

Fiscal Stimuli and Consolidations

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Smets-Wouters (2007) and beyond

- ▶ The size government spending multipliers, how long they last, the optimal timing of a fiscal retrenchment all require *quantitative models*
- ▶ Gold standard: SW07 - a RBC closed economy model with wage and price stickiness, habit in consumption, indexed Calvo contracts, capacity utilization and a Taylor rule
- ▶ Used extensively for studying monetary policy
- ▶ Being extended in many dimensions - e.g., a banking sector
- ▶ But is it suitable for fiscal policy?

A Model Fit for Purpose

- ▶ MP labour market frictions
- ▶ **deep habits (rather than superficial habits) in private and public consumption** $\Rightarrow$ empirical evidence on consumption, real wage and mark-up, following government spending expansion
- ▶ CES rather than CD production $\Rightarrow$ empirical evidence on time-varying factor shares

Reproduces fiscal multipliers in the high range of VAR studies and the observed joblessness of the recovery even in a flexi-price world ([Cantore *et al.*(2011)]).

- ▶ ZLB constraint
- ▶ Government Budget Constraint with a risk premium that increases with the government debt-income ratio as in [Corsetti *et al.*(2011)].
- ▶ A more developed fiscal side with government production (see [Pappa(2009)]).

Three Empirical Regularities

- ▶ So far, DSGE contributions analyzing fiscal stimulus in models with or without unemployment have produced fiscal multipliers *below* the range of estimated values.
- ▶ But they have also failed to match *three empirical regularities*.

After a government spending expansion:

1. **private consumption is crowded in** (Blanchard and Perotti (2002), Gali et al. (2007), Pappa (2009), Monacelli et al. (2010), Fragetta and Melina (2011));
2. **real wages rise** ((Pappa (2005), Gali et al. (2007), Caldara and Kamps (2008), Pappa (2009), Fragetta and Melina (2011));
3. the **price mark-up falls** (in RBC this is constant)(Monacelli and Perotti (2008) and Canova and Pappa (2011).

Deep Habits

Ravn et al. (2006) find that in an RBC model augmented with deep habits in consumption, a government spending shock:

- ▶ crowds in consumption;
- ▶ fosters the real wage;
- ▶ reduces the mark-up.

How does this work?

Deep Habits and the Fiscal Transmission Mechanism I

The utility of household j derives from a composite of private and public consumption goods. The private component is

$$(X_t^c)^j = \left[\int_0^1 (C_{it}^j - \theta^c S_{it-1}^c)^{1-\frac{1}{\eta}} di \right]^{\frac{1}{1-\frac{1}{\eta}}}, \quad (1)$$

where $\theta^c \in (0, 1)$ is the degree of deep habit formation on each variety and η is the elasticity of substitution between varieties.

S_{it-1}^c denotes the *stock of external habit* in the consumption of good i , which evolves according to

$$S_{it}^c = \varrho^c S_{it-1}^c + (1 - \varrho^c) C_{it}, \quad (2)$$

where C_{it} is *total* consumption and $\varrho^c \in (0, 1)$ implies persistence. The optimal demand for each variety, C_{it}^j is obtained by minimizing total expenditure $\int_0^1 P_{it} C_{it}^j di$ over C_{it}^j , subject to (1) giving:

$$C_{it}^j = \left(\frac{P_{it}}{P_t} \right)^{-\eta} (X_t^c)^j + \theta^c S_{it-1}^c,$$

Deep Habits and the Fiscal Transmission Mechanism II

Similarly for the government service component. Investment is also a composite of goods but does not feature habit formation.

Under deep habits the mark-up is counter-cyclical due to the co-existence of two effects: an *intra-temporal effect* and an *inter-temporal effect*.

