Banking Integration and Stability: The Trade-off between Risk Sharing and Contagion Risk[1]

Phuong Le[a,b,c,]

[a] *Ethifinance, France*
[b] *Paris Saclay University, France*
[c] *Ho Chi Minh City University of Banking, Vietnam*

Abstract

The significant expansion of cross-border banking raises complex questions about its ambiguous effects on the stability of the local banking system. This paper aims to analyze how three aspects of banking integration affect stability (bank insolvency risk, credit risk, and liquidity risk). By using the data set of 3217 bank-year observations and cross-border banking claims/liabilities in ASEAN-6 in the period of 1996-2018, this research found: (i) the foreign banking capital exposures induce the banking system less stable (ii) however, the balance degree of the banking capital integration and the physical participation of foreign banks make the banking system more stable. Moreover, this research also investigates the mechanism of contagion risk via the transmission of banking risk and the uncertainty information channel by employing a spatial model with ASEAN's 30 counter-party countries. These findings suggest that ASEAN-6 should improve the regulation quality to increase banking stability under the banking integration situation. Last but not least, the policymaker should recognize the trade-off effect of banking integration on bank stability, especially the different impacts of capital inter-bank exposures and the physical presence of foreign banks.

Keywords: Banking integration, Stability, ASEAN-6, Contagion risk, Risk sharing, Cross-border banking

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1. Introduction

Banks, as several banking crises throughout history have demonstrated, are fragile institutions. This is to a large extent unavoidable and is the direct result of the core functions they

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perform in the economy. It is often said that banks, or more generally financial intermediaries, are inherently unstable and prone to volatility (Gu et al., 2019). The financial crisis of 2008 demonstrated how the inter-bank linkages and contagion risk play a crucial role in financial stability. Following the crisis, the higher banking integration is, the more easily the instability can be transmitted through the connections among the banking systems, which could lead to the collapse of the global financial system. Cross-border banking has developed significantly since the 1990s and has been dominated by a few advanced economies (AEs) and financial centers (Moghadam, 2011). In emerging markets (EMEs), although cross-border exposure remains relatively low, foreign banks have started to play an important part as active investors during the last two decades. The literature on the real effects of cross-border banking extensively analyzes the importance of banking integration for financial stability and contagion risk. However, there are also several less clear-cut financial stability implications of foreign capital exposures and foreign-bank penetration. In this context, a better understanding of the relationship between banking integration and stability is absolutely necessary.

One the one hand, the banking integration can have beneficial effects, such as channeling financial resources to their most productive uses or improving competition, and risk-sharing possibilities, which helps the banking system more stable. De Haas and Van Lelyveld (2010) suggests that foreign ownership of banks can have counter-cyclical effects since affiliates of foreign banks do not have to reduce credit supply in times of financial crisis idiosyncratic to the domestic economy. Dages et al. (2000) conclude that foreign ownership of banks in Argentina and Mexico contributed to greater stability of the financial system during crises in emerging markets. Using a sample of ten Central and Eastern European countries, Dinger (2009) finds the stabilizing effect of foreign-owned banks on emerging economies. Deng et al. (2007) highlight the positive effects of geographic diversification.

On the other hand, from the related theoretical literature, it is well-known that cross-border linkages in banking make countries more susceptible to contagion risk, makes the banking system less stable (Allen et al., 2012, Gai and Kapadia, 2010). The positive view changed when the financial crisis spread from developed to emerging markets, and regulators started to worry that parent banks would drain liquidity from their local subsidiaries and began to consider foreign ownership as a potential source of risk. It also has potential costs in the form of contagion and capital flow volatility (Allen et al., 2011). The repatriation of local banks' profits may put pressure on the current account. Foreign-owned banks may prefer to provide local loans in foreign currency, especially in the currency of the home country if they refinance themselves in the home market via the parent bank. This could increase the vulnerability of borrowers to exchange-rate movements and transmit back to banks via increased credit risk. Additional sources of risk may stem from the transfer of decision-making and risk management to the foreign headquarters and unification of the rules within the whole banking group, which does not take into account local concerns and may lead to worse access to financing from local small and medium-sized enterprises (Winkler and Beck, 2005).

This research sheds light on the effects of banking integration on banking system stability. I use a panel dataset with country-level data for 6 ASEANs, and their 30 advanced and emerging counter-parties around the world, for the period 1996–2018. Being considered to be a great success story in the history of economic development, ASEAN countries have also been the most vulnerable ones in terms of financial stability. This region has outpaced the rest of the world in GDP growth per capita since the late 1970s and remains one of the fastest-growing regions in the world with average annual real gains of more than 5% (Almekinders et al., 2015). Taken as a whole, ASEAN is already the seventh-largest economy in the world and promises to become a pivotal consumer market in the near future. However, economic sustainability was challenged by the fact that the region was severely hit by two major financial crises in just over a decade. The regional currency crisis in 1997-1998 and adverse feedbacks from the 2007-2008 global financial crisis show vivid evidence about shock transmission within and between countries/ regions. Therefore, investigating the recent wave of foreign entry in this area, economy-wide risk interactions and spillover effects of ASEAN countries attract the attention of potential investors and policymakers, especially in the context of the establishment of the ASEAN Economic Community (AEC) by end-2015, and further regional financial arrangements. Understanding the influence of cross-border banking on stability has become an urgent research priority.

The results highlight that the three aspects of banking integration have heterogeneous impacts on stability, and there is a trade-off between risk-sharing possibilities and contagion risk. Moreover, by employing the spatial interaction terms, this research analyses the mechanism of instability and uncertainty information transmission through banking connections and their influences on the banking system. The rest of this paper is structured as follows: Section 2 presents a literature review. Section 3 presents the methods and data. Empirical results and a discussion are given in Section 4. Lastly, Section 5 includes some conclusions.

2. Literature review

The empirical part of the paper is related to different strands of literature. An increasing number of studies analyze cross-border exposures in banking; however, academic literature still leaves subtle messages about the consequences of banking integration on stability. Tonzer (2015) concluded that although the banking connections allow for improved risk-sharing among the banking systems, shocks can be spread through the inter-bank linkages. On the one hand, Schoenmaker and Wagner (2013) argued that cross-border banking could also reduce the volatility of lending and the risk of banking failures. On the other hand, Cetorelli and Goldberg (2011) shows that cross-border lending to emerging economies diminished during 2007–2009. This was mainly the case for foreign lending banks located in a country suffering an adverse liquidity shock. According to Allen and Gale (2000), in tranquil times, cross-linkages among banks enhance risk-sharing and liquidity allocation, but the spread of shocks across regions is facilitated in times of crisis. In the context of cross-border banking, cross-linkages toward banking systems abroad can thus improve risk-sharing and lower the impact of domestic shocks. This occurs because international connections in banking open up diversification possibilities and reduce the probability of regional defaults. However, cross-linkages can be detrimental and cause feedback effects if they are maintained with banking systems under financial distress. (Stiglitz, 2010).

Moreover, previous studies often investigated these influences under the only single aspect of banking integration. For example, Tonzer (2015) used international linkages in interbank markets of 18 advanced countries in the period 1994–2012, while Eisenbeis and Kaufman (2008) employed cross-border banking in the form of direct investment. In contrast, Demirgüç-Kunt et al. (1998) and Lee and Hsieh (2014) examined the stability issue with the foreign bank entry. In this research, I take account of three aspects of banking integration: banking openness degree, overall balanced degree, and foreign participant ratio. The first two aspects relate to the capital form of banking integration, while the final one is considered as the physical form. The heterogeneous impacts of banking integration's aspects are found in the literature:

Firstly, the stability issues can be affected by the banking openness degree. Tonzer (2015) found that stronger linkages taking the form of larger inter-bank exposures tend to increase contagion risk. Establishing more linkages implies, at the same time, a higher number of potential channels of contagion. The effect of interbank connections also depends on their size. Nier et al. (2007) shows that for a given level of connectivity, an increase in interbank asset exposures facilitates the propagation of shocks and causes a higher number of defaults. Georg (2013) analyzes contagion risk in different types of networks. He finds that interbank loan volumes above an upper threshold decrease systemic stability. The threshold level depends on the level of inter-connectedness. Larger exposures are less likely to conflict with financial stability for higher levels of interconnectedness. Hence, larger international exposures can be assumed to make banking systems prone to spillovers. For example, banking systems might not be able to withstand large and unexpected withdrawals or sudden losses in cross-border claims. How far this holds true might depend on the level of network diversification. Thus, this study will test whether the number of foreign claims as well as liabilities directed toward a network of banking systems affects banking risk.

