Optimal Fiscal and Monetary Rules in Normal and Abnormal Times

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Introduction

- The previous paper presented a NK model with Rotemberg price stickiness and convex investment adjustment costs augmented with deep habit formation.
- We refine the fiscal sector in that the government finances its expenditures by raising *distortionary taxes* and by issuing government bonds.
- In addition, we allow for a *sovereign risk* to generate a premium in the interest payments paid by the government.
- Again we study the welfare-optimal (Ramsey) policy, a time-consistent (discretionary) policy and optimized simple Taylor type rules involving both monetary (the nominal interest rate) and fiscal instruments (taxes and government spending).
Extended Model: Government Debt

- A no-defaulting government raising real bonds of value $b_t^G$ with nominal return $R_t^g$ faces a budget constraint in real terms

$$b_t^g = \frac{R_{t-1}^g b_{t-1}^g}{\Pi_t} + G_t - T_t,$$

whereas the household also holding real private bonds, $b_t$, with nominal return $R_t$, has a budget constraint

$$b_t + b_t^g + \text{other exp} = R_{t-1} \frac{b_{t-1}}{\Pi_t} + \Psi_{t-1} R_{t-1}^g \frac{b_{t-1}^g}{\Pi_t} + \text{other income}$$

- By arbitrage $R_t^g = \Psi_t R_t$; i.e., $\Psi_t$ is a risk premium which is $1/(\text{prob default})$.

- Assume $\Psi_t = \exp\left(\phi \frac{b_t^g}{Y_t}\right)$ similar to [Corsetti et al.(2011)]. Choose an extreme calibration of $\phi$. 
Extended Model: Taxes

- Total taxes are given by
  \[ T_t = \tau_t^C C_t + \tau_t^W w_t n_t h_t + \tau_t^K R_t^k K_t^p + \tau_t^L \]

- To reduce the number of tax instruments to one, we impose that \( \tau_t^C, \tau_t^W, \tau_t^K \) and \( \tau_t^L \) deviate from their steady state by the same proportion (i.e. \( \tau_t^C = \bar{\tau}^C, \tau_t^W = \bar{\tau}^W \) etc) and the proportional uniform tax change \( \tau_t \) is our tax instrument.

- Tax rates in the steady state are \( \tau_C = \tau_W, \tau^L = \tau_K = 0 \), an empirical compromise to the Ramsey steady state. Therefore large distortions remain.

- With this steady-state tax structure, the Ramsey steady state of the non-linear optimization about which we formulate a LQ approximation has \( b^g = \Pi = 0 \).
General Monetary and Fiscal Simple Rules

The rules in their most general form are

\[
\log \left( \frac{X_t}{X} \right) = \rho_x \log \left( \frac{X_{t-1}}{X} \right) + \rho_{x\pi} \ln \left( \frac{\Pi_t}{\Pi} \right)
\]

\[
+ \rho_{xy} \log \left( \frac{Y_t}{Y} \right) + \rho_{xB}(B_{t-1} - B)
\]

for instruments \( X = R, \tau, G \) with \( x = r, \tau, G \). \( \rho_x \in [0, 1] \), \( \rho_{ry}, \rho_{\tau y} \geq 0, \rho_{Gy} \leq 0, \rho_{TB} \geq 0, \rho_{GB} \leq 0 \).

Assignment Issues: Which Authority is Responsible for What?
We adopt the conventional assignment: \( \rho_{rB} = \rho_{\tau\pi} = \rho_{G\pi} = 0 \).

Active-Passive Policies ([Leeper(1991)]):

- Active Monetary, Passive Fiscal (standard assumption)
  \( \frac{\rho_{r\pi}}{1-\rho_r} > 1 \) (the Taylor Principle); \( \rho_{TB} > 0, \rho_{GB} < 0 \) (fiscal instrument stabilize debt)

- Passive Monetary, Active Fiscal (Leeper, [Cochrane(2011)])
  \( \frac{\rho_{r\pi}}{1-\rho_r} < 1 \) (the Taylor Principle not satisfied); \( \rho_{TB} = \rho_{GB} = 0 \).

