

IMF Working Paper

The Impact of Foreign Bank Deleveraging on Korea

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Asia and Pacific Department

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Abstract

Korea was hit hard by the 2008 global financial crisis, with the foreign bank deleveraging channel coming prominently into play. The global financial crisis demonstrated that a sharp deleveraging can be transmitted to emerging markets through the bank lending channel to a slowdown in credit growth. The analysis finds that a sharp decline in external funding led to relatively modest decline in domestic credit by Korean banks, due to concerted policy efforts by the government in 2008. Impulse responses from a Dynamic Stochastic General Equilibrium (DSGE) model calibrated to Korea shows that it appears better prepared to handle such shocks relative to 2008. Indeed, Korea is much more resilient to such shocks due to the efforts by the authorities, which has led to the strengthening of external buffers, such as higher foreign exchange reserves and bilateral and multilateral currency swap arrangements.

JEL Classification Numbers: G2, E3, E5.

Keywords: Global banks, liquidity shock, cross-border lending

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Contents	Page
I. Introduction	3
II. Korea's Linkages to International Banks: Stylized Facts	4
III. Effect of Foreign Bank Deleveraging on Korea: Evidence from a DSGE Model.....	5
A. Model Description.....	6
B. Impulse Responses	10
IV. The Transmission of the 2008 Crisis to Korean Banks: Regression Analysis	14
V. Conclusion	19
References.....	20
Figures	
1. Stock of Consolidated Foreign Claims to Euro Area, U.K., U.S., and Japan Banks.....	5
2. Consolidated Foreign Claims of European and U.S. Banks on Selected Asian Economies.....	5
3. Stock of Consolidated Foreign Claims by Sector	5
4. Quarterly Change in Consolidated Foreign Claims	6
5. Impulse Responses to Negative Foreign Borrowing Shocks	14
6. Quarterly Change in Exchange Rate Adjusted Locational Cross Border Claims of BIS Reporting Banks.....	15
7. Change in External Liabilities of Banks	16
Tables	
1. Ratios of Liabilities and Trade to GDP.....	12
2. Parameter Values	12
3. Variance of Impulse Responses	13
4. Summary Statistics: Domestic Banks and Foreign Bank Branches.....	17
5. Panel Regression Results	19

I. INTRODUCTION

1. International banks constituted a key channel of transmission of financial stress during the global financial crisis (GFC). Indeed, the collapse in capital flows to emerging markets in the aftermath of the crisis was dominated by the precipitous fall in cross-border bank loans, as linkages with international banks played a major role in the transmission of the crisis (April 2009 *World Economic Outlook*). In the second half of 2011, as the crisis in Europe deepened and pressures on European banks intensified, deleveraging ensued in response to the European Banking Authority's higher targets on bank capital adequacy ratios. So far, the evidence suggests it has been relatively orderly and gradual. The funding strains eased due to the European Central Bank's Long-Term Refinancing Operations (LTRO) and resulted in re-leveraging by European banks in the first quarter of 2012.

2. Looking ahead, the possibility of a pull back resulting from a further intensification of the euro zone crisis cannot be ruled out. As the April 2012 *Global Financial Stability Report* (GFSR) pointed out, while some deleveraging by European banks is inevitable and even desirable, it is crucial to try to avoid synchronized and large scale shrinkage of balance sheets which would have serious implications for economic activity and financial markets within Europe and elsewhere.

3. This paper contributes to the emerging literature on the transmission to the real economy of the external funding shock to bank balance sheets during the GFC. We focus specifically on Korea as it is one of the economies in Asia that is significantly exposed to foreign bank funding risks as it relies on wholesale funding, though considerably less than in the past. This dependence resulted in serious knock-on effects during the 2008 crisis. This paper assesses whether the credit supply response in Korea to deleveraging by foreign banks was different than in other economies.

4. This paper asks the following questions:

- What is the nature of Korea's linkages to international banks, and how have they evolved over time?
- How and to what extent did the freeze in external funding during the 2008 crisis affect Korean economy and the banks?
- Has the sensitivity to foreign bank inflows changed in the post-2008 period?

5. We use two approaches to analyze the effect of foreign bank deleveraging on Korea: impulse response functions from a DSGE) model with a full-fledged banking sector and bank-level panel regressions.

6. The paper is structured as follows: the next section explores the links between foreign banks and Korea by comparing the extent and nature of reliance on foreign bank funding within Asia. Section III presents a DSGE model that incorporates a fully fledged banking sector to trace the spillovers from foreign bank deleveraging on output and

external variables. It provides a rich description of the setup of the model and also compares the differences in responses before and after the global financial crisis. Section IV presents the panel regression framework and results. Section V concludes.

II. KOREA'S LINKAGES TO INTERNATIONAL BANKS: STYLIZED FACTS

7. Foreign bank claims on Korea are sizeable, both relative to the size of the economy and compared with other countries in the region. The stock of consolidated claims of foreign banks on Korea stood at around US\$300 billion at end-March 2012 which amounts to about 25 percent of GDP. Around half of these claims are vis-à-vis European banks, though the mitigating factor is that the bulk of European claims are to United Kingdom banks as the effect of deleveraging is expected to be more muted in case of U.K. banks (Figure 1). As a result of deleveraging since 2008, the outstanding claims of euro area banks have fallen sharply from their peak of US\$110 billion in 2008 to only US\$38 billion, respectively, at end-March 2012. The deleveraging was offset to some extent by U.S. and Japanese banks which increased their outstanding claims to US\$97 billion and US\$48 billion, respectively at end-March 2012. Consolidated claims include both cross-border lending and credit extended by the local subsidiaries and branches of foreign banks. Compared with other countries in the region, Korea relies heavily on funding from foreign banks along with Australia, Malaysia, New Zealand, and Taiwan Province of China (Figure 2).

