2 Sailing the Same Stormy Seas: Slow-Burn Contagion Risk in ASEAN+3

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2.1 Introduction

ASEAN+3 economies have drawn important lessons from past crises which point to two sources of systemic risk: sudden stops and slow-burn contagion. A sudden stop happens when a financial crisis comes thick and fast: the country sees massive capital outflows, a sharp currency depreciation, a stock market collapse, and an economy sliding quickly into recession.[2] A slow-burn contagion is about a prolonged tightening of international credit conditions and economies that struggle from a persistent lack of credit. The two events need not occur in the same place. The sudden stop may happen in a particular region but cause global banks exposed to that region to stop lending elsewhere, in what is called the common lender channel of contagion.

When sudden stops turn into contagion, it can be assumed that something connects the affected countries to one another. Wyplosz, Eichengreen, and Rose (1996) find evidence of contagion that spreads more easily to countries closely tied by trade linkages. This interconnectedness could also involve what Aizenman, Hutchison, and Jinjarak (2013) describe as correlated investor sentiment. Indeed, Masson (1998) characterizes contagion as a situation in which a crisis in one country leads foreign investors to change their minds or their risk tolerances with regard to other countries. Consistent with a change in risk tolerances, Kim, Loretan, and Remolona (2010)

[1] The author thanks Diwa Guinigundo, Masahiro Kawai, Khor Hoe Ee, Rogelio Mercado Jr., Cyn-Young Park, Ramkishen S. Rajan, Johnny Ravalo, Yasuyuki Sawada, Ilhyock Shim, Kwanho Shin, James Villafuerte, and Philip Wooldridge for helpful comments.

[2] Mendoza (2010, p. 1941) defines sudden stops as "reversals of international capital flows, reflected in sudden increases in net exports and the current account."

present evidence from the credit-default swap (CDS) market showing that the contagion in the global financial crisis happened because risk was repriced worldwide. Indeed, Wu et al. (2016) find that while economic fundamentals tend to drive regional contagion, a collapse in investor appetite for risk tends to drive global contagion.

This change in investors' minds or in prices of risk may be a function of the extent to which the countries are connected to the same financial cycle. Rey (2015) has identified a global financial cycle that is related to the United States (US) monetary policy. Possibly of more concern to ASEAN+3 economies is a common regional factor. Cheung, Qian, and Remolona (2019) find a common factor in the movements of current-account balances in Asia, and this helps explain the accumulation of international reserves in the region. In the taxonomy of Kara, Tian, and Yellen (2015), identifying such a common factor would be a non-network way of measuring interconnectedness.

Before the Asian financial crisis of 1997, the common factor may have reflected what Park and Rajan (2021) describe as "premature and perverse financial liberalization, with inadequate attention paid to prudential regulations, as well as the fact that the ASEAN+3 region had a severely underdeveloped financial system that was predominantly bank-based." Another common factor would be the "original sin," which has been characterized by Hausmann and Panizza (2003) as the inability of countries to borrow in their own currencies. When they borrow in foreign currencies, the resulting mismatch makes them vulnerable to crisis. Such conditions evidently led Asia into financial crisis in 1997, given that three of the five countries had accumulated deep current-account deficits while tolerating excessive growth in domestic credit.[3]

The risk of a region-wide slow-burn contagion would depend in part on the common funding concentration risk of the various economies to the same set of banks, especially when these banks are tightly interconnected. Koch and Remolona (2018) show that in the Asian financial crisis, the common lender channel was a source of slow-burn contagion, in which international lending to the five crisis-hit countries did not recover for at least 5 years.

More recently, for the ASEAN+3 economies, common lenders that could fuel slow-burn contagion seem to have changed places since the global financial crisis. In terms of direct cross-border borrowing from global banks,

[3] Indonesia and the Republic of Korea had somewhat more modest deficits.

the concentration in euro area banks has evidently declined while concentration in Japanese and United Kingdom (UK) banks has increased.

In measuring concentration risk, however, it is important to account for links among global banks. In this chapter, the Shapley value is proposed as a direct network measure of interconnectedness. Its unique analytical advantage is in taking account of the contributions to systemic risk from different combinations of major lending jurisdictions—just as these have always been a factor in historical episodes of regional and global crises.

This chapter finds that shifts in interconnectedness have not been even across ASEAN+3 countries. The concentration risk faced by ASEAN economies excluding Singapore has risen, especially in their loans from banks in Japan and the United States.[4] At the same time, the concentration risks of the People's Republic of China (PRC) and the Republic of Korea are very similar and have risen, especially with regard to common exposures to UK and euro area banks. In the end, the "ASEAN 9" economies (ASEAN member countries excluding Singapore) have the highest concentration risk in loans from Japanese banks, while the PRC and the Republic of Korea are exposed to a similar magnitude of concentration risk in loans from banks in the UK, the US, and the euro area.[5]

Nonetheless, at least for now, ASEAN+3 financial systems can deal with these risks from a position of strength. Current accounts are largely in surplus. The region's banks hold capital buffers that exceed international regulatory standards. Even while central banks are sitting on large piles of international reserves, a regional commitment under the Chiang Mai Initiative Multilateralization (CMIM) makes funding from members available should any in the group need balance-of-payments support.[6] Even so, further development of corporate bond markets is still needed so that they can take a role as an alternative source of funding, or—as former chair of the US Federal Reserve Board Alan Greenspan famously put it—as a "spare tire" (Greenspan 1999). More broadly, even as banking integration proceeds in the region, a regional framework for dealing with the risk of a region-wide slow-burn contagion is still needed.

[4] As explained in Section 2.4, Singapore is excluded from this group of borrowers, because as an offshore banking center, it plays the role of an intermediary rather than a borrower.

[5] This order of banking jurisdictions reflects their importance in concentration risk. This ordering rule will be followed in the rest of the paper.

[6] The author owes this point to Diwa Guinigundo.

In what follows, the discussion starts with a review of the literature on sudden stops and slow-burn contagion, then examines the risk of sudden stops in the ASEAN+3 economies. Concentration risk of slow-burn contagion is further considered in terms of direct exposures. Thereafter, the chapter takes account of the global banking network and measure concentration risk in the form of Shapley values. A discussion of policy options concludes the chapter.

2.2 Review of Literature

The literature distinguishes between two types of cross-border propagation of financial crises. To adopt the terms used by Kaminsky, Reinhart, and Vegh (2003), such contagion may be "fast and furious" as in sudden stops, or it may be "slow-burn" as in a prolonged period of tight credit. Wu, Erdem, Kalotychou, and Remolona (2016) find sudden-stop contagion primarily a regional phenomenon, while slow-burn spillover effects can often be global. While sudden stop tends to operate through asset prices and capital flows, slow burn tends to operate through bank lending.

The large literature on financial crises has established that financial crises originate from lending booms. With data from 1870 to 2008, for example, Schularick and Taylor (2012) show that crises are simply "credit booms gone bust." The credit boom is typically driven by a period of unwarranted optimism. In the case of the boom leading to the Asian financial crisis, optimism seems to have been generated by economic reforms, largely in the form of financial liberalization in the various countries. As Park and Rajan (2021) point out, these turned out to have paid inadequate attention to prudential regulation.

In emerging markets, credit booms are often enabled by cross-border credit flows. Avdjiev, McCauley, and McGuire (2012) find that it is specifically international bank credit that tends to matter, rather than positions in local currency. Such international credit also often is a mechanism for the transmission of slow-burn contagion across countries.

When contagion arises as credit booms go bust, some sort of interconnectedness among the economies involved must exist. There are many ways to measure interconnectedness. Kara, Tian, and Yellen (2015) distinguish between network and non-network measures. Network measures may be direct or indirect. Direct measures explicitly map pairwise relationships between institutions.

