Monetary Policy, Capital Controls, and International Portfolios

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Motivation

- Large literature on optimal monetary policy in open economies...
  - Terms-of-trade management
  - Currency of pricing
  - Financial frictions
- Yet, little about the role of **asset market structure**...
  - Most studies have a single bond or complete markets
  - Potentially relevant! Large increase in size of external balance sheets across many asset classes, valuation effects...

This paper

- Small open economy model
  1. Incomplete markets + Home asset → insurance objective
  2. Nominal rigidities → demand-management objective
  3. More than one asset → portfolio problem
- Analytical characterization using a small-risks approximation of
  - Optimal monetary policy
  - Optimal portfolio
  - Taxes on financial assets
- Quantitative model: Deviate from inflation targeting?

Related Literature: Contributions

- Optimal Monetary Policy in Open Economies with Incomplete Markets
  - **Closest**: Benigno (2009a, 2009b) and Senay and Sutherland (2017)

⇒ Fully optimal policy with portfolio choice; interaction with capital controls

- Joint monetary and portfolio/macroprudential policy problem
  - **Closest**: Farhi-Werning (2016), Engel and Park (2017), Ottonello and Perez (2017)

⇒ Tighter characterization using approximation; problem with commitment

- Solving DSGE models with portfolio choice
  - **Closest**: Judd and Guu (2001), Devereux and Sutherland (2011), Tille and van Wincoop (2010)

⇒ equivalence result; role of portfolio tax

Model

- Today: Two period model
  - Specific preferences, technology & shocks
  - Two assets (home and foreign currency bonds)
- Results are much more general
  - Dynamic, general preferences, technology & shocks
  - Arbitrary asset market structure
- Important assumption: Perfect stabilization under complete markets
  - No financial friction, exogenous terms-of-trade, no mark up shocks, single nominal rigidity...

Preferences

- Home households

$$\mathbb{E}\ln\left(C_{Ts}^{\alpha}C_{Ns}^{1-\alpha} - \frac{1-\alpha}{1+\psi}L_s^{1+\psi}\right)$$

  - Own firms and tradable endowment $\{Y_{Ts}\}$

- Foreign households

$$\mathbb{E}\ln\left(C_{Ts}^{*}\right)$$

  - Foreign is large: C_{Ts}^{*} taken as given

Technology and Market Structure

- Technology

$$Y_{Ns} = Z_s Y_s^I$$
$$Y_s^I(i) = L_s(i)$$

- Y_{Ns}: competitive
- Y_s^I: fixed price $P_s^I(i) = 1 \ \forall s$

Financial Markets

1. Foreign-currency bond B^*

$$1 \to R^*$$

2. Domestic-currency bond B

$$1 \to R E_0 E_s^{-1}$$

- Free access to all markets by all agents (i.e., no financial friction)

Financial Markets

1. Foreign-currency bond B^*

$$1 \rightarrow 1$$

2. Domestic-currency bond B

$$1 \rightarrow RE_s^{-1}$$

- Free access to all markets by all agents (i.e., no financial friction)

Government Tools

1. Monetary policy: exchange rate rule $\{E_s\}_{s \in S}$ ▸ money rule
2. Capital controls: portfolio tax τ_B on home asset

$$(1 + \tau_B)B + B^* + T_0 = 0$$

3. Lump-sum subsidies $T_0 \to$ rebate tax revenue

- Problem under **commitment**

Equilibrium conditions

- Simplifying,

$$\frac{\alpha L_s}{(1-\alpha) C_{Ts}} = E_s$$

$$Y_{Ts} + (RE_s^{-1} - 1)B = C_{Ts}$$

$$\mathbb{E}((1+\tau_B)^{-1} RE_s^{-1} - 1) u_T(s) = 0$$

$$\mathbb{E}(RE_s^{-1} - 1) C_s^{*-1} = 0$$

- Note that using the first equation we may write

$$\{C_{Ns}(C_{Ts}, E_s), L_s(C_{Ts}, E_s)\}$$

Planning problem

$$\max_{\{C_{Ts}, E_s^{-1}\}_{s \in S}, R, B} \mathbb{E} \underbrace{V(C_{Ts}, E_s; Z_s)}_{\text{indirect utility}}$$