Secondly, banking stability has the benefits of a more balanced and high diversification degree in inter-bank linkages. The trade-off between risk-sharing possibilities and contagion risk can be affected by the degree of diversification or interconnections. Following traditional theoretical arguments raised by e.g., Diamond (1984) and Winton (1999), diversification allows banks to reduce risks. The general advice that follows is, "don't put all your eggs in one basket". This suggests that a more geographically diversified portfolio can lower the probability of events of distress regarding foreign asset holdings. The probability of spillovers can, therefore, be affected by the degree of diversification or interconnectedness. Theoretical results point toward a non-monotonic relationship (Allen and Gale, 2000, Gai and Kapadia, 2010). For example, Nier et al. (2007) modeled the banking system as a network with different degrees of connectedness. They find a non-monotonic relationship between interconnectedness and contagion risk. At low levels of interconnectedness, additional link formation increases contagion risk. This is due to a dominating role of linkages as transmission channels of shocks. Additional linkages decrease contagion risk if interconnectedness is already high. In this scenario, more linkages help banking systems withstand shocks.

Finally, foreign entry was supposed to be significantly related to banking stability. The foreign banks enhance local banks' performance by introducing new technologies, new products, knowledge spillovers, advanced management skills, and better corporate governance structures (Hermes and Lensink, 2004, Gopalan et al., 2010), which improves the local financial system, thereby contributing to the more stable financial system (Ozili, 2018). Demirgüç-Kunt et al. (1998) found foreign bank participation could (1) lower the probability that a country will experience a banking crisis, (2) lower overhead costs and profits of domestic banks, and (3) accelerate overall economic growth by boosting domestic banking efficiency. According to Van Horen and Claessens (2012), foreign banks have higher capital and more liquidity but lower profitability than domestic banks do. However, in developing countries is foreign bank presence is negatively related to domestic credit creation. During the global crisis, foreign banks reduced credit more compared to domestic banks, except when they dominated the host banking systems.

The other strand of literature is about theoretical network papers, which suggest that interconnections in the banking system create channels that can transmit shocks between different units (Allen and Babus, 2009, Allen et al., 2012). A straight-forward application of these concepts is provided by Allen and Gale (2000). Their basic idea is that overlapping claims connect to other regions. This facilitates redistributing liquidity between areas and provides liquidity insurance. At the same time, excessive liquidity shocks can cause contagion through cross-holdings of deposits. A significant result is that the probability of contagion depends on the degree of interconnectedness. Although there was an increase in the theoretical literature on systemic risk and shock propagation in networks, a thorough understanding of how networks' interactions affect systemic stability is still missing (Schweitzer et al., 2009, Tonzer, 2015). Moreover, Tonzer (2015) showed there is a trade-off between risk-sharing possibilities and contagion risk. Contagion is facilitated through the existence of cross-linkages. Hence, the question of whether cross-linkages to more (less) stable banking systems have a positive (negative) effect on stability at home should be analyzed.

The studies such as Upper and Worms (2004), Degryse et al. (2010), Liedorp et al. (2010) and Tonzer (2015) more closely match the basic idea of theoretical models. In their setup, a bank/banking system suffers a shock that can be transmitted to other banks/banking systems through linkages among the individual entities. Relying on simulation techniques, Degryse et al.

(2010) find that liquidity shocks specific to one entity can cause a breakdown of the whole financial system. These studies are, in most cases, based on aggregate balance sheet positions of banks. This is due to the lack of disaggregated data on exposures between banks. Mutual linkages are simulated under the assumption that total interbank positions are distributed equally across counterparties. This is a strong assumption that might drive the results. Additionally, these studies are often restricted to contagion analysis among the banks within one country and for one time period or only limit to a group of specific countries. This research uses the banking linkages, which are calculated by data on bilateral cross-border exposures of ASEAN to all their counterparties worldwide.

To analyze the possibility of spillovers from connected systems, I make use of a spatial modeling approach similar to that of Cohen-Cole et al. (2010), Liedorp et al. (2010) or Tonzer (2015). This econometric technique enables analysis of how banking stability in one country is affected by events in other countries while accounting for interbank linkages among them. Effects stemming from changes in interbank asset or liability positions can be separated from spillovers arising from lending or borrowing to more or less stable banking systems. However, this paper takes into account both the banking instability and economic policy uncertainty spillover via banking connections. Schoenmaker and Oosterloo (2005) suggested that contagion risk can transmit under the form of the information channels. Moreover, policy uncertainty also has a long-run impact on banking stability (Albulescu and Ionescu, 2018). Roukny et al. (2018) found that interconnections can be considered as a source of tension in systemic risk.

The paper contributes to the existing literature in several ways. Firstly, the three aspects of the two forms of banking integration were employed to test the impact on stability. Secondly, besides the bank solvency risk, which is often used as the proxy for stability in the literature, the liquidity and credit risk also are taken into account to exhibit a more precise picture of banking integration's effects. Thirdly, a spatial model is used to study the spillovers of banking instabilities as well as economic policy uncertainty via the inter-bank network, though it has rarely been used in the related literature. Finally, the inter-bank linkages and contagion risk in ASEAN-6 are tested with all their counter-parties around the world, not limited to any specific group.

3. Method and data

3.1. Banking stability measures

This research uses three proxies for banking stability: the bank insolvency risk, credit risk, and liquidity risk.

The first proxy, the insolvency risk, was computed by the commonly used indicator: the z-score (Laeven and Levine, 2009, Demirgüç-Kunt and Huizinga, 2010, Houston et al., 2010). The following calculation formula for the z-score of the banking system i at the time t was employed:

$$ZSCORE_{kit} = \frac{ROA_{kit} + (E/A)_{kit}}{\sigma(ROA)_{kit}}$$

Where ROA_{kit} denotes the bank's total return on assets (net profit/total assets); $(E/A)_{kit}$ is the equity to assets ratio; and $\sigma(ROA)_{kit}$ represents the standard deviation of returns on total assets estimated as a three-year moving average. A higher value for the $ZSCORE$ implies lower the probability of failures or bank solvency risk, which indicates that the banks are more stable (Lepetit and Strobel, 2013). Moreover, the natural logarithm of $ZSCORE_{kit}$ is used because the z-score is considered to be highly skewed (Laeven and Levine, 2009, Houston et al., 2010, Fernández et al., 2016). The required data is taken from the Orbis Bank Focus.

Furthermore, this research also considers the other specific risk aspects of the banking system via the credit risk and liquidity risk. The non-performing loans to total loans ratio (NONLOAN) is the traditional measures of bank credit risk (Martinez Peria and Schmukler, 2001, Nier and Baumann, 2006, Fernández et al., 2016). A low non-performing loan to gross loan ratio reflects a better banks' asset quality, which subsequently improves banking stability (Ozili, 2018).

$$NONLOAN = \frac{\text{The non-performing loans}}{\text{Total loans}}$$

Regarding the liquidity risk, the chapter employs the liquidity ratio of the banking system (DESPO and LIQUID). In the research of Wagner (2007), he found the more liquidity of bank assets, the less banking stability, because the banks with the high liquidity of bank assets will have an incentive to take a huge amount of new risk, which outweigh the positive direct impact on stability.

$$DESPO = \frac{\text{Ratio of Core Deposit}}{\text{Total Assets}}$$

$$LIQUID = \frac{\text{Short-Term Liabilities}}{\text{Liquid Assets}}$$

3.2. Banking integration measures

Banking integration degree is analyzed via three indicators: Foreign bank participation (FOR), Banking openness ($OPEN$), and Overall balanced degree ($OVER$). While the first indicator is the proportion of foreign banks to the total banks, the last two indicators were calculated by employing the methods in paper Ha et al. (2019). Each indicator shows each aspect of banking integration. FOR reveals the physical integration of the local banking system via the presence of foreign bank in the local market. OPEN demonstrates how the banking system opened through the sum of capital flows in-out. OVER reflects the balance, and the diversification degree of capital flows in-out.