An indirect way for interconnectedness to manifest is the presence of a financial cycle that affects different economies. Rey (2015), for example, identifies a global financial cycle in capital flows, asset prices, and credit growth. She finds that the cycle is correlated with VIX, an indicator of risk aversion in financial markets. Forbes and Warnock (2012) find that the timing of surges and stops in capital flows are related to VIX. Rey's analysis suggests that a determinant of the global financial cycle is monetary policy in the US. Bruno and Shin (2015) provide evidence that US monetary policy affects the leverage of global banks and credit growth in the international financial system. There is a regional version of Rey's financial cycle. In looking at the accumulation of reserves in Asia, Cheung, Qian, and Remolona (2019) find a common regional factor related to current-account balances.

While historically, the source of regional crises and contagion in the Asian region has been cross-border bank lending, corporate bond flows can also cause problems. Mizen et al. (2018) looked at 5,668 financing decisions by firms in seven Asian emerging markets over 1995 to 2012. These markets include five ASEAN countries: Indonesia, Malaysia, the Philippines, Singapore, and Thailand. They find that even in countries with onshore markets, it is often easier for unseasoned firms to issue corporate bonds offshore in a foreign currency than to issue onshore in the local currency. Indeed, Coppola et al. (2020) find large corporations in ASEAN+3 have been issuing corporate bonds in US dollars through their affiliates abroad. The largest such issuance has been by companies from the PRC.

Park and Shin (2018), using bilateral data from the Bank for International Settlements (BIS) international banking statistics, find that direct exposures of the country's own and the overall region's banking sectors to crisis-affected countries are systematically related to capital outflows during the global financial crisis. They also find that when lenders and borrowers belong to the same region, the lenders are less likely to retreat from those same borrowers at the time of financial stress. Koch and Remolona (2018) document the bank lending channel of contagion, in which international banks that suffer heavy losses in one country tend to reduce lending to other countries. They document such slow-burn contagion in the Asian financial crisis, and the same in the global financial crisis through 2008 and 2009, and the European sovereign debt crisis from 2010 to 2012.

Underlying such slow-burn contagion is the interconnectedness of the global banking system. Measuring the systemic risk of this often focuses on downside tail risks. Acharya et al. (2012), for example, have proposed

the systemic expected shortfall to reflect an institution's propensity to be undercapitalized when the system as a whole is undercapitalized. Adrian and Brunnermeier (2016) have proposed "CoVar," which is a systemic risk version of the value-at-risk measure used by individual commercial banks.

In these situations, the development of local currency corporate bond markets may mitigate the risks of regional contagion. Gyntelberg, Ma, and Remolona (2005) find that such markets are often illiquid due to narrow investor bases, inadequate microstructures, and a lack of timely information about issuers. Amstad et al. (2016) discuss ways these conditions can be turned around in Asian emerging markets.

2.3 Sudden-Stop Contagion Risk in ASEAN+3 Economies

A balance-of-payments crisis is also known as a sudden stop. It is a situation in which the external financing of a current-account deficit comes to an abrupt halt. As pointed out by Cecchetti and Schoenholtz (2018), a sudden stop forces a country to adjust sharply so as to close its current-account deficit. The adjustment often means a contraction of credit in the financial system and a reduction in investment that are so drastic they plunge an economy into a recession. Moreover, as shown by the Asian financial crisis, a sudden stop in one country can easily lead to sudden stops in neighboring countries. The risk of such a sudden-stop contagion depends partly on how closely precrisis current-account balances in the region move together.

The risk of sudden stops is often transmitted through asset prices. To measure systemic risks in general, Diebold and Yilmaz (2014) propose variance decompositions of stock returns and volatilities. This is an indirect way of measuring interconnectedness. Variance decompositions of volatilities are particularly interesting. This is because volatilities can be seen as indicators of fear in the market. Focusing on systemic risk in financial markets, Dungey, Luciani, and Veredas (2013) propose a methodology based on the Google PageRank algorithm to rank systemically important financial institutions (SIFIs). They take account of the interconnections between the finance sector and the real economy.

In an interesting example of measuring interconnectedness indirectly, Fry-McKibbin, Hsiao, and Tang (2014) identify nine crisis episodes using a regime-switching model. To analyze the nature of a sudden-stop contagion, they focus on the dependence structures of equity markets

through correlation, co-skewness, and co-volatility. They find that the Great Recession of 2008–2010 was a true global financial crisis, and financial interconnectedness was the source of crisis transmission.

A Common Regional Factor

Cheung, Qian, and Remolona (2019) seek to identify a common regional financial factor that can lead to a contagion in sudden stops. Identifying such a factor is a non-network way of measuring interconnectedness. The motivation is to explain the build-up of international reserves in Asia since the Asian financial crisis. There are three possible common factors: (i) an economic growth variable, (ii) a current-account balance variable, and (iii) a financial-account balance variable. Cheung, Qian, and Remolona find that the current-account balance variable is the only statistically significant common economic factor.

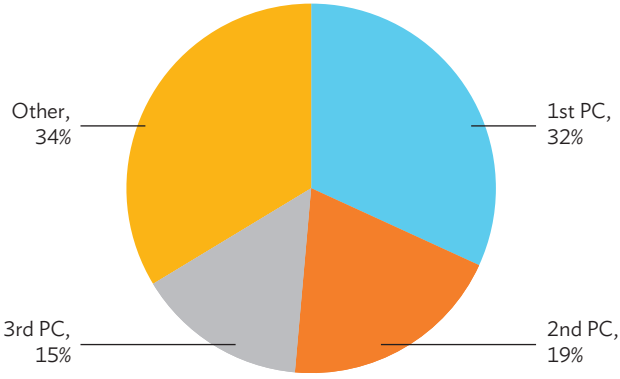
Hence, in this chapter the risk of a sudden-stop contagion is assessed by analyzing the covariation in the current-account balances of the ASEAN+3 countries. This covariation will reflect the whole network of trade links and financing links between these countries and also the network of links between them and third countries. The question is: Can just a small number of factors explain these links?

To answer that, the principal components are extracted from current-account movements. Principal components are a long-established way of reducing the dimensionality of a data set. They do so by means of orthogonal linear transformations of the data. In the analysis here, they are a parsimonious way of modeling the covariance structure of current-account movements. The resulting country loadings on the principal components are indirect measures of centrality in the network.

In assessing the risk of sudden-stop contagion in ASEAN+3, only the countries for which quarterly current-account data are available from Q1 2010 to Q4 2018 are considered. We exclude Japan, because of its special role as a creditor country. Singapore and Hong Kong, China are also excluded because of their role as offshore banking centers. This leaves seven of the larger countries: the PRC, Indonesia, the Republic of Korea, Malaysia, the Philippines, Thailand, and Viet Nam. The principal components are then extracted from the quarterly change in the ratio of the current-account balance to GDP for each of the seven countries from Q1 2010 to Q4 2018.

How much can the principal components explain? In Figure 2.1, the pie chart shows how much each of three principal components can explain current-account movements during the sample period. As shown in the pie chart, the first principal component explains 32% of the variation in the current-account movements of the seven ASEAN+3 countries in the sample. The second principal component explains 19% of that variation and the third principal component 15%.

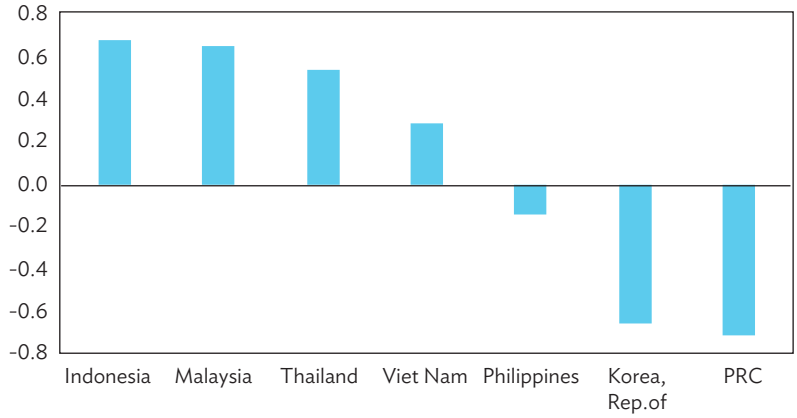
Figure 2.1: How Much Can the Principal Components Explain?



