiment is intended to proxy for an increase in the sensitivity of utility to aggregate risk. Studies that attempt to measure the utility cost of aggregate risk from the observed level of the equity risk premium have obtained values for this parameter in double figures.

Table I also shows the welfare loss of running a rule-of-thumb policy that holds the debt-GDP ratio stable every period. These costs are nearly an order of magnitude lower, at around 0.1% of certainty-equivalent consumption. This is in line with the well-known result (see eg Lucas (2003)) that the welfare gains from stabilising consumption around trend in models such as these is very small, of the order of 0.01%-0.1% of certainty-equivalent consumption. Furthermore, both the optimal rule and the rule of thumb prescribe a relaxation of fiscal policy in response to trend growth shocks, the main source of uncertainty for the EME policymaker. Finally, the table shows that the welfare cost of omitting second-order terms from the policy function is negligible, unless risk aversion is high and debt intolerance low.

**Table I: Welfare loss from suboptimal policy**

| | | | Welfare loss | | |
|---|---|---|---|---|---|
| $\theta$ | $\kappa$ | $\sigma_e$ | Industrialised country policy | Constant D/Y policy | First-order policy |
| 2 | 5 | 0.1% | -0.7% | -0.1% | 0.0% |
| 2 | 5 | 10.0% | -0.7% | -0.1% | 0.0% |
| 6 | 5 | 0.1% | -1.6% | -0.2% | 0.0% |
| 6 | 5 | 10.0% | -1.9% | -0.2% | -0.1% |
| 6 | 1 | 0.1% | -2.3% | -0.4% | -0.5% |
| 6 | 1 | 10.0% | -8.2% | -0.9% | -0.5% |

## Chart 11: Output gap shocks, high signal noise



## 5 Conclusion

This paper is concerned with how an optimising EME sovereign should set fiscal policy so as to smooth consumption, and whether such a policy would appear pro or countercyclical to an econometrician. Our results should not be intepreted as directing specific fiscal policy implications at any particular emerging market: we use Mexico in the simulations purely as a clear example of a country with an output process that exhibits typical 'EME' characteristics.

We find that risk-averse policymakers should run substantially tighter fiscal policies when faced with 'EME' output processes (ie more volatile trend growth rates). In our baseline parameterisation, uncertainty reduces the average debt-GDP ratio by around 10% in EMEs, whereas the reduction is an order of magnitude lower for industrialised-country output processes. These results are broadly robust to increases in risk aversion and the precision of information about the components of output, and to varying degrees of 'debt intolerance'. In all cases, and particularly when the interest rate is sensitive to the debt-GDP ratio, the primary fiscal balance should respond strongly to disequilibria in the debt-GDP ratio, at an increasing rate as the ratio moves further from its steady-state level.

We find that the fiscal policy of an optimising EME policymaker will be countercyclical on conventional measures, in our baseline parameterisation. This is despite the fact that policymakers respond procyclically to trend growth shocks, and even initially respond procyclically to output gap shocks when information on the source of the shock is imprecise. Detrending output with a Hodrick-Prescott filter takes much of the fluctuation in the stochastic trend out of the data, leaving the correlation dominated by the countercyclical policy response to the output gap.

The welfare costs of naively running a fiscal policy that would be appropriate for an industrialised country are around 1% of certainty-equivalent consumption, but are sensitive to assumptions about capital markets and risk aversion. This suggests that policymakers should be careful in simply transferring fiscal policy prescriptions from industrialised countries to emerging markets. We find that a simple rule-of-thumb policy entails rather small welfare losses, of the order of 0.1% of certainty-equivalent consumption, relative to the optimum.

Within the existing literature, our model is perhaps most closely comparable to the one in Aguiar and Gopinath (2004a). They find that net exports (the analogue of the fiscal balance in our model, given our assumptions about the behaviour of the private sector) in an EME populated by optimising agents should be procyclical, because the shocks such economies face are predominately to the trend growth rate. In contrast, we find that the optimal fiscal balance rule will appear countercyclical. We relax the strong assumption that temporary and permanent shocks to the stochastic trend of output can be distinguished in real time, requiring instead that the agent filters the data as best she can (as in Miniane (2004)). But this does not account for the discrepancy, because it remains when information on the source of the shock is very precise. Another key difference is that our model omits investment; the cyclical behaviour of investment flows, and their impact on output, may account for the difference in results.

Further work could usefully examine the robustness of our results to alternative assumptions about monetary policy, the utility function, the output process (particularly its exogeneity with respect to fiscal policy), the denomination of debt, and private sector access to capital markets.

## Appendix A: Parameter values

| Variable | Symbol | Value |
|---|---|---|
| Risk-free interest rate (annualised) | $r_f$ | 3% |
| GDP growth (annualised) | $\overline{g}$ | 3.5% |
| Subjective discount factor (annualised) | $\beta$ | 0.97 |
| Coefficient of relative risk aversion | $\theta$ | 2 |
| Parameter determining shape of risk premium function | $\kappa$ | 5 |

| Parameter | EME | Industrialised |
|---|---|---|
| $\rho_\varepsilon$ | 0.94 | 0.88 |
| $\rho_g$ | 0.72 | 0.94 |
| $\sigma^2_{\eta^\varepsilon}$ | 0.0041 | 0.0057 |
| $\sigma^2_{\eta^g}$ | 0.0109 | 0.0014 |

## Appendix B: Policy cyclicality for first-order policy function

| | EME | | Industrialised | |
|---|---|---|---|---|
| $\sigma_e$ | $\sigma_r = 0$ | $\sigma_r = 5$ | $\sigma_r = 0$ | $\sigma_r = 5$ |
| 0.1% | 24.5% | 25.1% | 36.2% | 30.4% |
| 0.5% | 22.3% | 21.1% | -1.2% | -2.8% |
| 10.0% | 21.8% | 20.2% | -25.6% | -19.8% |

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