Monetary Policy and Capital Controls: Coordination in a World with Spillovers

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Martin M. Guzman Joseph E. Stiglitz

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Motivation

- Monetary policy by one large country can have effects on other countries
- Other countries are likely to respond
- Key questions:
  - How to think about the resulting global equilibrium?
  - How could global coordination improve matters?
  - When are there important externalities? When are they negative? When are they positive?
  - What can be done to enhance the likelihood of global coordination
  - In the absence of (perfect) coordination, what can countries do to protect themselves against adverse actions of others?
  - Are there externalities (spillovers) from these protective measures?
  - How can global financial architecture (the rules of the game) improve matters?

Example: QE2

- Probably had only minimal effects on US
  - Effects on LT government rates small
  - Effects on private sector rates even smaller
  - Has not led to much more lending to only sector which is constrained, SME
- One of the main channels by which it had effects was "competitive devaluation"
  - Even though US denies that it was its "intent" predictable consequences of low interest rate
  - Especially in period when ECB focused exclusively on inflation and Japan mantained more conventional monetary policies

Large Externalities associated with Monetary Policy by Large Country

- Adverse effects associated with competitive devaluation
- Many emerging markets believe it had adverse effects on them, as liquidity stimulated their economies
  - Money it's going where it's not needed
  - Especially with credit channel in US still clogged

Response

- These countries offset the actions
  - Imposing capital controls
  - Buying dollars to keep their exchange rates from appreciation
    - Fed "sold" dollars, other CB "bought" dollars
    - Does such a move have effect on US, other countries, global economy?
- Effects are being seen once again with the announcement of forthcoming tapering of QE

Not first instance of Effects of Monetary Policy by Large Country Having Global Repercussions

- Latin America lost decade was at least partly (or perhaps largely) a consequence of sudden change in US monetary policy, marked increase in interest rates

Important Lesson

- Monetary Policy in a World of Globalization, and several "large" players may be markedly different in the closed economy

Previous Research

- Used reduced form equations relating instruments (e.g. money supply, regulatory constraints, such as capital adequacy and reserve requirements and restrictions on capital flows) to societal welfare in a single period model
- To establish that there were in general large externalities
  - And attempted to trace out some of the channels through which those externalities were exercised, e.g. not just interest rates but liquidity
  - Important point: full effects of monetary policy cannot be captured in models focusing only on interest rates and assuming perfect capital markets
- The Nash equilibrium was in general inefficient
  - Cooperation could improve matters

Previous Research

- There were instruments that countries could use to protect themselves against these externalities
- But there were externalities associated with the use of these instruments
  - Ambiguous welfare effects of constraints on the use of these instruments –capital controls could lead to a Nash equilibrium with higher welfare
- Suggested that restrictions on the use of these instruments not only might reduce the (Nash) equilibrium on welfare, but might also reduce the scope for cooperation

Other previous research

- IO literature ("multimarket contact and collusive behavior", Bernheim and Whinston (1990)): pooling incentive compatibility constraints of two different markets may increase likelihood of cooperation
  - Multimarket contact is irrelevant for markets that are identical in terms of sustaining collusion and increasingly relevant as they differ in that regard
  - Optimal monetary and capital controls policy may not correlate perfectly with shocks, hence having both in the cooperation pool may increase likelihood of cooperation

Contributions of this paper

- Explicit specification of societal objective function (involving inflation and unemployment), and the derivation of the relationship between that and policy instruments of both countries
- Showing conditions under which capital controls can increase or decrease welfare in a symmetric Nash Equilibrium

Contributions of this paper

- Setting the problem of cooperation in a repeated game
  - Enhacing the prospects of cooperation
  - And showing explicitly how expanding the set of instruments can increase the likelihood of cooperation

A model with spillovers
The environment

- Two large countries, A and B
- Objective function: minimization of inflation and deviations of employment with respect to a target
- Assume existence of a Phillips curve
- Infinitely repeated game
- Countries receive demand shocks
- There are spillovers: monetary policy of one country affects the other country
    - Case 1: only one policy instrument, monetary policy
    - Case 2: two policy instruments, monetary policy and capital controls
        - Capital controls will affect size of monetary policy and direct demand shocks spillovers

A model with spillovers
Policy goals and constraints

- Static loss function:

$$L^i = \frac{1}{2}p^{i^2} + \frac{\lambda}{2}(x^i - x^*)^2$$

  - p: inflation, x: employment, x^*: target of employment, λ: preferences over inflation and employment stability
  - Identical preferences and targets for both countries
  - We treat p as the monetary policy instrument (usual simplification)