PC = principal component.
Note: The data refer to the principal components of the quarter-on-quarter changes in the current account balance-to-GDP ratios of Indonesia, Malaysia, the People's Republic of China, the Philippines, the Republic of Korea, Thailand, and Viet Nam. The period covered is from Q1 2010 to Q4 2019.
Source: Author, based on CEIC, IMF International Financial Statistics Database, and national sources (accessed May 2021).

Country loadings on these principal components provide a convenient indirect measure of network interconnectedness. Figure 2.2 focuses only on the loadings on the first principal component. The current accounts of Indonesia, Malaysia, and Thailand load most heavily on this principal component, with each exceeding 50%. This means if one of these countries were to experience a sudden stop, network links would lead the other two into a sudden stop. The PRC and the Republic of Korea both load negatively on the first principal component, with both loadings exceeding 50% in absolute value. This suggests that if either the Republic of Korea or the PRC experienced a sudden stop, the other economy is likely to find itself in the same boat. Loadings for the Philippines and Viet Nam are both relatively small, suggesting that they are not likely to be part of a sudden-stop contagion involving the others.

Figure 2.2: Loadings on the First Principal Component



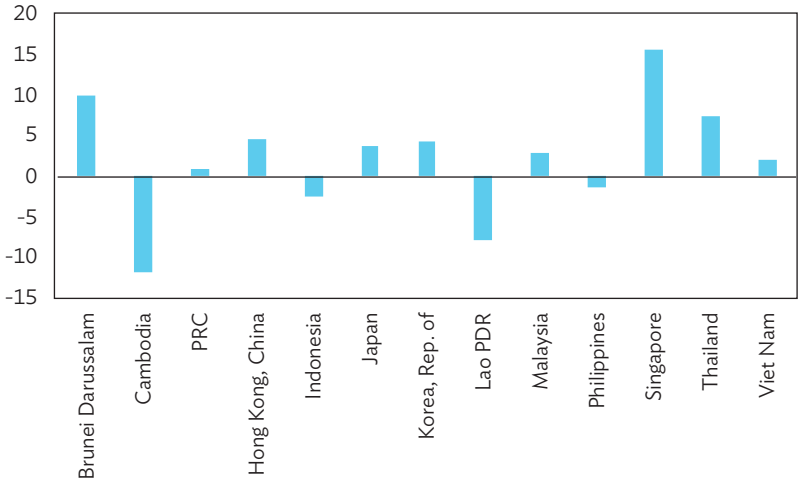
PRC = People's Republic of China.
Note: The data refer to the principal components of the quarter-on-quarter changes in the current account balance-to-GDP ratios of Indonesia, Malaysia, the PRC, the Philippines, the Republic of Korea, Thailand, and Viet Nam. The period covered is from Q1 2010 to Q4 2019.
Source: Author, based on CEIC, IMF International Financial Statistics Database, and national sources (accessed May 2021).

For the ASEAN+3 economies, the risk of sudden-stop contagion is clearly different from what it was before the Asian financial crisis. At that time, the crisis engulfed five of the sample countries. This time, Indonesia, Malaysia, and Thailand are still closely interconnected, while the PRC and the Republic of Korea are more closely interconnected. At the same time, contagion risks are now mitigated by these countries' large international reserves.

Today's Risk of Sudden-Stop Contagion

As of 2019, the risk of a sudden-stop contagion among the ASEAN+3 economics is less than it was just before the Asian financial crisis. Among the 13 economies (including Hong Kong, China), as shown in Figure 2.3, only Cambodia and the Lao People's Democratic Republic are running current-account deficits in excess of 7% of GDP. As small economies, they are unlikely to be a source of sudden-stop contagion. Indonesia and the Philippines are also running current-account deficits but they are under 3% of GDP. By contrast, the eight other economies are running significant current-account surpluses.

Figure 2.3: Current Account Balance, 2017–2019 Average
(% of GDP)

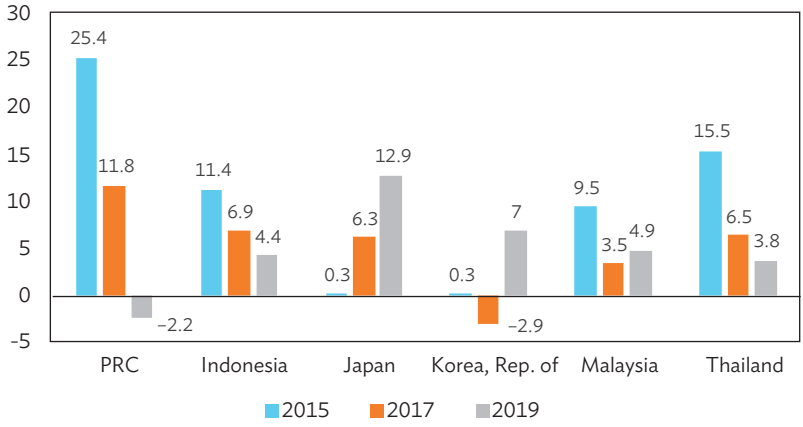


GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Author, based on CEIC, IMF International Financial Statistics Database, and official sources (accessed May 2021).

Moreover, the domestic front is not showing credit growth at concerning levels. The credit-to-GDP gap is the early-warning indicator favored by the BIS. Aldasoro, Borio, and Drehmann (2018) argue this indicator is as good as any in predicting a financial crisis. As shown in Figure 2.4, the six largest countries among the ASEAN+3, which are the only ones for which BIS provides estimates of the credit-to-GDP gap, do not show excessive credit growth.

If there is something to worry about at this time, it is not sudden-stop contagion, but rather slow-burn contagion.

Figure 2.4: Credit-to-GDP Gaps, 2015–2019
(%)



GDP = gross domestic product, PRC = People's Republic of China.
Note: Credit-to-GDP gaps is defined as the difference between the credit-to-GDP ratio and its long-term trend, in percentage points. Long-term trend is calculated using a one-sided Hodrick-Prescott filter with a lambda of 400,000.
Source: BIS Credit-to-GDP Gaps Database (accessed July 2020).

2.4 Concentration Risk of Slow-Burn Contagion in ASEAN+3 Economies

Shifts in banking interconnectedness among the ASEAN+3 countries in the decade since the global financial crisis are important to understand. That is because they indicate the fundamental nature of the slow-burn contagion operating through the common lender channel. This channel is discussed in detail by Koch and Remolona (2018) for the Asian financial crisis, the global financial crisis, and the European sovereign debt crisis. Where ASEAN+3 financial systems end up in their interconnections in 2019 would then be indicative of funding concentration risk and future channels of slow-burn contagion.

Grouping the Borrowing Countries

The analysis in this section relies on data from the BIS Consolidated Banking Statistics. These data properly assign credit risk exposures to creditors' home jurisdiction—unlike locational statistics, which assign exposures to where the claims are booked. In the consolidated data set, 23 of the largest creditor countries report such data by bank nationality. Among them, the euro area

countries are lumped together because they share the same currency. Among the 19 jurisdictions in the euro area, 11 of the largest report international bank claims data to the BIS.

The borrowing countries are divided into two groups: (i) the ASEAN 9 (ASEAN economies excluding Singapore); and (ii) the PRC and the Republic of Korea (two of the "plus 3" of the ASEAN+3 economies, with Japan the third). This is not an arbitrary division. From the point of view of funding concentration risk, the interconnectedness of the various ASEAN 9 countries involves largely the same lending banks, just as the interconnectedness of the PRC and the Republic of Korea involves largely the same banks. In other words, when it comes to contagion, the ASEAN 9 countries are in the same common lender channel as each other, while the PRC and the Republic of Korea would similarly find themselves together in another common lender channel. In the BIS data set, total claims on the ASEAN 9 countries as of end-2019 were $358 billion and amounted to $669 billion on the PRC and the Republic of Korea together.[7]

Among the ASEAN 9, three of the large borrowers—Indonesia, Malaysia, and the Philippines—have very similar concentration risks. The three have Japanese banks as their most important source of cross-border loans and rely heavily for those loans on banks in the UK; the US; and Taipei,China. A fourth large borrower, Thailand, is somewhat different in that it relies on "outside area" banks, in which PRC banks seem likely to play significant roles. A fifth large borrower, Viet Nam, is different in that it does not borrow from US banks. The main difference between the PRC and the Republic of Korea is that the former relies most heavily on UK banks, while the latter relies more on US and Japanese banks.