8. Credit from foreign banks to Korea flows to both the banking system and the non-bank private sector. The Korean banking sector is reliant on wholesale funding, including from abroad, as around 25 percent of foreign claims outstanding (US\$85 billion) were vis-à-vis the banks at end-March 2012 (Figure 3). While the dependence on wholesale funding has declined relative to 2008, given the large outstanding amounts, further deleveraging clearly still poses a risk. A substantial portion of foreign bank credit is extended directly to the Korean non-bank

Figure 1. Korea: Stock of Consolidated Foreign Claims to Euro Area, U.K., U.S., and Japan Banks
(In billions of U.S. dollars)

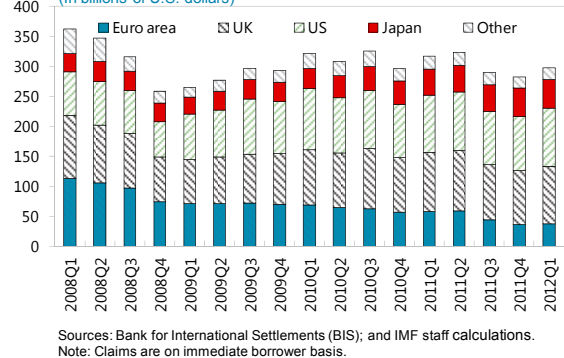


Figure 2. Consolidated Foreign Claims of European and U.S. Banks on Selected Asian Economies 1/
(In percent of GDP, as of 2012 Q1)

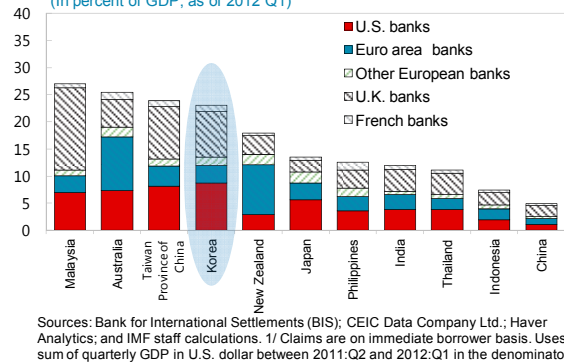
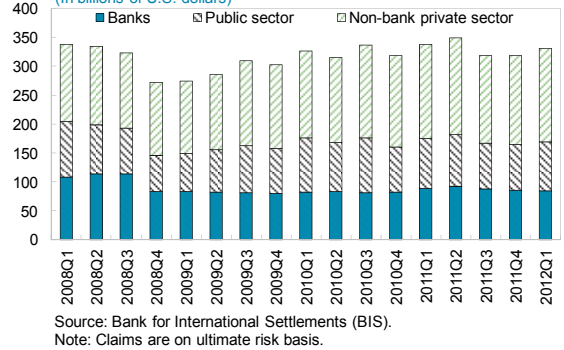


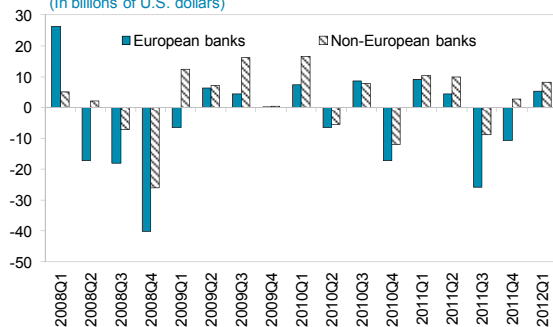
Figure 3. Korea: Stock of Consolidated Foreign Claims by Sector
(In billions of U.S. dollars)



private sector (around 50 percent of credit outstanding in Q1 2012), and this share has been increasing over time. There is anecdotal evidence that suggests that foreign banks, particularly European banks, have been particularly active in providing trade finance, syndicated loans, and project finance.

9. Foreign banks pulled back from Korea in the second half of 2011, though much less than during the global financial crisis. As the euro area crisis intensified in August–September 2011, global banks started to pare back assets globally, including from Korea. Outstanding claims of European banks on Korea fell by around 15 percent and 7 percent (quarter on quarter) in the third and fourth quarters of 2011, respectively.² Overall, the retrenchment was less than during 2008, as data from the Bank for International Settlements (BIS) suggest a withdrawal of around US\$40 billion in the second half of 2011, compared with a decline of US\$100 billion in 2008. Among euro area banks, the pullback in the second half of 2011 was the sharpest by French banks, which reduced claims by half. Italian and Spanish banks also retrenched though the amounts outstanding are much smaller than for French banks. Deleveraging was not limited to banks from the euro area as U.S. banks and U.K. banks also reduced claims on Korea during this episode. However, other Asian banks, in particular Japanese banks, stepped in to partially fill the gap.

Figure 4. Korea: Quarterly Change in Consolidated Foreign Claims (European vs. Non-European Banks)
(In billions of U.S. dollars)



Source: Bank for International Settlements (BIS).
Note: Claims are on immediate borrower basis.

III. EFFECT OF FOREIGN BANK DELEVERAGING ON KOREA: EVIDENCE FROM A DSGE MODEL

10. The spillovers from foreign bank deleveraging are analyzed in an open economy New Keynesian DSGE model. The DSGE model used is a small open economy version of Iacoviello (2011), which incorporates the banking sector as a key channel of transmission through which repayment shocks spillover to the economy. In this paper, we extend the Iacoviello (2011) model into a small open economy model, which is thus very closely related to that of Dao and Kang (2012), who extend Iacoviello (2011) into a two-country model. To consider the impact of global bank deleveraging, domestic banks in a small economy are assumed to borrow from global banks. The model follows the standard set-up of the New Keynesian DSGE model, with attributes such as price (wage) stickiness and

² The numbers on the extent of deleveraging are based on the BIS's consolidated banking statistics and are not exchange rate adjusted. During a period of global financial stress with local currencies in emerging Asia depreciating against the U.S. dollar, these statistics will overestimate the extent of reduction of claims (in U.S. dollar terms). However, while the magnitudes include this valuation effect, the main takeaway is that deleveraging by European banks did affect Korea in the second half of 2011.

some adjustment costs. The model is calibrated to the characteristics of the Korean economy.

A. Model Description

Households

11. Households are divided into two types, patient households and impatient households. The differences between them stem from the fact that the discount factor of patient households, β_p , is higher than that of impatient households, β_i . That is, patient households become depositors due to their higher discount factor, while impatient households become borrowers as their discount factor is lower.