The *intra-temporal effect* can easily be understood by looking at the demand faced by an individual firm i :

$$AD_{it} = C_{it} + G_{it} + I_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\eta} (X_t^c + X_t^g + I_t) + \theta^c S_{it-1}^c + \theta^g S_{it-1}^g$$

The 'effective' price elasticity of demand $\tilde{\eta}_{it} \equiv -\frac{\partial AD_{it}}{\partial p_{it}} \frac{p_{it}}{AD_{it}}$
 $= \eta - \frac{(\theta^c S_{it-1}^c + \theta^g S_{it-1}^g)}{AD_{it}}$ now increases with demand and the price mark-up is therefore counter-cyclical.

Deep Habits and the Fiscal Transmission Mechanism III

The other determinant comes from the *inter-temporal effect*: the awareness of higher future sales coupled with the notion that consumers form habit at the variety level, makes firms inclined to give up some of the current profits – by temporarily lowering their mark-up – in order to *lock-in new consumers into customer/firm relationships* and charge them higher mark-ups in the future.

A government spending expansion, under deep habits, still causes a *negative wealth effect*. However, the drop in the mark-up, which in turn implies higher future sales, translates into a higher demand for labour and *an increase in the real wage*. The increase in equilibrium wage makes leisure relatively more expensive and causes a *substitution effect towards consumption* that more than compensate the negative wealth effect. As a result, consumption rises.

Core Model

- ▶ NK Model with deep habits
- ▶ Rotemberg price contracts
- ▶ CES Composite of X_t^c and X_t^g (Cobb-Douglas at first)
- ▶ Lump sum taxes and balanced budget constraint
- ▶ Monetary Rule

$$\begin{aligned}\log\left(\frac{R_t}{\bar{R}}\right) &= \rho_r \log\left(\frac{R_{t-1}}{\bar{R}}\right) \\ &+ (1 - \rho_r) \left[\rho_\pi \log\left(\frac{\Pi_t}{\bar{\Pi}}\right) + \rho_y \log\left(\frac{Y_t}{\bar{Y}}\right) \right]\end{aligned}$$

- ▶ Optimized Rule just for fiscal shocks
- ▶ $\rho_r \in [0, 1]$, $\rho_r + \rho_\pi > 1$ (rule out 'super-inertial' case with $\rho_r > 1$).

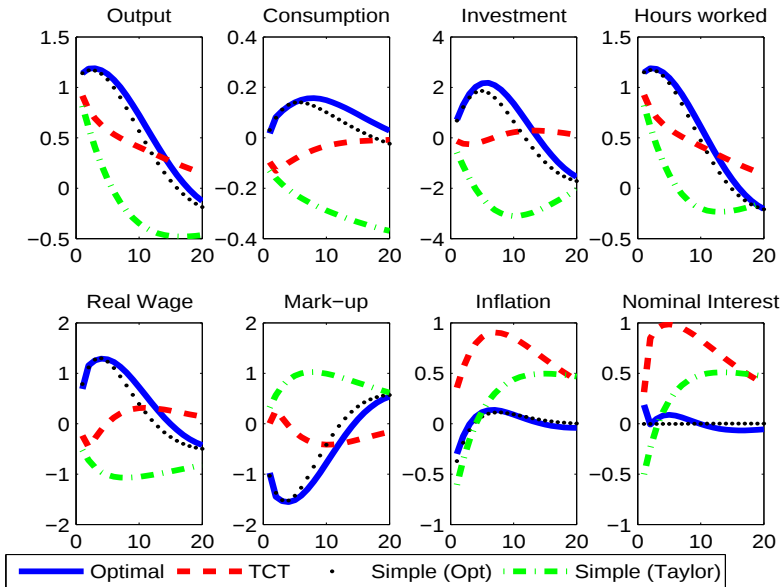
Effects of a Fiscal Stimulus in Core Model

Rule	$[\rho_r, \rho_\theta, \rho_y]$	Welfare Loss (%)
Optimal (Ramsey)	not applicable	0
Time Consistent (TCT)	not applicable	152
Conventional Taylor	$[0, 1.5, 0.50]$	90.2
Empirical Taylor (SW)	$[0.81, 2.04, 0.08]$	8.54
Quasi-Empirical Taylor	$[0.81, 2.04, 0.50]$	24.7
Optimized Simple	$[1.00, 0.00587, 0.0137]$	0.96
Optimized Price Level	$[1.00, 0.00635, 0.00]$	0.97