Foreign bank participation (FOR)

The first indicator, Foreign bank participation (FOR), is computed as the ratio of foreign banks to total banks in the country. The foreign banks enhance the performance of local banks through introducing new technologies, new products, knowledge spillovers, advanced management skills, and better corporate governance structures (Hermes and Lensink, 2004, Gopalan et al., 2010), which improves the local financial system, thereby contributing to the more stable financial system (Ozili, 2018). So the banking stability is expected to positively associate with foreign bank participation.

Banking Openness degree (OPEN)

For a given country, cross-border banking flows can take place in two directions. First, the banks of one country may invest their assets abroad. Second, banks from foreign countries may invest in assets of this country. The first type of cross-border banking is 'outward', and the second one is 'inward' (Pérez et al., 2005, Schoenmaker and Wagner, 2013).

The outward integration of a country is measured by the ratio of total outward assets to the total banking assets of this country. Therefore, an index of outward integration of country i was calculated, as follows:

$$OUT_i = \frac{\sum_{k,k \neq \{i\}} f_{i,k}}{a_i}$$

where $\mathrm{Out_i}$ is the outward integration index of country i, a_i is the total (local plus foreign) banking assets of country i, and $f_{i,k}$ is the total assets banks from country i have in country k. The index of inward integration is similar, which is measured by the total inward assets over the total banking assets. So the index of inward integration of country i is

$$IN_i = \frac{\sum_{k,k \neq \{i\}} f_{k,i}}{a_i}$$

Based on the Trade Openness index, the second indicator of banking integration was built: *Banking Openness degree*. It is measured by the sum of inward and outward integration, so it is the total amount of inflow (bank assets of a given country that are owned by foreign banks) and outflow (the assets held abroad by banks of a given country), divided by the total banking assets of the given country. The second indicator gives the degree of openness to banking integration of a particular country.

$$OPEN_i = OUT_i + IN_i$$

where:

- $OPEN_i$ is the banking openness degree of country i.
- OUT_i is an index of the outward integration of country i, and IN_i is an index of the inward integration of country i.

Overall balanced degree (OVER)

The third measure $OVER$ focuses on balance as well as diversification aspects of banking integration. Schoenmaker and Wagner (2013) proposes various ways of measuring banking integration. The integration balance of country i was defined as follows:

$$BAL_i = 1 - \frac{|OUT_i - IN_i|}{OUT_i + IN_i}$$

Moreover, the integration will be more effective if it maximizes the benefits of diversification. An index of the effectiveness of diversification in outward integration can thus be constructed by looking at the shares of the country's outward investment portfolio in the other countries for diversification. An index of the diversification of the outward investment of country i is thus given by the Herfindahl Index (Woerheide and Persson, 1992):

$$DIV_i^{out} = 1 - HI_i = 1 - \sum_{j,j \neq \{i\}} W_{i,j}^2 = 1 - \sum_{j,j \neq \{i\}} \left(\frac{f_{i,j}}{\sum_{k,k \neq \{i\}} f_{i,k}} \right)^2$$

where DIV_i^{out} is the index of diversification in the outward investment of country i, and $W_{i,j}$ is the proportion of the portfolio of the outward investment of country i that is placed in other countries. I use the Herfindahl Index instead of the method presented by Schoenmaker and Wagner (2013), because I consider not only the banking integration in one region but also the banking integration of ASEAN-6 with the rest of the world. For the reason that Schoenmaker and Wagner (2013) method is more suitable for intraregional banking integration, the Herfindahl Index is used to better reflect both in the ASEAN-6 and the rest of the world. A similar index can also be constructed for inward investment:

$$DIV_i^{in} = 1 - HI_i = 1 - \sum_{j,j \neq \{i\}} W_{j,i}^2 = 1 - \sum_{j,j \neq \{i\}} \left(\frac{f_{j,i}}{\sum_{k,k \neq \{i\}} f_{k,i}} \right)^2$$

where: DIV_i^{in} is the index of diversification of the inward investment of country i, and $W_{j,i}$ is the proportion of the portfolio of the inward investment of country i that is held by other countries.

Finally, the overall balanced index of integration of country i is the average of the balance and diversification aspects.

$$OVER_i = \frac{1}{3} \left(BAL_i + DIV_i^{out} + DIV_i^{in} \right)$$

This third indicator $OVER_i$ will be one if banking integration of country i is perfect and zero if integration is very poor. There are four levels: well-balanced integration from 0.75 to 1; weakly balanced integration from 0.50 to 0.74; unbalanced integration from 0.25 to 0.49; and very unbalanced integration from 0 to 0.24.

3.3. Method

To test the impact of banking integration on the banking stability, I employ the following baseline model:

$$y_{it} = \alpha + \beta y_{i,t-1} + \gamma BI(p)_{it} + \delta M_{it} + \theta X_{it} + \varepsilon_{it} \tag{1}$$

where:

- The dependent variable y_{it} reflects the banking stability of country i at the time t through three proxies: the bank insolvency risk, credit risk or liquidity risk.
- BI is the degree of banking integration of country i at time t; BI is measured via three indicators p: BI(1) the Banking Openness degree, BI(2) the Overall Balanced degree, and BI (3) the Foreign Participation ratio.
- $\mathrm{M_{it}}$ reflects the local macroeconomic and global condition variables.
- $\mathrm{X_{it}}$ reflects the banking system condition variables.
- and $\varepsilon_{\mathrm{it}}$ is a vector of error terms.

Discussion of the control variables

The first control group includes ***macroeconomic factors***. GDP growth (GDPG), exchange rates (FX), inflation (INF), Crisis time (CRISIS), Global Economic Policy Uncertainty (GEPU), and TED spread (TED) are used to control for the macroeconomic variables affecting the banking sector stability. During economic expansions, the banks will have more chances to develop their business with increasing lending, expanding the transaction services, and lowering loan defaults. So the GDP growth is expected to correlate with banking stability positively. Inflation (INF) is used to control for macroeconomic factors influencing banking sector stability (Jokipii and Monnin, 2013). During inflationary periods, banks are able to charge higher prices for banking (and financial services) offered to customers. Banks can benefit from higher price margins during inflationary periods to increase their profitability, which contributes to greater banking stability (Jokipii and Monnin, 2013); therefore, I expect a positive relationship between banking sector stability and inflation. TED, GEPU, and CRISIS are related to financial conditions. When the global financial conditions change, many studies concluded that banking stability would be affected due to global banking connections. The more TED spreads and GEPU increases, the higher risk aversion in international financial markets (Cerutti, 2015). Moreover, it could be more difficult for the borrowers to repay the principal and/or the interest on the loan facility in the crisis. Therefore, a negative relationship is expected between global financial conditions and banking stability.

The second group of variables is ***banking system conditions***: banking regulation policy (REG), financial freedom (FFI), size (SIZE), concentration (CON), profitability (ROE), and efficiency (COST). The institutional and country-governance quality is control by employing the regulatory quality (REG) indexes from WGI World Bank. The better law is, the more stable the banking system is. Caporale et al. (2018) investigates the supervisory styles of European bank regulators and their impact on banking stability. They examine banks from 15 European Union (EU) countries and find that supervisory culture significantly affects the stability of banks in Europe. Financial freedom should correlate with higher banking sector stability; therefore, I expect a positive relationship between banking sector stability and FFI. SIZE variable reflects the size of the banking sector. The bigger the banking sector, the higher the depth and/or breadth of financial intermediation in the financial system of a country. Provided that a robust systemic risk regulatory framework is in place, a large banking sector should be relatively more stable compared to a small banking sector; hence, a positive relationship between banking stability and banking sector size is expected (Ozili, 2018). CON, ROE, and COST reflect the structure, profits, and efficiency of a banking system. The effect of banking concentration on banking stability is not clear, as indicated by opposing arguments already discussed in the literature review (Mishkin, 1999, Allen and Gale, 2004, Boyd and De Nicolo, 2005), while the more efficient and profitable banking system would be more stable. Berger and DeYoung (1997) argue that efficient banks are better at managing their credit risks because they can improve their stability by mitigating high non-performing loans. Profitable banks have a higher net interest margin and are more stable than less profitable banks (Dwumfour, 2017); therefore, a positive relationship between net interest margin and banking sector stability is expected.