12. Patient households supply labor $N_{p,t}$ to labor unions and receive nominal wage $W_{p,t}^u$. They deposit $D_{p,t}$ with domestic banks and receive $R_{p,t}D_{p,t}$ in the next period. $R_{p,t}$ is the gross rate of interest paid on deposits. Patient households purchase final consumption goods $C_{p,t}$ at the price of $P_{C,t}$ from retailers. They purchase housing $H_{p,t}$ at the price of $Q_{H,t}$ from housing producers and sell the depreciated housing $(1 - \delta_H)H_{p,t}$ back to the housing producers in the next period. They hold foreign assets $B_{p,t}$, which yields a gross rate of return of $R_{p,t}^F$. Patient households have utility from consumption, housing and foreign assets and disutility from work. Their utility maximization problem is then given by :

$$\max_{C_{p,t}, H_{p,t}, N_{p,t}, D_{p,t}, B_{p,t}} E_t \sum_{t=0}^{\infty} \beta_p^t \left[\ln C_{p,t} + j_p \ln H_{p,t-1} + \tau_p \ln(1 - N_{p,t}) + \xi_p \ln \frac{S_t B_{p,t}}{P_{C,t}} \right]$$

$$\text{s. t. } P_{C,t}C_{p,t} + Q_{H,t}H_{p,t} + D_{p,t} + S_t B_{p,t} = W_{p,t}^u N_{p,t} + Q_{H,t}(1 - \delta_H)H_{p,t-1} + R_{p,t-1}D_{p,t-1} + S_t R_{p,t-1}^F B_{p,t-1} + Div_{p,t}$$

where $Div_{p,t}$ is the dividends from wholesalers and labor unions to patient households, S_t exchange rate, j_p , τ_p and ξ_p parameters showing the preferences of patient households for housing, working and foreign assets, respectively, and δ_H the housing depreciation rate.

13. Impatient households supply labor $N_{i,t}$ to labor unions and receive nominal wage $W_{i,t}^u$. They borrow $L_{i,t}$ from domestic banks and pay $R_{i,t}L_{i,t}$ in the next period with $R_{i,t}$ being the gross rate of interest charged on impatient household borrowing. The amount of impatient households' borrowing is constrained by the value of their housing. Impatient households purchase final consumption goods $C_{i,t}$ at the price of $P_{C,t}$ from retailers. They trade their housing $H_{i,t}$ with the housing producers in the same way as patient households. Impatient households have utility from consumption and housing and disutility from working. The utility maximization problem of impatient households is then given by :

$$\begin{aligned}
& \max_{C_{i,t}, H_{i,t}, N_{i,t}, L_{i,t}} E_t \sum_{t=0}^{\infty} \beta_i^t [\ln C_{i,t} + j_i \ln H_{i,t-1} + \tau_i \ln(1 - N_{i,t})] \\
& \text{s. t. } P_{C,t} C_{i,t} + Q_{H,t} H_{i,t} + R_{i,t-1} L_{i,t-1} = \\
& \quad W_{i,t}^u N_{i,t} + Q_{H,t} (1 - \delta_H) H_{i,t-1} + L_{i,t} + Div_{i,t} \\
& \quad R_{i,t} L_{i,t} \leq m_i Q_{H,t+1} (1 - \delta_H) H_{i,t}
\end{aligned}$$

where $Div_{i,t}$ is dividends from labor unions to the impatient households, j_i and τ_i parameters showing the preferences of impatient households for housing and working, and m_i the ratio of borrowing to the value of their housing.

Entrepreneurs

14. Entrepreneurs rent capital K_{t-1} to firms and receive rental revenues $R_t^K K_{t-1}$ with R_t^K being the rate of return on capital. Entrepreneurs borrow $L_{e,t}$ from domestic banks and pay $R_{e,t+1} L_{e,t}$ in the next period. $R_{e,t}$ is the gross interest rates charged for entrepreneur borrowing, and the amount of their borrowing is constrained by the value of capital. Entrepreneurs purchase capital from capital producers at the price of $Q_{K,t}$ and sell the depreciated capital $(1 - \delta_K) K_t$ back to capital producers in the next period. Entrepreneurs purchase final consumption goods $C_{e,t}$ at the price of $P_{C,t}$ from retailers. The consumption utility maximization problem of entrepreneurs is then given by :

$$\begin{aligned}
& \max_{C_{e,t}, K_t, L_{e,t}} E_t \sum_{t=0}^{\infty} \beta_e^t \ln C_{e,t} \\
& \text{s. t. } P_{C,t} C_{e,t} + R_{e,t} L_{e,t-1} + Q_{K,t} K_t = L_{e,t} + [R_t^K + Q_{K,t} (1 - \delta_K)] K_{t-1} \\
& \quad R_{e,t+1} L_{e,t} \leq m_e Q_{K,t+1} K_t (1 - \delta_K)
\end{aligned}$$

where β_e is the discount factor of entrepreneurs, δ_K the rate of capital depreciation, and m_e the ratio of borrowing to the value of their capital.

Domestic banks

15. The domestic banks have two outside sources of funding, namely, deposits from patient households and the borrowing from foreign banks, $L_{F,t}$. The gross rate of interest on their foreign borrowings is $R_{b,t}^F$. Domestic banks extend loans to impatient households and entrepreneurs. Whenever they change their funding and lending structures, they bear adjustment costs.

16. Domestic banks have two constraints with regards to funding. One is a net worth constraint and the other a foreign borrowing constraint. The net worth constraint implies that the amount of their outside funding should be less than some fraction of their lending. Put differently, the net worth should be greater than some fraction of lending. The foreign borrowing constraint implies that their foreign borrowing should be lower than some fraction of differences between lending and deposits.

17. Domestic banks purchase the final consumption goods $C_{b,t}$ at the price of $P_{C,t}$ from retailers. The consumption utility maximization problem is then given by :

$$\begin{aligned} & \max_{C_{b,t}, D_{p,t}, L_{i,t}, L_{e,t}, L_{F,t}} E_t \sum_{t=0}^{\infty} \beta_b^t \ln C_{b,t} \\ \text{s. t. } & P_{C,t} C_{b,t} + R_{p,t-1} D_{p,t-1} + L_{i,t} + L_{e,t} + S_t R_{b,t-1}^F L_{F,t-1} + \frac{\phi_{D_P}}{2} (D_{p,t} - D_{p,t-1})^2 \\ & + \frac{\phi_{L_i}}{2} (L_{i,t} - L_{i,t-1})^2 + \frac{\phi_{L_e}}{2} (L_{e,t} - L_{e,t-1})^2 + \frac{\phi_{L_F}}{2} (S_t L_{F,t} - S_{t-1} L_{F,t-1})^2 \\ & = D_{p,t} + R_{e,t} L_{e,t-1} + R_{i,t-1} L_{i,t-1} + S_t L_{F,t} \\ & D_{p,t} + S_t L_{F,t} \leq \gamma_e L_{e,t} + \gamma_i L_{i,t} \\ & S_t R_{F,t} L_{F,t} \leq m_b (L_{i,t} + L_{e,t} - D_{p,t}) \end{aligned}$$

where β_b is the discount factor of domestic banks, ϕ_{D_P} , ϕ_{L_i} , ϕ_{L_e} and ϕ_{L_F} the parameters showing the adjustment costs occurring when domestic banks change their deposits, impatient household lending, entrepreneur lending and foreign borrowing, respectively, γ_i and γ_e their net worth constraint with respect to impatient household lending and entrepreneur lending, respectively, and m_b the ratio of foreign borrowing to differences between lending and deposits.

