Chapter 5

GLOBAL NETWORK IN CROSS-BORDER INTERBANK FLOWS:
THE CASE OF SOUTH KOREA

By
Seohyun Lee

1. Introduction

The globalisation and integration of financial markets have strengthened the degree of economic and financial interlinkages among countries. Global mutual funds actively enter into international bond and equity markets and their collective behaviour becomes crucial in shaping asset prices. In addition, cross-border banking flows have grown substantially. Domestic banks’ exposures to foreign assets and liabilities have increased steadily in the recent two decades. Also, foreign branches and subsidiaries of global banks have extended their operations widely in the advanced and emerging economies alike.

The consequences of the high level of international linkages in the banking sector can be summarised under three headings: macroeconomic, financial and policy-related consequences. First, to some extent, the higher cross-border integration in the banking sector may have positive effects on macroeconomic activities. For instance, through efficient allocation of global funds, it supports output growth of the less developed countries. A higher level of bank linkages can also promote international trade as the banking sector becomes more effective and plays an important role as a financial intermediary for firms that produce tradable goods (Caballero, Candelaria, and Hale, 2018).

Second, an increase in cross-border interbank transactions has significant financial consequences. International banking can increase banking sector competition and help improve domestic banks’ efficiency. Moreover, a higher level of banking integration enables investors to diversify idiosyncratic risks and thus facilitate risk-sharing among banks. On the other hand, however, a complex financial network can easily propagate financial stress from banks’ home country to any host country with sound banking system. As we had seen during the Asian financial crisis (AFC), the global financial crisis (GFC) and the European debt crisis, those countries can suffer from a sudden reversal of capital flows and severe financial instability. Battiston, et al. (2012) demonstrate that a financial network can be most resilient for intermediate levels of integration, but not at its maximal.

Due to their macroeconomic and financial effects, the complex and extensive interlinkages in the banking sector have become a paramount concern for policymakers and regulators. To ensure financial stability, policymakers pay more attention to changes in the conditions of global financial markets and monitor the sources and channels of systemic risk that may have significant knock-on effects on their own economies. Furthermore, a complex global financial network can intensify

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monetary policy spillovers across countries. Due to the highly connected global financial market, the quantitative easing of the advanced economies caused global co-movements in short- and long-term interest rates and capital inflows towards the emerging economies in search of higher yields. Analogously, the monetary policy normalisation of the U.S. since 2015 has significantly affected global money flows, posing risks of a sudden reversal of capital flows.

The high complexity in the financial network is also evident in the Asia-Pacific region. Since the AFC in 1997, the financial markets in the region have experienced a remarkable growth. A robust economic growth of the emerging countries, such as China, India and Vietnam, has attracted foreign capital inflows directly to these countries or to the regional financial centres, such as Hong Kong, Singapore, and Macau. Furthermore, the advanced economies in the region, such as Australia, South Korea, and Taiwan, have actively expanded their international exposure in the region to benefit from the growing trade and investment flows between these economies and the rest of Asia.

Clearly, South Korea is one of the key players in the Asia-Pacific financial network. The South Korean banking system has become more linked to international and regional financial markets. Before the GFC, Korean banks were less internationally active on the asset side of their balance sheets: their international assets amount to less than 8% of its annual GDP. However, the assets of Korean banks have expanded noticeably to 16% of annual GDP at the end of 2017. On the funding side of banks’ balance sheets, they have been more integrated globally than their asset side, having international liabilities equivalent up to 22% of annual GDP. What is more interesting is that Korea becomes a net creditor to Asia and the Pacific countries after the GFC. The amount of assets to the major Asia-Pacific countries has been growing tremendously from 2013 while the amount of liabilities to these economies has not changed much since 2007.

The active participation of Korean banks in international operations provides benefits to the Korean economy, but it also poses greater risks. External shocks – financial crises, monetary policy shocks in the large advanced economy, and macroeconomic shocks to countries to which Korean banks have large exposures – can be transmitted to the Korean financial system and adversely affect the economy. A common creditor, a global bank that dominates cross-border banking activities, can create systemic risk via various channels. Because it is difficult to identify such common creditors and assess the complexity of cross-border financial interconnectedness and its impact, it may obscure the potential risks of contagion effects stemming from the global financial network.

