Completed 5/15/09, fixed some typos 5/20/09

Topic 9: Optimal Monetary Policy and International Policy Coordination

- Now that we understand how to construct a utility-based intertemporal open macro model, we can use it to study the welfare implications of alternative policies.

- We study three interrelated questions:
  the choice of exchange rate regime,
  the choice of monetary policy rule, and
  the choice of whether to coordinate monetary policy with other countries.

Day 1: New Open Economy Models of Policy

Part 1: Bacchetta and van Wincoop (AER 2000)

- This paper focuses on the choice of exchange rate regime. It re-examines the long-standing question of whether a fixed exchange rate regime promotes welfare by encouraging more trade.

- There is a large empirical literature that has tried to estimate the effect that exchange rate volatility has on the volume of trade. Results tend to disagree with each other, and there is no conclusive conclusion. This paper may help explain why.

Model:

1) a general utility function, where consumption and leisure are not additively separable.

2) local currency price stickiness

3) cash in advance constraint

4) countries equal in size

5) a simple linear production function: $Y=L$

6) only one period.

Some key Equilibrium conditions:

1) Exchange rate determination: simple story

$$e = M / M^*$$

2) Nominal wage is determined by the ratio of marginal utilities of consumption and leisure:

$$W = P \, U_l / U_c$$

2) Optimization problem implies that firms set home and foreign prices as markups over expected costs:

$$p_H = \frac{\theta}{\theta - 1} \frac{E\left[U_c WM\right]}{E\left[U_c M\right]} = \frac{\theta}{\theta - 1} P \frac{E\left[U_l M\right]}{E\left[U_c M\right]}$$

$$p_H^* = \frac{\theta}{\theta - 1} \frac{E\left[U_c WM^*\right]}{E\left[U_c eM*\right]} = \frac{\theta}{\theta - 1} P \frac{E\left[U_l M^*\right]}{E\left[U_c M\right]}$$

- Note the role of expectations. Without them, price would be a simple markup over the wage cost.

- But we must here consider the correlation terms

$$E\left[U_l M\right] = E\left[U_l\right] + E\left[M\right] + \mathrm{cov}\left[U_l, M\right]$$

- This will be an additional markup in the price-setting, a type of risk premium.

4) Effects of change in money supplies.

Solve for home consumption: does not depend on M*:

$$C = M / P$$

Solve for home leisure: depends equally on M and M*:

$$l = 1 - 0.5(M / P) - 0.5(M^* / P^*)$$

Implications for trade volume:

- Given symmetry and demand functions, we can measure trade as:

$$Trade = \frac{Exports + \text{Im}\, ports}{GDP} = \frac{1}{1/2 + 1/2\left(p_H / p_H^*\right)^{1-\theta}}$$

- So trade volume depends on ratio of prices.

- Recall that this depends on numerators: $E(U_l M)$ and $E(U_l M^*)$

$$p_H = \frac{\theta}{\theta - 1} P \frac{E\left[U_l M\right]}{E\left[U_c M\right]} \qquad p_H^* = \frac{\theta}{\theta - 1} P \frac{E\left[U_l M^*\right]}{E\left[U_c M\right]}$$

Consider several cases:

1) Fixed exchange rate: We know $M = M^*$

$\rightarrow E(U_l M) = E(U_l M^*) \rightarrow \; p_H = p_H^* \rightarrow$ trade =1.

2) Flexible exchange rate, $M \neq M^*$

The result now depends on the specification of utility:

a) consumption and leisure are additively separable ($U_{cl} = 0$)

U_l depends on l alone, and l affected equally by M & M^*

so $E(U_l M) = E(U_l M^*) \rightarrow \; p_H = p_H^* \rightarrow$ trade =1

$$p_H = \frac{\theta}{\theta - 1} P \frac{E[U_l M]}{E[U_c M]} \qquad p_H^* = \frac{\theta}{\theta - 1} P \frac{E[U_l M^*]}{E[U_c M]}$$

b) substitutes: $U_{cl} < 0$

$\uparrow M \rightarrow \uparrow C$, but M^* does not

$U_l \uparrow$ less for M shocks than for M^* shocks.

So home sales are less risky and

$E(U_l M) < E(U_l M^*) \rightarrow p_H < p_H^* \rightarrow$ trade <1

Conclude: flexible exchange rates inhibit trade in this case.

c) <u>complements</u>: $U_{cl} > 0$

Now $U_l \uparrow$ <u>more</u> for *M* shocks than for *M** shocks.

So home sales are more risky and

$E(U_l M) > E(U_l M^*) \rightarrow p_H > p_H^* \rightarrow$ trade >1

Conclude: flexible exchange rates <u>encourage</u> trade in this case.

