Optimal Monetary Policy in a ‘Sudden Stop’

with Jorge Roldos (IMF) and Fabio Braggion (Northwestern, Tilburg)
Modeling Issues/Tools

- Small, Open Economy Model
- Interaction Between Asset Markets and Monetary Policy
- Limited Participation Model of Money.
Motivation

• Asian Financial Crisis: ‘Sudden Stop’
  – Current Account Swings Negative to Positive by 15 Percentage Points of GDP
  – Output Drops 12 Percent, Consumption a Little More, Employment a Little Less
  – Asset Prices and Exchange Rates Drop by Over 40 Percent
• Controversy: How Should the Domestic Monetary Authority Respond?
• Two Responses:
  – Krugman-Stiglitz:
    * A Crisis is a Time When Economies are Slipping Into Recession.
    * Medicine Appropriate for US: Interest Rate Cut.
    * If It’s Good Enough for the US, then It’s Good Enough for Thailand.
  – IMF: A Crisis is a Time When Foreign Investors are Rushing for the Exits. Need High Rates to Stop Them.
Motivation ...

- What *Did* They Do? Both!

- Was Policy Erratic, Responding to Different Advice at Different Times?
- Our Argument: this Policy May have been Roughly *Optimal.*
Motivation ...

- Model Highlights Key Features of Crisis Economies:
  - General Evidence From Surveys of ‘Credit Crunch’
were higher in large firms and local firms than in SMEs and foreign controlled firms, respectively. It is particularly remarkable that the proportion of large firms rejected for loans rose dramatically from 21% in the first half of 1997 to 61% in the same period of 1998. This does not concord with the general belief that SMEs suffered more severely from the credit crunch.

**Fig.9. Availability of Credit after the Crisis**

![Graph showing availability of credit after the crisis]

**D. Transparency and Disclosure**

Even before the financial crisis began unfolding, the East Asian financial system, not excluding Korea’s, had often been criticized for its insufficient transparency and disclosure of financial information. Concerning this issue, we asked firms whether their financial statements were audited by outside accounting firms, whether they needed audited statements to receive a bank loan, and whether they had to secure their loan with collateral.

On the issue of audited statements, about two-thirds of surveyed firms answered that they were audited by outside accounting firms. Almost all of the large firms and about 60% of SMEs affirmed this. In order to qualify for a bank loan, approximately 62% of firms needed audited statements, specifically, about 95% of large firms and 56% of SMEs. Thus, judging from this, it can be inferred that there is sufficient transparency and disclosure of financial information in Korea. Therefore, the actual problem in Korea is neither whether firms are audited by outside accounting firms nor whether they provide audited statements to receive a bank loan, but it is how much credibility the audited statements hold and how much importance banks attach to them in determining loan provisions. Unfortunately, this information cannot be obtained from our survey.

Meanwhile, on the issue of collateral, 86% of firms answered that they had to provide collateral to receive bank loans. This reflects the fact that Korean banks...
Motivation ...

• Analysis: Compute Optimal Monetary Policy in a Variant on Model in Christiano, Gust, Roldos (*JET*, 2004)

• Model Highlights Key Features of Crisis Economies:
  – General Evidence From Surveys of ‘Credit Crunch’
  – Collateral Constraints on Loans in Crisis Economies Tightened

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Secured</th>
<th>Secured as % of Total</th>
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</thead>
<tbody>
<tr>
<td>1993</td>
<td>47.5</td>
<td>7.9</td>
<td>16.5</td>
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<tr>
<td>1994</td>
<td>64.9</td>
<td>11.5</td>
<td>17.7</td>
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<td>1995</td>
<td>93.0</td>
<td>16.1</td>
<td>17.3</td>
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<td>1996</td>
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<tr>
<td>1997</td>
<td>143.7</td>
<td>61.4</td>
<td>42.7</td>
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<tr>
<td>1998</td>
<td>77.3</td>
<td>25.9</td>
<td>33.5</td>
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<tr>
<td>1999</td>
<td>73.1</td>
<td>26.3</td>
<td>35.9</td>
</tr>
</tbody>
</table>

* Thailand: banks loaned 70-80% of collateral pre-crisis, 50-60% after crisis (Edison, Luangaram and Miller (2000))
Motivation ...