In light of these pressing issues, the paper focuses on the cross-border network analysis of banking flows. In particular, we would like to answer how the global network has developed in the Asia-Pacific region and how important is South Korea as a financial intermediary in the region. We construct a dataset for cross-border interbank flows of South Korea between 2005Q2 and 2018Q1 and examine the network structure before, during and after the GFC. The aim of this chapter is to identify potential roles of financial network on cross-border interbank flows and to draw important policy implications.

2. See Remolona and Shim (2015) for the analysis of the changing role of banks in Singapore and Hong Kong after the GFC.
3. As of the end of 2017, the total amount of assets of Asia-Pacific economies held by Korean banks is equivalent to 40% of total international assets they own. These economies include Australia, Bangladesh, China, Hong Kong, India, Indonesia, Macau, Malaysia, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Chinese Taipei, Thailand, and Vietnam.
The paper is organised as follows. Section 2 overviews the banking sector of South Korea. Section 3 explains the dataset and examines the trends in aggregate cross-border bank flows. Section 4 defines the key measures of network analysis and explores the network structure using these measures and network graphs. Finally, Section 5 concludes.

2. Banking Sector of South Korea

Banks in South Korea can be classified into two categories: commercial banks and specialised banks (see Table 1 for the number of banks in each category). Commercial banks consist of nationwide and local banks and branches of foreign banks. The number of branches of foreign banks is 38 as of February 2018 and the ratio of total assets of foreign bank branches to those of domestic banks has decreasing from 13.1% in 2013 to 9.6% in 2017.

Special banks are banks established under special act rather than the universal Banking Act. Those include the Korea Development Bank, Industrial Bank of Korea, Korea Eximbank, Nonghyup Bank and Suhyup Bank. Their main business models can be different from those of commercial banks because they were founded to finance and manage special projects of the sectors that could suffer from insufficient access to funding by commercial banks only.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Number</th>
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<tbody>
<tr>
<td>Nationwide Banks</td>
<td>8</td>
</tr>
<tr>
<td>Local Banks</td>
<td>6</td>
</tr>
<tr>
<td>Branches of Foreign Banks</td>
<td>38</td>
</tr>
<tr>
<td>Specialised Banks</td>
<td>5</td>
</tr>
</tbody>
</table>

As of end of first quarter of 2018, commercial banks’ total assets amount to 1,561 trillion won, increased by 6.8% from the previous year (see Figure 1). The profitability of commercial banks in terms of Return on Assets (ROA) slightly improved from the last quarter of 2017 (see Figure 2). Net interest margin remained low due to the persistently low policy rate (see Figure 2).

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4. Two internet-only banks (K-Bank and Kakao Bank) are included among nationwide banks.
5. The ratios are computed based on the fiscal year average (Source: Financial Supervisory Service).
The Korean banking sector is currently facing favourable overseas funding conditions with relatively low level of CDS premium (see Figure 3). In terms of asset soundness, commercial banks’ average substandard-or-below loan ratio is 0.70 % at the end of the first quarter of 2018. There was only a mild pick-up in the ratio for large corporations in the last quarter of 2017 while the loans to Small and Medium Enterprises and households remain sound (see Figure 4). This was partly due to the commercial banks’ efforts to improve risk management.

The amount of transactions among financial institutions has increased by 7.6 % from the end of 2017 to 2,120 trillion won. The composition of the transactions among non-bank financial institutions are the largest (58.6 %) followed by the transactions between bank and non-bank (37.2 %) and those among banks (4.2 %). To have a closer look at the network structure of the financial sector and banking sector, the interconnectedness graphs are examined (see Figure 5 and 6).
The four largest-ranked financial institutions in terms of bilateral transaction volumes are domestic banks, securities companies, investment funds, and trusts. While branches of foreign banks have connections with other sectors, domestic banks are playing an important role within the Korean financial sectors. Figure 6 shows the interconnectedness of the banking sector based on mutual transactions among domestic banks. It includes 19 domestic banks: nationwide and local commercial banks and special banks. It identifies six Domestically Systemically Important Banks (D-SIBs). The D-SIBs for 2019 identified by Financial Services Commission are four bank holding companies (Shinhan Financial Group, Hana Financial Group, KB Financial Group, NH financial Group) and one bank (Woori Bank).