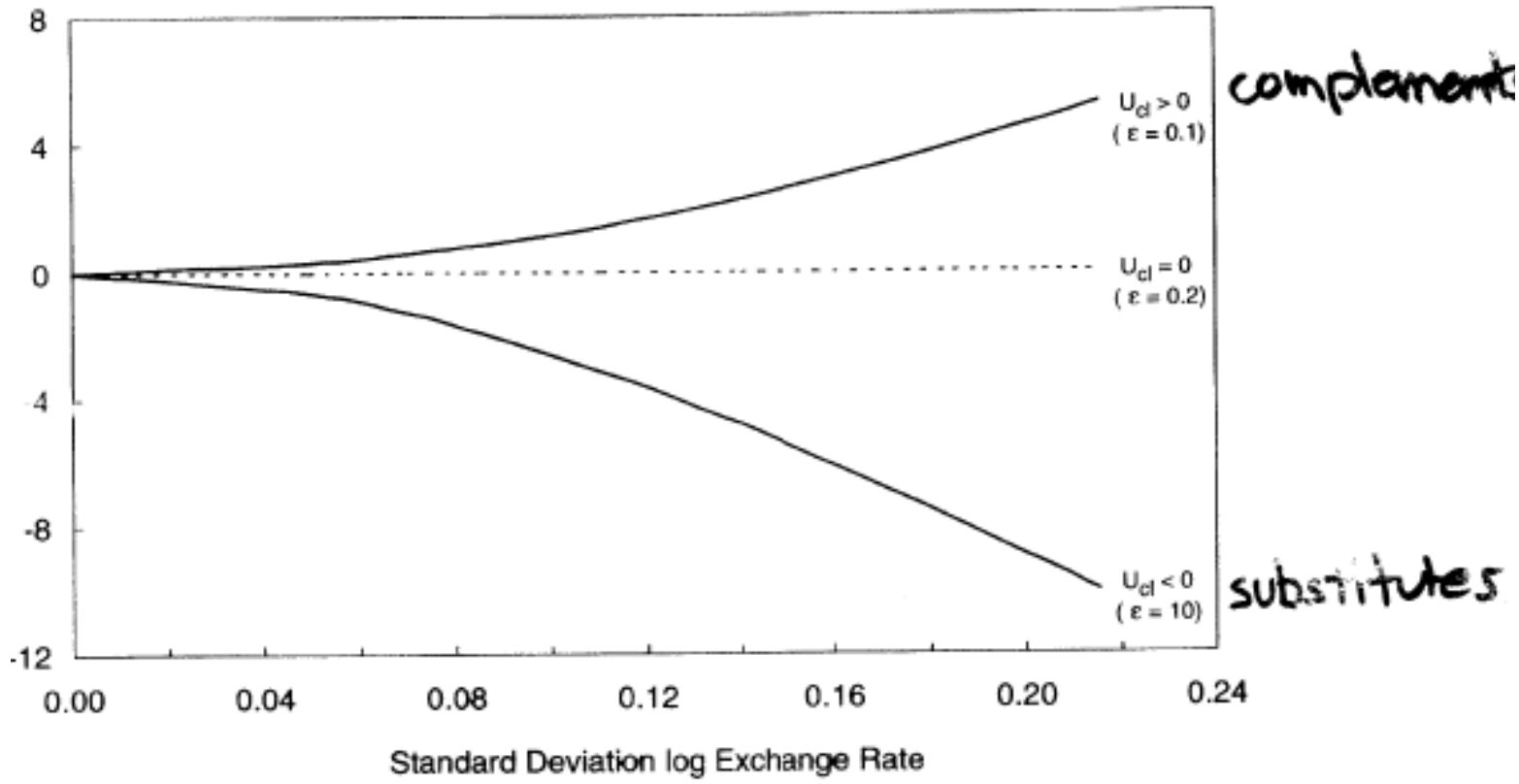


FIGURE 1. PERCENTAGE INCREASE IN TRADE WHEN SWITCHING FROM FIXED TO FLOAT

Implications for Welfare:

- The authors show that generally, welfare moves in the same direction as trade does.

- So again, exchange rate volatility will hurt welfare if consumption and leisure are substitutes,

- but it will actually improve welfare if consumption and leisure are complements.

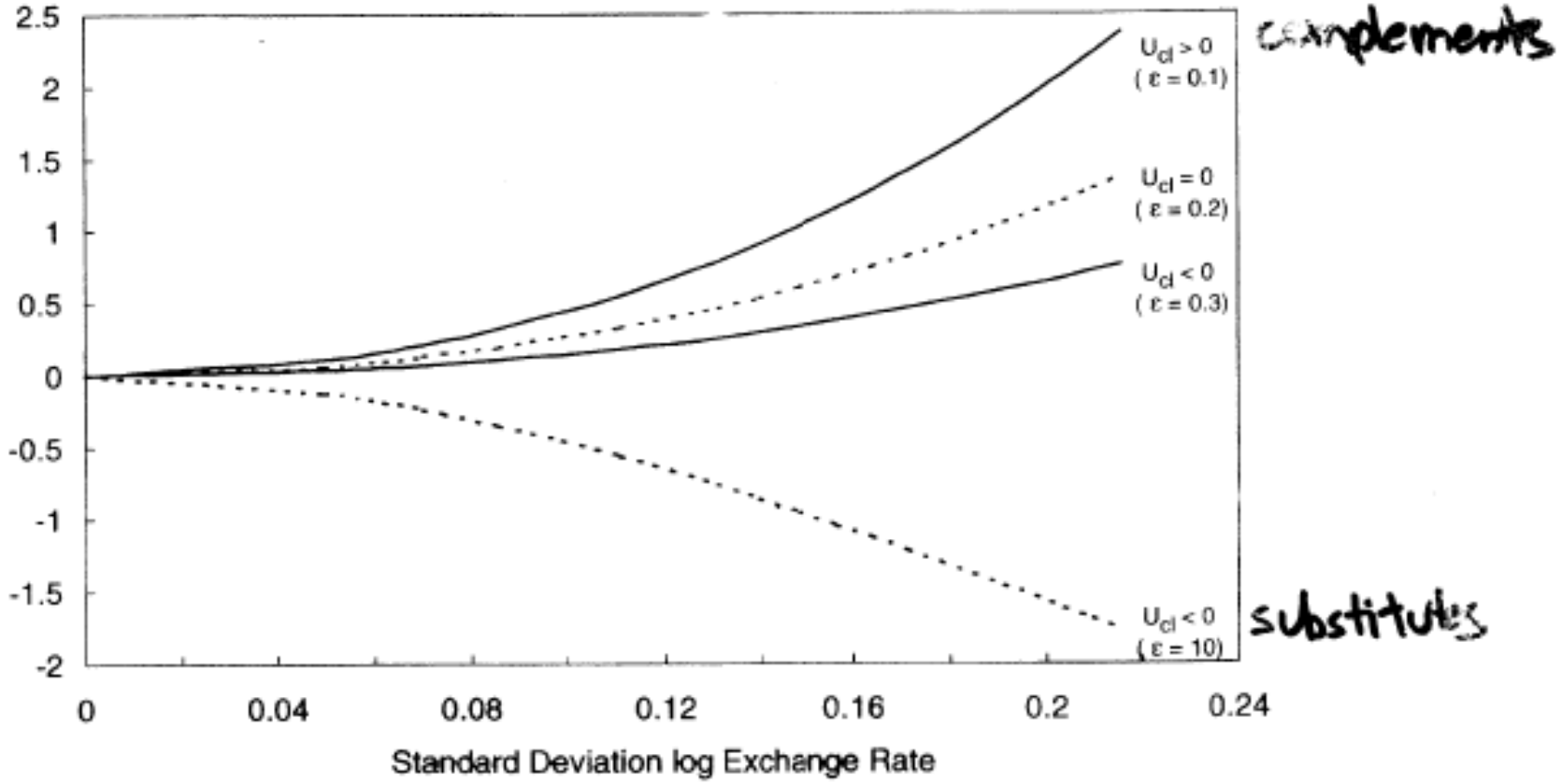


FIGURE 2. WELFARE GAIN WHEN SWITCHING FROM FIXED TO FLOAT

Part 2: Calvo, Kamenik and Kumhof (2008)