subject to

$$Y_{Ts} + \underbrace{(RE_s^{-1} - 1)B}_{\text{transfer}} - C_{Ts} = 0$$

$$\mathbb{E} \underbrace{(RE_s^{-1} - 1)B}_{\text{transfer}} C_s^{*-1} = 0$$

$\Rightarrow$ V was obtained replacing $\{C_{Ns}(C_{Ts}, E_s), L_s(C_{Ts}, E_s)\}$

1. Monetary policy $\{E_s\}$
2. Portfolio B (i.e., decentralized via the portfolio tax τ_B)

Approximation Method

- Parametrize shocks $\xi_s = \bar{\xi} + \epsilon u_s$ and study limit $\epsilon \to 0$
- Two steps
  1. Derive standard LQ problem (as in Benigno Woodford 2012) around arbitrary steady-state portfolio
  2. Maximize over steady-state portfolio
- FOC of approximate problem coincide with perturbation approach on FOCs of nonlinear problem more
  - This is true **only** if you have a portfolio tax (or if you do not need it)
  - Otherwise: Additional **quadratic** constraint (see paper)

Approximate Welfare

- Around arbitrary $\bar{B}$,

$$\mathbb{E}_0 V(s) = -k_0 \mathbb{E}_0 \left[\frac{1}{2}\chi(1+\bar{B}\mu)^2 \underbrace{\left(e_s - \frac{e_s^{dm}(0)}{1+\bar{B}\mu}\right)^2}_{\text{demand-management}} + \frac{1}{2} \underbrace{(\bar{B}e_s + \mathcal{T}_s)^2}_{\text{insurance}} \right] + t.i.p. + O(\epsilon^3)$$

- Two key statistics:
  - Desired transfer under complete markets and flexible prices

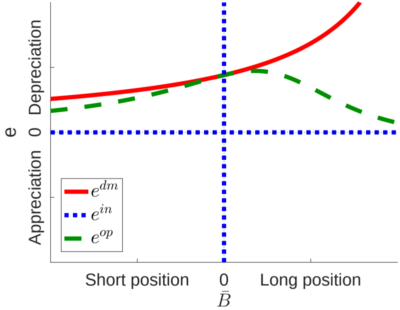
$$\mathcal{T}_s = \alpha y_{Ts} + c^*_{Ts}$$

  - Exchange rate that closes the output gap without home-currency bonds

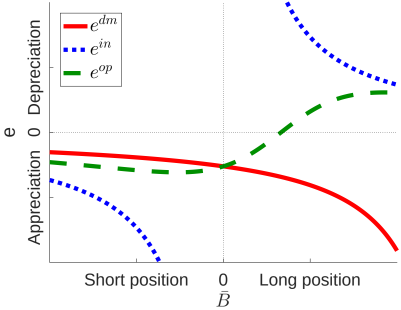
$$e_s^{dm}(0) = \frac{1-\alpha}{\alpha+\psi} z_s - \frac{\psi}{\alpha+\psi} y_{Ts}$$

- Two important parameters:
  - $\chi = (1-\alpha)\alpha(\psi+\alpha) > 0$: insurance vs. demand-management
  - $\mu = -\frac{\psi}{\alpha(\psi+\alpha)} < 0$: wealth effect