Capital/housing producers

18. Capital producers sell capital K_t to entrepreneurs. They use the intermediate investment goods $I_{K,t}$ at the price of $P_{I_{K,t}}$ and the depreciated capital $(1 - \delta_K)K_{t-1}$ at the price of $Q_{K,t}$ to produce capital. These investment goods and depreciated capital are purchased from retailers and entrepreneurs, respectively. The profit maximization of capital producers is then given by :

$$\begin{aligned} & \max_{K_t, I_{K,t}} E_t \sum_{l=0}^{\infty} \beta_p^l \frac{u'(C_{p,t+l})}{u'(C_{p,t})} [Q_{K,t+l} K_{t+l} - Q_{K,t+l} (1 - \delta_K) K_{t+l-1} - P_{I_{K,t+l}} I_{K,t+l}] \\ \text{s. t. } & K_{t+l} = (1 - \delta_K) K_{t+l-1} + \left[1 - \frac{\phi_{I_K}}{2} \left(\frac{I_{K,t+l}}{I_{K,t+l-1}} - 1 \right)^2 \right] I_{K,t+l} \end{aligned}$$

where $u'(C_{p,t})$ is the marginal utility of patient household consumption, ϕ_{I_K} the parameter representing the adjustment costs of transforming investment goods into capital.

Housing producers produce housing and sell it to households. The profit maximization problem of the housing producers is the same as that of the capital producers.

Firms

19. Firms rent capital from entrepreneurs and hire labor from labor packers. R_t^K , $W_{p,t}$ and $W_{i,t}$ are the prices that firms pay for capital, patient household labor and impatient household labor, respectively. Using these production factors, firms produce intermediate

goods Y_t through the Cobb-Douglas production function and sell these goods to wholesalers at the price of $P_{D,t}^\omega$. The profit maximization problem of firms is given by :

$$\begin{aligned} & \max_{K_{t-1}, N_{p,t}, N_{i,t}} P_{D,t}^\omega Y_t - R_t^K K_{t-1} - W_{p,t} N_{p,t} - W_{i,t} N_{i,t} \\ \text{s. t. } & Y_t \\ & = A_t (K_{t-1})^\alpha (N_{p,t})^{(1-\varphi)(1-\alpha)} (N_{i,t})^{\varphi(1-\alpha)} \end{aligned} \quad (26)$$

where α is the capital income shares and φ the labor income shares of impatient households, and A_t the variable showing their technology level.

Wholesalers and retailers

20. In order for the model to exhibit price stickiness, we introduce wholesalers and retailers.³ Wholesalers purchase intermediate goods, and differentiate them and finally sell them to retailers. Differentiation of intermediation goods gives wholesalers the power of setting their prices. Wholesalers decide the optimal prices with indexation, following Calvo (1983). Domestic wholesalers and imported goods wholesalers are distinct in that they purchase either domestic intermediate goods or foreign intermediate goods.

21. Retailers purchase differentiated goods, and combine and sell them to households, entrepreneurs, domestic banks, capital producers and housing producers. The combined goods sold to households, entrepreneurs and domestic banks become final consumption goods, while the combined goods sold to capital producers and housing producers become capital investment goods and housing investment goods, respectively.

Labor unions and labor packers

22. To give the model wage stickiness, labor unions and labor packers are introduced. Labor unions hires labor from households, and differentiate and supply it to labor packers. Similar to wholesalers, labor unions can set the optimal wages during differentiation via Calvo (1983), with indexation. Labor packers hire differentiated labor, and combine and supply it to firms.⁴

Foreign sector

23. Since we assume that the economy under consideration is a small open economy, the foreign sector is so large that the domestic sector cannot affect the foreign sector, but the foreign sector can affect the domestic sector. The foreign sector is interconnected with the domestic sector in two ways. Firstly, firms export their intermediate goods to foreign wholesalers, while domestic imported good wholesalers import foreign intermediate goods.

³ To see how the optimal prices are determined by wholesalers and retailers, please refer to Bernanke et al (1999), Iacoviello (2005) etc.

⁴ To see how the optimal wages are determined, refer to Smet and Wouters (2007).

Secondly, domestic banks borrow from foreign banks, and patient households save their foreign assets and place them with foreign banks.

24. Net exports and net capital flows between the domestic and foreign sectors should cancel out, and so the following equality always holds :

$$P_{D,t}^{\omega} EX_t + S_t R_{p,t-1}^F B_{p,t-1} + S_t L_{F,t} = S_t P_{F,t}^{\omega} IM_t + S_t B_{p,t} + S_t R_{b,t-1}^F L_{F,t-1}$$

where EX_t and IM_t represent exports and imports, and $P_{D,t}^{\omega}$ and $P_{F,t}^{\omega}$ are the respective prices of exports and imports.

Monetary Policy

25. The central bank set the interest rates of deposits according to the Taylor rule as follows :

$$R_{p,t} = R_{p,t-1}^{\rho_{Rp}} \left[R_p \left(\frac{Y_t}{Y} \right)^{\vartheta_Y} \left(\frac{P_{C,t}}{P_C} \right)^{\vartheta_P} \right]^{1-\rho_{Rp}}$$

where ρ_{Rp} the smoothing parameter, ϑ_Y and ϑ_P the responses of the central bank to output and price, respectively, and R_p, Y and P_C the steady-state values of $R_{p,t}$, Y_t and $P_{C,t}$, respectively.

B. Impulse Responses

26. The model is used to trace out the effects on the economy when global banks deleverage and thereby reduce their credit supply to the domestic economy. Figure 5 below show the impulse responses to such a negative foreign credit supply shock. The drop in foreign borrowing reduces the size of domestic bank balance sheets. Thus, domestic banks cut their lending to entrepreneurs, who in turn reduce their investment, leading to a decline in output. Also, when global credit supply to the small open economy decreases, the exchange rate depreciates, leading to an increase in imported goods prices, which results in a higher overall price level. However, exchange rate depreciation boosts exports, which offsets the decline in output to some extent.