Class discussion:

1) Question to investigate
2) Model features: familiar and new
3) Solution and evaluation methodology chosen
4) Results and intuition

4) Result and main intuition:

Role of terms of trade shocks:

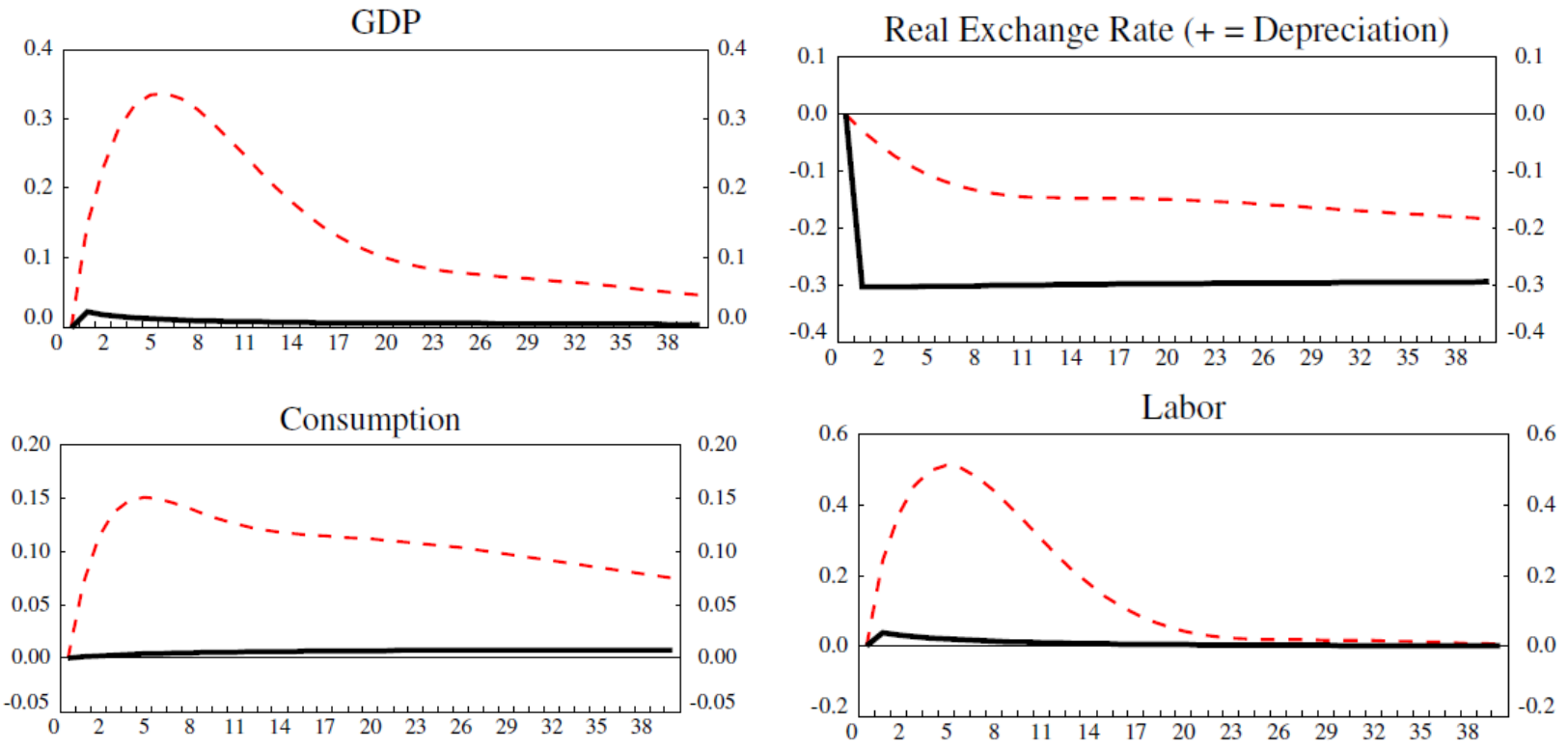
- Form of shock: rise in foreign preference for home goods (weight in consumption aggregator).

- Adjustment requires a rise in the domestic relative price, but this hard to do under sticky prices.

- Policy rules: Inflation targeting performs better than exchange rate targeting, because flexible exchange rates are an easy way of facilitating adjusting in relative prices.

- Impulse responses: bigger movement in output, consumption and labor under exchange rate target rule.

- Positive TOT shock (small openness) (solid line is inflation targeting policy; dashed line is exch. rate targeting policy)



Role of terms of markup shock:

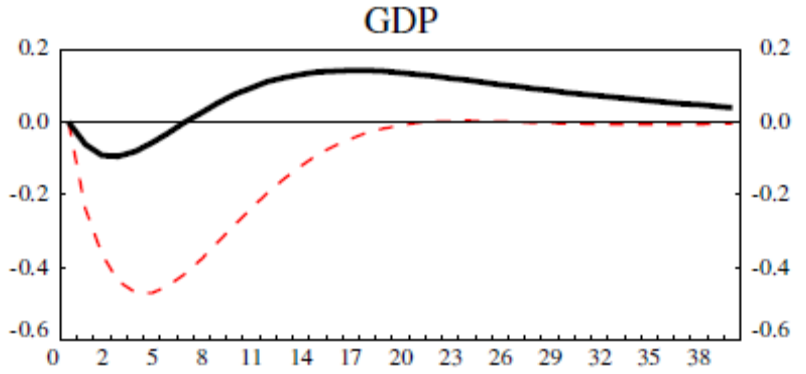
- Form of shock: fall in elasticity of substitution leading to larger markup and price. Applies only to domestic sales, since international trade is assumed competitive.