Moreover, to analyze the contagion risk through banking integration, the spatial interaction term $\omega_{ijt}h_{jt}$ was added. According to the research of Cohen-Cole et al. (2010), Liedorp et al. (2010), Tonzer (2015), the spatial modeling approach is suitable for analyzing the spillovers, especially in international banking. However, this research not only concerns whether banking (in)stability like the previous researches, but also tests whether the economic uncertainty news is transmitted from one country to another country via inter-bank connections. The extended model is

$$y_{it} = \alpha + \beta y_{i,t-1} + \gamma BI(p)_{it} + \delta M_{it} + \theta X_{it} + \eta \sum_{j,j \neq \{i\}}^{n} \omega_{ijt} h_{jt} + \varepsilon_{it} \tag{2}$$

$$\omega_{ijt} = \frac{f_{i,j}}{\sum_{k,k \neq \{i\}} f_{i,k}}$$

Where:

- $f_{i,j}$ is the banking capital exposures correspond to the country pair i and counter-party country j. It can be total capital flows, or only inflow (interbank assets) or outflow (interbank liabilities) between the country i and counter-party country j.

- h_{jt} can be the banking instability or the uncertainty information in the counter-party country j at the time t.

3.4. Data

The data used in this research are drawn from several sources. The ASEAN is well covered with 6/10 countries: Vietnam, Thailand, Indonesia, Malaysia, Philippines, and Singapore (these countries account for more than 95% of the GDP of the ASEAN).

Financial data of commercial banks in ASEAN-6 were taken from BankScope and Orbis Bank Focus. Bank Focus includes all the data from 2011 to 2018. BankScope is the old version of Bank Focus that has the data from 1996-2010. There are 20992 observations about commercial banks in the BankScope and Orbis Bank Focus. On ORBIS, there are some banks that publish two sets of accounts: one based on the 'annual reports (IFRS preferred)' and another based on the 'local registry filings'. Furthermore, for each of these sets of accounts, they have consolidated accounts, unconsolidated accounts, or both accounts. In this research, the IFRS reports with consolidated accounts were prioritized in the case this bank has different reports. Then, I exclude banks with the missing data to compute the banking competition. Finally, my dataset contains 3217 observations cover six countries from 1996 to 2018; see Table Appendix 7 for more details. It is an unbalanced panel data; however, it remained the most sufficient and latest dataset among the research about the ASEAN banking system in the literature review.

Cross-border banking flows (Banking claims and liability) are taken from the locational banking statistics of the Bank for International Settlements (BIS). The banking integration is calculated by the methods developed by Ha et al. (2019). The macroeconomic conditions data were taken from World Development Indicators dataset of World Bank dataset, and Datastream of Thomson Reuters.

A summary of all variables is presented in Table 1, the descriptive statistics in Table 2 and the correlation matrix in Appendix 8.

4. Results and Discussion

4.1. Banking Integration and Stability in ASEAN-6

This section presents a preliminary picture of the banking integration and banking stability in the ASEAN-6.

Figure 1 represents the evolution of the ZSCORE of the ASEAN-6 banking system from 1996-2018. This shows the stability degree of all ASEAN-6 has fluctuated in the research time; and dropped dramatically in the two financial crises: the 1997 Asian financial crisis and the global financial crisis of 2007-2008. But on the whole, it has been enhancing over time. In 2018, Singapore remained the safest banking system in the region with the highest ZSCORE (4.2852), while Vietnam has the lowest ZSCORE (3.0557). However, this shows the large increase in ZSCORE after the 1997 Asian financial crisis when ZSCORE in all ASEAN-6 countries was lower than 1.5.

This is further evidenced by the non-performing loan ratio (figure 2). NONLOAN in all countries decreased sharply during the period 1996-2018. Banking in ASEAN-6 increasingly controls their credit quality well and makes the financial system safe and sound. The average NONLOAN of ASEAN-6 in 2018 is only 2.44%, extremely low compared with NONLOAN after the financial Asian crisis: 21.56%.

The evolution of banking integration in ASEAN-6 is demonstrated in figure 3. Although there has been a sharp rise in cross-border banking activities, the banking openness degree OPEN registered a gradual decrease from 0.5 to 0.28 between 1996 to 2018. Moreover, the overall balanced degree reached a peak at 0.825 in 2017, before hitting a free fall to 0.74 in 2013. However, OVER of ASEAN-6 still reached a good balance degree at 0.765 in 2018. Regarding the foreign participants, FOR experienced a spectacular rise in the research period, climbing to a new peak of 34.8% in 2013. The main reason for this upward trend was related

Table 1: Description of the variables (banking stability)

Variable/Code	Description	Source	Expected sign
Banking Stability:			
Insolvency risk (ZSCORE)	ZSCORE is an indication for the probability of bank failures	Computed by the author using the Orbis Bank Focus dataset	
Credit Risk (NONLOAN)	The non-performing loans to total loans ratio	Computed by the author using Orbis Bank Focus dataset	
Liquidity Risk 1 (DESPO)	Ratio of Core Deposit to Total Assets	Computed by the author using Orbis Bank Focus dataset	
Liquidity Risk 2 (LIQUID)	Ratio of Short-Term Liabilities to Liquid Assets	Computed by the author using Orbis Bank Focus dataset	
Banking Integration:			
Banking Openness Degree (OPEN)	This index gives an indication of the degree of openness to banking integration of a particular country	Computed by the authors using the data from BIS, Central Banks	+/-
Overall Balanced Integration degree (OVER)	This index gives an indication of the degree of balance and diversification to banking integration of a particular country	Computed by the authors using the data from BIS, Central Banks	+/-
Foreign Banks among Total Banks (FOR)	The ratio between the number of foreign banks and the number of total banks	World Bank, Financial Development Indicator	+/-
Control variables:			
Gross Domestic Product (GDPG)	The growth rate of Gross domestic product	World Bank, World Development Indicator	+
Financial freedom (FFI)	Financial freedom is a measure of banking efficiency as well as a measure of independence from government control and interference in the financial sector	Heritage Foundation	+
Banking Crisis Dummy (CRISIS)	A banking crisis is defined as dummy variable (1=banking crisis, 0=none)	World Bank, Financial Development Indicator	-
The TED Spread (TED)	The difference between the three-month LIBOR and the three-month T-bill interest rate	Datastream (Thomson Reuters)	-
The inflation rate (INF)	the annualized percentage change in the consumer price index	World Bank, World Development Indicators	-
Foreign Exchange rate (FX)	Natural logarithm of official exchange rate (local currency units relative to the U.S. dollar	IFS (IMF)	+/-
The Global EPU (GEPU)	The global Economic Policy Uncertainty index (Baker et al., 2016)	Economic Policy Uncertainty site	-
The Volatility Index (VIX)	The real-time market index that represents the market's expectation of 30-day forward-looking volatility	Datastream (Thomson Reuters)	-
The bank size (SIZE)	Natural logarithm of total assets in million US$	Central Bank reports, BankScope	+
Bank Profits (ROE)	Average Return on Equity (Net Income/Total Equity) (%)	Computed by the author using Orbis Bank Focus dataset	+
Regulatory Quality (REG)	Estimate of general regulatory quality	World Bank, The Worldwide Governance Indicators	+
Banking Concentration (CON)	Assets of five largest banks as a share of assets of all commercial banks	Computed by the authors using the Orbis Bank Focus dataset	+/-
Efficiency (COST)	Measuring as Bank cost to income ratio of a bank system	Computed by the authors using the Orbis Bank Focus dataset	+

Table 2: Descriptive statistics for banking stability

Statistic	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
ZSCORE	1.99	1.02	−0.63	1.24	2.83	4.29
NONLOAN	6.69	7.52	0.36	1.99	9.33	53.66
DESPO	0.73	0.17	0.07	0.72	0.83	0.93
LIQUID	0.74	0.17	0.07	0.73	0.83	0.95
FOR	27.98	15.83	0.00	15.00	40.50	58.00
OPEN	0.37	0.23	0.14	0.20	0.45	1.27
OVER	0.77	0.08	0.49	0.72	0.82	0.91
REG	0.31	0.86	−0.80	−0.33	0.58	2.26
GDPG	4.89	3.27	−13.13	4.16	6.57	14.53
FFI	63.97	12.71	39	55.8	67.2	89
CRISIS	0.13	0.34	0	0	0	1
GEPU	111.50	35.66	62.92	77.41	125.35	185.32
TED	0.53	0.57	0.10	0.21	0.49	2.61
VIX	22.36	10.18	9.45	13.57	28.27	45.45
FX	4.66	3.61	0.20	1.34	9.15	10.04
INF	4.84	9.21	−0.87	1.68	5.76	78.40
SIZE	12.29	1.22	8.42	11.73	13.19	14.48
COST	0.55	0.28	0.25	0.43	0.58	2.89
CON	0.01	0.05	0.0000	0.001	0.01	0.36