27. To see the changes in response of the Korean economy at around the time of the global financial crisis, we consider two states: pre-GFC and post-GFC. The main differences between these two states are as follows. Firstly, the external debt-to-GDP ratio has decreased markedly since the crisis, while foreign reserves have increased. Secondly, both household and corporate debt-to-GDP ratios have risen, which has boosted the overall level of domestic liabilities in Korea. Lastly, the ratio of exports and imports to GDP has increased, so that the Korean economy has become more dependent on the world economy. The ratios of the actual data in Table 1 demonstrate these changes in Korean economy.

28. The changes in Korea at around the time of the GFC, as mentioned above, are also reflected in the steady-state of the DSGE model. The ratios of the steady-state in Table 1

are well matched with those of the actual data in both the pre- and the post-GFC states. Different steady-state values in the pre- and post-GFC states are obtained by applying a different parameterization to each state. More specifically, the parameters affecting the levels of debt and trade in the steady-state have different values depending upon the state. For example, m_b is a very important parameter in deciding the level of external debt—the higher m_b is, the higher the level of external debt. Considering that the level of external debt has gone down since the crisis, we assign a lower value to m_b in the post-GFC state. Main parameters which have different values in the pre- and post-GFC state are summarized in Table 2.

Table 1. Ratios of Liabilities and Trade to GDP

	Pre-GFC		Post-GFC	
	Steady-State	2008 data	Steady-State	2011 data
Household Debt/Nominal GDP	2.65	2.86	2.94	3.00
Corporate Debt/Nominal GDP	2.56	2.59	2.69	2.69
Foreign Debt/Nominal GDP	1.33	1.34	1.19	1.19
Foreign Reserves*/Nominal GDP	0.99	1.02	1.09	1.09
Real Export/Real GDP	0.40	0.40	0.45	0.46
Real Import/Real GDP	0.40	0.34	0.45	0.37

* Foreign reserves correspond to Foreign Assets in the model

Table 2. Parameter Values

Parameter	Pre-GFC	Post-GFC
β_p	0.9870	0.9910
m_i	0.8400	0.8510
m_e	0.5800	0.5900
m_b	0.6400	0.5940
ω^*	0.6000	0.5500

* The ratio of domestic goods to the sum of domestic goods and imported goods

29. The dotted line and the solid line in Figure 5 represent the impulse responses of the Korean economy to negative foreign borrowing shocks in the pre-GFC and the post-GFC states, respectively. Although there are no large quantitative differences in the drops in domestic variables such as consumption and investment between the two states, it is noteworthy that the responsiveness of external variables including foreign assets and the exchange rate has become less sensitive in the post-GFC state. These results show that the economy has become more resilient to such shocks. This increased resilience could be explained by the changes in the liability structure in Korea since the crisis. Korea's external debt-to-GDP ratio has declined, while its foreign reserves have increased. This improved

external liability structure may limit the impact of reduced foreign borrowing shocks on external variables in the post-crisis period. However, increased external stability does not lead into improved domestic stability, as the impulse responses of the domestic variables are almost the same across the two states. This result may be because higher domestic liability level since the crisis hinders the transmission of external stability to domestic stability.

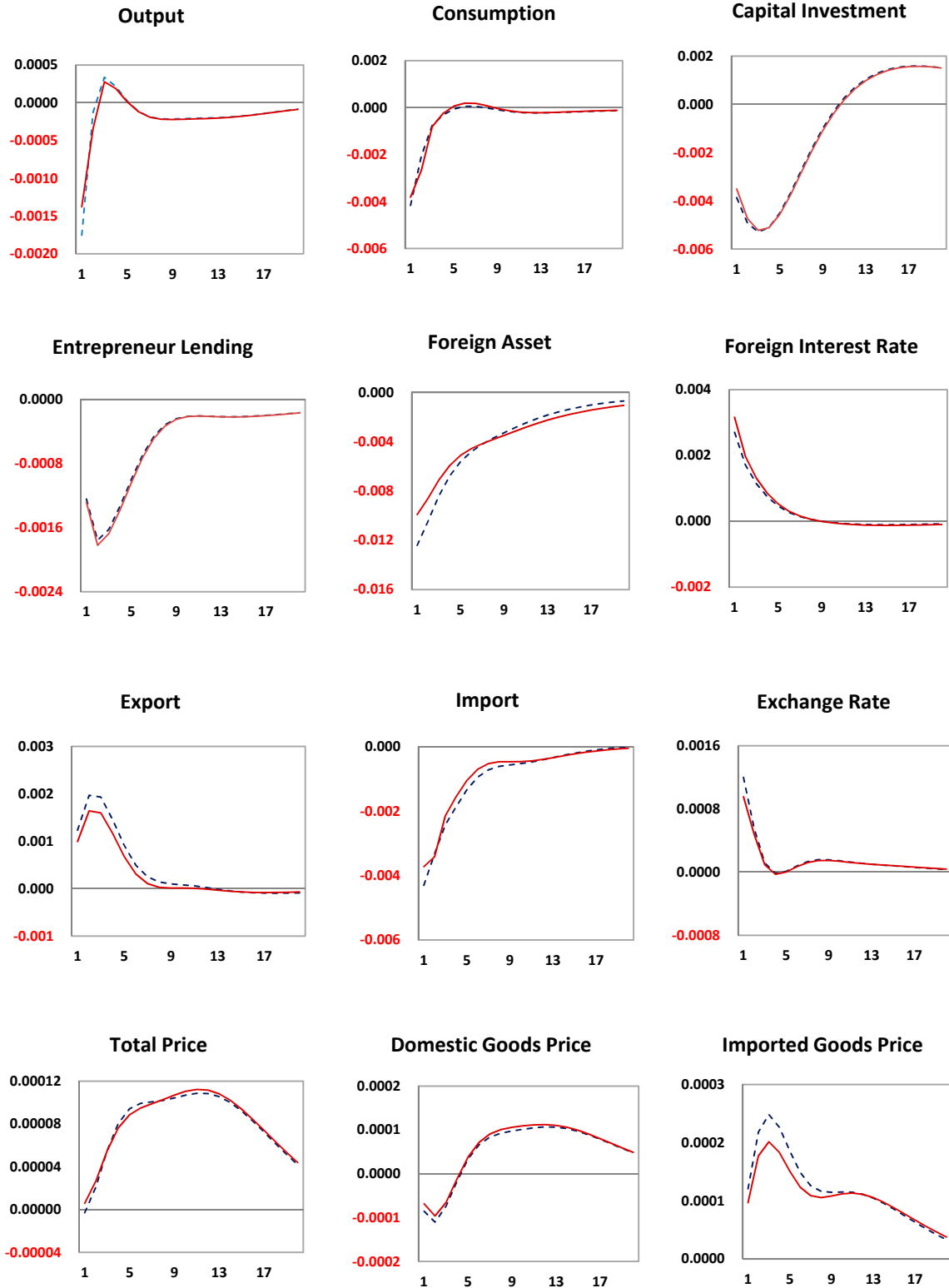
30. Table 3 shows the variance of the impulse responses in the pre and post-GFC states. As we can infer from Figure 5, the volatility of many external variables such as foreign assets, exports and exchange rates drop sharply after the crisis. However, the volatility of domestic variables does not change very much around the time of the crisis, although there are slight increases in the volatility of consumption, entrepreneurial lending and domestic goods prices.