When it comes to Singapore and Hong Kong, China, both are offshore banking centers that are intermediaries rather than direct lending or borrowing jurisdictions. They were considered separately and their intermediary roles were analyzed with the help of a different data set, the BIS Locational Banking Statistics. Unlike the Consolidated Banking Statistics, as mentioned before, the locational data estimate claims based on where they are booked rather than the nationality of the lender that bears the credit risk.

[7] Unfortunately, the PRC has yet to report consolidated banking statistics to the BIS. However, it is suspected that Chinese banks account for a large part of "outside area" lending to the region (Koch and Remolona 2018).

Japan is also considered separately. While it is one of the +3 countries, its significance is as a creditor country rather than a borrowing country, and it is an important part of the global network of major creditor jurisdictions.

Lending Jurisdictions Play Musical Chairs

In the decade since 2009, our two groups of borrowing countries showed somewhat divergent trends in their reliance on cross-border bank credit. International bank claims on the five largest ASEAN 9 economies as a group increased from 2.5% of their combined GDP in 2009 to 4.6% of their GDP in 2019. In contrast, on the part of the PRC and the Republic of Korea, such claims declined slightly from 4.4% of their combined GDP in 2009 to 4.0% in 2019.

Over the past decade, the most remarkable shift in banking interconnections with the ASEAN+3 as a whole was the ascendancy of UK banks and the decline of euro area banks. The start of the decade saw US banks dominating cross-border lending to the PRC and the Republic of Korea, and Japanese banks dominating such lending to the ASEAN 9 countries. By the end, UK banks had gained the most ground, especially in the PRC and the Republic of Korea. Japanese banks also gained some, strengthening their already dominant position in the ASEAN 9 countries. In the meantime, euro area banks lost much of their market share, especially in the ASEAN 9 countries.

Japanese banks as lenders to ASEAN ex-Singapore

The euro area banks suffered heavy losses in the European sovereign debt crisis of 2010–2013. Consistent with the common lender channel of contagion, these banks drastically reduced their lending activity in Asia. As reported in Table 2.1, they went from a 13% share of international claims on the ASEAN 9 countries in 2009 to just 5% in 2019. UK banks also lost ground, although not nearly to the same extent as the euro area banks. The share of claims from UK banks fell from 12% in 2009 to 9% in 2019.

Table 2.1: International Bank Claims on ASEAN ex-Singapore by Jurisdiction of Lending Banks, 2009 and 2019

Lending Jurisdiction	Q4 2009		Q4 2019	
	Amount Outstanding ($ billion)	Proportion (% share)	Amount Outstanding ($ billion)	Proportion (% share)
Japan	28.1	18.3%	93.3	26.1%
Outside area	8.5	5.5%	40.9	11.4%
United Kingdom	17.7	11.5%	32.1	9.0%
Taipei,China	4.2	2.7%	26.4	7.4%
United States	14.0	9.1%	26.3	7.4%
Euro area	20.1	13.1%	18.4	5.1%
Switzerland	–	–	14.0	3.9%
Republic of Korea	–	–	8.4	2.3%
Australia	2.7	1.7%	7.5	2.1%
Canada	0.9	0.6%	1.0	0.3%
Sweden	–	–	0.3	0.1%
Others	57.5	37.4%	89.2	24.9%
Total	153.6	100.0%	357.6	100.0%

Note: "Outside area" refers to jurisdictions that do not provide consolidate bank claims data to the Bank for International Settlements (BIS). As explained in Koch and Remolona (2018), "outside area" lending likely includes lending by banks in the People's Republic of China.
Source: Author, based on BIS Consolidated Banking Statistics Database (accessed July 2020)

Japanese banks entered the breach left by euro area and UK banks. In 2009, Japanese banks already held the dominant share of international claims on the ASEAN 9 countries as a group, accounting for 18%. In the course of the decade that followed, these banks became even more dominant, so that by 2019 they held 26% of those claims in the region. "Outside area" banks also gained market share, and it is possible that Chinese banks account for a large part of such gains.

UK banks as lenders to the PRC and the Republic of Korea

In the meantime, on the side of the PRC and the Republic of Korea, the decade saw lending activity by UK banks displacing US banks. In 2009, US banks were the dominant lenders to the PRC and the Republic of Korea, accounting for 21% of international claims to the two countries (Table 2.2). Like euro area banks, however, the large US banks also suffered heavy losses in the global crisis, and like euro area banks they found themselves withdrawing from Asia. In the course of the decade, they more than half of their market share (or over 12 percentage points) in the two borrowing countries, so that by 2019 they accounted for only 8.4% of international claims. Japanese banks also lost market share, almost to the same extent

as US banks. It was the outside area banks who took over. In the course of the decade, they expanded their market share by 31 percentage points, and accounted for 46% of international claims by 2019.

Table 2.2: International Bank Claims on the People's Republic of China and the Republic of Korea by Jurisdiction of Lending Banks, 2009 and 2019

	Q4 2009		Q4 2019	
Lending Jurisdiction	Amount Outstanding ($ billion)	Proportion (% share)	Amount Outstanding ($ billion)	Proportion (% share)
Outside area	66.2	15.6%	490.0	46.3%
United Kingdom	48.9	11.5%	122.7	11.6%
United States	87.9	20.7%	89.0	8.4%
Japan	53.9	12.7%	64.5	6.1%
Euro area	41.8	9.8%	55.9	5.3%
Switzerland	–	–	35.7	3.4%
Taipei,China	7.1	1.7%	26.3	2.5%
Australia	5.4	1.3%	20.9	2.0%
Canada	7.2	1.7%	15.9	1.5%
Republic of Korea	–	–	14.7	1.4%
Sweden	1.6	0.4%	1.1	0.1%
Other	104.1	24.5%	122.2	11.5%
Total	424.2	100.0%	1,058.8	100.0%

PRC = People's Republic of China.
Note: "Outside area" refers to jurisdictions that do not provide consolidate bank claims data to the Bank for International Settlements (BIS). As explained in Koch and Remolona (2018), "outside area" lending likely includes lending by banks in the PRC.
Source: Author, based on BIS Consolidated Banking Statistics Database (accessed July 2020).

The role of the Singapore and Hong Kong, China banking centers

To understand the role of Singapore and Hong Kong, China as banking centers in the region, the chapter examines how these two centers intermediate funds. It is presumed that funds originating from bank jurisdictions outside the region often first find their way to banks in Hong Kong, China; the PRC; or Singapore before they are lent to borrowers in other ASEAN+3 economies. Hence, data from the BIS Locational Banking Statistics, which report cross-border bank claims on residents of Singapore and Hong Kong, China, are used. These claims are typically loans or deposits and are broken down by the location of the banking offices that hold these claims.

Before the global crisis of 2008–2009, Singapore and Hong Kong, China played somewhat different roles in intermediating savings from different parts of the world. At that time, as documented by Remolona and Shim

(2015), banks in Hong Kong, China tended to take savings from outside the region and lend them to borrowers within the region. Banks in Singapore, by contrast, tended to take savings from the region and lend them outside the region. Since the crisis, however, the two banking centers have increasingly played similar roles, taking savings from outside the region and lending them within the region.

In 2009, both banking centers were tied closely to UK and euro area banks. As shown in Table 2.3, banking offices in the UK and euro area held loan and deposit claims amounting to 21% of such cross-border claims on residents of Singapore and Hong Kong, China. By 2019, however, banking offices in the euro area had become the leading holders of these claims, with 18% of the total. Banking offices in the UK and the US together held another 19%. Locational data do not tell us how the funds eventually find their way to the ultimate borrowers in the rest of the ASEAN+3 economies.