Overall, the banking sector has remained stable with sufficient capacity for withstanding domestic and external shocks. However, there are considerable uncertainties that can put pressure on the Korean economy and financial sector. In particular, the monetary policy normalisation of central banks in the major countries and protectionism can be detrimental factors heightening uncertainties. Therefore, it is necessary to focus on the potential external risks that may threaten financial stability and how cross-border financial network affects the transmission of such risks to the domestic banking system.

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6. Figure 6 shows six D-SIBs because it includes Jeju Bank which is a subsidiary of Shinhan Financial Group.
3. Data

In order to examine the global financial network structure of the Asia-Pacific region, we construct a dataset of cross-border interbank transactions using the Locational Banking Statistics data obtained from the Bank for International Settlement (BIS). BIS provides three types of statistics: Locational Banking Statistics (LBS), Consolidated Banking Statistics (CBS), and Syndicated Loan Statistics (SLS). LBS data is collected on gross (unconsolidated) basis and therefore, includes positions vis-à-vis affiliates of foreign banks residing in different countries. It covers international lending and borrowing of banks in the narrow sense as it focuses on loans and deposits of banks’ balance sheet. On contrary, CBS focuses on the assets side of balance sheet and covers financial claims on consolidated basis where inter-office positions are netted out.

One of the advantages of using LBS data over CBS data is that it is compatible with other official statistics, such as external debt and Balance of Payment (BOP) data. In addition, LBS provides foreign exchange rate and breaks adjusted data whereas CBS does not. As LBS reports bilateral bank flows of total claims and total liabilities, it is consistent with the recent approaches in academic papers that emphasise the analysis of gross capital flows rather than net capital flows.7

LBS data reports the bilateral banking activities, borrowing and lending, and the scope of counterparty countries to include is important for data preparation. To examine the external exposures of banking flows to the rest of the world, the total claims and liabilities to all other counterparty countries are retrieved from the BIS statistics (see Figure 7). South Korea’s banking sector was at net liability position to the rest of the world until most recently. Cross-border liabilities of Korean banks increased dramatically from the end of 2005 until the first quarter of 2008. After the GFC, liabilities declined for about a year and recovered to approximately US$220 million. Liabilities remained stable in the subsequent years until it reached US$260 million in the third quarter of 2014. Total amount of claims to the rest of the world continuously increased from US$50 million in 2005 to just above US$250 million in 2017. There were two episodes of deleveraging in 2008 and 2012 and a rapid increase from 2013 to 2015.

For our main analysis, we consider bilateral banking transactions with major countries in the Asia-Pacific region and the other globally systemically important countries, such as the G7, Switzerland and Luxembourg (see Table 2 for the complete list of countries). The total number of countries for the analyses is 27, excluding South Korea. Core countries are defined as reporting countries in the BIS Locational Banking Statistics. In order to track the network structure of core countries, the cross-border banking flows data for the reporting countries need to have bilateral bank flows data, i.e. bank flows to individual counterparty. Therefore, some of the reporting countries without such data are categorised as periphery countries.8

7. See, for example, Forbes and Warnock (2012); Broner, et al. (2013); and Milesi-Ferretti and Tille (2011).
8. Note that our analyses may have limitations due to the data availability. For most of the reporting economies, banks’ total assets and liabilities to the rest of the world are available from 1998. However, in some cases, bank’s total assets and liabilities to individual economy (bilateral transactions data) are not available for the same sample period. For example, South Korea started to report bilateral bank flows from the first quarter of 2005, while Hong Kong did so from the fourth quarter of 2014.
### Table 2
List of Economies