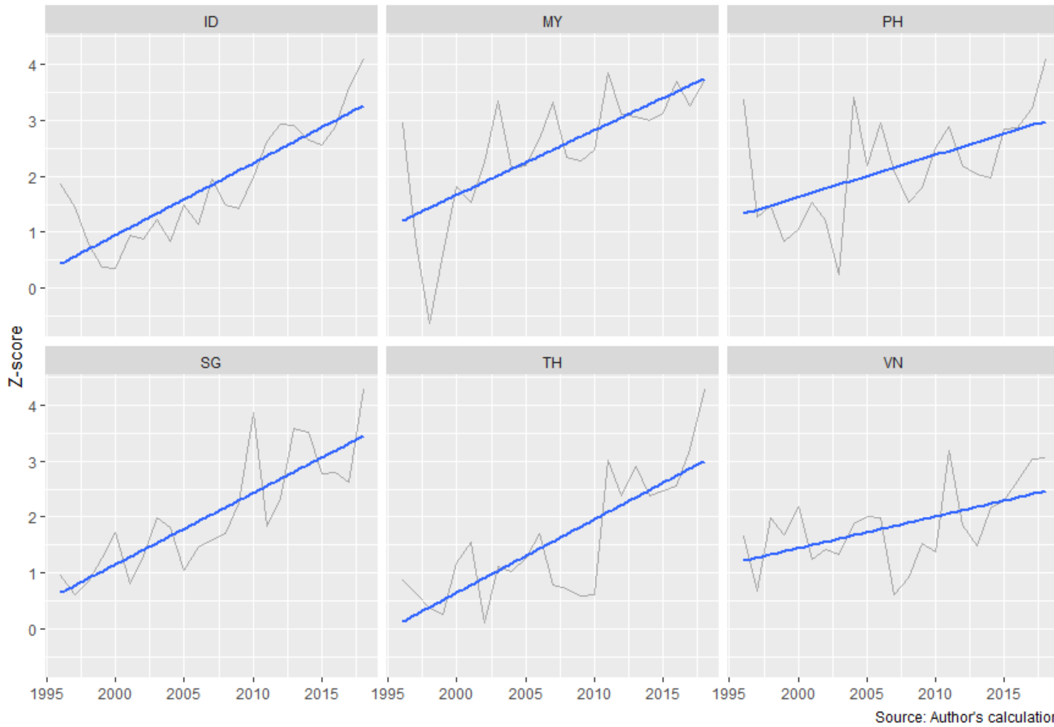
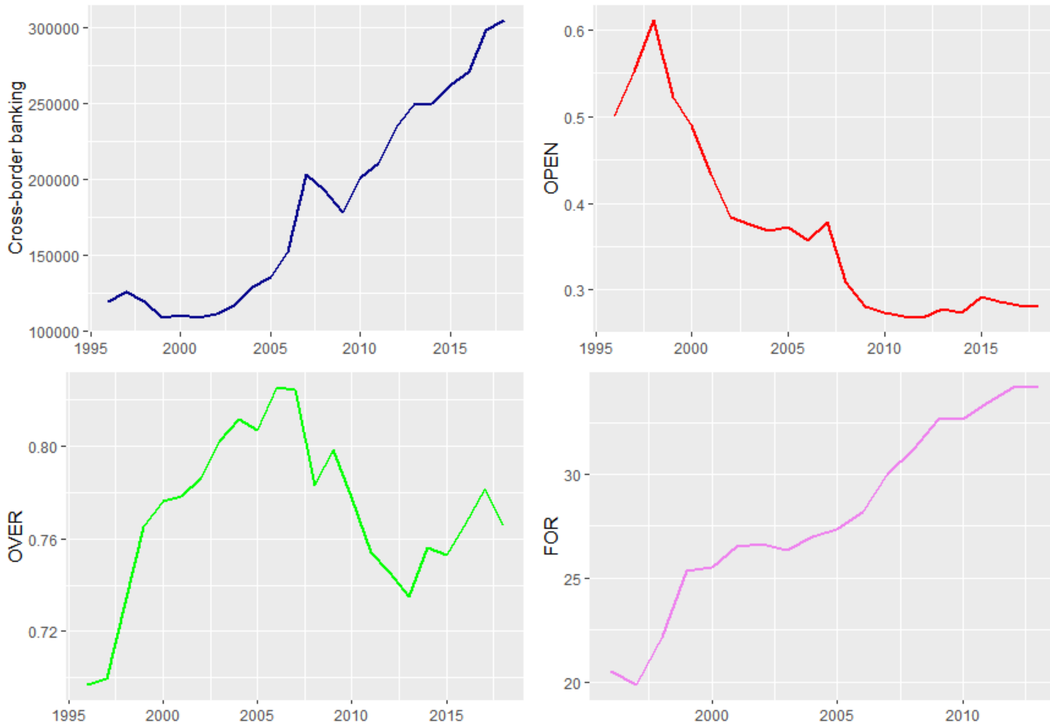


Figure 1: The evolution of ZSCORE in ASEAN-6, 1996-2018

Figure 2: The non-performing loans ratio (NONLOAN) of the ASEAN-6, 1996-2018

to the stronger open policies in the ASEAN-6 banking sector. The access for foreign bank penetration into the local market has been widened in recent years.



Note: Cross-border banking: total foreign claims (adjusted by GDP deflator) of ASEAN-6, OPEN: Average of ASEAN-6's Banking Openness degrees, OVER: Average of ASEAN-6's Overall balanced degrees, FOR: Average of ASEAN-6's foreign bank penetration ratios.

Source: BIS, Locational Banking Statistics, World Bank and Author's calculations.

Figure 3: The evolution of banking integration in ASEAN-6, 1996-2018

The main research question of this study is the effect of banking integration on the stability of a banking system. Figure 4 reveals that the negative relationship between OPEN and ZSCORE. However, in Figure 3, there are observed differences among three banking integration indicators (OPEN, OVER, and FOR), so that it could be a suggestion for the heterogeneous in the effect of the capital - the physical form of banking integration on the banking stability. This research will investigate this effect in the next section.

Figure 5 presents information on ASEAN banking's network structure. Following the predictions of network models, both the existence of bilateral linkages and the network structure matter for causing contagion. The ASEAN-6 banking system was widely diversified, with 30 counter-parties in all continents around the world. The mean of outward and inward diversifi-