Response to NT productivity and endowment shocks



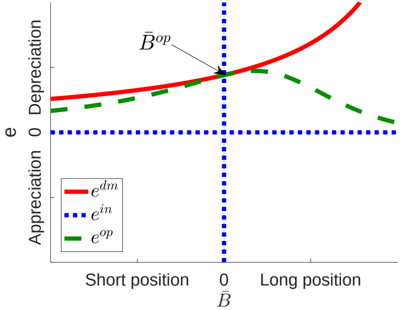
(a) Productivity shock



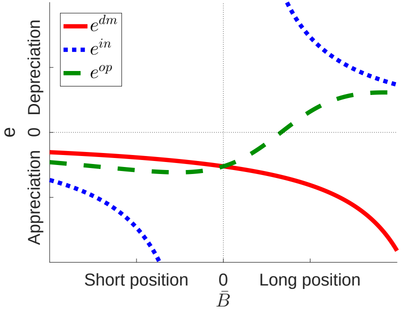
(b) Endowment shock

▸ portfolio

Response to NT productivity and endowment shocks



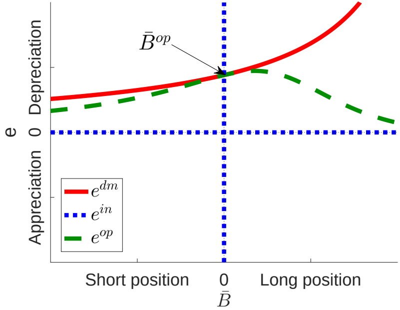
(c) Productivity shock



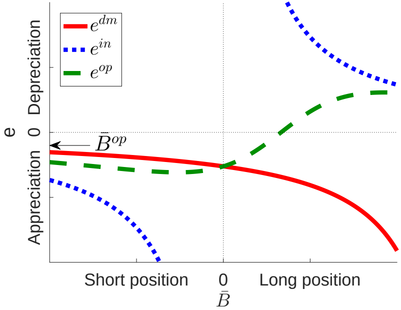
(d) Endowment shock

portfolio

Response to NT productivity and endowment shocks



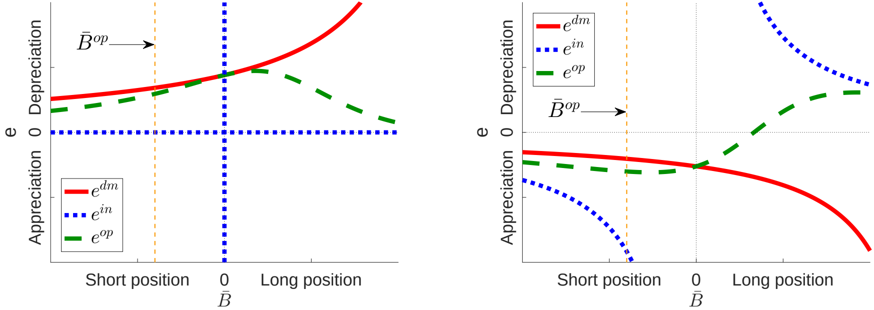
(e) Productivity shock



(f) Endowment shock

portfolio

Response to NT productivity and endowment shocks

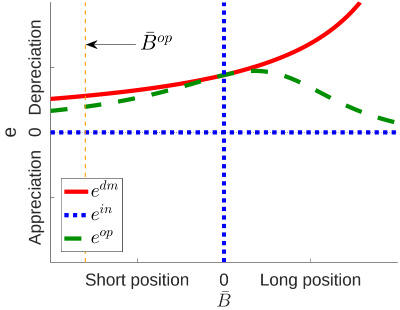


(g) Productivity shock

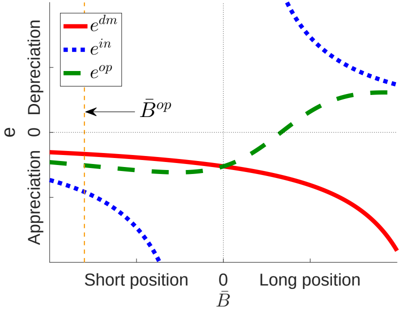
(h) Endowment shock

portfolio

Response to NT productivity and endowment shocks



(i) Productivity shock



(j) Endowment shock

portfolio

Optimal portfolio

Proposition: Optimal portfolio

If μ is not too large, positions become **larger** (in absolute value) when the insurance motive becomes more important ($\uparrow \sigma^2_{\mathcal{T}} / \sigma^2_{e^{dm}(0)}$ or $\downarrow \chi$)