<table>
<thead>
<tr>
<th>Country</th>
<th>Abbreviation</th>
<th>Type</th>
<th>Sample period</th>
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</thead>
<tbody>
<tr>
<td>Australia</td>
<td>AU</td>
<td>C</td>
<td>1998q1 – 2018q1</td>
</tr>
<tr>
<td>Canada</td>
<td>CA</td>
<td>C</td>
<td>2007q3 – 2018q1</td>
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<tr>
<td>Chinese Taipei</td>
<td>TW</td>
<td>C</td>
<td>2000q4 – 2018q1</td>
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<tr>
<td>France</td>
<td>FR</td>
<td>C</td>
<td>1998q1 – 2018q1</td>
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<tr>
<td>Germany</td>
<td>DE</td>
<td>C</td>
<td>1998q1 – 2018q1</td>
</tr>
<tr>
<td>Hong Kong, SAR</td>
<td>HK</td>
<td>C</td>
<td>2014q4 – 2018q1</td>
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<tr>
<td>Italy</td>
<td>IT</td>
<td>C</td>
<td>2014q4 – 2018q1</td>
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<tr>
<td>Japan</td>
<td>JP</td>
<td>C</td>
<td>1998q1 – 2018q1</td>
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<td>Luxembourg</td>
<td>LU</td>
<td>C</td>
<td>1998q1 – 2018q1</td>
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<tr>
<td>Macau, SAR</td>
<td>MO</td>
<td>C</td>
<td>2004q1 – 2018q1</td>
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<tr>
<td>Philippines</td>
<td>PH</td>
<td>C</td>
<td>2016q4 – 2018q1</td>
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<td>South Korea</td>
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<td>Vietnam</td>
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Notes: C denotes core (reporting) economies of which the data for individual counterparty countries are available, P denotes periphery (non-reporting) countries.
Figure 8 shows the total amounts of cross-border exposures of Korean banking sector to 27 economies. Total liabilities exhibit similar trends as in Figure 7 with exception that the deposits from these 27 economies (liabilities) flattened out after 2013 while the total liabilities further increased since 2013. Total claims to these economies have shown robust increase since 2005 but milder than the claims to the rest of the world.

![Figure 7: Total Amounts of Cross-border Bank Flows: All Economies](image1)

![Figure 8: Total Amounts of Cross-border Bank Flows: 27 Economies](image2)

Notes: Total claims and liabilities are in billion US dollars.
Sources: BIS Locational Banking Statistics.

We investigated whether these cross-border bank flows from and to South Korea differ with respect to the counterparty country. Figure 9 demonstrates the bank flows between South Korea and the G7 countries (United States, United Kingdom, Canada, Japan, Germany, France, Italy), Luxembourg and Switzerland. South Korean banks have net liabilities to the banks of those countries. Total borrowings from these selected advanced economies reached its peak in 2008 but dropped in the aftermath of the financial crisis. It recovered its previous peak in 2011 but the level of claims slightly fell afterwards. Total claims (lending) have remained stable around US$40 million with a slight pick-up at the end of 2017.

Figure 10 shows the trend of cross-border bank flows between South Korea and other periphery countries in the Asia-Pacific region. It includes Bangladesh, China, India, Indonesia, Malaysia, Myanmar, Nepal, New Zealand, Pakistan, Singapore, Sri Lanka, Thailand and Vietnam. Unlike the claims on assets of advanced countries in Figure 9, there was a substantial increase in the claims on assets of Asia-Pacific periphery countries from 2011. Due to this remarkable increase, the amount of loans of Korean banks to the region has exceeded that of deposits from the region since 2013.

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9. We include Luxembourg and Switzerland because they have a globalised banking sector.
We investigate trends in the subset of the Asia-Pacific region to examine the different dynamics in the trends. Figure 11 exhibits the banking flows between Korea and three regional financial centres, Hong Kong, Singapore and Macau. These financial centres can serve as intermediaries of international funding to the Asia-Pacific region. Korean banks have more liabilities than claims with the regional financial centres. The trend of total liabilities tends to track that of total liabilities to the advanced economies (Figure 9) as the money flows in these countries would follow international investors’ risk appetite.
Figure 12 identifies the trends in bank flows with two large economies that has been experienced a rapid economic growth recently, China and India. The Korean banks’ lending to these two countries increased exponentially after the GFC. Reflecting the recent slowdown in these economies, total claims declined in 2015-16 substantially but recovered since then.

On the whole, South Korean banks’ cross-border exposures in both asset and liability side have expanded considerably. The expansion of claims (lending) to foreign countries has been driven by the lending to developing countries in the Asia-Pacific region. The fluctuations in total liabilities (borrowing) largely depend on the economic conditions and monetary policy of advanced economies.