Table: Optimal and ad hoc Monetary Rules Compared

Notes: The welfare loss is reported as a % increase of that under optimal policy. For integral simple rules with $\rho_r = 1$, the rule is expressed as $\log\left(\frac{R_t}{\bar{R}}\right) = \rho_r \log\left(\frac{R_{t-1}}{\bar{R}}\right) + \rho_\pi \log\left(\frac{\pi_t}{\bar{\pi}}\right) + \rho_y \log\left(\frac{Y_t}{\bar{Y}}\right)$.

Effects of a Fiscal Stimulus in Core Model



Bayesian Estimation of Core Model

- ▶ Estimation Strategy - One-step
- ▶ Data
- ▶ Estimated Parameters
- ▶ Model Comparisons
- ▶ Second Moment Comparisons
- ▶ Impulse Responses

One-step Estimation

- ▶ Let $y = \{y_t^\tau + y_t^c\}_{t=1}^T$ be the log of a vector of times series with non-cyclical and cyclical components: y_t^τ , y_t^c and

$$y_t^c = S y_t^\dagger$$

$$y_{t+1}^\dagger = \Phi(\theta^m) y_t^\dagger + \Psi(\theta^m) \nu_{t+1}$$

where $y_{t+1}^\dagger$ represents the variables in the DSGE model and S is a selection matrix that picks out observables, θ^m are the structural parameters of the model, θ ; ν_{t+1} are mutually uncorrelated innovations of the structural model.

- ▶ Furthermore, we assume that y_t^τ is represented by

$$y_{t+1}^\tau = y_t^\tau + \mu_t + \epsilon_{t+1}^1$$

$$\mu_{t+1} = \mu_t + \epsilon_{t+1}^2$$

where $\epsilon_{t+1}^j \sim N(0, \Sigma_j)$, and Σ_j is diagonal for $j = 1, 2$.

- ▶ The setup is very flexible - deterministic trends and unit root with a drift special cases.
- ▶ Two-step procedure problematic ([Canova and Ferroni(2011)])

Data

Variable	Description
GDP_Deflator	GDP deflator
index	Population index
y_obs	Real per capita GDP
g_obs	Real per capita government spending
c_obs	Real per capita consumption
i_obs	Real per capita investment
rn_obs	Quarterly Federal Funds rate
pi_obs	Inflation

Table: Data transformations - Observables

Structural shocks are: ϵ_t^B , ϵ_t^P , ϵ_t^I , ϵ_t^G , ϵ_t^M , ϵ_t^A .

Estimated Parameters

parameter	prior mean	post. mean	5% CI	95% CI	Prior	prior stdev
γ	2	1.9802	1.0632	2.8989	norm	1.5
σ_c	1.5	1.3734	0.8193	1.9131	norm	0.3750
ϱ^C	0.8	0.8380	0.7090	0.9530	beta	0.10
θ^C	0.8	0.7047	0.6127	0.7981	beta	0.10
ϱ^G	0.8	0.9129	0.7914	0.9949	beta	0.10
θ^G	0.8	0.6760	0.5085	0.8388	beta	0.10
σ_x	0.999	0.7034	0.4620	0.9437	gamma	1.00
ξ	25.300	25.2331	23.5999	26.8421	norm	1.00
ρ_π	1.5	1.8337	1.5104	2.1494	norm	0.25
ρ_r	0.75	0.8529	0.8049	0.9023	beta	0.1
ρ_y	0.25	0.0338	0.0015	0.0657	norm	0.05

Table: Posteriors results for model parameters

Model Comparisons: Deep versus Superficial Habit

- In the superficial habit case habit formation is applied to total consumption and hence equations (1) and (2) become:

$$(X_t^c)^j = (C_t^j - \chi^c S_t^c), \quad (3)$$

where now $\chi^c \in (0, 1)$ is the degree of superficial habits formation on total consumption, and S_{it}^c evolves according to

$$S_t^c = \varrho^c S_{t-1}^c + (1 - \varrho^c) C_{t-1}, \quad (4)$$

where $\varrho^c \in (0, 1)$ again implies persistence.