- Model Highlights Key Features of Crisis Economies:
  - General Evidence From Surveys of ‘Credit Crunch’
  - Collateral Constraints on Loans in Crisis Economies Tightened
  - Intermediate Inputs are an Important Component of Imports

<table>
<thead>
<tr>
<th>Year</th>
<th>Thailand Total</th>
<th>Intermediate</th>
<th>% of Total</th>
<th>Korea Total</th>
<th>Intermediate</th>
<th>% of Total</th>
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<tr>
<td>1995</td>
<td>70,718</td>
<td>25,061</td>
<td>35%</td>
<td>135,119</td>
<td>64,611</td>
<td>48%</td>
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<td>1996</td>
<td>72,248</td>
<td>24,874</td>
<td>34%</td>
<td>150,339</td>
<td>68,556</td>
<td>46%</td>
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<td>1997</td>
<td>63,286</td>
<td>21,860</td>
<td>35%</td>
<td>144,616</td>
<td>69,361</td>
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<td>1998</td>
<td>42,403</td>
<td>14,744</td>
<td>35%</td>
<td>93,282</td>
<td>45,593</td>
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<tr>
<td>1999</td>
<td>49,919</td>
<td>18,205</td>
<td>36%</td>
<td>119,752</td>
<td>57,253</td>
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<tr>
<td>2000</td>
<td>62,181</td>
<td>23,663</td>
<td>38%</td>
<td>160,481</td>
<td>78,975</td>
<td>49%</td>
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<tr>
<td>2001</td>
<td>61,847</td>
<td>22,978</td>
<td>37%</td>
<td>141,098</td>
<td>71,929</td>
<td>51%</td>
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<tr>
<td>2002</td>
<td>64,317</td>
<td>24,461</td>
<td>38%</td>
<td>152,126</td>
<td>73,891</td>
<td>49%</td>
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</tbody>
</table>
Motivation ...

- Model Highlights Key Features of Crisis Economies:
  - General Evidence From Surveys of ‘Credit Crunch’
  - Collateral Constraints on Loans in Crisis Economies Tightened
  - Intermediate Inputs are an Important Component of Imports
  - Intermediate Inputs are Closely Correlated with Output During Crisis.
Intermediate Goods Import vs. GDP
(Index 1995 = 100)

Sources: CEIC; and WEO.

Figure 2
Structure of Model

• Small, Open Economy with Traded and Nontraded Goods

• Imported Intermediate Inputs and Labor Must be Financed in Advance
  – Trigger of Crisis:
    * Collateral Shock.
    * Sudden Tightening of Binding Collateral Constraints.
  – We Do Not Explain Why this Shock Occurs
    * We Only Hope to Explain the Consequences

• Labor Market Frictions
  – Short Run: Labor Hard to Adjust in Tradable Sector
  – Longer Run: Labor Everywhere Flexible
Outline

• Dynamic Model

• Simulation of Optimal Policy
  – Comparison with Korean Data

• Draw Attention to the Unusual Nature of the Monetary Transmission Mechanism
  – Welfare and Output Increased in First Period with Increase in Domestic Interest Rate

• Carefully Go Through A Highly Simplified (Non-Monetary, Static) Version of the Model to Better Understand Monetary Transmission Mechanism.
Flow of Goods and Labor in the Model

- Household
  - Final Consumption Good
    - Traded Goods
    - Non-traded Goods
    - Foreign Sector
    - Labor Market
Model

• Agents: Households, Final Good Firms, Intermediate Good Firms, Foreign Sector.

• Households

$$\max_{c_t,L_t} \sum_{t=0}^{\infty} \beta^t \left[ c_t - \frac{\psi_0}{1+\psi} L_t^{1+\psi} \right]^{1-\sigma}$$

$$P_t c_t \leq W_t L_t + \tilde{M}_t - D_t$$

$$\tilde{M}_{t+1} = R_t (D_t + X_t) + P_t^T \pi_t + W_t L_t + \tilde{M}_t - D_t - P_t c_t$$

$$\tilde{M}_{t+1} \sim \text{money chosen by household}$$

$$R_t \sim \text{gross domestic nominal rate}$$

$$X_t \sim \text{money injection by central bank}$$

$$\pi_t \sim \text{profits}$$

$$D_t \sim \text{deposits of cash with intermediary.}$$
Outline ...
Final Good Firms (‘Retailers’):

\[
c = \min \left\{ (1 - \gamma) c^T, \gamma c^N \right\}.
\]