- Shocks map differently to statistics $e^{dm}_s(0)$ and $\mathcal{T}_s$
  - High $|B| \Rightarrow$ costly to accomodate $e^{dm}_s(0)$
  - High $|B| \Rightarrow$ easy to create $\mathcal{T}_s$
- General asset structure: *sensitivity of portfolio to MP* (see paper)

Implications for exchange rate volatility

Proposition: Optimal exchange rate volatility

1. Suppose the portfolio decision is constrained (i.e.$|\bar{B}| = \bar{K}$). Then exchange rate volatility $\sigma_e^2/\sigma^2_{e^{dm}(0)}$ **increases** with the importance of the insurance motive ($\uparrow \sigma_T^2/\sigma^2_{e^{dm}(0)}$ or $\downarrow \chi$)
2. Suppose $\mu\bar{B} \geq 0$ and the optimum $\bar{B}$ is interior. Then, exchange rate volatility $\sigma_e^2/\sigma^2_{e^{dm}(0)}$ **decreases** with the importance of the insurance motive. If $\mu\bar{B} < 0$, the result is ambiguous.

- General asset structure: *sensitivity of excess returns to MP* (see paper)

example

Portfolio choices are approximately efficient

Proposition

Private portfolio decisions are efficient in the limit, i.e., $\tau_B = O(\epsilon^3)$

- No differential tax on home vs. foreign-currency bond
- **Key:** Economy would be **efficient** if markets were **complete**
- **Not key:** Simple asset structure; static model $\rightarrow$ result much more general

Conclusion

- Framework to study joint optimal monetary policy and portfolio choice
  - Much more general than this particular setup!
  - *Caveat*: "Steady-state" portfolio tax important for tractability in general
- When market incompleteness is important...
  - $\uparrow$ sensitivity of external balance sheet to MP
  - Lowers cost of creating transfers ex post
  - Prevents accomodating demand to avoid undesirable transfers
- Market incompleteness **alone**: weak argument for portfolio taxes

Optimal monetary policy given $\bar{B}$

Proposition: Optimal exchange rate

The optimal exchange rate is given by

$$e_s^{op}(\bar{B}) = (1 - \omega(\bar{B}))e_s^{dm}(\bar{B}) + \omega(\bar{B})e_s^{in}(\bar{B}) + O(\epsilon^2)$$

where where e_s^{dm} and e_s^{in} are the demand-management and insurance targets,

$$e_s^{dm}(\bar{B}) = \frac{1}{1 + \mu\bar{B}} e_s^{dm}(0)$$

$$e_s^{in}(\bar{B}) = -\frac{1}{\bar{B}}\mathcal{T}_s$$

and ω is given by

$$\omega = \frac{\bar{B}^2}{\bar{B}^2 + \chi(1 + \mu\bar{B})^2}.$$

More in the paper...

- Dynamic model
  - Everything goes through analytically
  - New "cost-minimization problem": Solve optimal way of creating excess-return at 0 (use savings taxes!)
- Calibration for Canada
  - Weight on insurance target: around 8% (sensitive to cost of inflation)
  - Welfare gains of completing markets (including an additional financial asset) significantly larger under optimal policy relative to inflation targeting

More in the paper I

- Solution under cooperation (when $m < \infty$)
  - Analytical: as-if m was twice as large ($\uparrow |B|$, $\downarrow \sigma_{rr}^2$) and no portfolio tax
  - Large quantitative gains due to small m
- General asset structures
  - Model with equity in non-tradable sector: χ increases with price flexibility
  - Any: Sufficient statistic of "exposure" to monetary policy in static model
  - No portfolio tax result ($m = \infty$) robust