A model with spillovers
Policy goals and constraints

- Constraint: existence of a Phillips curve

$$x^i = \gamma^i p^i + (1 - \gamma^j) p^j + \nu^i$$

  - $\gamma^i \in (0, 1)$ denotes spillovers of MP of country i to country j
  - ν^i are demand shocks:

$$\nu^i = \epsilon^i + \theta^i \epsilon^j$$

    - ϵ^i is the direct demand shock to country i, observable and iid, $\epsilon^i \sim N(0, \sigma_i^2)$
    - Demand shocks have also spillovers across countries
    - $\theta^i \in [0, 1)$: size of demand shocks spillovers
    - Capital controls will affect γ^i and θ^i
  - $\gamma^i \in (0, 1)$ means that country i absorbs all the costs of monetary policy but does not enjoy all the benefits

A model with spillovers

Case 1: only one instrument, p

- What is the global equilibrium with no coordination?
- What is the global equilibrium under cooperation?

A model with spillovers

Case 1: only one instrument, p, decentralized solution

No global cooperation case:

- Optimal monetary policy: in each period, choose p in order to minimize loss function subject to constraint
- Nash equilibrium described by

$$p_N^i = n_{x,i}^p x^* + n_{\epsilon^i,i}^p \epsilon^i + n_{\epsilon^j,A}^p \epsilon^j$$

$$x_N^i = n_{x,i}^x x^* + n_{\epsilon^i,i}^x \epsilon^i + n_{\epsilon^j,i}^x \epsilon^j$$

  - Coefficients n_i^h depend on preferences and spillovers

A model with spillovers

Case 1: only one instrument, p, decentralized solution

- Static loss

$$L_N^i = N_{x,i}x^{*2} + N_{x\epsilon^i,i}x^*\epsilon^i + N_{x\epsilon^j,i}x^*\epsilon^j + N_{\epsilon^i,i}\epsilon^{i2} + N_{\epsilon^j,i}\epsilon^{j2} + N_{\epsilon^i\epsilon^B,i}\epsilon^i\epsilon^j$$

  - Losses in period t depend on employment preferences, domestic shocks, external shocks, and the interaction of domestic and external shocks

A model with spillovers

Case 1: only one instrument, p, decentralized solution

- Expected losses (present discounted value)

$$\sum_{t=0}^{\infty} \beta^t EL_N^i = \frac{1}{1-\beta}[N_{x,i}x^{*2} + N_{\epsilon^i,i}\sigma_i^2 + N_{\epsilon^j,i}\sigma_j^2 + N_{\epsilon^i\epsilon^j,i}\sigma(\epsilon_i,\epsilon_j)]$$

  - Expected losses depend on variance of domestic and external shocks, covariance of domestic and external shocks, and preferences discount factor
  - Assumption: $\sigma(\epsilon_i, \epsilon_j) = 0$

A model with spillovers

Case 1: only one instrument, p, cooperative solution

Cooperation case

- Optimal monetary under cooperation comes from minimizing joint losses

$$L_c^A + L_c^B = \frac{1}{2}p^{A2} + \frac{1}{2}p^{B2} + \frac{\lambda}{2}(x^A - x^*)^2 + \frac{\lambda}{2}(x^B - x^*)^2$$

- Cooperative equilibrium described by

$$p_C^i = c_{x,i}^p x^* + c_{\epsilon^i,i}^p \epsilon^i + c_{\epsilon^j,i}^p \epsilon^j$$

$$x_C^i = c_{x,i}^x x^* + c_{\epsilon^i,i}^x \epsilon^i + c_{\epsilon^j,i}^x \epsilon^j$$

  - Coefficients c_i^h depend on preferences and spillovers

A model with spillovers

Case 1: only one instrument, p, cooperative solution

Characteristics of equilibrium: Nash vs. Cooperation

- If both countries receive positive demand shocks, monetary policy is more expansionary in both countries under cooperation
- If country i receives positive demand shock and country j receives negative demand shock, monetary policy of country i (j) is more (less) expansionary under cooperation

A model with spillovers

Case 1: only one instrument, p, cooperative solution

- Static loss:

$$L_C^i = C_{x,i}x^{*2} + C_{x\epsilon^i,i}x^*\epsilon^i + C_{x\epsilon^j,i}x^*\epsilon^j + C_{\epsilon^i,i}\epsilon^{i2} + C_{\epsilon^j,i}\epsilon^{j2} + C_{\epsilon^i\epsilon^j,i}\epsilon^i\epsilon^j$$