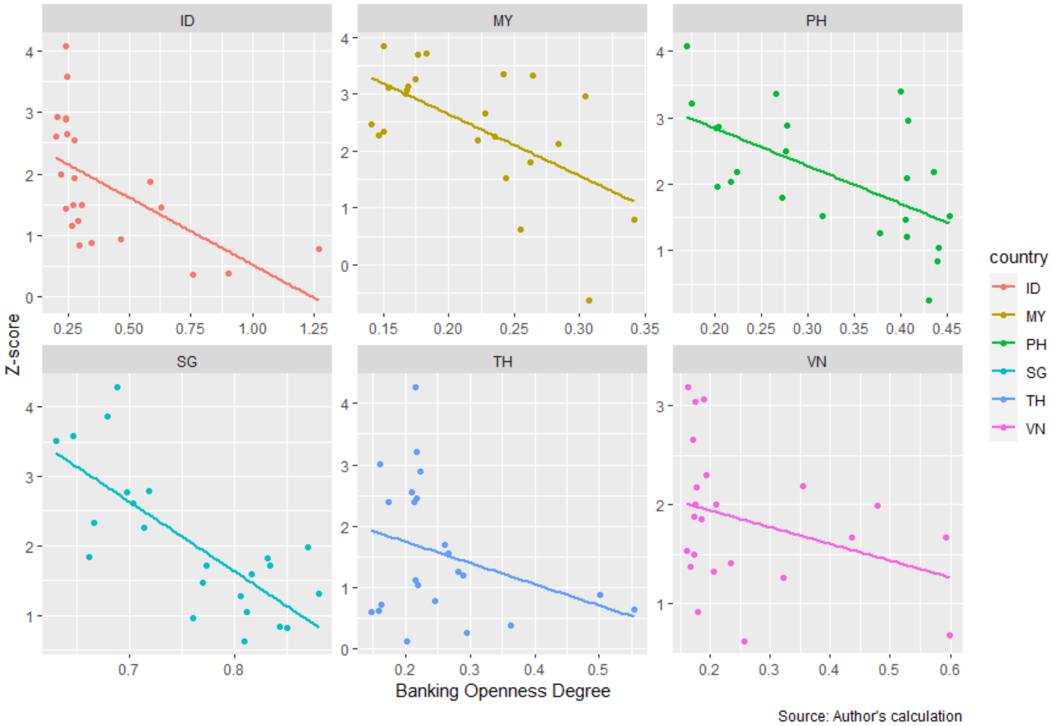


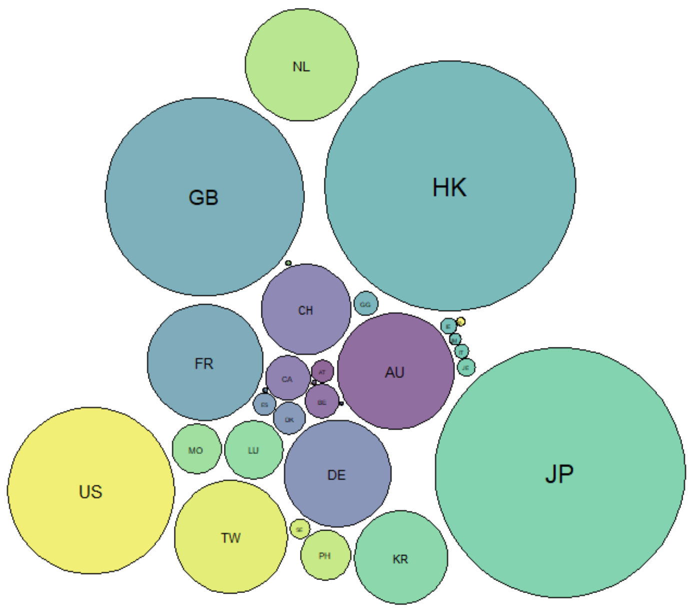
Figure 4: The relationship between the Banking Openness and Z-score in ASEAN-6, 1996-2018

cation was approximately 0.80. It can be seen in Figure 5 that the banking system in ASEAN-6 had a massive exposure to Hong Kong, Japan, the United Kingdom, the European Union, and the United States. At the same time, ASEAN-6 banks had very little banking interaction with South America and Africa.

4.2. Estimation Results

To test the impact of banking integration on banking stability, the equation (1) in subsection 3.3 is used. However, to avoid the case that some control variables used in a multiple regression model are not associated with the dependent variable. Including such irrelevant variables leads to unnecessary complexity in the resulting model. By removing these variables and setting the corresponding coefficient estimates to zero, I can obtain a more easily interpreted model. Now least squares are extremely unlikely to yield any coefficient estimates that are precisely zero. So in the first step, I employ the best subsection method for performing feature selection or variable selection, excluding irrelevant variables from a multiple regression model.

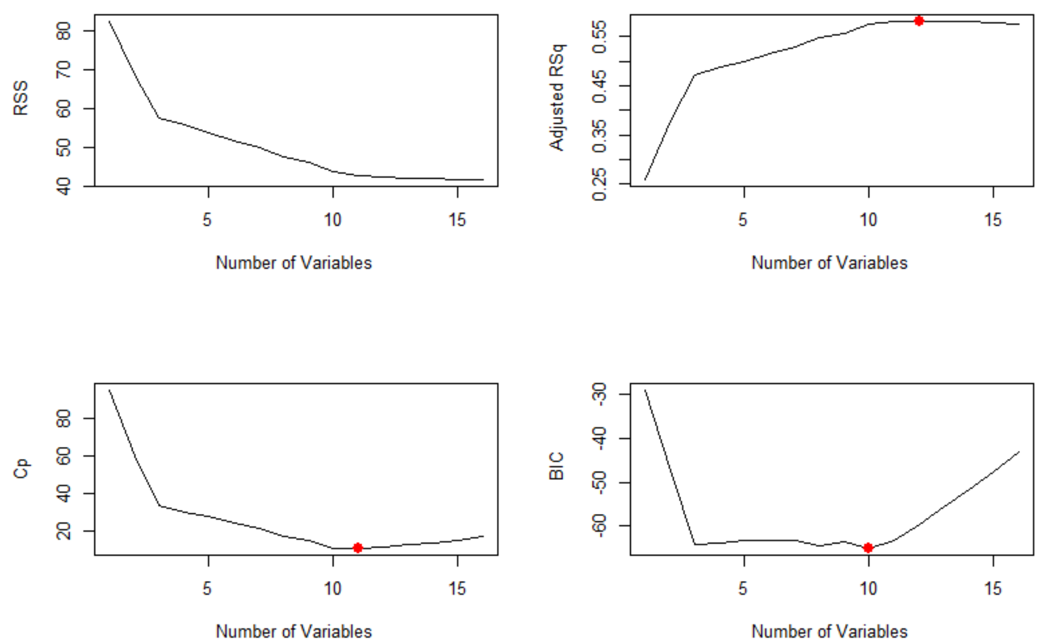
Best subset selection results in creating a set of models, each of which contains a subset of



Note: The graph shows the network of 30 counter parties which have cross-border banking activites with ASEAN banking systems in the year 2018 (the counter-parties' list at Appendix 9). Source: BIS, Locational Banking Statistics

Figure 5: The network exposures of ASEAN-6 Banking System

the p dependent variables. In order to implement these methods, I need a way to determine which of these models is best. The model containing all of the predictors will always have the smallest RSS and the largest R2 since these quantities are related to the training error. Therefore, RSS and R2 are not suitable for selecting the best model among a collection of models with different numbers of predictors. In order to choose the best model concerning test error, I consider three approaches: Cp, Bayesian information, criterion (BIC), and adjusted R2. According to the result in figure 6, the ten-variable model could be the best choice compared to the sixteen independent variables (the lag of ZSCORE, the interaction between OPEN and REG, and fourteen variables in table 1). The empirical result is shown in table 3.



Note: Cp, BIC, and adjusted R2 are shown for the best models of each size for the subset. For each possible model containing a subset of the sixteen independent variables in the data set, Cp, BIC, and adjusted R2 are displays. The frontier lines track the best model for a given number of predictors, according to RSS and R2. Though the data set contains only fourteen predictors, the x-axis ranges from 1 to 16 since there are the lag of ZSCORE and the interaction between OPEN and REG.

Figure 6: Best Subset Selection

Banking integration and stability

This research estimate the impact of banking integration on the banking stability ($ZSCORE$)

by using fixed effects estimators with three different independent variables: Banking Openness ($OPEN$), Overall Balanced Degree ($OVERALL$) and Foreign Banks ratio (FOR). Table 3 present the regression results for my baseline specifications. In addition, random effects estimators were employed. The Hausman specification test indicated that there was a systematic difference between the fixed and random effects models and therefore confirmed that the fixed effects estimator was efficient in my empirical framework.

In the table 3, the columns (1), (2), (4), and (6) are used to pre-exam the results of the models, which are run for the different groups of explanatory variables with fixed effects. Column (3), (5), and (7) are the completed models that are run for all explanatory variables with fixed effects. In what follows, I focus on the analysis of results obtained from Fixed Effect estimations from these columns.

Column 3 and 5 in the table 3 show the results of the effect of capital integration: the first (OPEN) and second proxies (OVER) of banking integration. Regarding the Banking Openness degree (column 3), I find that the degree of openness is negatively associated with ZSCORE. The banking system with a higher openness degree of the inter-bank capital flows faces the risk of lowering banking stability. However, an overall balanced degree of banking integration OVER is found positively associated with ZCORE. The result for the OVER reveals that countries whose banking systems have unbalanced in-out capital flows as well as concentrated linkages toward few counter-parties increase financial risk. In contrast, being more diversified across interlinked banking systems and distributing cross-border exposures equally between inward and outward has a positive effect on stability.