4. Network Analysis

4.1 Methodology

To define a network, two elements are required: nodes and edges. In our context of cross-border banking flows, a node refers to a country and an edge the amount of cross-border financial positions. Since we have both incoming and outgoing links, the cross-border bank flows network can be described as a directed network. For the claims data, nodes with outgoing links are reporting countries and lenders. For the liabilities data, nodes with outgoing links are also reporting countries but, in this case, borrowers.

Node degree indicates the number of bilateral links for a country (node). In other words, the degree of a node is the number of edges that are adjacent to the node. A country with higher node degree implies that the country has many cross-banking contracts among the other countries in the region. For a directed network, in-degree can be defined as the number of bilateral links to a target country while out-degree as those from a source (reporting) country.

Weighted node degree (node strength) is the total amount of cross-border banking flows from (weighted out-degree) or to (weighted in-degree) a given node. This metric reflects the intensity of financial flows for a given country. By definition, out-degree and weighted out-degree for periphery (non-reporting) countries equal to zero.

Clustering coefficient indicates how nodes are embedded in their neighbourhood or how complete the neighbourhood of a node is. It ranges from 0 to 1. If every node in the neighbourhood of a given node is all connected, the clustering coefficient is 1. If no nodes in the neighbourhood is linked, the clustering coefficient is 0. The average clustering coefficient gives an overall clustering of a network. Reporting countries tend to have smaller clustering coefficients because they lend to or borrow from wide range of countries including both other reporting and periphery countries, but the neighbours are not necessarily connected to each other. However, a country whose cross-border financial transactions are limited to global financial centres that are likely to be interconnected, tend to have larger clustering coefficients.
Betweenness centrality is the measure for the relative frequency of a node appearing in the shortest paths between every other pairs of nodes in the network. The betweenness centrality for node $v$ is computed as follows:

$$BC(v) = \sum_{s \in N} \frac{\sigma_{s,t}(v)}{\sigma_{s,t}}$$

where $\sigma_{s,t}$ is the total number of the shortest paths between node $s$ and node $t$, $\sigma_{s,t}(v)$ is the number of the shortest paths between $s$ and $t$ that contains node $v$. The betweenness centrality reflects how influential a country is as an intermediary of money flows in the network.

Distance between two nodes can be defined as the length of the shortest path between them. Closeness centrality is the average distance from a given starting node to all other nodes in the network. In particular, closeness is computed as the reciprocal of the sum of distance between a given node and all others.\(^{10}\)

$$C(v) = \sum_{s \in N} \frac{1}{d(s,v)}$$

where $d(s,v)$ is the distance between the nodes, $s$ and $v$. Therefore, the more central the node is in a network, the closer the node is to all other nodes.

4.2 Empirical Results

4.2.1 Network Measures

Based on the definition of the various network metrics, we compute these measures and analyse the trends of network measures for total claims and liabilities, respectively. Figure 13 shows in- and out-degree for claims data. The number of out-links are larger than that of in-links for South Korea. The in-degree represent the number of out-links from the reporting countries to South Korea among the entire sample countries. The average out-degree slightly increased after 2013, implying that the Korean banks’ asset holdings became more diversified in terms of the destination of loans.

Figure 14 illustrates weighted in- and out-degree of South Korean cross-border bank flows. The level of weighted in-degree is higher than that of weighted out-degree, indicating that the amount of bank loans to South Korea is larger than the amount that Korean banks lend to other countries in the network. This is because the network includes advanced countries which South Korea rely on for funding. Weighted in-degree plummeted immediately after the GFC and gradually recovered from 2009. There was a strong increase in weighted in-degree in 2015 and it flattened out afterwards. Weighted out-degree have shown a steady increase, implying the expansion of cross-border lending of South Korean banks.

\(^{10}\) To compare the measure across different network, closeness centrality can be normalised by multiplying the reciprocal by the number of nodes, $N$. 
The clustering coefficient for South Korea has risen substantially after 2015 (see Figure 15). This implies that the neighbouring countries of Korea are more interconnected in the network.\footnote{It should be noted that sharp increases in the clustering coefficient in 2014q4 and 2016q4 may be due to the inclusion of Hong Kong, Italy and Philippines as BIS reporting countries. However, the upward trend is robust regardless of the inclusion.}

Betweenness centrality in Figure 16 shows how influential South Korea is in the network. It increased during the GFC periods, suggesting that Korea played an important role to provide funding to the region as the other advanced economies were severely hit by the crisis. However,
betweeness steadily dropped since 2011 as the troubled advanced countries recovered and the financial intermediation function that Korea had served during the crisis weakened.