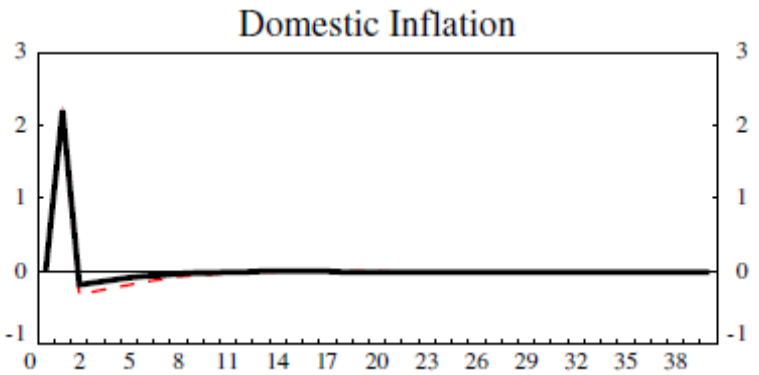
- Optimal Adjustment: lower production during period of distortion to production.

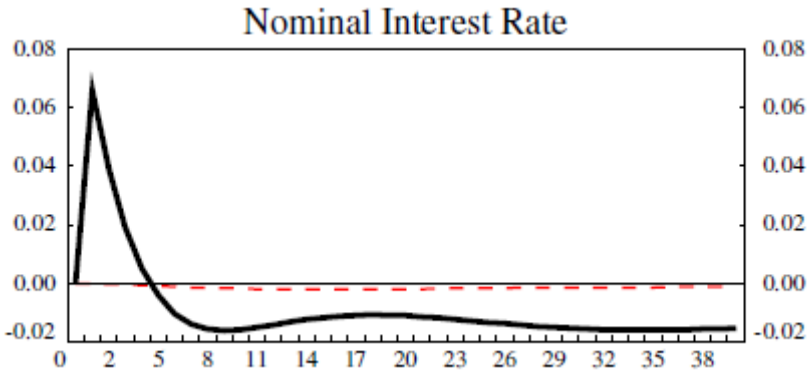
- Policies: shock implies a jump in level of price followed by low inflation rate. Inflation targeting rule responds to low inflation by lowering interest rate and expanding production. Bad response. Exchange rate target does not imply this.

- Impulse responses: note spike then drop in inflation, drop in interest rate (after initial inflation effect)

Markup shock (small openness) (solid line is inflation targeting policy; dashed line is exch. rate targeting policy)







Summarize above: Terms of trade shocks favor inflation targeting rule, while markup shocks favor exchange rate targeting rule.

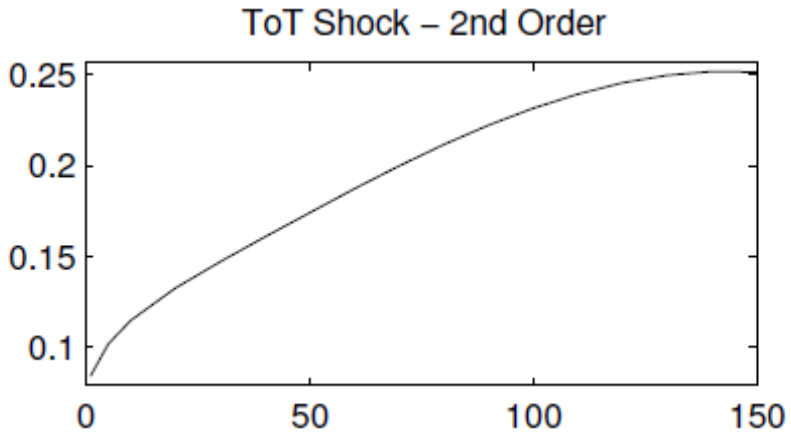
Effects of openness:

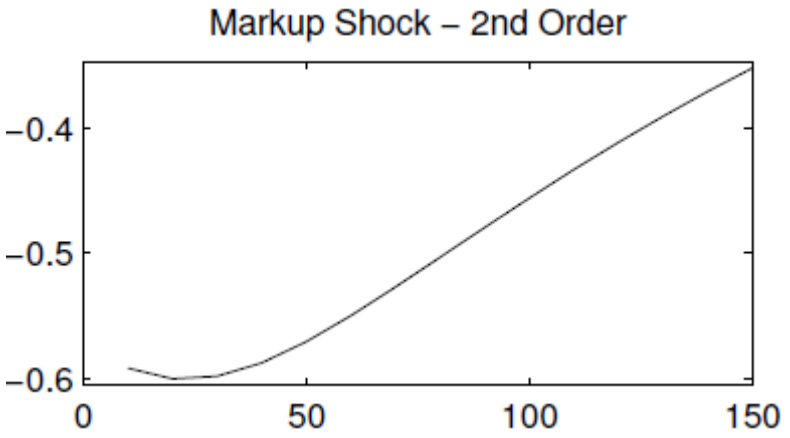
- Terms of trade shocks become more important as trade becomes a larger share of production.

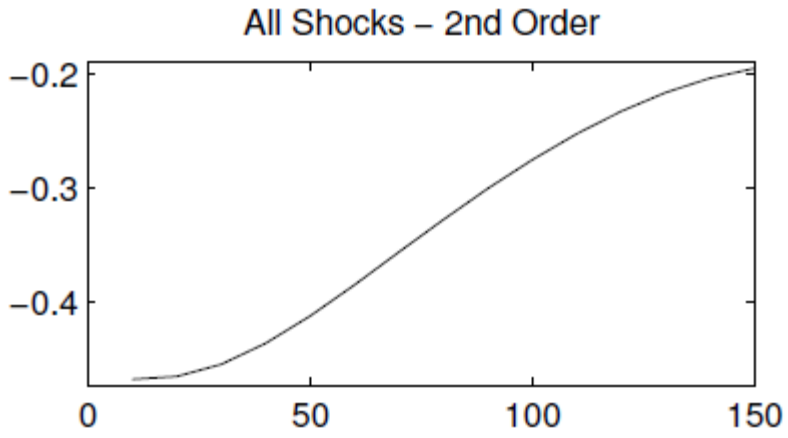
- Markup shocks become less important, since foreign trade is assumed competitive with no markups.