- \(c^N\) ~ non-traded intermediate input
- \(c^T\) ~ traded intermediate input
• Domestic Intermediate Good Firms:
  – Technology, traded goods:

\[
y^T = \left\{ \theta [\mu_1 V]^\frac{\xi-1}{\xi} + (1 - \theta) [\mu_2 z]^\frac{\xi-1}{\xi} \right\}^\frac{\xi}{\xi-1},
\]

\[
V = A \left( K^T \right)^{\nu} \left( L^T \right)^{1-\nu},
\]

\[\xi \sim \text{elasticity of substitution between } V \text{ and } z\]

\[z \sim \text{foreign intermediate good}\]

  – Short Run Friction:

  Traded Good Firm Decides $L^T$ At Start of Period

  – Technology, non-traded goods:

\[
y^N = (K^N)^\alpha (L^N)^{1-\alpha}.
\]
Outline ...
• Objective of Intermediate Good Firms:

\[
\max \sum_{t=0}^{\infty} \beta^t \Lambda_{t+1} \pi_t,
\]

\[
\pi_t = p_t^N y_t^N + y_t^T - w_t R_t L_t - R^* z_t - r^* B_t + (B_{t+1} - B_t)
\]

• Collateral Constraint:

\[
\tau \frac{Q_t^N}{S_t} K^N + \tau \frac{Q_t^T}{S_t} K^T \geq R^* z_t + (1 + r^*) B_t
\]

\[
q_t^i = VMP_{K^i,t} + \lambda_t \tau^i q_t^i + \frac{q_t^i + 1}{1 + \rho_t}, \quad q_t^i = \frac{Q_t^i}{S_t}, \quad i = N, T.
\]

• Resource Constraints:

\[
y_t^N = c_t^N
\]
\[
y_t^T = c_t^T + R^* z_t + r^* B_t - (B_t' - B)
\]
### Parameters Values of the Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<td>$\beta$</td>
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<tr>
<td>$\gamma$</td>
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<tr>
<td>$\psi$</td>
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<tr>
<td>$R$</td>
<td>1.11</td>
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<tr>
<td>$R^*$</td>
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<tr>
<td>$K^N$</td>
<td>10</td>
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<tr>
<td>$\nu$</td>
<td>0.5</td>
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<tr>
<td>$K^T$</td>
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<td>$\mu_1$</td>
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<td>$\mu_2$</td>
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<td>$\tau$</td>
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<td>$\theta$</td>
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<td>$\psi_0$</td>
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<td>$\sigma$</td>
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<tr>
<td>$A$</td>
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<tr>
<td>$\xi$</td>
<td>0.1</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**Note:** Here, $\beta$, $R$ and $R^*$ are expressed in annualized terms.
Timing

Collateral Shock

Monetary Action

0

Traded Good
Firm Decides
Employment in
Traded Sector

Household
Deposit Decision

1

Production,
Consumption Occur

2
Effects of Collateral Shock

- Economy in Steady State Until Period 0, Ignoring Collateral Constraint.
- Collateral Constraint Unexpectedly Imposed and Binding in Period 0
  - Current Account Switches to Positive As Firms Pay Down Debt.
- Intertemporal Euler Equation of Firm

\[ 1 = \beta \frac{\Lambda_{t+2}}{\Lambda_{t+1}} (1 + r^*) (1 + \lambda_{t+1}), \ t = 0, 1, 2, \ldots . \]

\( \Lambda_{t+1} \) multiplier on household budget constraint

- We Assume \( \beta (1 + r^*) = 1 \), so

\[ \frac{\Lambda_{t+1}}{\Lambda_{t+2}} = 1 + \lambda_{t+1}, \ t = 0, 1, 2, \ldots . \]

- With \( \lambda_{t+1} > 0 \), Consumption Level Low, Growth High
- \( B_t \) Falls Until \( \lambda_t \rightarrow 0 \).
Effects of Collateral Shock ...

Response of Debt and Output to Collateral Shock In the Absence of Monetary Policy Response (Fixed Money Growth)

In the absence of monetary policy response (fixed money growth), the high shadow value of debt induces firms to pay it down. The level of international debt in the old steady state is reflected in the graph as a significant drop due to a financial crisis. The level of debt in the new steady state is shown to recover gradually over time, with output during the transition also depicted, indicating a period of economic recovery following the shock.
Optimal and Constant Money Growth

- Current Account
- Real GDP
- Employment
- Consumption
- Imports
- Asset Prices
- Nominal Interest Rate
- Nominal Exchange Rate (Price of Traded)
- Inflation

- Optimal Money Growth
- Constant Money Growth

Legend: Optimal Money Growth in blue, Constant Money Growth in green dotted line.
Simulation vs. Actual Korean Data