	Model DH	Model SH
LLs	-369.69	-375.60
prob.	0.9973	0.0027

Table: Likelihood Race :Marginal Log-likelihood (LL) Values and Posterior Model Odds

- According to [Jeffries(1996)], a BF over 100 (LL over 4.61) is “decisive evidence”. Hence the model with ‘Deep Habits’ is “decisively” preferred.

Second Moment Comparisons I

Model	Standard Deviation					
	Output	Consumption	Investment	Gov. Spending	Inflation	Interest rate
Data	0.96	0.60	4.20	1.09	0.17	0.30
Model DH	0.99	0.57	4.19	1.03	0.21	0.42
Model SH	1.10	0.63	4.43	1.03	0.22	0.38
Model	Cross-correlation with Output					
	Output	Consumption	Investment	Gov. Spending	Inflation	Interest rate
Data	1.00	0.72	0.92	-0.23	0.13	0.59
Model DH	1.00	0.70	0.88	0.13	-0.05	-0.10
Model SH	1.00	0.69	0.89	0.16	-0.09	-0.05
Model	Autocorrelations (Order=1)					
	Output	Consumption	Investment	Gov. Spending	Inflation	Interest rate
Data	0.78	0.78	0.80	0.71	0.14	0.89
Model DH	0.85	0.76	0.89	0.71	0.48	0.95
Model SH	0.86	0.77	0.90	0.73	0.53	0.93

Table: Selected Second Moments of the Model Variants

Second Moment Comparisons II

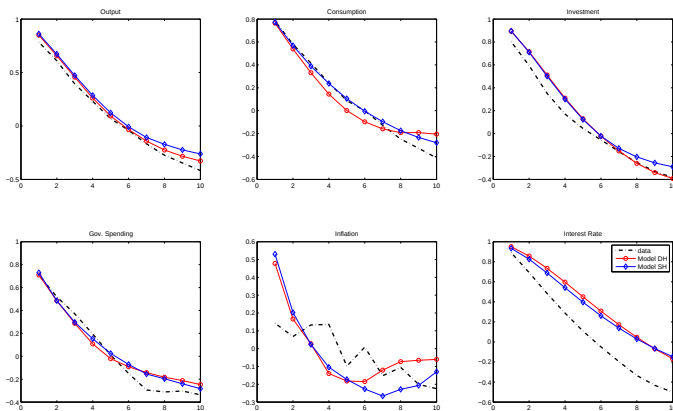


Figure: Autocorrelations of Observables in the Actual Data and in the Estimated Models

Impulse Responses

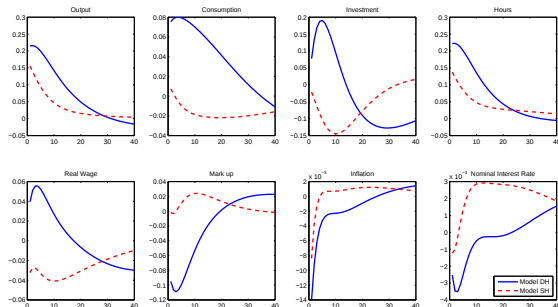


Figure: Bayesian IRFs - Gov. Spending shock

Extended Model: Government Debt

- ▶ A no-defaulting government faces a budget constraint

$$B_t^g = \frac{R_t^g B_{t-1}^g}{\Pi_t} + G_t - T_t,$$

whereas the household has a budget constraint

$$B_t + B_t^g + \text{other exp} = R_t B_{t-1} / \Pi_t + (1 - \vartheta_t) R_t^g B_{t-1}^g / \Pi_t + \text{other income}$$

where $\vartheta_t = 0$ with probability $1 - \text{prob}_t$ and $\vartheta_t = \theta$ (the 'haircut') with probability (of default) prob_t .