Overall conclusion: More openness raises the importance of those shocks that favor inflation targeting over exchange rate targeting.

Welfare: how much better is inflation targeting: how much consumption must take away from agents under inflation targeting to make them indifferent to exch. rate targeting.







Day II. The New Keynesian Approach

Part 1. Overview of Clarida, Gali and Gertler (JME 2002)

Objective: extend the New Keynesian modeling approach, widely applied in the closed economy literature, to a two-country context.

Main finding:

- The lessons of the closed economy literature apply here: it is optimal for policy rules to target just inflation to eliminate the welfare losses due to price dispersion.
- There is no benefit to additionally targeting the exchange rate.

Main Model Features

- Two countries (H,F) and two country-specific traded goods
- Identical Cobb-Douglas preferences in both countries.
- Complete asset markets.
- Intermediate goods production linear in labor.
- Monopolistically competitive, set prices in staggered fashion a la Calvo, in currency of seller (PCP).
- Households have market power in labor market (but wages are not sticky).
- Cost push shocks (u): shocks to the wage markup, as well as productivity shocks (a)
- Assume fiscal policy subsidies to offset steady state markups in wage and price.
- Note: Model implies LOP and PPP hold.

Collapse the system (FOCs, market clearing and constraints) into an IS/Phillips-Curve framework, determining the log output gap ($\tilde{y}$) and inflation in price of home goods (π) conditional on the path of the nominal interest rate (r).

Expectations-augmented IS curve:

Output gap depends negatively on the ex-ante real interest rate and on expected future output gap:

$$\tilde{y}_t = \mathrm{E}_t\{\tilde{y}_{t+1}\} - \sigma_0^{-1}[r_t - \mathrm{E}_t\{\pi_{t+1}\} - \overline{rr}_t]$$

(where rr is domestic natural real interest rate)

Expectations-augmented Phillips curve:

Inflation depends on the output gap, expected future inflation, and shocks to wage markup (cost-push shock)

$$\pi_t = \beta \mathrm{E}_t\{\pi_{t+1}\} + \lambda \tilde{y}_t + u_t$$

Note, defining the terms of trade $S_t \equiv P_{Ft} / P_{Ht}$, there is a relationship between terms of trade and the output gap (lower-case indicates logs):

$$s_t = \left(\tilde{y}_t - \tilde{y}^*_t \right) + \bar{s}_t$$

Central bank objective function:

- Take second-order approximation of household utility around flexible price equilibrium.

- Implies a quadratic objective function (where the welfare loss from a deviation from the optimum is expressed as a fraction of steady-state consumption):

$$\mathbb{W}^{\mathrm{H}} \equiv -(1-\gamma)\frac{\Lambda}{2}\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t [\pi_t^2 + \alpha \tilde{y}_t^2]$$

- Welfare loss depends on both inflation and output gap (latter with weight α)

- This is the same as the objective function in closed economy models.

Intuition: Why is inflation a bad thing?

- Under Calvo price stickiness, there is dispersion among the prices charged by home firms.
- Those firms that set their prices farther in the past have prices farther from the optimal price level, which can imply large efficiency losses.
- Note that the inflation rate here is the domestic producer price, because it is the price-setting of domestic firms that is the distortion.
- In the absence of other distortions, it would be optimal to use policy to prevent any fluctuation in PPI inflation.
- But cost push shocks are a second distortion here (changes in monopolistic distortion). This creates a trade-off between the goals of zero inflation and zero output gap.

Central Bank Targeting Criteria:

- Assume central bank chooses output and inflation each period to optimize the welfare function above, subject to the Phillips curve above.
- Solution implies the following targeting rule trading off output gap and inflation (where ξ is p rice elasticity of demand for intermediate goods) (analogous for foreign)

$$\tilde{y}_t = -\xi\pi_t$$

Substitute this into the Phillips curve and solve forward, to get a reduced form solution for inflation and output gap in terms of cost push shock:

$$\pi_t = \psi u_t,$$

$$\tilde{y}_t = -\xi\psi u_t,$$

$$\text{where } \psi \equiv [(1-\beta\rho)+\lambda\xi]^{-1} > 0$$

Observations:

- In absence of cost-push shocks, able to maintain both price stability and close the output gap.
- Otherwise, cost push shock generates tradeoff between output gap and inflation.
- This result is same as in past closed economy models.
- Openness does not affect the optimality condition or how aggressively central bank should adjust output gap in response to deviations of inflation from target.
- The only effect of openness is on how much the cost push shock affects inflation (through effect on slope of Phillips curve, elasticity of mc with respect to output)

Central Bank Interest rate Instrument Rule:

- Combine optimality condition with IS curve to derive the interest rate rule to implement the policy:

$$r_t = \overline{rr}_t + \vartheta \mathrm{E}_t\{\pi_{t+1}\} \quad \text{where}$$

$$\vartheta = 1 + \frac{\xi\sigma_0(1-\rho)}{\rho} > 1$$

- Note that the rule only needs to specify a response to inflation. Even though the output gap is considered in the tradeoff, it does not need to appear in the policy rule.

- This rule implies the interest rate must be raised more than one-for-one with inflation.

- Same as closed economy, except that openness affects σ_0, the interest elasticity of domestic spending.

Implication for the exchange rate:

- This policy rule does not imply stabilization of the exchange rate.

- The exchange rate responds to cost push shocks and productivity shocks:

$$
\begin{aligned}
e_t &\equiv e_{t-1} + s_t - s_{t-1} + \pi_t - \pi_t \\
&= e_{t-1} - \omega\xi\psi(\Delta u_t - \Delta u_t^*) + (\Delta a_t - \Delta a_t^*) + \psi(u_t - u_t^*) \\
&= e_{t-1} - (\omega\xi - 1)\psi(u_t - u_t^*) + \omega\xi\psi(u_{t-1} - u_{t-1}^*) + (\Delta a_t - \Delta a_t^*).
\end{aligned}
$$

Part 2. Engel (2009)

Objective:

- Argues that specific simplifying model assumptions in previous papers like CGG (2002) lead to conclusion that policy makers do not need to stabilize the exchange rate.

- Foremost among these is the assumption that LOP and PPP hold, which clearly are counterfactual.