While looking at the physical integration - the third proxy or banking integration (column 7 – Table 3), FOR shows the positive association with ZCORE. The increase in foreign participation leads the local banking system more stable. The foreign banks could improve the local financial system via knowledge spillovers (Hermes and Lensink, 2004, Gopalan et al., 2010), so their penetration thereby contributing to the more stable financial system (Ozili, 2018).

Regarding the control variables, all the significant variables have the expected signs. CRISIS, TED, and CON have negative impacts on ZSCORE. Conversely, FFI, and REG have significant and positive effects on ZSCORE with the magnitude of 0.035 and 2.0441, respectively. GDPG, and COST don't have any insignificant effects on ZSCORE.

Contagion risk and network spillovers

Table 3: The impact of banking integration on the the probability of banking failures

	Dependent variable:						
	log(ZSCORE)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lag(log(ZSCORE), 1)	0.4891***	0.3912***	0.2922***	0.5891***	0.3894***	0.2996***	0.2207***
	(0.0684)	(0.0731)	(0.0760)	(0.0732)	(0.0791)	(0.0756)	(0.0801)
OPEN	-2.4944***	-1.4751**	-1.9088***				
	(0.4795)	(0.5744)	(0.5673)				
OVER				2.7241**	2.3090*		
				(1.2377)	(1.1842)		
FOR						0.0554***	0.0423***
						(0.0119)	(0.0126)
REG			2.0441***		0.5812		-0.2384
			(0.5988)		(0.5001)		(0.5471)
GDPG		-0.0164	-0.0039		-0.0117		-0.0038
		(0.0213)	(0.0205)		(0.0218)		(0.0211)
FFI		0.0374*	0.0350*		0.0461**		-0.0161
		(0.0202)	(0.0202)		(0.0219)		(0.0255)
CRISIS		-0.7451***	-0.9201***		-1.1783***		-0.7310***
		(0.2613)	(0.2755)		(0.2458)		(0.2658)
TED		-0.2399**	-0.2235**		-0.2777**		-0.2173*
		(0.1141)	(0.1083)		(0.1161)		(0.1108)
COST			0.0730		0.2143		0.3008
			(0.2681)		(0.2869)		(0.2737)
CON			-2.7323*		0.2151		0.8856
			(1.6019)		(1.5682)		(1.4901)
OPEN:REG			-3.7025***				
			(0.8594)				
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	134	134	134	134	134	104	104
R^2	0.4314	0.4945	0.5672	0.3371	0.4953	0.3008	0.4156
Adjusted R^2	0.4006	0.4500	0.5135	0.3011	0.4373	0.2513	0.3267
F Statistic	48.9462***	20.3777***	15.8564***	32.7990***	13.3011***	21.2939***	7.2697***

Note: *p<0.1; **p<0.05; ***p<0.01

The dependent variable is ln(ZSCORE). The columns 1-3 and 4-5 estimates with the proxies of the capital banking integration: banking openness (OPEN) and overall balanced degree (OVER), respectively. While the 6-7 employ foreign bank participation (FOR) as the proxy for physical banking integration. Regarding the control variables, Local macroeconomic factors: GDPG, CRISIS, TED represent the economic growth, crisis time, and the TED Spread. Banking system characteristics: FFI, REG, CON, COST represent financial freedom, regulatory quality, concentration, and efficiency of the local banking system. All the columns estimates with fixed effects. In parentheses is the standard error.

Furthermore, the network term is added to analyze the contagion risk via the network spillover (See the equation (2) in subsection 3.3). In table 4, the column (1), (2), and (3) related to the banking (in)stability spillovers through the inter-bank connections. While the column (4), (5), and (6) consider whether the economic policy uncertainty news is transmitted and affected the local banking stability via banking integration or not. Regarding the result in table 4, the instability of the foreign banking system can spread out and affect others via the capital in-out flows. The network term with the nodes calculated using all capital flows (column 1) is positively significant on the ZSCORE. This implies that the more connected to the stable counter-parties, the more stable in the home banking system. In particular, the borrowing spatial terms (column 2) also show the positive sign; it means the banking systems linked to more stable foreign counter-parties through borrowing positions benefit positive spillover effects. However, the result can also be interpreted as vice versa: linkages to less stable banking systems can worsen financial stability at home. This suggests that it matters to whom connections are maintained. In this way, the result supports the hypothesis relating to: risk-sharing possibilities arise if linkages are maintained with stable counter-parties. Linkages favor contagion risk to less stable counter-parties. The lending spatial terms (column 3) is not significant, this indicates that the contagion risk is not transferred via the lending channel.

Regarding the network uncertainty information terms, the result in the column (4), (5), and (6) show these spatial interaction effects are not significant. It means that the economic policy uncertainty information from a particular economy or region doesn't affect the ASEAN-6 banking stability via banking integration. The lags of these network terms are tested, but the same results are gotten. This indicates that information contagion risks are not transmitted through cross-border banking in ASEAN.

Banking integration and Credit risk - Liquidity Risk

This section analyses the effect of banking integration on the other aspects of banking stability in ASEAN-6. In the table 5, the column (1), (2) and (3) related to the credit risk, and the column (4) and (5) related to the liquidity risk. OPEN is a significantly positive relationship with the non-performing loans in the banking system, while FOR has the opposite effect. The result on column (2) shows that the OVER has no relationship with the non-performing loan. From the column (4) - (7), OPEN and FOR also has a positive impact on the liquidity in the ASEAN banking system. This result may be explained by the fact that the

Table 4: Contagion risk via the foreign inter-bank exposures/ Network spillovers

	Dependent variable:					
	log(ZSCORE)					
	(1)	(2)	(3)	(4)	(5)	(6)
log(lag(ZSCORE, 1))	0.2606***	0.2562***	0.2605***	0.2924***	0.2920***	0.2898***
	(0.0727)	(0.0716)	(0.0742)	(0.0762)	(0.0762)	(0.0776)
OPEN	-1.3629**	-1.3012**	-1.5502***	-1.8947***	-1.8726***	-1.8908***
	(0.5549)	(0.5484)	(0.5494)	(0.5699)	(0.5765)	(0.5798)
REG	1.8165***	1.8950***	1.8157***	2.1114***	2.1005***	2.0399***
	(0.5762)	(0.5651)	(0.5907)	(0.6183)	(0.6174)	(0.6018)
GDPG	-0.0041	-0.0052	-0.0033	-0.0028	-0.0029	-0.0040
	(0.0191)	(0.0189)	(0.0193)	(0.0207)	(0.0207)	(0.0206)
FFI	0.0102	0.0062	0.0181	0.0338*	0.0348*	0.0353*
	(0.0203)	(0.0203)	(0.0201)	(0.0204)	(0.0203)	(0.0204)
CRISIS	-0.7315***	-0.6878**	-0.8248***	-0.9288***	-0.9333***	-0.9256***
	(0.2743)	(0.2719)	(0.2719)	(0.2770)	(0.2784)	(0.2786)
TED	-0.1969*	-0.1888*	-0.2036**	-0.2241**	-0.2260**	-0.2232**
	(0.1011)	(0.1002)	(0.1022)	(0.1087)	(0.1089)	(0.1088)
COST	0.1471	0.0720	0.1870	0.0744	0.0777	0.0738
	(0.2502)	(0.2477)	(0.2568)	(0.2690)	(0.2693)	(0.2692)
CON	-2.3366	-2.2753	-2.2497	-2.9654*	-2.9209*	-2.6716
	(1.4997)	(1.4837)	(1.5163)	(1.6852)	(1.6759)	(1.6493)
Instability spatial effect (all)	0.5494**					
	(0.2364)					
Instability spatial effect (liabilities)		0.6648***				
		(0.2380)				
Instability spatial effect (claims)			0.3195			
			(0.1964)			
Uncertainty spatial effect (all)				0.0019		
				(0.0041)		
Uncertainty spatial effect (liabilities)					0.0013	
					(0.0034)	
Uncertainty spatial effect (claims)						-0.0009
						(0.0052)
OPEN:REG	-3.0479***	-3.2505***	-3.0035***	-3.8168***	-3.7758***	-3.6740***
	(0.8341)	(0.8071)	(0.8771)	(0.8974)	(0.8819)	(0.8798)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128	128	128	134	134	134
R^2	0.5628	0.5714	0.5525	0.5679	0.5678	0.5673
Adjusted R^2	0.5014	0.5112	0.4896	0.5103	0.5101	0.5096
F Statistic	13.3402***	13.8167***	12.7934***	14.3402***	14.3291***	14.3016***

Note: *p<0.1; **p<0.05; ***p<0.01

The dependent variable is ln(ZSCORE). All the columns estimate with fixed effects. Banking openness (OPEN) is employed as a proxy for banking integration. The spatial interaction terms are included to test the contagion risk via the network spillover. The columns 1-3 related to the banking (in)stability spillovers via all the cross-border banking activities, liabilities and claims, respectively. Columns 4-6 consider the network uncertainty information terms. Regarding the control variables, Local macroeconomic factors: GDPG, CRISIS, TED represent the economic growth, crisis time, and the TED Spread. Banking system characteristics: FFI, REG, CON, COST represent financial freedom, regulatory quality, concentration, and efficiency of the local banking system. In parentheses is the standard error.

more capital inflows and more foreign participants enter, the higher the local banking system's liquidity is.