- ▶ By arbitrage $[(1 - \text{prob}_t) + \text{prob}_t(1 - \theta)]R_t^g = R_t$; i.e., $(1 - \text{prob}_t\theta)R_t^g = R_t$.
- ▶ Assume $R_t^g = \exp\left(\phi \frac{B_t^g}{Y_t}\right) R_t$.
- ▶ Impose an upper bound on the variance of debt so prob of hitting 100% Debt-GDP ratio is very small

Extended Model: Taxes

- ▶ The government budget constraint is

$$B_t^g = \frac{\exp\left(\phi \frac{B_t^g}{P_t Y_t}\right) R_t B_{t-1}^g}{\Pi_t} + G_t - T_t,$$

where $T_t = \tau_t^C C_t + \tau_t^W w_t n_t h_t + \tau_t^K R_t^k K_t^p + \tau_t^L =$ total taxes

- ▶ To reduce the number of tax instruments to one, we impose that τ_t^C , τ_t^W , τ_t^K and τ_t^L deviate from their steady state by the same proportion (i.e. $\tau_t^C = \tau_t \bar{\tau}^C$, $\tau_t^W = \tau_t \bar{\tau}^W$ etc) and the proportional uniform tax change τ_t is our tax instrument
- ▶ Tax rates in the steady state are empirical rather than optimal. Therefore large distortions remain.

General Monetary and Fiscal Rules

- The rules in their most general form

$$\begin{aligned}\log\left(\frac{R_t}{R}\right) &= \rho_r \log\left(\frac{R_{t-1}}{R}\right) + (1 - \rho_r) \left[\rho_\pi \log\left(\frac{\Pi_t}{\Pi}\right) \right. \\ &\quad \left. + \rho_y \log\left(\frac{Y_t}{Y}\right) + \rho_{rB} \log\left(\frac{B_{t-1}}{B}\right) \right]\end{aligned}$$

$$\begin{aligned}\log\left(\frac{\tau_t}{\tau}\right) &= \rho_\tau \log\left(\frac{\tau_{t-1}}{\tau}\right) + (1 - \rho_\tau) \left[\rho_{\tau B} \log\left(\frac{B_{t-1}}{B}\right) \right. \\ &\quad \left. + \rho_{\tau Y} \log\left(\frac{Y_t}{Y}\right) + \rho_{\tau \pi} \log\left(\frac{\Pi_t}{\Pi}\right) \right],\end{aligned}$$

$$\begin{aligned}\log\left(\frac{G_t}{G}\right) &= \rho_G \log\left(\frac{G_{t-1}}{G}\right) + (1 - \rho_G) \left[-\rho_{GB} \log\left(\frac{B_{t-1}}{B}\right) \right. \\ &\quad \left. - \rho_{GY} \log\left(\frac{Y_t}{Y}\right) - \rho_{G\pi} \log\left(\frac{\Pi_t}{\Pi}\right) \right],\end{aligned}$$

- Assignment Issues: Which Authority is Responsible for What?
- Active-Passive Policies ([Leeper(1991)])

Stabilization Policy

Two aspects of monetary and fiscal optimal stabilization policy:

- ▶ **Policy for ‘normal times’.**

- ▶ Design rules to minimize an expected conditional welfare loss starting at some steady state (ss).
- ▶ Our ss is that of the non-linear Ramsey problem about which we calculate a quadratic loss function and linearize the model (LQ).
- ▶ Problem is purely stochastic: optimal policy is in response to all future stochastic shocks hitting the economy
- ▶ 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.

- ▶ **Crisis Management**

- ▶ The economy starts far from the ss. E.g., a large B_t/Y_t and possibly a binding ZLB constraint.
- ▶ 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 decompose.

Optimal Policy for Normal Times I

LQ approximation to the optimization problem about a large distortions steady state.