Table 2.3: Cross-Border Bank Loan and Deposit Claims on Residents of Singapore and Hong Kong, China by Location of Banking Office, 2009 and 2019

	Q4 2009		Q4 2019	
Location of Banks	**Amount Outstanding** ($ billion)	**Proportion** (% share)	**Amount Outstanding** ($ billion)	**Proportion** (% share)
Euro area	56.1	10.2%	173.7	17.6%
United States	32.8	6.0%	93.9	9.5%
United Kingdom	58.7	10.7%	90.1	9.1%
Hong Kong, China[1]	–	–	80.8	8.2%
Australia	6.3	1.1%	33.8	3.4%
Taipei,China	19.5	3.5%	29.4	3.0%
Macau, China	–	–	16.4	1.7%
Switzerland	23.0	4.2%	15.5	1.6%
Luxembourg	28.0	5.1%	7.1	0.7%
Republic of Korea	5.4	1.0%	4.6	0.5%
Others	320.3	58.2%	442.5	44.8%
Total	550.1	100.0%	987.8	100.0%

[1] Banking offices in Hong Kong, China are reported to hold claims on Singapore residents. It is likely that banking offices in Singapore hold also hold claims on residents of Hong Kong, China. However, Singapore does not report such data to the Bank for International Settlements (BIS).
Source: Author, based on BIS Locational Banking Statistics Database (accessed July 2020).

It is significant that Japanese banks are nowhere to be seen in these locational data on loans and deposits to residents of Singapore and Hong Kong, China, and yet the consolidated statistics show them to be playing a dominant role as ultimate lenders. One way to reconcile the two sets of data is to see the

interbank markets in Singapore and Hong Kong, China as facilitating a process by which banks in the euro area, the UK, and the US lend to Japanese banks, which in turn lend the funds to borrowers in the rest of ASEAN+3. Indeed, locational data for Q4 2019 show that banks in Japan have loan and deposit liabilities to banks in Hong Kong, China amounting to $101 billion, second only to loan and deposit liabilities to banks in the US.

Much of this intermediation is evidently conducted in US dollars. The BIS locational data also provide a breakdown of cross-border loans and deposits by currency. The US dollar accounts for 66% of these claims in Hong Kong, China as of Q4 2019 and 68% of these claims in Singapore. In Hong Kong, China, the euro is the second most important currency, accounting for 11% of these claims. In Singapore, however, the Japanese yen is the second most important currency, accounting for 10% of these claims. Indeed, Gourinchas (2019) has shown the dominance of the US dollar has increased over time, partly because of complementarities in the use of this currency for both trade and finance.

2.5 Global Banking Networks and Shapley Values

In assessing concentration risk, there is need to go beyond the direct exposures and take account of the indirect exposures through the global banking network. In this network, global banks lend actively to one another. Such global interbank lending can be quite significant, as shown in Table 2.4. Allen and Gale (2000) explain how global banks insure themselves against regional liquidity shocks by holding claims against each other. However, this arrangement is vulnerable. A small liquidity shock in one region can spill over to others. There is also a currency dimension. When Japanese banks lend abroad, they tend to lend in US dollars and evidently get those by swapping yen with dollars from US banks.

Hence, a banking jurisdiction's role within the network is important. To Alves et al. (2013), the simplest measure of connectivity is a "bank's degree," which is the number of links from that bank to other banks. Those links could be given weights in various ways, such as by their relative importance. The Shapley value is used as a measure of network centrality. This measure is more appealing than just counting the links between banks. Not only does it account for the size of those links, it also accounts for all possible episodes of financial stress. In some episodes, certain links will matter and others will not, while in other episodes all links may matter. In the Asian financial crisis, for example, the links that mattered most involved the Japanese banks.

In the European sovereign debt crisis, the links that mattered most were with euro area banks.

The Global Banking Network

In measuring links among global banks, the focus of this chapter is on the five jurisdictions—Japan; the UK; the US; the euro area; and Taipei,China — from whom ASEAN+3 economies borrow the most. The BIS Consolidated Statistics report lending and borrowing between bank counterparties in the different jurisdictions. Relying on those statistics, Table 2.4 shows the proportion of what banks in a given jurisdiction borrow from banks in the other jurisdictions. The strongest global interconnections are between US and Japanese banks, and between euro area and UK banks. The table shows that Japanese banks account for 37% of what US banks borrow from banks abroad. At the same time, US banks account for 27% of what Japanese banks borrow from banks abroad. At the same time, euro area banks account for 52% of what UK banks borrow from other banks. UK banks account for 12% of euro area bank borrowing from banks outside the currency area. By contrast, global interconnections involving Taipei,China banks are relatively weak, although they do rely significantly on funds from US banks.

Table 2.4: The Global Network of the Major Creditor Jurisdictions of ASEAN ex-Singapore, the People's Republic of China, and the Republic of Korea

Proportion of interbank lending to total claims on borrowing jurisdictions, 2019 (% share)

	Borrowing Jurisdictions				
Lending Jurisdictions	**Japan**	**United Kingdom**	**United States**	**Euro area**	**Taipei,China**
Japan		12.6%	37.1%	16.2%	18.5%
United Kingdom	15.4%		17.8%	11.7%	19.7%
United States	26.8%	10.4%		13.6%	31.9%
Euro area	30.2%	51.8%	20.7%		--
Taipei,China	2.8%	1.1%	1.4%	--	

PRC = People's Republic of China.
Source: Author, based on BIS Consolidated Banking Statistics Database (accessed July 2020).

This calculation uses only the creditor jurisdictions that account for the top four direct exposures to each of our two borrowing groups within ASEAN+3, as of 2019. For the ASEAN 9, these jurisdictions are Japan; the UK; Taipei,China; and the US. For the PRC and the Republic of Korea, these are the UK, the US, Japan, and the euro area. For both groups of borrowers, "outside

area" creditors figure significantly. Unfortunately, there are no data on who exactly these creditors are and there is no data on their links with the global banking network.[8] Fortunately, it is likely that these creditor banks have weak links to the global network, and leaving them out of the analysis will not provide misleading results.

Why Shapley Values?

In the taxonomy of Kara, Tian, and Yellen (2015), the Shapley value is a direct network measure of interconnectedness. Instead of explicitly mapping pairwise relationships between institutions, however, the data available allow us to carry out this mapping only at the level of banking jurisdictions. The Shapley value offers the analytical advantage that, unlike other network measures, it recognizes the empirical reality that not all important contagion episodes encompass the whole network. Some important contagions are regional, others global. For example, in looking at nine recent episodes of equity-price contagion, Fry-McKibbin, Hsiao, and Tang (2014) find that only the Great Recession of 2008–2009 was truly global in scope. The analysis below considers 15 possible combinations of lending jurisdictions that lead to systemic risk. In addition, the Shapley value offers appealing analytical properties, such as additivity, symmetry, and uniqueness of the solution.

To calculate Shapley values, each lending jurisdiction is treated as a player in a cooperative game. In specifying characteristic functions for different coalitions of players, different combinations of major jurisdictions that could be involved in a contagion through the common lender channel are considered (Box 2.1). In the language of game theory, the "payoff" to the coalition corresponds to the contribution to the concentration risk of the corresponding jurisdictions. It is assumed that concentration risk is proportional to the size of the claims on the borrowing countries. This is consistent with Koch and Remolona (2018), who find that when Japanese banks had the largest proportion of claims on the crisis-hit countries of 1997, they were also the banks that reduced lending the most, reducing their exposure to the region by 80% over 5 years in the wake of the crisis. Although Japanese banks at that time were struggling with their own domestic crisis, the onset of their withdrawal from crisis countries corresponded closely to the Asian financial crisis.

[8] As noted by Koch and Remolona (2018), "Chinese banks have become an increasingly important provider of international bank credit, to borrowers both within and outside Asia. At the moment, [however] the PRC does not report consolidated banking claims."

Box 2.1: The Mathematical Properties of the Shapley Value

The Shapley value is a concept introduced by Shapley (1953) for cooperative games. In such a game, a coalition of players generates a payoff that is shared by the coalition as a whole. The Shapley value divides up that payoff to allocate it to individual players based on their marginal contributions. For our purposes, the payoff is the amount of concentration risk.