Table 3. Variance of Impulse Responses

	Pre-Crisis (A)	Post-Crisis (B)	Ratio (B/A)
Output	3.81	2.73	0.72
Consumption	22.69	22.80	1.01
Capital Investment	169.39	166.10	0.98
Entrepreneur Lending	11.45	12.27	1.07
Foreign Asset	514.60	410.90	0.80
Foreign Borrowing Interest Rate	12.48	16.84	1.35
Export	12.59	8.30	0.66
Import	43.90	35.79	0.82
Exchange Rate	1.94	1.32	0.68
Total Price	0.17	0.18	1.04
Domestic Goods Price	0.17	0.19	1.07
Imported Goods Price	0.37	0.29	0.78

Note : 200 impulse periods are used for computation, and variances are standardized by their own steady-state values.

Figure 5. Impulse Responses to Negative Foreign Borrowing Shocks



Notes:

1. The y-axis measures the percentage deviation from the steady state.
2. ——— Post-GFC, - - - - Pre-GFC

IV. THE TRANSMISSION OF THE 2008 CRISIS TO KOREAN BANKS: REGRESSION ANALYSIS

31. This section empirically analyzes the extent to which a large retrenchment by foreign banks has the potential to lead to knock-on effects on Korean banks and domestic credit supply. Financial stress could transmit to the real economy in a number of ways. A credit crunch could arise from a withdrawal of foreign wholesale funding to the domestic banking sector or through a direct reduction in foreign credit to the non-bank private sector (which is fairly substantial in the case of Korea).

32. We examine the last episode during which there was a dramatic retrenchment by foreign banks. In 2008—a year that encompassed both the Bear Stearns episode and Lehman Brothers bankruptcy—global banks heavily pared back foreign assets across the world. Therefore, the global financial crisis provides a natural experiment to test the responsiveness of domestic credit to shocks to external funding.

Figure 6. Korea: Quarterly Change in Exchange Rate Adjusted Locational Cross Border Claims of BIS Reporting Banks
(In billions of U.S. dollars)



33. The recent literature has found that international banks have played a significant role in transmitting the global financial crisis to emerging markets. A closely related paper by Aiyar and Jain-Chandra (2012 a) analyzes Asia's reliance on European banks, and the extent to which a large retrenchment by European banks could spill over to the real economy and lead to a reduction in credit supply in Asia. It finds that the impact on credit supply from a shock in external funding in a broad sample of recipient economies was substantial; however, while the credit supply response in Asia was also significant, it was about half the size of the response in other regions due to the strength of policy buffers and sound balance sheets.

34. As is well established, during the global financial crisis, the Korean banking system faced a severe shock to external funding. To illustrate this, Figure 6 shows the quarterly change in exchange rate adjusted *locational* cross border claims of BIS reporting banks on Korea (this includes only cross border lending but the advantage is that it is exchange rate adjusted, as opposed to the consolidated banking statistics described in the last section). Cross border claims on Korea fell by more than US\$70 billion between 2008 Q2 and 2009 Q1. This figure exceeds US\$85 billion once local claims by foreign banks are factored in. This constituted a sudden stop as banks were unable to rollover their short-term debt, putting severe stress on the foreign exchange (FX) market. The sharp capital outflows also led to the equity market declining by around 35 percent in a span of a few months. As Figure 4 shows, the bulk of this retrenchment was attributable to bank

deleveraging by European banks, despite the fact that Europe was not the epicenter of the 2008 crisis.⁵

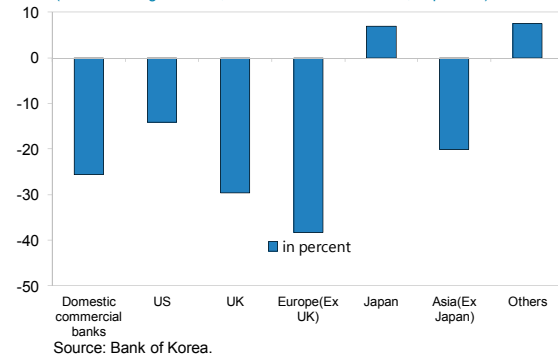
35. The decline in external liabilities was broad based during the global financial crisis. It was not the case that external funding to foreign bank branches was pulled back more than funding to domestic Korean

banks. As the international interbank markets froze, global banks activated the internal (i.e., within a given banking group) capital market channel and reduced funding to affiliates in emerging markets, including Korea, to buffer the balance sheet of the head office. However, domestically owned banks were also badly hit as they relied on external capital markets to fund local activities. Figure 7 is based on

regulatory bank-level data from the Bank of Korea and includes domestic banks and foreign bank branches by country of origin. During the global financial crisis, the retrenchment of external funding to Korean domestic banks was around 25 percent, roughly in line with the deleveraging vis-à-vis U.K. bank branches operating in Korea, whereas other European banks pulled back more sharply from their branches in Korea. During this period, in line with the BIS data, Japanese banks increased their claims on Korean banks to provide a small offset.