  - Losses in period t depend on employment preferences, domestic shocks, external shocks, and the interaction of domestic and external shocks

A model with spillovers

Case 1: only one instrument, p, cooperative solution

- Expected losses (present discounted value)

$$\sum_{t=0}^{\infty} \beta^t EL_C^i = \frac{1}{1-\beta}[C_{x,i}x^{*2} + C_{\epsilon^i,i}\sigma_{\nu,i}^2 + C_{\epsilon^j,i}\sigma_{\nu,j}^2]$$

  - Expected losses depend on variance of domestic and external shocks, covariance of domestic and external shocks, and the preferences discount factor

A model with spillovers

Case 1: only one instrument, p, Equilibrium

- Can cooperation be achieved in the repeated game?
- If one country deviates, they will both play Nash forever beginning with the following period
  - Comparison of gain and expected losses from deviation at time 0
    - Gain is one-period and depends on current shocks
    - Loss is multi-period (from 1 to ∞) and depends on variances and covariances of shocks

A model with spillovers

Case 1: only one instrument, p, Equilibrium

- Gain from deviation

$$
\begin{aligned}
GD(p) = \quad & L^i_C(p^i_C, p^j_C) - L^i_D(p^i_D, p^j_C) \\
& = (C_{x,i} - D_{x,i})x^{*2} + (C_{x\epsilon^i,i} - D_{x\epsilon^i,i})x^*\epsilon^i + \\
& (C_{x\epsilon^j,i} - D_{x\epsilon^j,i})x^*\epsilon^j + (C_{\epsilon^i,i} - D_{\epsilon^i,i})\epsilon^{i2} + \\
& (C_{\epsilon^i\epsilon^j,A} - D_{\epsilon^i\epsilon^j,i})\epsilon^i\epsilon^j + (C_{\epsilon^j,i} - D_{\epsilon^j,i})\epsilon^{j2}
\end{aligned}
$$

- p^i_D is the optimal response of country i to cooperative behavior of country j

A model with spillovers

Case 1: only one instrument, p, Equilibrium

- Expected discounted loss from deviation

$$
\begin{aligned}
ELD^i(p) = \quad & E\sum_{t=T}^{\infty}\beta^t[L(p_N^i, p_N^j) - L^i(p_C^i, p_C^j)] \\
& = \frac{\beta}{1-\beta}[(N_{x,i} - C_{x,i})x^{*2} + (N_{\epsilon^i,i} - C_{\epsilon^i,i})\sigma^2_{\nu,i} \\
& +(N_{\epsilon^j,i} - C_{\epsilon^j,i})\sigma^2_{\nu,j}]
\end{aligned}
$$

A model with spillovers

Case 1: only one instrument, p, Equilibrium

- Cooperation set

  Definition: $\Psi(\epsilon^i, \epsilon^j) = \{\epsilon^i, \epsilon^j; \beta, \gamma^i, \gamma^j, \theta^i, \theta^j, \lambda, x^*, \sigma^2_{\nu,i}, \sigma^2_{\nu,j} : ELD^i(p) - GD^i(p) > 0, i = A, B\}$ is the set in which cooperation is achieved when p is the only policy instrument.

- How does cooperation depend on shocks?
  - Probability of cooperation depends negatively on absolute value of the domestic shock
  - Probability of cooperation depends positively on the value of $\epsilon^i \epsilon^j$

A model with spillovers

Case 2: two policy instruments, MP and capital controls

- Possibility of determining a policy regime before the execution of the policy action
- Policy regime is characterized by capital controls policy
- Capital controls will affect spillovers
  - They will affect monetary policy spillovers (γ^i)
  - They will affect direct demand shocks spillovers (θ^i)
    - Hence, capital controls will affect variances of demand shocks