- Current Account
- Real GDP
- Employment
- Consumption
- Imports
- Asset Prices
- Nominal Interest Rate
- Nominal Exchange Rate (Price of Traded)
- Inflation

Comparison of Simulation and Actual Korean Data.
Heart of Analysis

- Raising Interest Rate Leads to Higher Employment, Asset Prices and Welfare

- Puzzle:
  - Interest Rate is Like Tax on Labor
    * Why Does Raising Tax on Labor Lead to More Employment and Higher Welfare?
  - Asset Values Correspond to Inputs that Complement Labor
    * Why Does Raising Tax on Labor Raise Value of Complementary Inputs?

- Answer: Higher Wedge on Labor Permits Reduction in Another Wedge, Collateral Constraint

- Will Work Through a Simple Example, Where Analytic Result is Possible
Simplified Model Economy

• Households
  – Maximize

\[ u(c, L) = c - \frac{\psi_0}{1 + \psi} L^{1+\psi} \]

– subject to:

\[ pc \leq wL + \pi + T \]

• Firms:

– Final Good Technology:

\[ c = \min \left\{ (1 - \gamma)c^T, \gamma c^N \right\} . \]
Simplified Model Economy ...

– Traded and Non-Traded Good Technology:

\[ y^T = Az^\theta, \quad y^N = K^\alpha L^{1-\alpha}. \]

– Market Clearing

\[ y^T = c^T + R^* z, \]
\[ y^N = c^N. \]

– Intermediate Good Firm Problem: maximize

\[ \pi = p^N y^N + y^T - q(K - K_0) - w(1 + \tau) L - R^* z, \]
\[ \text{s.t. } \tau^N q K \geq R^* z. \]
Simplified Model Economy ...

- Timing

1. Labor Tax Rate, $\tau$, Selected
2. Domestic Market in Physical Capital, with Price:

$$ q = \frac{\alpha p^N K^{\alpha-1} L^{1-\alpha}}{1 - \lambda \tau^N}. $$

3. Production and Trade Occurs.

- Labor Supply:

$$ \psi_o L^\psi = \frac{w}{p} $$

- Labor Demand:

$$ p^N (1 - \alpha) K^\alpha L^{-\alpha} = (1 + \tau) w $$
Results

• Proposition: If there is a unique equilibrium in which the collateral constraint binds, then an increase in $\tau$ leads to an increase in Real Exchange Rate ($p^N$), Asset Values ($q$), Imports ($z$), Employment ($L$), Welfare.

• Rise in $\tau$ Increases Marginal Cost of Nontraded Goods

• Relative Price, $p^N$, of Non-Traded Goods, Rises

• Value of Assets in Non-Traded Good Sector Increase.

• Relaxation of Collateral Constraint:
  – Imports of Intermediate Good Expand
  – Increased Production of Tradeable Good
  – Increased Demand (Leontieff Helps Here!) For Non-Tradable Good
  – Supports Increased Employment in Non-Tradable Sector.
Figure: Labor Market Equilibrium

Results ...
Results ...

\[ f(\lambda; \tau) = \tau^N q(\lambda; \tau) K - z(\lambda) \]

Figure 4: The Effect of An Increase in the Labor Tax Rate
Figure 5: Equilibrium Associated With Various Tax Rates

\begin{align*}
\text{utility} & = \tau \\
\text{p}^N & = \tau \\
\text{q} & = \tau \\
\text{L} & = \tau \\
\lambda & = \tau \\
\text{z} & = \tau
\end{align*}
Conclusion

• Identified Factors That Make Raising the Interest Rate in Immediate Aftermath of Financial Crisis Optimal

• Simulated a Model With These Properties (Inflexible Factors of Production in Short Run) and Found that Actual Interest Rate Response May Have Been Roughly Optimal.

• Broader Implications of Analysis:
  – Monetary Transmission Mechanism May Be Profoundly Different When Collateral Constraints are Binding.
  – Perhaps Binding Collateral Constraints are Binding More Often in Developing Countries, Where Collateral May Be in Short Supply

• Connections to Related Literature:
  – “Non-Keynesian Effects of Fiscal Policy”, “Expansionary Fiscal Consolidations” (Giavazzi-Jappelli-Pagano, Perotti)
  – Results in Financial Frictions Literature that Raising Interest Rates May Be Good When Borrowing Constraints Bind (Kocherlakota (AER, 2002).)