Figure 7. Korea: Change in External Liabilities of Banks

(Peak to Trough Decline, from 2008 Q1 to 2009 Q1, In percent)



Data and regressions

36. We use an extensive bank-level database from the BOK to analyze the impact of an external funding shock on the provision of credit by banks. The sample comprises 41 banks operating in Korea, of which 13 are domestic banks, while 28 are foreign bank branches. Foreign bank branches are affiliates of international banks domiciled in a number of countries, such as the United States, the United Kingdom, Europe excluding the United Kingdom, Japan, and others. The data are based on bank balance sheets, from the first quarter of 2002 until the fourth quarter of 2011.

37. Table 4 shows the summary statistics for this sample of banks. The main variables of interest are loans to the domestic economy, divided into loans to companies and loans to households, and external liabilities of banks. As noted above, the external funding

⁵ While the United States is another important source country for Korea, the U.S. foreign claims data from the BIS have a serious structural break. In late 2008, the surviving stand-alone investment banks, including Goldman Sachs and Morgan Stanley, were transformed into bank holding companies and included for the first time in the BIS sample. As a result, the U.S. claims series shows a sharp *increase* in early 2009.

shock translated into a sharp reduction in external liabilities for both domestic banks and foreign bank branches. The growth rate of domestic lending slowed down from the pre-crisis to the crisis period. While the same trend is witnessed for foreign bank branches, their importance in domestic lending is limited, with domestic banks accounting for 96 percent of total domestic loans. Instead, foreign bank branches in Korea typically focus on raising FX funds, including from their headquarters, and providing them to domestic banks through the swap market, and are not usually a provider of domestic credit.

Table 4. Summary Statistics: Domestic Banks and Foreign Bank Branches

(%)	Domestic Banks		FBBs	
	Pre-crisis growth rate	Crisis growth rate	Pre-crisis growth rate	Crisis growth rate
Loans to companies	37.47	10.32	29.43	-4.81
Loans to households	17.33	4.08	4.13	-0.68
Deposits	19.44	6.89	68.23	-12.33
Borrowings	13.58	3.63	82.5	-15.65
External liabilities	83.07	-21.78	226.74	-23.14
Bonds	55.68	9.88	-	-

Sources: Bank of Korea; and IMF staff calculations.

Panel regressions

38. The following econometric specification is used to analyze the impact of an external funding shock on domestic credit:

$$\Delta \text{domesticlending}_{it} = \alpha_i + \beta X_{it-1} + \gamma \Delta \text{extliab}_{it-1} + \delta \text{timedum}_t + \varepsilon_{it} \dots (1)$$

Where $i=1 \dots N$ refers to the number of banks in the sample and $t=1 \dots T$ refers to time. The main dependant variable is the change in loans to domestic residents (these are constructed as the sum of bank lending to households and to companies). The explanatory variables include the change in external liabilities, which is the main variable of interest to test the transmission of the external funding shock. The bank-specific control variables include the size of a bank calculated as the log of total assets, liquidity of bank's assets calculated as cash plus securities scaled by total assets, and the share of funding from deposits is calculated as deposits divided by total liabilities. The priors are that banks that are larger, more liquid and have a more stable source of funding are likely to cut lending by less when faced with an external funding shock. It can be argued that larger banks encounter smaller informational asymmetries than smaller banks, and more liquid and better capitalized banks are able to marshal their resources to maintain lending when faced with a funding shock. The above regression includes bank-specific fixed effects. Also included are time dummies to control for the business cycle and economic policies, including the effect of changes in monetary policy, changes in regulation or government interventions, or changes in supervision. The time dummies also represent another way to capture any changes in loan demand effects through time. Reflecting the difference in business models, we estimate the regression separately for domestic banks and foreign bank branches.

39. The estimation is confronted with two issues: potential endogeneity and disentangling loan demand from loan supply. This paper disentangles the portion of the observed lending slowdown that emanates from reduced loan supply, as opposed to loan demand. It is entirely conceivable that during the crisis, new loans dried up as economy activity slowed rapidly leading to reduced demand for credit, and therefore a decline in the ex post observed loans. Therefore, to establish the operation of a bank lending channel, the identification of a lending supply shock is critical by isolating loan demand shocks. Secondly, the relationship between domestic credit and foreign banking flows can in principle run in both directions. Reduced foreign inflows can lead to a decline in domestic credit, but it is also possible that anemic economic activity and bank credit may attract fewer inflows. This potential endogeneity may mean that the regressors could be correlated with the error term. To circumvent these issues, we estimate the panel regression by using dynamic Generalized Method of Moments (GMM) using the Arellano and Bond (1991) estimator to ensure consistency of the estimates.

40. We test for changes in this relationship during the global financial crisis. The next specification introduces a crisis dummy C , which takes the value of one during the period 2008Q1–09Q1. The external liabilities variable is interacted with the crisis dummy to gauge whether the coefficient changes during the crisis period. We estimate the following equation:

$$\Delta \text{domesticlending}_{it} = \alpha_i + \beta X_{it-1} + (\gamma_c * C + \gamma) \Delta \text{extliab}_{it-1} + \delta \text{timedum}_t + \varepsilon_{it} \dots (2)$$

41. The results of the whole sample regression are summarized in Table 5. Given the different business models for domestic banks and foreign bank branches, we run these regressions separately. Columns 1 and 2 contain the regressions for domestic banks using fixed effects and dynamic GMM estimation, respectively. The finding is that size and a greater reliance on a deposit base are all positively associated with domestic lending. Furthermore, an increase in external liabilities is significantly associated with an increase in lending by domestic banks, although the magnitude is small. A 1 percent increase in external funding leads to a 0.01 percent increase in domestic lending using fixed effects. However, using dynamic GMM estimation for domestic banks, the coefficient on external liabilities is insignificant. Columns 3 and 4 show the regressions for foreign bank branches using fixed effects and dynamic GMM, respectively. As expected, the domestic lending by foreign bank branches is not sensitive to bank specific characteristics. Indeed, foreign bank branches are not very active in retail banking and focus on providing foreign exchange liquidity to domestic banks. These relationships hold during normal times.

42. Next we turn to the estimation of the relationship during the crisis. As noted above, a crisis dummy is introduced into the panel regression and interacted with the main variable of interest, namely the change in external liabilities. However, the results show (contained in column 5) that the crisis dummy is not statistically significant. The effect on domestic bank credit was relatively limited due to the efforts to provide liquidity during

the crisis. The Bank of Korea provided banks with US dollar liquidity as well as Korean won liquidity when necessary, and allowed banks to adjust themselves in the face of financial crisis. As noted in Aiyar and Jain-Chandra (2012 a and b), in Asia, a stronger policy response and healthier balance sheets of local banks led to a smaller credit supply impact of foreign bank deleveraging.