Rule	$[\rho_r, \rho_{r\pi}, \rho_{ry}, \rho_{rB}]$	$[\rho_\tau, \rho_{\tau B}, \rho_{\tau y}, \rho_{\tau\pi}]$	Loss	$\text{var}(R_t)(\%)$	$\text{var}(\tau_t)(\%)$
Optimal (Ramsey)	not applicable	not applicable	0	0.35	308
Time Consistent	not applicable	not applicable	1420	11.9	223
Optimized Simple I	[0.20, 1.36, 0.00 ,0]	[0.74, 2.08, 7.69 ,0]	497	0.37	40
Optimized Simple II	[0.00, 1.11, 0.03 , 0.02]	[0.76, 1.63, 4.54 , 3.67]	435	0.29	21

Table: Optimal Interest Rate and Taxation Rule

Notes: The welfare loss is reported as a percentage increase relative to optimal policy.

Optimal Policy for Normal Times II

Rule	$[\rho_r, \rho_{r\pi}, \rho_{ry}, \rho_{rB}]$	$[\rho_G, \rho_{GB}, \rho_{Gy}, \rho_{G\pi}]$	Loss	$\text{var}(R_t)(\%)$	$\text{var}(G_t)(\%)$
Optimal (Ramsey)	not applicable	not applicable	0	0.56	59
Time Consistent	not applicable	not applicable	48	0.20	0.32
Optimized Simple I	[1.00, 0.025 0.00 ,0]	[0.00, 0.48, 1.51 ,0]	58	0.13	148
Optimized Simple II	[1.00, 0.025, 0.00 ,0.00]	[0.00, 0.53, 1.72 , 0.43]	56	0.01	1.49

Table: Optimal Interest Rate and Government Spending Rule

Notes: The welfare loss is reported as a percentage increase relative to optimal policy.

Optimal Policy for Normal Times III

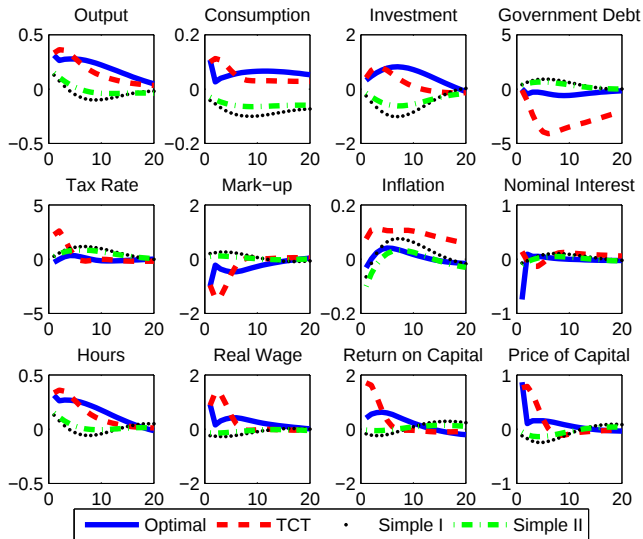


Figure: Tax and Interest Rate Rules with Tax Revenue Shock

Optimal Policy for Normal Times IV

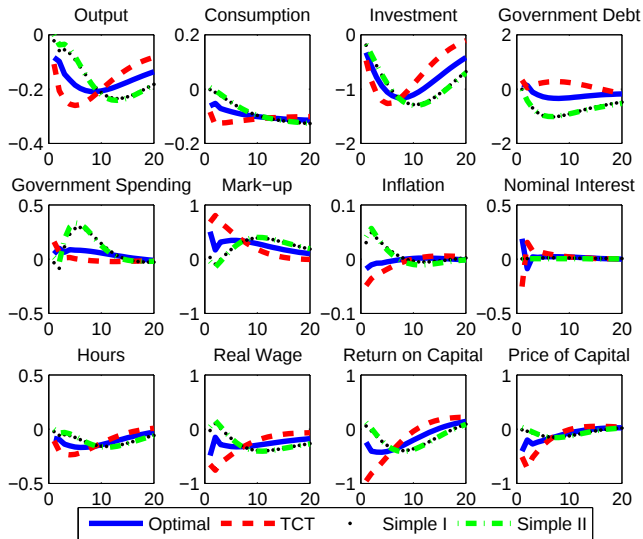


Figure: Gov Spending and Interest Rate Rules with Tax Revenue Shock

Comments

1. With a persistence parameter around 0.75 for both simple rules, there is evidence that optimal fiscal adjustment using taxes should be gradual – a familiar tax-smoothing result.
2. In the long-run denoting proportional deviations by lower case:

$$r_t = 1.36\pi_t$$

$$\tau_t = 2.08b_t + 7.69y_t = 2.08(b_t - y_t) + 9.77y_t$$

$$\Delta r_t = 0.025\pi_t \text{ (a price-level rule : } r_t = 0.025p_t\text{)}$$

$$g_t = -0.48b_t - 1.51y_t = -0.48(b_t - y_t) - 1.99y_t$$

for the government spending rule with no persistence at all.

3. The welfare losses and the impulse response indicate that the ability of the simple rules to mimic the Ramsey optimal policy, observed with optimal monetary alone, is not a feature of rules with two instruments. Indeed the optimized g_t rule is even slightly worse than the time consistent policy. But in *consumption equivalent terms* these differences are small.
4. Third, the variances of the interest rate and quite low indicating the zero lower bound is rarely reached.

Crisis Management: Fiscal Consolidation I

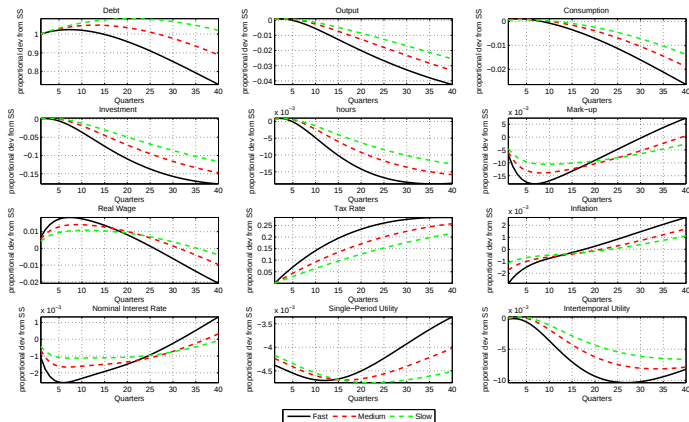


Figure: Tax and Interest Rate Rules

Crisis Management: Fiscal Consolidation II

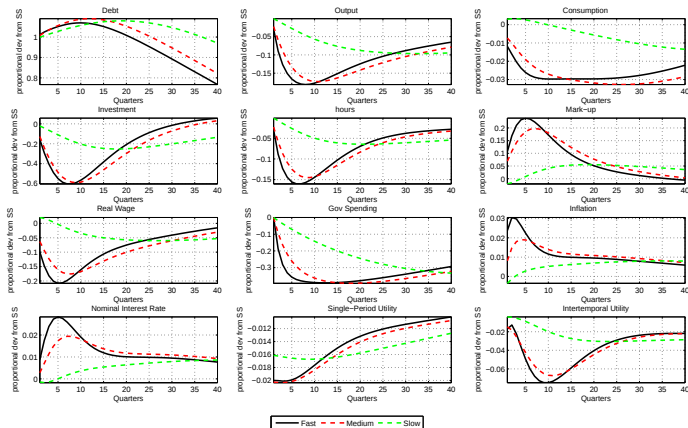


Figure: Gov Spending Interest Rate Rules

Comments

1. From the inter-temporal welfare, there appears to be *some support for slow consolidation*, especially when government spending only is used, and tax changes only yield a smaller welfare cost.
2. A further advantage of using the tax instrument only is there is no switch over of inter-temporal welfare over time which implies a *time-inconsistency* problem.

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** Optimal fiscal adjustment using taxes should be gradual even with a risk premium and an upper bound on the variance of debt. The ability of the simple rules to closely mimic the Ramsey optimal policy (observed with optimal monetary alone) is not a feature of optimal policy with two instruments and large steady state distortions.
- ▶ **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, especially with government spending alone.▶

Future Research

- ▶ Rework with informational consistency
- ▶ Better simple rules?
- ▶ Model with unemployment



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