Then the price level jumps to satisfy the government budget constraint - Fiscal Theory of the Price Level.
Stabilization Policy

Two aspects of monetary and fiscal optimal stabilization policy:

- **Policy for ‘normal times’.**
  - Design rules to minimize an *expected conditional welfare loss* subject to 4 shocks (preference, technology, investment, mark-up) starting at the steady state (ss).
  - Our ss is from the *non-linear Ramsey problem* about which we calculate a linearized model and quadratic loss function (LQ).
  - Problem is *purely stochastic*: optimal policy is in response to all future stochastic shocks hitting the economy.

- **Crisis Management**
  - Start far away from the ss of the debt-GDP ratio \( b_t/Y_t \).
  - Policy is required to both return the economy to the ss (a deterministic problem) and deal with future stochastic shocks (the stochastic problem).
  - With the LQ approximation *these two components conveniently decompose.*
Related Work

- **Normal Times:**
  - Exercise similar to [Schmitt-Grohe and Uribe(2007)] and [Kirsanova and Wren-Lewis(2012)] in a simpler model without habit at all, and [Leith *et al.*(2009)] in a similar model with deep habit.
  - None of these studies use an estimated model, compare commitment and discretion and impose a ZLB constraint.

- **Crisis Management:**
  - [Corsetti *et al.*(2011)] consider different speeds of consolidation in a very basic non-estimated NK model.
  - Optimal consolidation not examined.
Optimal Policy for Normal Times

- Assess contributions of all instruments together; government spending or taxes separately with monetary policy; monetary policy alone
- Simple rules can have passive or active fiscal policy (PF or AP)
- Report optimized simple rules
- The minimal welfare loss is reported as a consumption equivalent percentage increase above the optimal policy ($c_e$).

<table>
<thead>
<tr>
<th>Policy Mix</th>
<th>Rule</th>
<th>$[\rho_r, \rho_{r\pi}, \rho_{ry}]$</th>
<th>$[\rho_\tau, \rho_{\tau B}, \rho_{\tau y}]$</th>
<th>$[\rho_G, \rho_{GB}, \rho_{Gy}]$</th>
<th>Loss ($c_e$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Instruments</td>
<td>Optimal</td>
<td>not applicable</td>
<td>not applicable</td>
<td>not applicable</td>
<td>1.98 (0)</td>
</tr>
<tr>
<td>All Instruments</td>
<td>Time Cons</td>
<td>not applicable</td>
<td>not applicable</td>
<td>not applicable</td>
<td>3.43 (0.03)</td>
</tr>
<tr>
<td>All Instruments</td>
<td>Simple (PF)</td>
<td>[0.91, 5.00, 0.00]</td>
<td>[0.15, 0.25, 0.36]</td>
<td>[0.39, 0.25, 0.39]</td>
<td>2.19 (0.004)</td>
</tr>
<tr>
<td>All Instruments</td>
<td>Simple (AF)</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.44, 0.00, 0.50]</td>
<td>2.80 (0.02)</td>
</tr>
<tr>
<td>$R_t, T_t; G_t = G$</td>
<td>Simple (PF)</td>
<td>[1.00, 5.00, 0.00]</td>
<td>[0.62, 0.25, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>4.16 (0.04)</td>
</tr>
<tr>
<td>$R_t, T_t; G_t = G$</td>
<td>Simple (AF)</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.85, 0.00, 0.02]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>53.3 (1.02)</td>
</tr>
<tr>
<td>$R_t, G_t; T_t = T$</td>
<td>Simple (PF)</td>
<td>[0.89, 5.00, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.57, 0.25, 0.25]</td>
<td>2.26 (0.006)</td>
</tr>
<tr>
<td>$R_t, G_t; T_t = T$</td>
<td>Simple (AF)</td>
<td>[0.05, 0.00, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.44, 0.00, 0.50]</td>
<td>2.81 (0.02)</td>
</tr>
<tr>
<td>$R_t; \min T_t, G_t = G$</td>
<td>Simple (PF)</td>
<td>[1.00, 5.00, 0.00]</td>
<td>[0.00, 0.25, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>4.43 (0.05)</td>
</tr>
<tr>
<td>$R_t; T_t = T, G_t = G$</td>
<td>Simple (AF)</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>57.7 (1.11)</td>
</tr>
</tbody>
</table>