- Why does this matter? Exchange rate fluctuations lead to deviations from the law of one price, which lead to inefficient consumption allocations between countries.

A further critique of the literature:

- It is typical in the literature to pose the question as follows: Should a Taylor policy rule be augmented with a response to the exchange rate? The typical answer is no.

- But this does not mean that the policy rule does not imply extensive exchange rate stabilization.

- We saw in CGG above that even though the output gap is considered in the targeting tradeoff, it does not need to appear in the interest rate instrument rule.

Model Features:

- Based on model of CGG (2002) above, except…

- Price stickiness in local currency (LCP)

- Home bias in preferences: home households put a weight of v/2 on home goods and 1-v/2 on foreign goods, and vice-versa for foreign households.

Notation: log of deviation from law of one price:

$$\Delta_t \equiv e_t + p^*_{Ht} - p_{Ht}$$

Solution:

- Same procedures as in CGG: Use second order approximation to household utility function to derive loss function for policy maker:

  (note study only case of cooperative policy due to technical difficulties under LCP)

- Loss function includes terms like CGG: output gap and inflation (now for CPI). But also includes price deviations across countries (delta)

$$\Psi_t \propto \frac{\nu(2-\nu)\sigma(\sigma-1)}{4D}(\tilde{y}_t - \tilde{y}_t^*)^2 - \left(\frac{\sigma+\phi}{2}\right)((\tilde{y}_t)^2 + (\tilde{y}_t^*)^2) - \left(\frac{\nu(2-\nu)}{4D}\right)\Delta_t^2$$
$$-\frac{\xi}{2\delta}\left((\pi_t)^2 + (\pi_t^*)^2 + \frac{\nu(2-\nu)}{2}(s_t - s_{t-1})^2\right)$$

$$\Psi_t \propto \frac{\nu(2-\nu)\sigma(\sigma-1)}{4D}(\tilde{y}_t - \tilde{y}_t^*)^2 - \left(\frac{\sigma+\phi}{2}\right)((\tilde{y}_t)^2 + (\tilde{y}_t^*)^2) - \left(\frac{\nu(2-\nu)}{4D}\right)\Delta_t^2$$
$$-\frac{\xi}{2\delta}\left((\pi_t)^2 + (\pi_t^*)^2 + \frac{\nu(2-\nu)}{2}(s_t - s_{t-1})^2\right)$$

where

- ν indicates home bias
- σ is the intertemporal elasticity
- ϕ labor supply elasticity
- ξ determines the markup in prices

Why LOP deviations are inefficient:

- Even if home and foreign output gaps were zero and all inflation rates were zero, there still could be international relative price differences.

- Suppose $\Delta > 0$, then overall consumption in home would be high relative to foreign, because financial markets pay off to Home residents when their currency is weak.

- But home residents have a home bias for home goods. This would lead to overproduction in the home country.

Solve for targeting criteria

- Optimize policy objective subject to Phillips curve as in CGG (under the simplifying assumption ϕ=1).

- This implies two targeting criteria:

- The first is similar to CGG: tradeoff between world output gap and the world inflation rate. But inflation here is CPI.

$$\tilde{y}_t^W + \xi \pi_t^W = 0$$

- The second criterion is:

$$\frac{1}{\sigma}\tilde{q}_t + \xi \pi_t^R = 0$$

where q is the deviation of the real exchange rate from its efficient level.

$$q_t = e_t + p_t^* - p_t$$

Solve for interest rate instrument rules:

$$r_t = (\rho + (1-\rho)\sigma\xi)\pi_t + \overline{rr}_t$$

$$r_t^* = (\rho + (1-\rho)\sigma\xi)\pi_t^* + \overline{rr}_t^*$$

- These look just like the ones in CGG, except that inflation here is CPI.

- But even though it looks like policy makers respond only to the inflation rate, remember that these rules are based upon a tradeoff where policy makers are stabilizing LOP deviations along with inflation (and the output gap).

Questions for discussion:

- Would you like to know how much exchange rate stability/volatility is implied in the LCP case of Engel?

- Are deviations from the law of one price always inefficient (think about trade models).

- Would introducing forward exchange rate contracts affect the benefits of exchange rate stabilization here?

- Ideas for other features of the world that should be incorporated in the models, which could justify policy actions to stabilize the exchange rate?

- Ideas from trade literature on this question?

Day III: International Policy Coordination:

Part 1. Background on International Coordination:

There is a long-standing literature studying the benefits of international policy coordination, usually using Mundell and Fleming model.

- Analyze cost/benefit of flexible exchange rates.

- Benefit: can compensate for price stickiness in promoting equilibrium adjustment to shocks.

- Cost: But exchange rate variability can discourage international trade.

International Policy Coordination: Oudiz and Sachs (Brookings Papers, 1984)

- Spillovers lead to externalities in policy making:

- Example 1: global shock that lowers global demand

  - Could resolve by all countries using expansionary fiscal policy.

  - National policy makers may fail to respond alone, fearing leak away to foreign demand.

- Example 2: monetary expansions beggar they neighbor

  - Tend to cause currency depreciations that shift demand way from foreign goods.

  - The temptation might induce national policy makers to utilize policy too much, thereby generating excessive inflation.

  - Coordination could eliminate these externalities.

How large?

- Oudiz and Sachs argued that the size of the gains from coordination small because major economies are fairly closed, so spillovers small.

- Estimated gains at only about 0.5 percentage points of GDP for the U.S.

- But given that integration has increased over the last 20 years, will this conclusion change?

Part 2: Devereux and Engel (RES 2003)

a. Motivation

- This paper emphasizes the role of local currency pricing.

- main idea: In the cost/benefit analysis of exchange rate flexibility, under LCP, exchange rate flexibility no longer offers the benefit of promoting equilibrium adjustment.

b. Model:

- Two countries, shown here for countries of equal size.
- Prices preset by one period.
- Consider prices set in local currency (LCP) as well as producer's currency (PCP)
- Firms are monopolistically competitive.
- Households infinitely lived.
- Are two shocks: technology and money velocity.