Closeness centrality decreased during the GFC period and recovered its level approximately after 2013 on average. This indicates that South Korea became closer to each node of the network as a lender and thus more central to the network. This is consistent with the previous findings that emphasise the increasing role of South Korea as a funding source in the cross-border banking flows network.

**Figure 17**

Closeness Centrality

Notes: The measures are computed using total claims data. Sources: BIS Locational Banking Statistics.

In the following, we examine the network measures for total liabilities, banks’ deposits. With liabilities data, an out-link of South Korea means that Korean banks (borrowers) have deposits from non-residents (lenders). Analogous to this, an incoming link from a country to South Korea implies that Koreans (lenders) have deposit at foreign banks (borrowers).

Figure 18 shows in- and out-degree of liability. Similar to the claims result, out-degree clearly exceeds in-degree, meaning that the number of countries to which Korean banks owe liabilities is larger than the number of countries which owe liabilities to Korean depositors. Over time, both in- and out-degree have increased slightly, suggesting that the liability side of bank flows has become more diversified.

As seen in Figure 19, the level of weighted out-degree is much higher than that of weighted in-degree. This implies that the amount of deposits from non-residents into Korean banks is larger than the amount of residents’ deposits into the rest of the countries. In the first half of 2007, both weighted in- and out-degree rose steeply. This may reflect improved financial integration in the regional banking sector. However, it seems that the GFC discouraged the development of financial integration. There were strong signs of retrenchments (a decrease in residents’ deposit in foreign banks) and stops (a decrease in non-residents’ deposit in Korean banks) during the crisis period.
After the financial crisis, weighted out-degree levelled off while weighted in-degree increased substantially from 2014. This increase in weighted in-degree was mainly due to the entrance of Hong Kong’s bilateral banking flows data from the fourth quarter of 2014.\(^{12}\) In addition, an increase in Korean residents’ deposits into the US banks is one of the crucial reasons for the trend. Since the US monetary policy normalisation, markets have had a strong expectation of hikes in interest rates and appreciation of the US dollar. This expectation with motives of searching for higher yields led to such increase in deposits in the US banks.

**Figure 18**

*Degrees*

**Figure 19**

*Weighted Degrees*

Notes: The measures are computed using total liabilities data.

Sources: BIS Locational Banking Statistics.

Measures of connectivity in terms of liability are shown in Figure 20-22. The trends in clustering coefficient and betweenness are somewhat similar to that of claims data. Both graphs provide evidence of a highly connected regional financial network. As the network becomes denser, financially neighbouring countries of South Korea are getting more interlinked and Korea’s influence as an intermediary of banking flows has become less significant.

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12. The amount of liability of banks in Hong Kong to South Korea is approximately US$32 billion in 2014q4.
Notes: The measures are computed using total liabilities data. Sources: BIS Locational Banking Statistics.

Closeness centrality in Figure 22 indicates that the measure is slightly lower than the claims data. However, an upward trend since 2012 is more noticeable than that in the claims data.

Notes: The measures are computed using total liabilities data. Sources: BIS Locational Banking Statistics.
4.2.2 Network Graphs

Next, we plot network graphs for claims and liability data using a software, Gephi. In order to highlight the bank flows in the Asia-Pacific region, bilateral transactions between advanced economies (the G7, Luxembourg and Switzerland) are excluded in the network graphs. This is because the amount of bank flows among these advanced economies tend to be much larger than the amount of flows between advanced and other Asia-Pacific countries or among the Asia-Pacific countries.

Three features of graph – the size of nodes, and the colour of the nodes, and the thickness of edges – can represent different aspects of a network structure. In the following network graphs, the node size indicates weighted out-degree, the colour of node betweenness connectivity, and the thickness of arrows the amount of bank flows.

Figure 23-31 show the network graph of total claims data for nine selected periods: 1998, 2000, 2005, 2007, 2008, 2009, 2013, 2015, 2018. All are the graphs for the first quarter of selected years to avoid capturing undesirable differences due to seasonality. The right panels of each figure show the same network graph but highlighting only the countries that have financial linkages with South Korea.