43. The transmission of external liabilities to domestic credit supply was relatively limited as the above regression results show. Since the Asian financial crisis in late 1990s, Korean banks have strived to improve their balance sheets by matching funding currencies with operating currencies to solve the currency mismatch problem. This means that banks rarely use funds directly converted from foreign currency borrowing to extend domestic credit. Accordingly, the direct impact of changes in foreign currency borrowing upon domestic banks' credit supply has much lessened. This leads to very weak correlation between changes in banks' external liabilities and domestic credit supply as the regression results show.

Table 5. Panel Regression Results

Dependent variable : Δ Domestic Credit	1 Fixed effects (Domestic banks)	2 Arellano-Bond (Domestic banks)	3 Fixed effects (Foreign branches)	4 Arellano-Bond (Foreign branches)	5 Fixed effects (Domestic banks)
Δ External Liabilities	0.0068*** (0.0038)	0.0053 (0.0048)	0.0119 (0.0581)	0.0270 (0.0826)	0.0062 ²⁾ (0.0040)
Δ Liquidity	-0.2696* (0.0645)	-0.5388* (0.1150)	-0.5679 (0.4271)	-0.2889 (0.7349)	-0.2708* (0.0646)
Δ Size	0.4448* (0.0334)	0.7460* (0.0353)	-0.1666 (0.1669)	-0.2054 (0.2520)	0.4431* (0.0336)
Δ Deposits	0.3534* (0.0593)	0.6808* (0.0769)	0.3252 (0.8060)	0.5442 (1.3167)	0.3499* (0.0597)
Δ DC (L1)	-	-0.1121* (0.0321)	-	-0.4647* (0.0549)	-
With crisis interaction	No	No	No	No	0.0078 (0.0149)
N of obs	648	324	755	371	648
R-sq (within)	0.7729	-	0.0424	-	0.7730

Notes:

1) *, **, and *** denote 1%, 5% and 10% levels of significance respectively. Standard errors are in parentheses.

2) P-value = 11.6% (The crisis period defined as 2008 Q2 ~ 2009 Q1)

V. CONCLUSION

44. Korea was hit very hard by the 2008 global financial crisis, with the foreign bank deleveraging channel coming prominently into play. The intensification of the euro area crisis in the second half of 2011 also led to significant deleveraging of Korean assets by European banks. Korea was hit hard along with other Asian economies, though the retrenchment was more modest than during the global financial crisis, commensurate with the size of the shock. Although the euro area banks' exposure to Korea has substantially diminished, Korea may be vulnerable to sudden foreign bank deleveraging resulting from a further escalation of the crisis, as outstanding claims of European banks vis-à-vis Korea remain sizeable compared with other Asian countries. Furthermore, a significant worsening of the crisis and the accompanying deleveraging is unlikely to be confined to European banks alone and is likely to spillover to other international banks through global financial markets.

45. The global financial crisis demonstrated that a sharp deleveraging can be transmitted to emerging markets through the bank lending channel to a slowdown in credit growth. The analysis finds that a 1 percent decline in external funding leads to a 0.01 percent decline in domestic credit by domestic banks in Korea. The effect on the banking sector was limited by the efforts of the government to provide foreign currency liquidity.

46. Despite being vulnerable to sudden foreign bank deleveraging, Korea appears better prepared to handle such shocks relative to 2008. The DSGE model calibrated to Korea finds that the sensitivity of external variables (including net foreign assets) to a foreign bank deleveraging shock has become less after the global financial crisis, showing that the economy has become more resilient to such shocks. The increased resilience could be explained by a lower external debt to GDP ratio and higher foreign reserves since the crisis. Indeed, Korea is much better prepared to face such shocks due to the concerted efforts by the authorities, which has led to the strengthening of external buffers, such as higher foreign exchange reserves, bilateral and multilateral currency swap arrangements. At the same time, the adoption of macroprudential measures have reduced domestic banks' reliance on short-term wholesale funding, leading to lower exposures to foreign banks.

REFERENCES

- Aiyar, S., forthcoming, “From Financial Crisis to Great Recession: The Role of Globalized Banks,” *American Economic Review Papers and Proceedings* (May).
- Aiyar, S and S. Jain-Chandra, 2012a, “The Likely Effect on Asia of a Sharp Deleveraging by European Banks,” *Regional Economic Outlook: Asia and Pacific* (Washington: International Monetary Fund).
- , 2012b, “The Domestic Credit Supply Response to International Bank Deleveraging: Is Asia Different?,” IMF Working Paper No. 12/258 (Washington: International Monetary Fund).
- Arellano, M. and S. Bond, 1991, “Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, 58, pp. 277–297.
- Bernanke, B., Gertler M., and Gilchrist S., 1999, “The Financial Accelerator in a Quantitative Business Cycle Framework,” *The Handbook of Macroeconomics*, ed. by J. B. Taylor and M. Woodford, pp. 1341–1393.
- Calvo, G. A., 1983, “Staggered Prices in a Utility-Maximizing Framework,” *Journal of Monetary Economics*, 12, 383–398.
- Cetorelli, N., and L. Goldberg, 2011, “Global Banks and International Shock Transmission: Evidence from the Crisis,” *IMF Economic Review*, Vol. 59, No. 1, pp. 41–76.
- Dao, T. and Kang, T. (2012), “International Financial Business Cycles.”
- Ehrmann, M, L. Gambacorta, J. Martinez-Pages, P. Sevestre, and A. Worms, 2001, “Financial Systems and the Role of Banks in Monetary Policy Transmission in the Euro Area,” in Angeloni, Kashyap and Mojon edited “Monetary Transmission in the Euro Area.” (United Kingdom: Cambridge University Press).
- Iacoviello, Matteo, 2005, “House Prices, Borrowing Constraints and Monetary Policy in the Business Cycles,” *American Economic Review*, Vol. 3, 739–764.
- Iacoviello, Matteo, 2011, “Financial Business Cycle,” Federal Reserve Board (in progress).
- Khwaja, A and A. Mian, 2008, “Tracing the Effect of Bank Liquidity Shocks: Evidence from an Emerging Market,” *American Economic Review*, Vol. 98(4).
- Smets, Frank, and Raf Wouters, 2007, “Shocks and Frictions in U.S. Business Cycles: A Bayesian DSGE Approach,” *American Economic Review*, 97(3), 586–606.