Some details:

- Household preferences:

$$U_t = \frac{1}{1-\rho} c_t^{1-\rho} + \frac{\chi}{1-\varepsilon} V_t \left(\frac{M_t}{P_t} \right)^{1-\varepsilon} - \eta L_t$$

where V is the velocity shock: $\ln V_t = \ln V_{t-1} + v_t$

and ρ^{-1} is the intertemporal elasticity of consumption

and ε^{-1} is the intertemporal elasticity of money demand

- Preferences over home and foreign goods has unitary elasticity.

- implied money demand condition:

$$\frac{M_t}{P_t} = \chi^{1/\varepsilon} V_t^{1/\varepsilon} C_t^{\rho/\varepsilon} \left(i_t / (1+i_t) \right)^{-\frac{1}{\varepsilon}}$$

- Firms production function:

$$Y_t = \theta_t L_t$$

$$\ln \theta_t = \ln \theta_{t-1} + u_t$$

Firms will again here set an extra price markup due to risk of unexpected fluctuations in demand.

- Government: policy rule responds directly to shocks

$$m_t = m_{t-1} + a_1 u_t + a_2 u_t^* + a_3 v_t + a_4 v_t^*$$

(assumes commitment, not discretion)

- Assume complete asset markets

Consider a flexible price equilibrium: how economy SHOULD work:

1) Suppose positive home money demand shock: (v)

- price falls in proportion to clear money demand condition:

$$\frac{M_t}{P_t} = \chi^{1/\varepsilon} V_t^{1/\varepsilon} C_t^{\rho/\varepsilon} \left(i_t/(1+i_t)\right)^{-\frac{1}{\varepsilon}}$$

- no effect on any real variables.

2) Suppose a positive home productivity shock (u)

- rise in production of home good
- price of home good falls
- this shifts demand toward home goods, to absorb the extra production of it

Consider a fixed price equilibrium:

1) Suppose positive home money demand shock: (v)

- no change in price
- so consumption falls and interest rate rises to clear money demand condition: $\frac{M_t}{P_t} = \chi^{1/\varepsilon} V_t^{1/\varepsilon} C_t^{\rho/\varepsilon} \left(\frac{i_t}{1+i_t} \right)^{-\frac{1}{\varepsilon}}$

2) Suppose a positive home productivity shock (u)

- no change in relative price of home good
- so no change in demand for home good
- so home firms do not produce more, even though productivity is high

c. Results - PCP case

Solve for Nash equilibrium, for each country separately:

$$\max_{a_1,a_2,a_3,a_4} \quad E_{t-1}\tilde{U}_t = E_{t-1}\left[\frac{1}{1-\rho}c_t^{1-\rho} + \frac{\chi}{1-\varepsilon}V_t\left(\frac{M_t}{P_t}\right)^{1-\varepsilon}\right]$$

Solution for optimal policy parameters:

Shock:	Policy Parameter:	Interpretation:
Home technology:	$a_1 = 1 - \frac{(\varepsilon - 1)}{2\varepsilon}$	Always expansionary
Foreign technology:	$a_2 = -\frac{(\varepsilon - 1)}{2\varepsilon}$	Sign depends on ε
Home velocity:	$a_3 = \frac{1}{\varepsilon}$	Fully counteract shock.
Foreign velocity:	$a_4 = 0$	No response.

Foreign policy parameters are symmetric: $a_1^* = a_1, \quad a_2^* = a_2$

1) Replicates flexible equilibrium
- The sticky price distortion is the only distortion.
- Money supply accommodates increased money demand.
- When home output rises, need terms of trade shift demand toward home goods. Can mimic this by increasing the home money supply. (see next point)

2) Flexible exchange rates compensate for sticky prices.
- Monetary policy manipulates the exchange rate to shift the terms of trade to clear the goods market.
- So flexible exchange rates are a good thing here.

3) There is no gain from coordinating national policies.
Each country can achieve the flexible price equilibrium on its own, so there is no need to coordinate.

d. Results: LCP Case – New conclusions

Solution for optimal policy parameters:

Shock:	Policy Parameter:	Interpretation:
Home technology:	$a_1 = \frac{1}{2\varepsilon}$	Always expansionary
Foreign technology:	$a_2 = \frac{1}{2\varepsilon}$	Always expansionary
Home velocity:	$a_3 = \frac{1}{\varepsilon}$	same as PCP.
Foreign velocity:	$a_4 = 0$	No response (like PCP)

Foreign policy parameters are same as home for same shocks: $a_1^* = a_2, \quad a_2^* = a_1$

Note: Response to money shock same as PCP, but not techno shock

- Both countries adjust their money supply in exactly the same way to a technology shock.
- This means there is no change in the exchange rate.
- This is because the exchange rate no longer affects the terms of trade.

1) Does not replicate flexible equilibrium
   The Flexible price equilibrium would involve changes in the terms of trade, so that demand moves with the increased supply of home goods. This cannot happen here.

2) It is optimal to leave exchange rates fixed.
   Because exchange rate movements do not serve a function for shifting demand, there is no reason to manipulate them in the case of technology shocks. (confirmed by examining an explicit exchange rate rule)

3) There is no gain from coordinating national policies.
   - Can't achieve flexible price equilibrium by changing the exchange rate.
   - No temptation for countries to beggar-thy neighbor, because can't manipulate TOT to shift demand. No externality.

Part 3: Obstfeld and Rogoff (QJE 2002)

a) Motivation:

- Focuses on the benefits of international policy coordination.

- Result depends upon what economic distortions are present.

- In particular, what if incomplete asset markets distort international risk sharing.

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b) **Model**

1) Preferences:

As in Obstfeld-Rogoff (1995):

$$U = \frac{C^{1-\rho}}{1-\rho} + \chi \frac{M}{P} - kL$$

where k is random shift in the marginal disutility of effort, or a negative productivity shock (with innovation κ).

As usual, ρ, indicates the relative risk aversion.

2) Nontraded goods:

- C is a Cobb-Douglas aggregate over home nontradables, home tradables and foreign tradables:

$$C = C_N^{\gamma} C_T^{1-\gamma} = C_N^{\gamma} C_H^{\frac{1-\gamma}{2}} C_F^{\frac{1-\gamma}{2}}$$

- Under Cobb-Douglas preferences consumption of traded goods here will be equal across countries (this is a well-know technical trick in the literature) $C_T = C_T^*$ for all states.