For the period from 1998 to 2004, South Korea was not reporting the LBS data to the BIS. Thus, Korea is considered as a periphery country which receives funding from foreign banks and does not lend to the rest of the world. As seen in Figures 23 and 24, it borrowed from only eight advanced economies, the US, the UK, Japan, Germany, France, Luxembourg, Switzerland and Australia.

Figure 23
Network Graph (1998q1)

Notes: The node size indicates weighted out-degree, the colour of node betweenness connectivity, and the thickness of arrows the amount of bank flows. The right panel highlights the nodes that have bilateral link with Korea.

Sources: BIS Locational Banking Statistics.

13. Gephi is an open-source visualisation software for network graphs (https://gephi.org/).
From 2005q1, South Korea started to report bilateral cross-border bank flows data to the BIS and, therefore, Korea has out-links as well as in-links. In 2005q1, betweenness centrality of Korea was above the average and weighted out-degree increased. All countries except Hong Kong have either in- or out-links with Korea.\textsuperscript{14} Korean banks own assets of 26 countries, including those of the US (the amount of the US claims relative to total amount of international claims is 34 %), China (14 %), the UK (13 %), Singapore (8 %) and Japan (6 %).

\textsuperscript{14} There were no claims reported by Korean banks that belongs to Hong Kong. However, since Hong Kong started to report bilateral cross-border bank flows from 2014q1, we cannot rule out the possibility that an out-link from Hong Kong to South Korea exists.
In 2007q1, before the GFC had occurred, the financial network in the region became more complicated with South Korea being an important funding source of the region. Korea focused on the emerging countries with high growth potential as there was no link between Korea and the under-developed countries, such as Myanmar, Nepal and Bangladesh. The top five largest borrowers are the same and their relative amounts remain similar as in 2007q1.

![Network Graph (2007q1)](image)

Notes: The node size indicates weighted out-degree, the colour of node betweenness connectivity, and the thickness of arrows the amount of bank flows. The right panel highlights the nodes that have bilateral link with Korea.

Sources: BIS Locational Banking Statistics.

In 2008q1, the aggregate amount of foreign claims that South Korean banks own increased dramatically from US$47 billion in 2007q1 to US$74 billion. The proportion of the US claims declined slightly due to higher risks during the GFC while the European countries, such as the UK and France, attracted more funding from Korea. The in-links are mainly with advanced economies, such as the UK, the US, Japan, France and Germany.
In the aftermath of the crisis (2009q1), the size of foreign claims held by Korean banks dropped by 20%. The US, the UK and China remained as major borrowers of Korean banks. However, Korean banks no longer held as much Japanese financial assets due to the prolonged recession in Japan. The proportion of Japanese assets out of total foreign assets owned by Korean banks dropped from 7% in 2008 to 2% in 2009. But they held more assets of Singapore, the financial hub for fast growing ASEAN countries. The Korean assets owned by other 11 countries plunged, a 55% decrease, especially by the US and European countries, such as the UK, Germany and France.

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15. The proportion of Singaporean assets to the total foreign assets increased from 5% to 7% in 2009.
There was a structural change in the banking network in 2013q1. While the foreign claims held by Korean banks showed a robust increase, Korean banks held more assets of China (the share of Chinese assets in total foreign assets of Korea is 41%) and Indonesia (4%). In contrast, the proportions of claims of the US (20%) and the UK (5%) declined. This implies that Korea became an important source of funding in the Asia-Pacific region. In terms of claims of Korea held by foreign banks, Japan, the UK, and the US are the main sources of Korean banks funding.

In 2015q1, we observe that Hong Kong appears as a major player of the network. This is because Hong Kong had started to report the LBS data since 2014q4. In addition, it may be affected by the launch of the Shanghai-Hong Kong Stock Connect in November 2014. The Stock Connect allows mainland Chinese investors to purchase equities that are listed in Hong Kong, and lets foreigners buy mainland Chinese stocks in a less restrictive manner. It opened the investment opportunities to China for wider investors.