Table: 4. Optimal Interest Rate, Taxation and Gov Spending Rules and Welfare Outcomes.
With all three instruments:

1. The gains from commitment amount to $c_e = 0.03\%$ and almost all such gains can be achieved by an optimized simple rule with passive fiscal policy.

2. An optimized rule with active fiscal policy is worse than passive in welfare terms and consists of a constant interest and tax rates.

3. The optimized monetary rule with passive fiscal policy involves no response to output changes and with a very high degree of persistence is close to a price-level rule.
Comments: Switching off Instruments

The results from switching off the fiscal instruments one at a time indicate that:

1. Government spending is the more effective fiscal instrument.
2. With monetary policy alone and active fiscal policy all three tax instruments are held fixed at their steady states. Then it is left entirely to the price level to stabilize the economy and government debt in particular in the face of shocks.
3. This regime leads to the highest possible variances and welfare costs of $c_e = 1.11\%$ so we can conclude that this is a measure of the maximum cost of business cycle fluctuations.
4. Finally, apart from the case of simple rules with active fiscal policy, the standard deviation of the nominal interest rates are high indicating a zero lower bound problem. This we now turn to.
Optimal Policy for Normal Times: IRFs

Figure: IRFs for All Instruments: Technology Shock
Optimal Policy for Normal Times: IRFs

Figure: IRFs for Taxation Rule: Fiscal Stimulus (Gov Spending Shock)
Zero Lower Bound (ZLB) Constraint

- Table 5 in paper (page 14) gives high interest rate variances $\sigma_r^2$ implying a probability $p$ of hitting the ZLB $\in [0.14, 0.22]$.
- Impose a ZLB constraint that
  \[ \bar{R} \equiv E_0 [(1 - \beta) \sum_{t=0}^{\infty} \beta^t R_t] \geq k_r \sqrt{(R_t - \bar{R})^2} > 0 \]
- Equivalent to replacing the single period loss function terms in log-linearized variables is with \( L_t = y_t^T Q y_t + w_r (r_t - r^*)^2 \) where \( r^* \) is a nominal steady-state interest rate target. Do this only for computing the policy - then remove penalty from the welfare loss.
- For a given $\sigma_r$, the steady-state inflation rate that satisfies the ZLB constraint is given by $\pi^* = \max \left[ \frac{z_0(p)\sigma_r - R + 1}{R} \times 100, 0 \right]$ where $z_0(p)$ is the critical value of a standard normally distributed variable $Z$ such that $\text{prob} (Z \leq z_0) = p$.
- Optimal policy under the ZLB chooses an optimal combination $(w_r, \pi^*)$ - see Levine, McAdam and Pearlman (2008).
Imposing the ZLB: All Instruments with Commitment
Imposing the ZLB: All Instruments

<table>
<thead>
<tr>
<th>Rule</th>
<th>([\rho_r, \rho_{r\pi}, \rho_{ry}])</th>
<th>([\rho_\tau, \rho_{\tau B}, \rho_{\tau y}])</th>
<th>([\rho_G, \rho_{GB}, \rho_{Gy}])</th>
<th>Adjusted (c_e)</th>
<th>(w_r \times 10^{-3})</th>
<th>(\pi^*)</th>
<th>sd((R_t))</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPT</td>
<td>not applicable</td>
<td>not applicable</td>
<td>not applicable</td>
<td>2.09 (0.00)</td>
<td>6</td>
<td>0</td>
<td>0.36</td>
</tr>
<tr>
<td>TCT</td>
<td>not applicable</td>
<td>not applicable</td>
<td>not applicable</td>
<td>6.08 (0.08)</td>
<td>5</td>
<td>0.1</td>
<td>0.37</td>
</tr>
<tr>
<td>SIM(PF)</td>
<td>[1.00, 1.76, 0.00]</td>
<td>[0.51, 0.25, 0.07]</td>
<td>[0.63, 0.00, 0.23]</td>
<td>2.28 (0.002)</td>
<td>7</td>
<td>0</td>
<td>0.33</td>
</tr>
<tr>
<td>SIM(AF)</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.00, 0.00, 0.00]</td>
<td>[0.39, 0.00, 0.50]</td>
<td>3.40 (0.03)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table: 6. Imposing the Zero Lower Bound with All Instruments.