A model with spillovers

Case 2: two policy instruments, MP and capital controls

- τ^i denotes capital controls policy of country i, $\tau \in [0, 1]$
- **Assumptions** on capital controls:
  - Regime determined in t will affect spillovers in $t+1$

$$\gamma_t^i = \gamma^i(\tau_{t-1}^i, \tau_{t-1}^j)$$
$$\theta_t^i = \theta^i(\tau_{t-1}^i, \tau_{t-1}^j)$$

with

$$\frac{\partial \gamma_t^i}{\partial \tau_{t-1}^i} > 0 \ \& \ \frac{\partial \gamma_t^i}{\partial \tau_{t-1}^j} > 0$$
$$\gamma_t^i(1, \tau_{t-1}^j) = 1 \ \& \ \gamma_t^i(\tau_{t-1}^i, 1) = 1$$
$$\frac{\partial \theta_t^i}{\partial \tau_{t-1}^i} < 0 \ \& \ \frac{\partial \theta_t^i}{\partial \tau_{t-1}^j} < 0$$
$$\theta_t^i(1, \tau_{t-1}^j) = 0 \ \& \ \theta_t^i(\tau_{t-1}^i, 1) = 0$$

A model with spillovers

Case 2: two policy instruments, MP and capital controls

- We do not allow for different taxes on inflows and outflows
- If we did,we would be attempting coordination in three distinct instruments (with results similar to those described here for two)
- The effect of τ^i on γ^i is due to controls on outflows
- The effect of τ^i on γ^j and θ^i is due to controls on inflows

A model with spillovers

Case 2: two policy instruments, MP and capital controls, decentralized solution

No global cooperation case: no cooperation in p or in τ

- Firstly, we solve for Nash equilibrium in p
- Secondly, we solve for Nash equilibrium in τ as a function of expected $\{p_N^A, p_N^B\}$
- Nash equilibrium in τ dimension is the (fixed point) solution to the problem of minimization of next period expected loss, given the reaction function of the other country

$$Min_{\tau^i/\tau^j} \quad EL^i_{N\tau} = N^{\tau}_{x,i}(\tau^i,\tau^j)x^{*2} + N^{\tau}_{\epsilon^i,i}(\tau^i,\tau^j)\sigma^2_{\nu,i}(\tau^i,\tau^j) + N^{\tau}_{\epsilon^j,i}(\tau^i,\tau^j)\sigma^2_{\nu,j}(\tau^i,\tau^j)$$

A model with spillovers

Case 2: two policy instruments, MP and capital controls, decentralized solution

- Static loss:

$$L^i_{N\tau} = N^{\tau}_{x,i}x^{*2} + N^{\tau}_{x\epsilon^i,i}x^*\epsilon^i + N^{\tau}_{x\epsilon^j,i}x^*\epsilon^j + N^{\tau}_{\epsilon^i,i}\epsilon^{i2} + N^{\tau}_{\epsilon^j,i}\epsilon^{j2} + N^{\tau}_{\epsilon^i\epsilon^j,i}\epsilon^i\epsilon^j$$

- Expected discounted loss:

$$\sum_{t=0}^{\infty}\beta^t EL^i_{N\tau} = \frac{1}{1-\beta}[N^{\tau}_{x,i}(\tau^i_N,\tau^j_N)x^{*2} + N^{\tau}_{\epsilon^i,i}(\tau^i_N,\tau^j_N)\sigma^2_{\nu,A}(\tau^i_N,\tau^i_N) + N^{\tau}_{\epsilon^j,i}(\tau^i_N,\tau^j_N)\sigma^2_{\nu,j}(\tau^i_N,\tau^j_N)]$$

A model with spillovers

Case 2: two policy instruments, MP and capital controls, cooperative solution

Cooperation set

- Firstly, for cooperative solution in p we solve the problem of minimization of joint losses in period t as before
- Secondly, for cooperative solution in τ we solve the problem of minimization of expected joint losses
- We obtain the static loss and the expected discounted losses, that will now depend on τ as well

A model with spillovers

Case 2: two policy instruments, MP and capital controls. Welfare analysis

Is the existence of capital controls welfare-enhancing in the no cooperation case?

- Equivalently, is the loss of the Nash equilibrium with possibility of capital controls lower than the loss of the Nash equilibrium in absence of capital controls?
- Not necessarily –countries may benefit from greater spillovers–but they are certainly welfare enhancing if their effect on variance reduction is sufficiently high (Propositions 1 and 2)

A model with spillovers

Case 2: two policy instruments, MP and capital controls. Welfare analysis

Definition: $\tau^* \in \mathbb{R}_+ \mid EL^i(0, 0, p_n^A, p_n^B) = EL^i(\tau^*, \tau^*, p_n^A, p_n^B)$

Proposition 1. Suppose $\tau_C < \tau_N$. Then,

1. If $\tau^* > 1$, capital controls are welfare-enhancing
2. If $\tau^* \in (\tau_N, 1]$, capital controls are welfare-enhancing
3. If $\tau^* \in (\tau_C, \tau_N)$, capital controls reduce welfare
4. $\tau^* \notin (0, \tau_C]$