More in the paper II

- Solution without time-varying capital controls
  - Results go through, but $\uparrow\chi$ (higher cost of providing insurance)
  - Quantitatively similar due to long bond duration
- Solution with no capital controls whatsoever
  - If $m < \infty$, need to solve additional degree of indeterminacy (Lagrange multiplier)

Money supply rule

- Modify utility to

$$\max_{\{C_{Ts}, C_{Ns}, M_s, B\}} \mathbb{E}\{u(C_{Ts}, C_{Ns}, L_s, s) + \nu L(M_s/E_s)\}$$

- Yields money demand,

$$L'(M_s/E_s) \propto u_T(s)$$

$\Rightarrow$ Invert this to obtain E_s as a function of M_s

$\Rightarrow$ Take $\nu \to 0$ so that it does not enter planning problem

back

Optimization: Consumers

- Home consumer

$$
\begin{aligned}
u_N(s)/u_T(s) &= P_{Ns}/E_s && (1)\\
-u_L(s)/u_T(s) &= W_s/E_s && (2)\\
\mathbb{E}((1+\tau_B)^{-1}RE_s^{-1}-1)u_T(s) &= 0 && (3)\\
(1+\tau_B)B + B^* &= T_0 && (4)\\
E_sC_{Ts} + P_{Ns}C_{Ns} &= E_sY_{Ts} + W_sL_s + \Pi_s \\
&\quad + RB + E_sB^* + T_s \ \forall s && (5)
\end{aligned}
$$

- Foreign consumer

$$
\begin{aligned}
\mathbb{E}(RE_s^{-1}-1)u_T^*(s) &= 0 && (6)\\
B^f + B^{*f} &= 0 && (7)\\
E_sC_{Ts}^* &= E_sY_{Ts}^* + RB^f + E_sB^{*f} && (8)
\end{aligned}
$$

Optimization: Firms and government

- Firms

$$P_{Ns}F_{Y^I}(s) = P^I_s \tag{9}$$

$$P^I_s(i) = \frac{\eta}{\eta - 1}(1 + \tau^L)W_s \forall i \in (\phi, 1] \tag{10}$$

- Government

$$T_0 + B^g + B^{g*} = \tau_B B \tag{11}$$

$$T_s = \tau_L W_s L_s + RB^g + E_s B^{g*} \tag{12}$$

Market clearing

$$Y_{Ns} = F(s) \tag{13}$$

$$B + B^g + mB^f = 0 \tag{14}$$

$$B^* + B^{g*} + mB^{*f} = 0. \tag{15}$$

- Ricardian equivalence holds$\rightarrow$ $B^g = B^{g*} = 0$ wlog

back

Applying the method

Proposition: Equivalence to perturbation approach

Suppose u, u^* and F are locally analytic functions around the steady state.Then, maximizing

$$\mathbb{E}_0 V(s) = k_0 \mathbb{E}_0 \left[-\frac{1}{2} \underbrace{(\bar{B} e_s + \mathcal{T}_s)^2}_{\text{insurance}} - \frac{1}{2} \chi \underbrace{((1 + \bar{B}\mu) e_s - e_s^{dm}(0))^2}_{\text{demand-management}} \right] + t.i.p. + O(\epsilon^3)$$

with respect to $\{e_s\}$ and $\bar{B}$ yields a linear approximation of a solution to the first-order conditions of problem $\mathcal{P}$ around $(\bar{B}, \epsilon = 0)$ for $\{e_s\}$ and a bifurcation point of the system $\bar{B}$.