- Note that the perfect risk sharing condition under nontraded goods would be:

$\frac{U_{CT}^{*'}}{U_{CT}^{'}} = \frac{eP_T^*}{P_T} = 1$ under law of one price, so $U_{CT}^{'} = U_{CT}^{*'}$

- In general we cannot conclude that this is satisfied, because

$$U_{CT}^{'} = (1-\gamma)\frac{\left(C_N^{\gamma} C_T^{1-\gamma}\right)}{C_T},$$

and $C_T = C_T^*$ does not ensure that $U_{CT}^{'} = U_{CT}^{*'}$, due to nontradeds.

- But in the special case of log utility ($\rho = 1$), we have:

$$U_{CT}^{'} = (1-\gamma) C_T^{-1},$$

and $C_T = C_T^*$ does ensure that $U_{CT}^{'} = U_{CT}^{*'}$.

- Main point: risk sharing will fail to hold except in the special case of $\rho = 1$. So there will be an additional distortion in the model lowering welfare below the Pareto optimum.

3) Sticky wages:

- Wage rigidity instead of price. This is the other distortion in the model, preventing the Pareto optimal allocation.

- Same effect as sticky prices: extra markup due to risk lowers the mean level of production and consumption.

4) Shocks:

As in Obstfled-Rogoff (1995), the shock is decomposed into a common world component and the deviation between countries:

$$\kappa_w = \frac{\kappa + \kappa^*}{2}, \quad \kappa_d = \frac{\kappa - \kappa^*}{2}$$

5) Policies:

Money supply rule responding to shocks: (in logs)

$$m = -\delta_d \kappa_d - \delta_w \kappa_w$$

$$m^* = \delta_d{}^* \kappa_d - \delta_w{}^* \kappa_w$$

As usual, welfare will be measured in terms of expected utility:

Nash: $\max E[U], \quad \max E[U^*]$

Cooperative equilibrium $\max \frac{1}{2} E[U] + \frac{1}{2} E[U^*]$

c. **Results**:

1) Flexible wage allocation:

Useful to note that the model can replicate the flexible wage equilibrium if policy makers follow the policies:

$$\delta_d = \delta_d^* = 1$$

$$\delta_w = \delta_w^* = 1$$

Intuition:
If hit by a global rise in disutility of labor shock (k):

- Without rigidities: the real wage would rise and employment would fall, as workers shift out of production.
- Can mimic this if the policy maker lowers money in proportion, which lowers price level and raises real wage.

But if only home is hit by the shock:

- Without rigidities: the real wage would rise and employment would fall in only the home country.
- And since output can be produced relatively more easily in the foreign country, the real wage would fall there and induce a rise in employment.
- Can mimic if the home policy maker lowers money supply, and if the foreign country does the opposite.

Conclude:

- It is always possible to eliminate the sticky wage distortion. But Will this lead to a Pareto optimal result?
- Not if there is a second distortion (risk sharing).

2) Coordinated solution:

maximize: $\max \frac{1}{2}E[U]+\frac{1}{2}E[U^*]$ s.t.…

solution:
$$\delta_d = \delta_d^* = \frac{1-(1-\gamma)(1-\rho)}{1-(1-\gamma)^2(1-\rho)}$$
$$\delta_w = \delta_w^* = 1$$

Two Cases:

a) if $\rho = 1$:

- The optimal coordinated solution becomes the same as the flexible wage solution shown above.

- Intuition: when $\rho = 1$, there is no risk-sharing distortion; the only distortion is the sticky wage.

b) if $\rho \neq 1$:

- Now the optimal coordinated policy differs from the flexible wage solution, for asymmetric shocks δ_d .

Intuition:

- Policy maker takes advantage of the wage distortion to help alleviate the lack of risk sharing.
- If shock lowers output in the home country, want to shift some consumption goods from foreign to home country.
- For $\rho > 1$, do this by lowering home money supply more than otherwise, and raising foreign more. This improves the home terms of trade.
- For $\rho < 1$, the opposite is true.

3) Nash Solution:

maximize: $\max E[U], \quad \max E[U^*]$ s.t.….

solution:

$$\delta_d = \delta_d^* = \left[1-(1-\gamma)(1-\rho)\right]\frac{2-\gamma}{1-(1-\gamma)^2(1-\rho)+\rho(1-\gamma)}$$

$$\delta_w = \delta_w^* = 1$$

Two cases:

a) if $\rho = 1$:

- Optimal Nash solution same as flexible wage solution.
- Intuition: With risk sharing there is no temptation for beggar-thy-neighbor policies, so no externality to eliminate by coordination.

b) if $\rho \neq 1$:

- Now the Nash response differs from the cooperative solution.

Intuition:

- Now there is a lack of international risk sharing, so temptation for beggar-thy-neighbor policies.

- When $\rho > 1$, this can be accomplished by lowering money supply less in the home country than in the cooperative solution in response to a home negative productivity shock.

4) How large are the gains from coordination: calibration exercise.

Calibration: variance of shock = -0.01
share of nontraded goods: $\gamma = 0.6$

Compute:

i: gain from stabilization relative to a constant money supply rule (as a percent of output)

ii: gain from coordination relative to stabilization

$\rho =$	0.05	1	2	4	8
i. stabilization gain	3.110	1.01	0.330	0.110	0.030
ii. coordination gain	0.020	0	0.006	0.009	0.006
iii. ratio of i to ii.	0.008	0	0.019	0.080	0.180

Conclusions:

- Theoretically there may be gains for coordination when risk sharing is incomplete ($\rho \neq 1$)

- But the experiment indicates that even for rather high and low values of ρ, the gains from coordination are small relative to the gains from stabilization.

- So there does not appear to be good reason to promote international monetary policy coordination.

Contrast with older literature on coordination:

- Recall that Oudiz and Sachs found the gains from coordination are small because economies are rather closed
- The overall conclusion here is the same as the older literature, but for a different reason.
- Gains are small because when a government pursues optimal policy on its own, this looks very similar to the optimal policy of an international coordinator.
- If integration increases in the future, this will further lower the gains from coordination rather than raise them.
- As the share of traded goods approaches 100%, then risk sharing is complete, and no benefit.
- If asset markets become more integrated, this also improves risk sharing and lowers gains from coordination.