Proposition 2. Suppose $\tau_C > \tau_N$. Then, capital controls are welfare-enhancing

A model with spillovers

Case 2: two policy instruments, MP and capital controls, Equilibrium

- Can cooperation be achieved in equilibrium?
- Is cooperation more or less likely to be achieved in the two instruments case with respect to the one instrument case?
- We need to compare differences between expected losses and gains from deviation for given demand shocks –cooperation is more likely when that difference is larger

A model with spillovers

Case 2: two policy instruments, MP and capital controls, Equilibrium

- Gain from deviation in the two instruments case:

$$GD^i(\tau, p) = L^i(\tau_C^i, \tau_C^j, p_C^i, p_C^j) - L^i(\tau_C^i, \tau_C^j, p_D^i, p_C^j)$$

- Gain from deviation in the one instrument case (rewritten):

$$GD^i(p) = GD^i(0, p) = L^i(0, 0, p_C^i, p_C^j) - L^i(0, 0_C, p_D^i, p_C^j)$$

A model with spillovers

Case 2: two policy instruments, MP and capital controls, Equilibrium

- Expected discounted loss from deviation in the two instruments case:

$$\sum_{t=1}^{\infty} \beta^t ELD^A(\tau, p) = \frac{\beta}{1-\beta}[EL^i(\tau_N^i, \tau_N^j, p_N^i, p_N^j) - EL^i(\tau_C^i, \tau_C^j, p_C^i, p_C^j)]$$

- Expected discounted loss from deviation in the one instrument case (rewritten):

$$\sum_{t=1}^{\infty} \beta^t ELD^A(0, p) = \frac{\beta}{1-\beta}[EL^i(0, 0, p_N^i, p_N^j) - EL^i(0, 0, p_C^i, p_C^j)]$$

A model with spillovers

Case 2: two policy instruments, MP and capital controls, Equilibrium

- Cooperation set

Definition. $\Phi(\epsilon^i, \epsilon^j) = \{\epsilon^i, \epsilon^j; \beta, \gamma^i(\tau^i, \tau^j), \gamma^j(\tau^i, \tau^j), \theta^i(\tau^i, \tau^j), \theta^j(\tau^i, \tau^j), \lambda, x^*, \sigma^2_{\nu,i}, \sigma^2_{\nu,j} : ELD^i(\tau, p) - GD^i(\tau, p) > 0, i = A, B\}$ is the set in which cooperation is achieved when τ and p are the policy instruments

A model with spillovers

Case 2: two policy instruments, MP and capital controls, Likelihood of Cooperation

Proposition 3. For $\beta > 0$ and $\left.\frac{\partial \theta^i}{\partial \tau^i}\right|_{\tau^i=0} > \varepsilon$, $\varepsilon > 0$, then $\Psi(\epsilon^A, \epsilon^B) \subset \Phi(\epsilon^A, \epsilon^B)$

- Meaning of proposition: If the reduction of the variance of demand shocks when capital controls are increased from zero to positive is sufficiently large, then cooperation is more likely when both monetary policy and capital controls belong to the cooperation pool

A model with spillovers

Case 2: two policy instruments, MP and capital controls, Likelihood of Cooperation

- Intuition:
  - Gain from deviation does not depend on variances, it depends on shocks
  - Expected losses do depend on variances
  - Static loss under deviation is smaller with two instruments, but static loss under cooperation is also smaller $\rightarrow$ Gain from deviation is a small number
  - In the two instruments case, deviation is associated with gain in one dimension but triggers return to Nash equilibrium in two dimensions
  - Hence, coefficients of expected losses from deviation are larger in the two instruments case and variances of demand shocks increases after deviation $\rightarrow$ Increase in losses larger than increase in gains

Conclusions

- In the absence of coordination, countries may offset undesired effects of foreign countries' monetary policy by increasing capital controls
  - But global equilibrium would be suboptimal
  - It is not just that with capital controls the NE is suboptimal: There are some circumstances in which the presence of controls leads to a NE which is worse than one in which there are no controls
- Countries might not be able to agree on the right level of controls or the design of a cooperative control regime
  - But it may still pay them to agree not to use controls

Conclusions

- But more generally, allowing controls can both lead to an improved NE, and even more, a cooperative equilibrium that is better than the NE $\rightarrow$ Pooling policy instruments may increase the likelihood of cooperation