Tarashev, Borio, and Tsatsaronis (2010) have applied the concept to measuring systemic risk in a network of banks. As they point out, the concept has appealing mathematical properties for measuring network centrality:

Additivity: The sum of Shapley values equals the aggregate measure of concentration risk.

Symmetry: It does not matter in which order each banking jurisdiction is considered.

Dummy axiom: If the banking jurisdiction is not a source of concentration risk, its Shapley value is zero.

Linearity: The linear combination that relates characteristic functions is the same as the linear combination that relates Shapley values.

As shown by Mas-Colell, Whinston, and Green (1995), these properties lead to a unique division of the payoff.

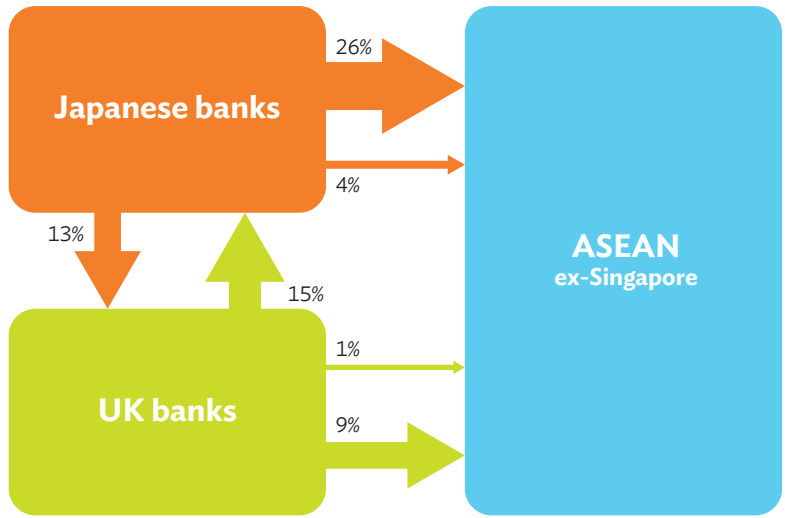
Calculating the Shapley value involves specifying a characteristic function, which maps every possible coalition of players to a payoff. Given the specified the characteristic functions, the Shapley value for player i is calculated as:

$$\varnothing_i(N) = \frac{1}{|N|!} \sum_{G} [\gamma(B_i^G \cup \{i\}) - \gamma(B_i^G)]$$

where N is the number of players, $\gamma(B_i^G \cup \{i\})$ is the payoff to the coalition that includes player *i* and $\gamma(B_i^G)$ is the payoff to the coalition that does not include player *i*. The formula assigns the same probability to every possible coalition.

To illustrate the calculation, consider for now only Japan and the UK, two ASEAN 9 creditor jurisdictions. By itself, Japan's exposure is 26% of all claims on the ASEAN 9 economies. However, UK interbank exposure to Japan is 13%. As shown in Figure 2.5, taking this into account results in an additional exposure of Japanese banks to ASEAN 9 of 4% and an additional exposure of UK banks of 1%. The two jurisdictions together would then represent a concentration risk of 40%.[9] In our calculation of Shapley values, interbank exposures are assumed to have the effect of heightening concentration risk, consistent with analysis by Allen and Gale (2000) of the vulnerability of the interbank market to liquidity shocks. The appendix provides a step-by-step calculation of the Shapley values.

Figure 2.5: Calculating the Characteristic Function with Two Banking Systems



UK = United Kingdom.
Source: Author.

As mentioned above, the calculations only include the four most important lending jurisdictions for ASEAN ex-Singapore and for the PRC and the Republic of Korea. Historically, at most three lending jurisdictions have been involved in regional or global financial crises: Moreover, to go beyond four lending jurisdictions would be an exercise in false precision, given

[9] This is the sum of the following four components: (i) 0.26 (direct exposure of Japanese banks; (ii) 0.01 (indirect exposure of UK banks through Japanese banks) or 0.15 times 0.26; (iii) 0.09 (direct exposure of UK banks); and (iv) 0.01 (indirect exposure of Japanese banks through UK banks) or 0.13 times 0.09.

that available data do not allow the exposures to "outside area" lending jurisdictions to be accounted. Even with only four lending jurisdictions, the number of all possible coalitions N is 15, where each coalition represents a possible episode of slow-burn systemic risk involving the common lender channel. There are four possible coalitions that include only a single lending jurisdiction, six possible coalitions that include two, four possible coalitions that include three jurisdictions, and one possible coalition that includes all four.

The Difference Made by the Global Banking Network

To highlight the amplification effects of the global banking network, concentration risk is calculated by assuming that financing in the interbank market leads to additional exposure to borrowing countries that is proportional to the amount of interbank lending. This will be reflected in the calculation of payoffs to various coalitions of players when deriving Shapley values. For ASEAN ex-Singapore, the calculation is carried out for the banking network that includes banks fromJapan; the UK; Taipei,China; and the US, which have the four largest direct credit exposures to the nine countries. For the PRC and Republic of Korea, the calculation includes the UK, the US, Japan, and euro area banks, which have the four largest direct credit exposures to the two countries. In each case, as mentioned above, the four different global lending jurisdictions lead to 15 possible coalitions.

The Shapley value calculations show that for ASEAN ex-Singapore, the network effects make the most difference in the concentration risk of US banks. Without the network effects, the nine countries together face a concentration risk in these banks of 7.4%. As reported in Table 2.5 and Figure 2.6, once the network effects are taken into account, the Shapley value shows a concentration risk that rises to 14.6%, which is an amplification of 97%. Nonetheless, the highest concentration risk remains with Japanese banks, with a Shapley value of 34%. As expected, network effects make the least difference in the concentration risk of Taipei,China banks, which are the banks with the weakest links in the global interbank network.

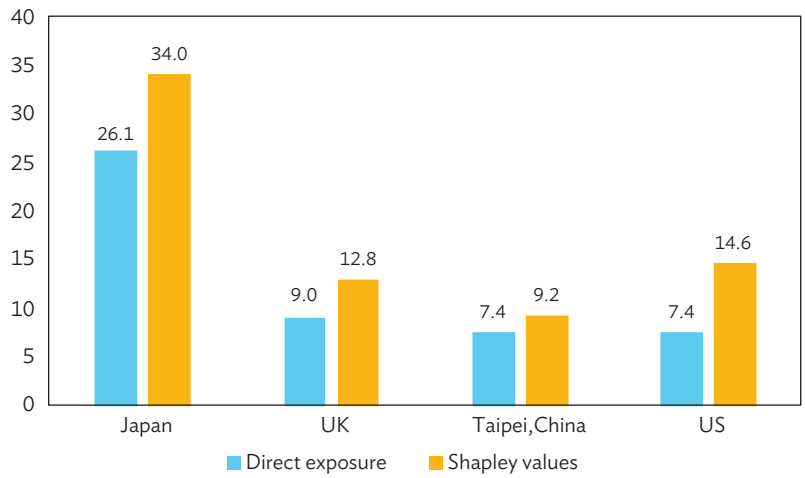
Table 2.5: Shapley Values That Account for the Global Banking Network

Top Four Creditor Jurisdictions	Claims in 2019 ($ billions)	Proportion of Total Claims (%)	Shapley Values (%)	Amplification (%)
Borrowers: ASEAN ex-Singapore (ASEAN 9)				
Japan	93.3	26.1	34.0	30.3
United Kingdom	32.1	9.0	12.8	42.2
Taipei,China	26.4	7.4	9.2	24.3
United States	26.3	7.4	14.6	97.3
Total		49.9	71.6	43.5
Borrowers: PRC and the Republic of Korea				
United Kingdom	122.7	11.6	17.5	50.4
United States	89.0	8.4	13.5	60.1
Japan	64.5	6.1	11.1	81.1
Euro area	55.9	5.3	11.3	112.3
Total		31.4	53.4.0	69.5

PRC = People's Republic of China.
Note: Contagion and Shapley values take account of lending links between creditor jurisdictions. ASEAN 9 is comprised of ASEAN economies excluding Singapore. Since the Shapley values are measured relative to the proportion of total claims, the sum of these values may exceed 100%.
Source: Author, based on BIS Consolidated Banking Statistics Database (accessed July 2020).