Major borrowers of Korean banks include China (the proportion of its assets owned by Korean banks out of the total foreign assets amounts to 44%), the US (17%), Indonesia (5%), Singapore (5%), and Vietnam (5%). Countries with higher Korean asset holdings are Hong Kong, Japan, the US and the UK.
The recent financial network graph (see Figure 31) shows somewhat similar structure as in the previous graph. Hong Kong remains as an important funding source of the region. The network has become denser and complex. As for Korea, borrowing to China has declined by 10%, leading to a drop in the share of Chinese claims to total foreign claims from 44% to 32%. This is due to the recent slowdown in the Chinese economy. Korean banks hold more US assets as the Fed has been normalising its policy rate.

Notes: The node size indicates weighted out-degree, the colour of node betweenness connectivity, and the thickness of arrows the amount of bank flows. The right panel highlights the nodes that have bilateral link with Korea.
Sources: BIS Locational Banking Statistics.
As for liabilities network structure, we summarise only some key features here (see the network graphs in the Appendix). From the network graphs from 1998 to 2004, we find that Korean residents had deposits in the banks of advanced economies, such as the US, the UK and Japan. In 2005q, South Korea started to report bilateral cross-border banking flows data to the BIS and both betweenness centrality and weighted out-degree increased. However, Korea had no links with some under-developed countries, like Sri Lanka and Nepal. Over time, the network has become more complex as in the claims network. Liabilities of Korean banks were distributed mainly in the US, the UK, China and Singapore as of the first quarter of 2018.

5. Conclusions

In this paper, we have shown that the financial network of cross-border banking activities in the Asia-Pacific region has become more complicated and interconnected. After the GFC, South Korea has been more active in serving as a financial intermediary for capital flows into and out of Asia and the Pacific: Korea is a net creditor to Asia-Pacific countries while being a net borrower from the advanced economies. This pattern of bank flows has been driven by several macroeconomic and financial factors. First, stronger growth in emerging Asia relative to the advanced economies attracted capital flows from the advanced countries and South Korea. While this trend continues, the recent economic slowdown in emerging Asia has slightly reduced the amount of capital flows to the region. Second, the advanced economies’ monetary policies have significant implications on cross-border bank activities and their network. The search for yield in the low interest rate environment after the GFC was the main driver of international banking flows towards the region. Recently, the normalisation of the US monetary policy has changed the direction of capital flows to the US. Lastly, high demands for lending in emerging Asia have influenced the trend. However, this trend also can be reverted as lending in advanced economies recovers with robust economic growth.

Several key policy implications can be drawn from the analyses of financial network. Although the central banks and regulators of the region have implemented various regulatory measures to mitigate the systemic risks due to cross-border financial interconnectedness, there is still room for improvement. Authorities in the region need to be more cooperative to identify and monitor regionally active banks, common and concentrated creditors. Sharing information between home and host countries is crucial for establishing the ground for multilateral cooperation in banking regulation. Constructive dialogue with banks is another way to support financial stability. It is important for policymakers to consider the balance between the prudential objectives and efficiency in the banking sector. Effective communication with banks help regulators understand more about the functions and objectives of financial institutions as well as ensure commitment of banks to prudential measures. Finally, in order to ensure financial stability, in-depth research on financial network should be strongly supported by the central bankers and financial regulators in the region. In today’s globally integrated world, it is essential to facilitate multilateral surveillance on economic and financial development.
References


Appendix A: Network Graphs of Total Liabilities

Figure 32: Network Graph (1998q1)

Figure 33: Network Graph (2000q1)

Figure 34: Network Graph (2005q1)

Notes: The node size indicates weighted out-degree, the colour of node betweenness connectivity, and the thickness of arrows the amount of bank flows. The right panel highlights the nodes that have bilateral link with Korea.

Sources: BIS Locational Banking Statistics
Figure 35: Network Graph (2007q1)

Figure 36: Network Graph (2008q1)

Figure 37: Network Graph (2009q1)

Notes: The node size indicates weighted out-degree, the colour of node betweenness connectivity, and the thickness of arrows the amount of bank flows. The right panel highlights the nodes that have bilateral link with Korea.

Sources: BIS Locational Banking Statistics.
Figure 38: Network Graph (2013q1)

Figure 39: Network Graph (2015q1)

Figure 40: Network Graph (2018q1)

Notes: The node size indicates weighted out-degree, the colour of node betweenness connectivity, and the thickness of arrows the amount of bank flows. The right panel highlights the nodes that have bilateral link with Korea.

Sources: BIS Locational Banking Statistics.