Approximating the solution

- $m = \infty$ to simplify
- FOC:

$$V_{1s} - \lambda_s = 0 \quad (16)$$

$$V_2 + BR\lambda_s + \varphi BRu'^*(s) = 0 \quad (17)$$

$$B\mathbb{E}_0 E_s^{-1}\lambda_s + B\varphi\mathbb{E}_0 E_s^{-1}u'^*(s) = 0 \quad (18)$$

$$Y_{Ts} + B(RE_s^{-1} - 1) - C_{Ts} = 0 \quad (19)$$

$$\mathbb{E}_0(RE_s^{-1} - 1)\lambda_s = 0 \quad (20)$$

$$\mathbb{E}_0(RE_s^{-1} - 1)u'^*(s) = 0 \quad (21)$$

- Apply IFT around (B, ϵ) to (16) - (20)

$$\Rightarrow \{C_T(B,\epsilon), , E_s^{-1}(B,\epsilon), R_s^{-1}(B,\epsilon), \lambda_s(B,\epsilon), \varphi(B,\epsilon)\}$$

Approximating the solution

- Let

$$H(B,\epsilon) \equiv \mathbb{E}_0(R(B,\epsilon)E_s^{-1}(B,\epsilon) - 1)(\lambda_s(B,\epsilon) - \varphi(B,\epsilon)u^*(B,\epsilon))$$

- Can show

$$\frac{\partial H}{\partial B} = 0$$
$$\frac{\partial^2 H}{\partial B \partial \epsilon} = 0$$

- Solve singularity

$$\hat{H}(\theta,\epsilon) = \begin{Bmatrix} \frac{H(\theta,\epsilon)}{\epsilon} \text{ if } \epsilon \neq 0 \\ \frac{\partial H}{\partial \epsilon} \text{ if } \epsilon = 0 \end{Bmatrix}$$

- $\frac{\partial \hat{H}}{\partial B} = 0$ when $\epsilon = 0$. Bifurcation point solves:

$$\frac{\partial \hat{H}}{\partial \epsilon} = 0$$

Approximating the solution

Theorem

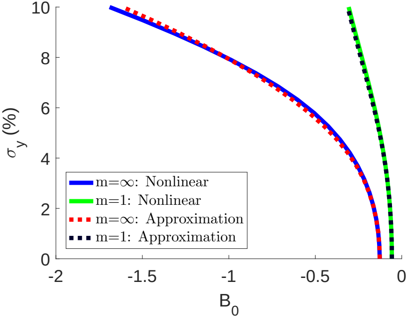
(Bifurcation Theorem). Suppose $H : \mathbb{R} \times \mathbb{R} \rightarrow \mathbb{R}$*, H is analytic for* (x, ϵ) *in a neighborhood of* $(x_0, 0)$*, and* $H(x, 0) = 0 \ \forall x \in \mathbb{R}$*. Furthermore, suppose that*

$$H_x(x_0, 0) = 0 = H_\epsilon(x_0, 0), H_{x\epsilon} \neq 0.$$

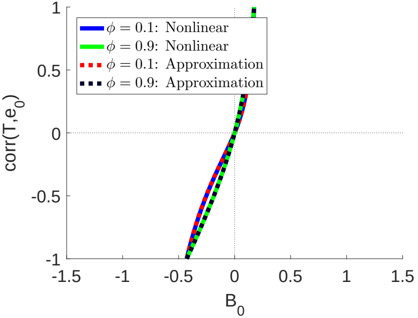
Then $(x_0, 0)$ *is a bifurcation point and there is an open neighborhood* $\mathcal{N}$ *of* $(x_0, 0)$ *and a function* $h(\epsilon)$*,* $h(\epsilon) \neq 0$ *for* $\epsilon \neq 0$*, such that h is analytic and* $H(h(\epsilon), \epsilon) = 0$ *for* $(h(\epsilon), \epsilon) \in \mathcal{N}$*.*