Figure 2.6: Shapley Values for ASEAN ex-Singapore, 2019

(%)



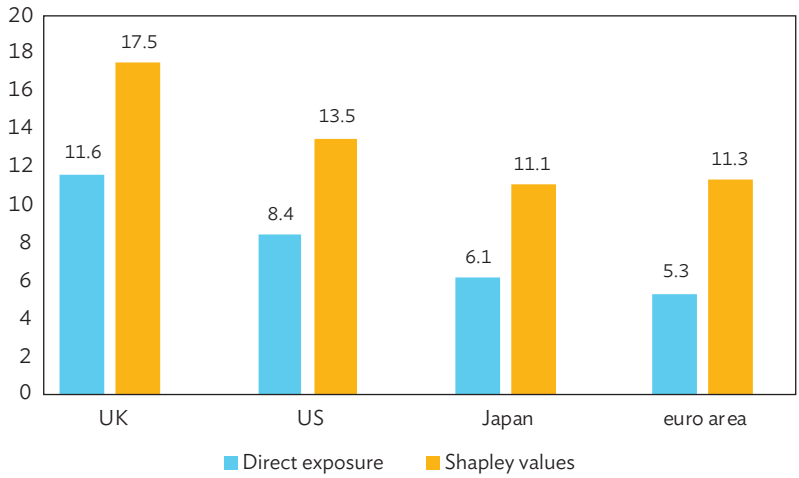
UK = United Kingdom, US = United States.
Source: Author's, based on BIS Consolidated Banking Statistics Database (accessed July 2020).

For the PRC and the Republic of Korea, the network effects make the most difference for the concentration risk of euro area banks. As shown in Table 2.5 and Figure 2.7, this risk rises from 5.3% to 11.3%, a network amplification of 112%. Nonetheless, the highest source of concentration risk remains the UK banks, with a Shapley value of 17.5%.

In general, the PRC and the Republic of Korea have lower concentration risk than the ASEAN 9 financial systems. This is in part because ASEAN 9 economies are somewhat more diversified in their international borrowing, although the lending jurisdictions tend to have strong interbank links between one another. While the Shapley values for the ASEAN 9 economies exceed 20% for loans from Japanese banks, none of these values for the PRC and the Republic of Korea come close to 20% for any lending jurisdiction. Nonetheless, a concern for both countries is the rather large sum of unidentified claims as reflected in "outside area" claims. This concern may be mitigated soon as the PRC and others begin to report consolidated banking statistics to the BIS.

Figure 2.7: Shapley Values for the People's Republic of China and the Republic of Korea, 2019

(%)



PRC = People's Republic of China, UK = United Kingdom, US = United States.
Source: Author, based on BIS Consolidated Banking Statistics Database (accessed July 2020).

2.6 Conclusion: Suggested Policy Measures

This chapter distinguishes between two sources of systemic risk: sudden stops and slow-burn contagion. The chapter shows that since the Asian financial crisis, economies of the region have addressed their vulnerability to sudden stops. When it comes to the vulnerability to slow-burn contagion, however, policy makers have work to do.

As the financial systems of the ASEAN+3 countries look to the rest of the 2020s, they do so from a position of resilience. The current accounts of most of the larger economies are in surplus. Banks are well capitalized and evidence from credit-to-GDP gaps suggests that domestic borrowers are not over leveraged. Their central banks have accumulated massive international reserves, while the Chiang Mai Initiative Multilateralization (CMIM) stands ready to provide some backup liquidity.

Moreover, as Park and Rajan (2021) have pointed out, "many of the ASEAN+3 economies initiated major finance sector reforms as a means of restructuring, strengthening and diversifying their financial systems." They add that "the fast-growing and highly intricate networks of trade, investment and cross-border financial flows within ASEAN+3, along with the fact that individually the economies are vulnerable to global shocks that might need a coordinated response, has led the region to consciously promote greater financial cooperation over the last two decades."

Turning to the remaining area of concern, the chapter explains how slow-burn contagion operates through the common lender channel. This vulnerability is exacerbated when the common lenders are themselves highly interconnected in a global banking network. Proposing the Shapley value as a measure of interconnectedness, this chapter finds that the ASEAN 9 economies face the highest levels of concentration risk in loans from Japanese banks, while for the PRC and the Republic of Korea the risk to some degree is largest in loans from banks in the UK, the UK, and the euro area.

To tackle the issue of concentration risk in foreign borrowing, one area that could use regional cooperation is in the development of local currency bond markets. Regulatory challenges also remain. Even as financial integration proceeds in the region, a regional framework is still needed for dealing with the risk of a region wide slow-burn contagion.

To further mitigate the concentration risk of slow-burn contagion, policy makers of the ASEAN+3 economies have at least two policy options. At the domestic level, they may consider macroprudential measures that restrict borrowing abroad. At the regional level, they may consider working within the ASEAN Banking Integration Framework (ABIF) to use Shapley values as measures of the concentration risk associated with slow-burn contagion and perhaps use these measures as a criterion in identifying R-SIBs.

Developing Local Currency Corporate Bond Markets

While local currency corporate bond markets in the ASEAN+3 economies have seen remarkable development in the past decade, these markets are still not able to play the role of Greenspan's spare tire in the event of a financial crisis. Indeed, Gochoco-Bautista and Remolona (2012) find that in the larger ASEAN+3 economies, banking systems are already reasonably well-developed, and markets for equities and government bonds have achieved critical mass even while remaining purely domestic. The corporate bond markets have lagged behind. Gochoco-Bautista and Remolona conclude that "the tug-of-war between the geography of information in the direction of more localized markets versus the critical mass required by network externalities makes the case for regional integration stronger for corporate bond markets than for other financial markets."

Indeed, among the fruits of regional cooperation has been an important regional initiative to foster local currency bond markets. That initiative is the Asian Bond Fund 2 (ABF2), a fund that invests in eight local currency bond markets in the region. As explained by Ma and Remolona (2005) and Chan et al. (2012), the fund has been part of a process of learning by doing, in which the central banks involved in the fund were able to identify significant impediments to market development. With those removed, ABF2 has become the largest index fund for local currency bond markets in the region.

In this context, it is useful to reiterate one of the proposals of Gochoco-Bautista and Remolona: that the ASEAN+3 central banks cooperate in establishing a regional repo market to provide cross-border liquidity to dealers in local currency corporate bonds. A few central banks in the region already have in place bilateral agreements that provide for the local currency settlement of swaps, repo transactions, and other cross-border transactions. For repo transactions, the agreements allow local currency government bonds to be accepted as collateral. The central banks that are party to these agreements include the Reserve Bank of Australia, Bank Indonesia, the Bank of Korea,

Bank Negara Malaysia, the Monetary Authority of Singapore, and the Bank of Thailand. Bilateral agreements could serve as the basis for an ASEAN-wide master agreement that would allow local currency corporate bonds from the region to be accepted as collateral in cross-border repo transactions.

Under this proposal, the regional master repo agreement might best be one that specifies tri-party contracts. These contracts would require a few clearing central banks. This clearing role could be played by the People's Bank of China (PBOC), the Bank of Japan, the Hong Kong Monetary Authority, and the Monetary Authority of Singapore. The People's Bank of China already plays a similar role for offshore yuan. If corporate bonds were included as eligible repo collateral, the clearing banks could prequalify these bonds and assess the appropriate repo haircuts for them.

A possible challenge in the use of local currency corporate bonds as collateral is their credit quality. Collateral that is internationally rated below double-A would seem unlikely to be acceptable even when subjected to haircuts. Amstad et al. (2016) do find that when it comes to local credit ratings, by far most corporate bonds issued in Indonesia, the PRC, the Republic of Korea, Malaysia, and the Philippines are highly rated, enjoying either triple-A or double-A ratings. In equivalent international credit ratings, however, these bonds would be rated close to that of the sovereign, which in this case could be as low as triple-B.[10] Nonetheless, the bilateral agreements already mentioned do accept government bonds with such low ratings as collateral in repo transactions, and so should arguably allow similarly rated corporate bonds to serve as collateral.