Note:

1. The imposition of the ZLB constraint *increases the gains from commitment* from \(c_e = 0.04\%\) to \(c_e = 0.08\%\).
2. The aggressive response of the nominal interest rate in the optimized simple rule with passive fiscal policy seen previously with no ZLB considerations now gives way to a far *more restrained stance*.
3. The interest rate regime is now a *pure price level rule*.
4. Alongside the *stochastic stabilization bias* of discretion we now see a deterministic *steady-state inflationary bias* of 0.1\% per quarter.
Crisis Management: How Fast, How Deep? IRFs for All Instruments following a Debt Shock

![Graphs showing various economic indicators like Output, Consumption, Investment, Government Debt/4GDP, Tax Rate, Mark-up, Inflation, Nominal Interest, Real Wage, Hours, Gov Spending, Fiscal Deficit/Y for different economic shocks and fiscal policies.]

- **Optimal**
- **TCT**
- **Simple (Passive Fiscal)**
- **Simple (Active Fiscal)**
Comments

1. From the inter-temporal welfare, there appears to be some support for slow consolidation in response to high initial debt. Along OPT the debt-GDP ratio falls by around 1% per year.

2. This consolidation is achieved using tax increases rather than a decrease in government spending.

3. If the government lacks commitment or must stick with the passive fiscal rules the optimal speed of fiscal consolidation is much faster.
Informational Assumptions

- Our informational assumptions are standard: The private sector has perfect information of all state variables including shocks and trend. The econometrician only observes data which excludes shocks and some state variables. The Ramsey policymaker must have perfect information to implement policy; but only to observe output, inflation and debt (and instruments) to implement simple rules.

- Let $I_{t}^{PS}$, $I_{t}^{PM}$, and $I_{t}^{Econ}$ be the information sets of the private sector, policymaker and econometrician respectively.

- Then have $I_{t}^{PS} = I_{t}^{PM} \supset I_{t}^{Econ}$ for the Ramsey problem and $I_{t}^{PS} \supset I_{t}^{Econ} \supset I_{t}^{PM}$ for simple rules.

- By contrast under informational consistency proposed by [Levine et al.(2012)], we have $I_{t}^{PS} = I_{t}^{PM} = I_{t}^{Econ}$ for the Ramsey problem and $I_{t}^{PS} = I_{t}^{Econ} \supset I_{t}^{PM}$ for simple rules.
Conclusions

- **Deep habit** crucially affects the fiscal transmission mechanism in that it leads to a counter-cyclical mark-up. This feature boosts the size of a output expansion or contraction with important consequences for monetary and fiscal policy.

- **Bayesian estimation** gives empirical support for deep as opposed to the more conventional ‘superficial’ habit and our estimated model produces fiscal multipliers in line with estimates from the SVAR literature.

- In **normal times** Simple rules with passive fiscal policy can mimic optimal policy. the ZLB increases the gains from commitment and introduces a deterministic steady-state inflationary bias alongside the stochastic stabilization bias of discretion.

- **Crisis management** consists of a carefully chosen degree of adjustment of fiscal policy towards the optimal long-run rules found for normal times. We find there some support for slow consolidation with the emphasis on tax increases rather than government decreases.
Future Research

- Rework with informational consistency
- Examine simple fiscal rules with 4-quarter horizons?
- Model with unemployment (see last paper in Conference).


Monetary and fiscal policy under deep habits.
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