back

Example: portfolio



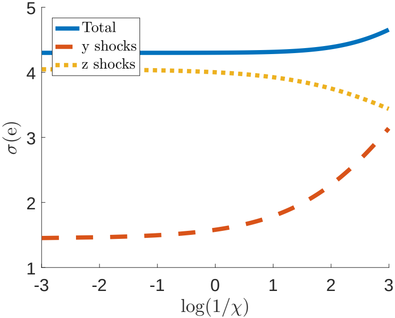
(k) Varying σ_y



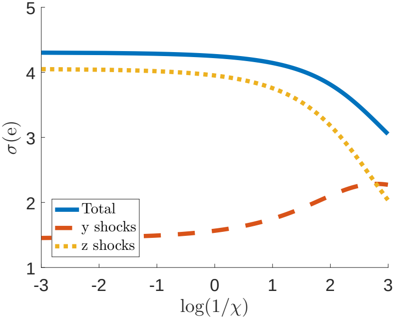
(l) Varying σ_{yz}

back

Example: MP shifts the volatility



(m) Constrained B



(n) Unconstrained B

back

Portfolio efficiency: Intuition

- FOC with respect to E yields, to first-order:

$$\hat{V}_E(s) = k_2 \hat{V}_{C_T} + O(\epsilon^2)$$

  - *Intuition*: deviate from $\hat{V}_E = 0$ to provide insurance, i.e. to stabilize $\hat{V}_{C_T}$

- Portfolio optimality implies

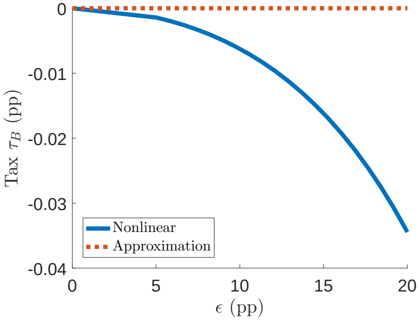
$$\mathbb{E} e_s \hat{V}_{C_T} = O(\epsilon^3)$$

- Since AD is the only externality, we have

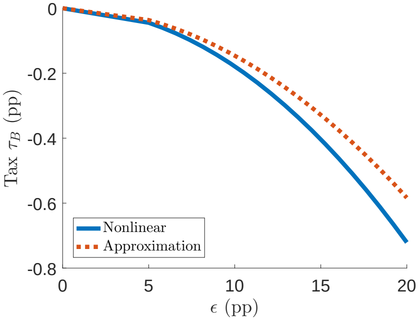
$$\hat{V}_{C_T} = \hat{U}_{C_T} + k_3 \hat{V}_E + O(\epsilon^2)$$

- Putting these together implies Home Euler holds to second-order. back

Example: taxes



(o) Full integration ($m = \infty$)



(p) Limited participation ($m = 1$)

back

Dynamic model: Savings taxes

Proposition

1. If wages are rigid ($\phi = 1$), savings taxes decay at rate $1 - \delta$

$$\tau_{B^*t} = -\bar{K}_0(\delta)(\delta\mu - \bar{K}_1 k_{ex}^{-1} k_{ux})(1-\delta)^t\{(1+\mu\bar{B})rr_0 - rr_0^{dm}(0)\} \tag{22}$$

where $\bar{K}_0 > 0$, $\bar{K}_1 > 0$ are constants, k_{ux} captures the reaction of private marginal utility to the output gap ($k_{ux} > 0$ implies agents overvalue tradable goods in booms). When $\delta = 0$, $\bar{K}_0(\delta) = 0$.
2. If bonds are short ($\delta = 1$), then saving taxes from $t \geq 1$ are given by

$$\tau_{B^*t} = k_{ux} R_\pi^{t-1} \pi_1$$

where R_π is the optimal decay rate of inflation after $t = 1$. At $t = 0$,

$$\tau_{B^*0} = k_0\mu\{(1+\beta^{-1}(1-\beta)k_{ec})rr_0 - rr_0^{dm}(0)\} + k_{ux}\Delta x_1$$

where $\bar{k} > 0$. If $k_{ex} > 0$, then $\Delta x_1 > 0$ and $\pi_1 > 0$.