If all that the proposed regional repo market did was to provide liquidity to existing corporate bonds, the proposal would not be that helpful. Earnest development of the region's corporate bond markets must include making them more accessible to lower-rated issuers. Hence, it is important that the proposed regional repo market accepts lower-rated issues as collateral.

To resolve the conflict between what is acceptable as repo collateral and what is required for the market to develop, ASEAN governments may wish to turn to the Credit Guarantee and Investment Facility (CGIF). This is a trust fund of the Asian Development Bank (ADB) which was established precisely to promote the development of deep and liquid local currency

[10] As of the writing of this report, the S&P sovereign ratings are double-A for the Republic of Korea; single-A for the PRC, Malaysia, and the Philippines; and triple-B for Indonesia.

bond markets in ASEAN+3 countries.[11] Here, the CGIF could provide enough of a credit guarantee to lower-rated corporate bond issues so that they would be acceptable as collateral in a regional repo market. Such a repo market would in turn serve to enhance the liquidity of these corporate bonds.

Macroprudential Measures

Macroprudential measures have become fairly common in Asia. Kim's (2019) study of macroprudential policy in 11 Asian countries finds that the most frequently used tools are the loan-to-value ratio and the reserve requirement. Some countries also use various forms of bank capital buffers. Bank Indonesia has implemented a capital conservation buffer, while the Bank of Korea has implemented one based on countercyclical capital.

Among the less common tools is the macroprudential stability levy. This is imposed by the Bank of Korea on banks' noncore foreign currency liabilities. Since the levy was introduced in 2011, it seems to have succeeded in its intention of lengthening the maturity structure of foreign borrowing.

Something like the Republic of Korea's macroprudential stability levy could be deployed against concentration risk. In this case, the imposition of the levy should be transparent. For example, it could be imposed on foreign loans from banks that come from a jurisdiction for which the computed Shapley value exceeds 10%. For the average ASEAN 9 country, based on the Shapley values reported in Table 2.5, this would mean applying the levy to Japanese, UK, and US bank loans. For the PRC and the Republic of Korea, this would mean applying the levy to UK, US, euro area, and Japanese bank loans.

Macroprudential measures in general should be carried out in coordination with monetary policy. Using panel vector autoregression, Kim (2019) concludes that contractionary macroprudential policy affects credit and output in much the same way that monetary tightening does. If this is the case, macroprudential measures might focus more on credit and monetary policy more on output.

[11] For more on the CGIF, see: https://www.cgif-abmi.org/.

Global and Regional Systemically Important Banks

The effects of macroprudential policy in one country often spill over into other countries. Patel (2017), for example, draws on a survey of emerging market central banks to identify channels through which the influence of macroprudential measures extends across national borders. These channels point to the need for international cooperation of macroprudential measures.

One of the mechanisms for cooperation is the Financial Stability Board (FSB), which includes the previous Financial Stability Forum's members and Group of 20 members that were not part of the forum, including the PRC; Hong Kong, China; Indonesia; Japan; the Republic of Korea; and Singapore. As part of its work, the FSB has been designating global systemically important banks (G-SIBs). The G-SIBs are identified through a transparent methodology. Domestic authorities then subject them to four sets of requirements: (i) higher capital buffers; (ii) standards of total loss-absorbing capacity; (iii) resolvability; and (iv) higher supervisory expectations.

When it comes to the higher capital buffers, the G-SIBs are placed in five different buckets, requiring different levels of additional capital. The assignment to buckets is based on a simple assessment methodology that relies on five "denominators" carrying the same weights:

- Size: Total exposures as defined in the Basel III leverage ratio.
- Cross-jurisdictional activity: Cross-jurisdictional claims and liabilities.
- Interconnectedness: Intra-financial system assets and liabilities, and securities outstanding.
- Substitutability/financial infrastructure: Assets under custody, payments infrastructure, and capital market underwriting activity.
- Complexity: Notional amounts of over-the-counter derivatives and other indicators.

While the denominators for cross-jurisdictional activity and interconnectedness are related to Shapley values, they are quite different. The Shapley values are more focused on the concentration risk of slow-burn contagion as faced by specific groups of borrowing countries, for which some lending jurisdictions are more important than others. The Shapley values also account for possible systemic risk scenarios in which the different lending jurisdictions could be involved. In this respect, the calculated Shapley values highlight the more important interconnections among the banking jurisdictions that are likely to drive the common lender channel of contagion.

For purposes of the resilience of the ASEAN+3 financial systems, the supervisory authorities could designate R-SIBs rather than rely entirely on the G-SIB framework. The objective of designating R-SIBs would be to impose additional capital buffers on their bank subsidiaries in the region, following the FSB practice with regard to G-SIBs. These buffers would be calibrated to discourage slow-burn contagion concentration risk, preferably using Shapley values as a denominator in the assessment methodology.

Relying on BIS Consolidated Banking Statistics to compute Shapley values means the identification of R-SIBs would be about their home jurisdictions rather than about individual banks. A caveat in using the current calculations of Shapley values is that the possibly large claims of banks in the PRC are not yet reported in the underlying consolidated statistics. Fortunately, this shortcoming will be remedied soon, because the PBOC has now committed to reporting such data to the BIS.

A possible mechanism for regional cooperation is the Executives' Meeting of East Asia-Pacific (EMEAP) central banks, a group that guides regional bank regulation through its Working Group on Banking Supervision. The members of EMEAP include nine of the ASEAN+3 central banks, the PBOC, Hong Kong Monetary Authority, Bank Indonesia, Bank of Japan, Bank of Korea, Bank Negara Malaysia, Bangko Sentral ng Pilipinas, Monetary Authority of Singapore, and Bank of Thailand. The Working Group on Banking Supervision also includes as members banking supervisory authorities such as the China Banking Regulatory Commission, Indonesia's Otoritas Jasa Keuangan, Japan's Financial Services Agency, and the Republic of Korea's Financial Supervisory Service.

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Appendix

A Step-by-Step Calculation of Shapley Values as Measures of Funding Concentration Risk with Two Banking Jurisdictions

To illustrate how the Shapley value is calculated as a way of measuring the funding concentration risk, the example of two banking jurisdictions lending heavily to ASEAN economies except Singapore are used, namely Japan and the UK. The calculation involves specifying a characteristic function and payoff for each possible coalition of lending jurisdictions.

Step 1: Specify the characteristic functions and payoffs.

Two possible coalitions involve one banking jurisdiction each.
The characteristic functions and corresponding payoffs are given by the direct shares of Japanese and UK banks in international claims on ASEAN ex-Singapore (Table 2.1):

$$\gamma(JP) = 26.1\% \qquad \gamma(UK) = 9.0\%$$

where *JP* represents Japanese banking jurisdiction and *UK* represents the UK jurisdiction.

There is only one other possible coalition: the one that involves the two banking jurisdictions together. The payoff for this coalition is given by:

$$\gamma(JP,UK) = [26.1\% + 9.0\%] + (26.1\%)(15.4\%) + (9.0\%)(12.6\%) = 40.3\%$$

where the first term (in brackets) is the sum of the direct shares $\gamma(JP)$ and $\gamma(UK)$; the second term is the part of the Japanese banking share that is accounted by interbank lending from UK banks, as reported in Table 2.4; and the third term is the part of the UK banking share accounted for by interbank lending from Japanese banks, also reported in Table 2.4.

Step 2: Calculate Shapley values.

Once the characteristic functions and payoffs have been specified, the Shapley value for player *JP* is calculated as:

$$\varnothing_{JP}(2) = \frac{1}{2}\gamma(JP) + \frac{1}{2}[\gamma(JP,UK) - \gamma(UK)] = 28.7\%$$

while for player *UK*, it is calculated as:

$$\varnothing_{UK}(2) = \frac{1}{2}\,\gamma(UK) + \frac{1}{2}[\gamma(JP,UK) - \gamma(JP)] = 11.6\%$$

One can check that the sum of the Shapley values is 40.3%, which gives us back the payoff to the coalition $\gamma(JP,UK)$.