back

Quantitative analysis: calibration

Parameter	Description	Value	Parameter	Description	Value
		A. Structural parameters			
β	Discount factor	0.99	ϕ_w	Probability of not adjusting prices	0.75
γ	Home risk aversion	2	η	Elasticity of substitution (varieties)	6
γ^*	Foreign risk aversion	2	δ	Bond depreciation	0.042
α	Tradable share	0.55	m	Measure of foreigners	0.18
ν^{-1}	Frisch elasticity	0.5	ϕ_π	Reaction to CPI inflation	1.5
ρ	Elasticity of substitution (T/NT)	0.74	ρ_i	Smoothing coefficient	0.84
		B. Shocks			
σ_z	Productivity s.d.	0.47%	ρ_ψ	Liquidity service persistence	0.79
σ_{p*}	Terms-of-trade s.d.	0.2%	$corr(\epsilon_t^z, \epsilon_t^{p*})$	Correlation: z and p^*	0.26
σ_{r*}	World interest-rate s.d.	0.23%	$corr(\epsilon_t^z, \epsilon_t^{r*})$	Correlation: z and r^*	−0.13
σ_{y*}	Foreigners' output s.d.	0.53%	$corr(\epsilon_t^z, \epsilon_t^{y*})$	Correlation: z and y^*	0.41
σ_ψ	Liquidity service s.d.	0.92%	$corr(\epsilon_t^{p*}, \epsilon_t^{r*})$	Correlation : p^* and r^*	−0.51
ρ_z	Productivity persistence	0.81	$corr(\epsilon_t^{p*}, \epsilon_t^{y*})$	Correlation: p^* and y^*	0.36
ρ_{p*}	Terms-of-trade persistence	0.74	$corr(\epsilon_t^{r*}, \epsilon_t^{y*})$	Correlation: r^* and y^*	−0.15
ρ_{r*}	World interest-rate persistence	0.87	$corr(\epsilon_t^{\psi}, \epsilon_t^{x})$	Correlation: ψ and others	0
ρ_{y^*}	World output persistence	0.88			

back

Quantitative analysis: results

	Taylor rule	Demand Management	Optimal	Optimal: fixed B	Optimal: Cooperation
		A. Domestic-currency bond positions and excess returns			
$\bar{B}$	−15.0%	−16.0%	−22.7%	−15.0%	−57.9%
ω			7.72%	3.57%	22.0%
$\sigma(rr)$:total	6.12%	3.79%	3.72%	3.82%	3.42%
$\sigma(rr) : r^*$	2.76%	1.58%	1.99%	1.91%	2.25%
$\sigma(rr) : \psi$	5.72%	3.44%	3.14%	3.32%	2.57%
$\sigma(rr) : y^*$	0%	0%	0.35%	0.35%	0.69%
		B. Policy instruments			
τ_B / *riskp.*		−80.5%	−103%		0%
$\sigma(\tau^*)$		0%	0.03%	0.02%	0.06%
$\sigma(e)$: total	3.59%	1.48%	1.60%	1.58%	1.70%
$\sigma(e) : r^*$	1.86%	1.48%	1.60%	1.59%	1.64%
$\sigma(e) : \psi$	3.35%	0.06%	0.19%	0.11%	0.48%
$\sigma(e) : y^*$	0%	0%	0.15%	0.10%	0.29%
		C. Welfare gains (% of first-best)			
Gains		11.9%	16.9%	15.0%	41.3%

back

No Portfolio Tax: Intuition

- Two observations
  1. No reason to tax under complete markets
  2. Cost of creating an excess return on the portfolio is the same across states to first-order
- 1 + 2 imply

  inefficient wedges (i.e., output gap) $\propto$ social marginal utility

- Disagreement between private agent and planner depends on wedge,

$$U_{C_T}(s) + \bar{k} \times \text{wedge}(s) \approx V_{C_T}(s)$$

- Putting both together,

  private marginal utility $\propto$ social marginal utility