About the network term, it has different impacts on Credit Risk and Liquidity. While leading to less credit risk, network spillovers let the liquidity of the ASEAN banking system increase. This indicates that being linked to more stable counter-parties benefits less credit risk and more liquidity in the home country. Banking systems that lend to less risky banks abroad and banking systems linked to more stable foreign counter-parties through borrowing positions face positive spillover effects. This indicates that both credit and funding risks are mitigated through cross-border lending to more stable banks.

4.3. Robustness check

Measuring the Quality of Fit

In order to evaluate the performance of the empirical baseline model, I split the data-set into training data and testing data to see how well its predictions actually match the observed data.[2]. The empirical baseline model (1) is regressed with the training set and then applied to the testing set to obtain the predicted values of ZSCORE.

Firstly, the t-test and f-test are used to test the difference between the actual and predicted value in the testing set. The results in the appendix 10 show that there are no actual differences in mean and variance. Secondly, figure 7 indicates that there is a high overlap distribution between actual and predicted value, except in Vietnam, with a small difference. While the graph 8 shows there is the same relationship between their values and OPEN. Finally, a list of metrics about measuring the quality of the empirical baseline model regression model is also demonstrated in the appendix 11.

The Panel-corrected standard errors (PCSE)

Moreover, to consider the deviations from contemporaneous correlation and unit-level heteroskedasticity of panel data, the Panel-corrected standard errors (PCSE) model (Bailey and Katz, 2011) was employed to allow better inferences from linear models estimated. With the results in Table 6, most of the explanatory variables in the three groups (banking integration,

[2]To randomly create balanced splits of the testing and training sets, the function createDataPartition was employed. Source: http://topepo.github.io/caret/data-splitting.html/ Hyndman and Athanasopoulos (2013), Forecasting: principles and practice. https://www.otexts.org/fpp

Table 5: The impact of banking integration on the credit risk and liquidity risk

	Dependent variable:						
	NONLOAN			DESPO		LIQUID	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lag(NONLOAN, 1)	0.2918***	0.4693***	0.4053***				
	(0.0632)	(0.0696)	(0.0783)				
OPEN	26.3589***			0.2422*		0.2526**	
	(3.7562)			(0.1228)		(0.1243)	
OVER		-9.0958					
		(9.1525)					
FOR			-0.2625**		0.0056***		0.0056***
			(0.1106)		(0.0017)		(0.0017)
REG	0.2600	-3.4823	3.0118	0.2058**	0.1471*	0.2047**	0.1444*
	(2.6926)	(3.2208)	(4.3471)	(0.0844)	(0.0793)	(0.0854)	(0.0806)
GDPG	-0.4340***	-0.8100***	-0.8215***	-0.0039	-0.0106*	-0.0040	-0.0108*
	(0.1295)	(0.1415)	(0.1549)	(0.0051)	(0.0055)	(0.0052)	(0.0056)
FFI	0.0256	0.0999	0.2382	-0.0091**	-0.0137**	-0.0089*	-0.0136**
	(0.1373)	(0.1652)	(0.2145)	(0.0046)	(0.0054)	(0.0046)	(0.0054)
CRISIS	-4.7085***	-0.7769	-3.0324	0.0179	0.0984*	0.0181	0.1012*
	(1.6363)	(1.8458)	(2.2438)	(0.0595)	(0.0571)	(0.0602)	(0.0580)
TED	-0.6800	-0.3270	-0.4924	-0.0330	-0.0219	-0.0334	-0.0220
	(0.5753)	(0.6915)	(0.7574)	(0.0257)	(0.0284)	(0.0260)	(0.0289)
COST	2.0916	-0.4293	0.2969	0.0465	0.0695	0.0514	0.0735
	(1.7393)	(2.0465)	(2.2589)	(0.0618)	(0.0675)	(0.0625)	(0.0686)
CON	0.1936	-3.4129	-5.7679	0.1875	0.2676	0.1820	0.2655
	(7.6649)	(9.2314)	(10.0689)	(0.3262)	(0.3544)	(0.3302)	(0.3602)
Instability spatial effect	-3.8356***	-5.8353***	-3.7425*	0.1521***	0.0174	0.1512***	0.0140
	(1.4234)	(1.7107)	(2.1757)	(0.0557)	(0.0795)	(0.0564)	(0.0808)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	120	120	96	132	102	132	102
R^2	0.7136	0.5856	0.5843	0.1242	0.1852	0.1245	0.1823
Adjusted R^2	0.6734	0.5275	0.5091	0.0518	0.1055	0.0522	0.1023
F Statistic	26.6555***	15.1179***	11.6641***	1.7154*	2.3242**	1.7210*	2.2792**

Note: *p<0.1; **p<0.05; ***p<0.01

In the first three columns 1-3, the dependent variable is credit risk (NONLOAN). Columns 4-7 relate to liquidity risk, where the dependent variables are DESPO and LIQUID. Banking openness (OPEN), overall balanced degree (OVER), and the foreign bank participation (FOR) as the proxies for banking integration. Regarding the control variables, Local macroeconomic factors: GDPG, CRISIS, TED represent the economic growth, crisis time, and the TED Spread. Banking system characteristics: FFI, REG, CON, COST represent financial freedom, regulatory quality, concentration, and efficiency of the local banking system. All the columns estimates with fixed effects. In parentheses is the standard error.

the macroeconomic conditions, and banking system characteristics) are still significant, and the empirical results remain robust. In general, results obtained from further analysis and robust tests support my main findings.

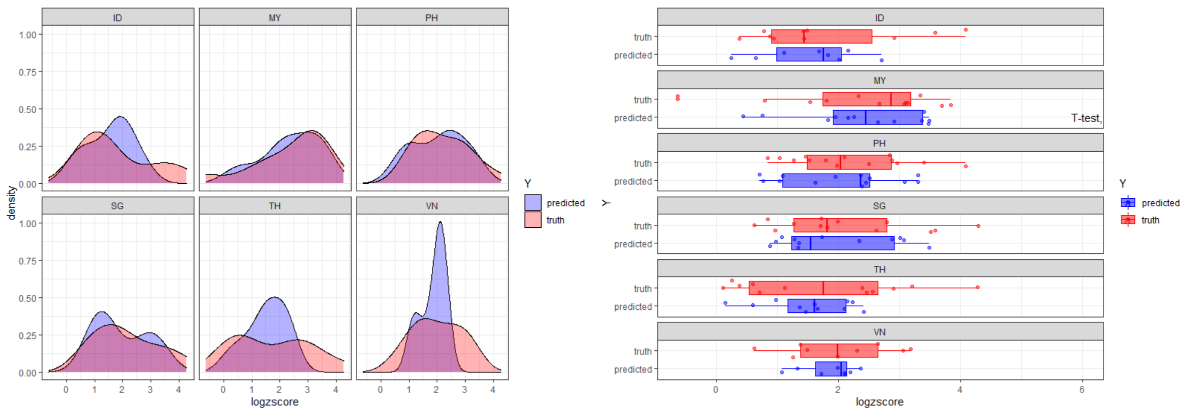


Figure 7: Distribution of The Actual Value and Predicted Value

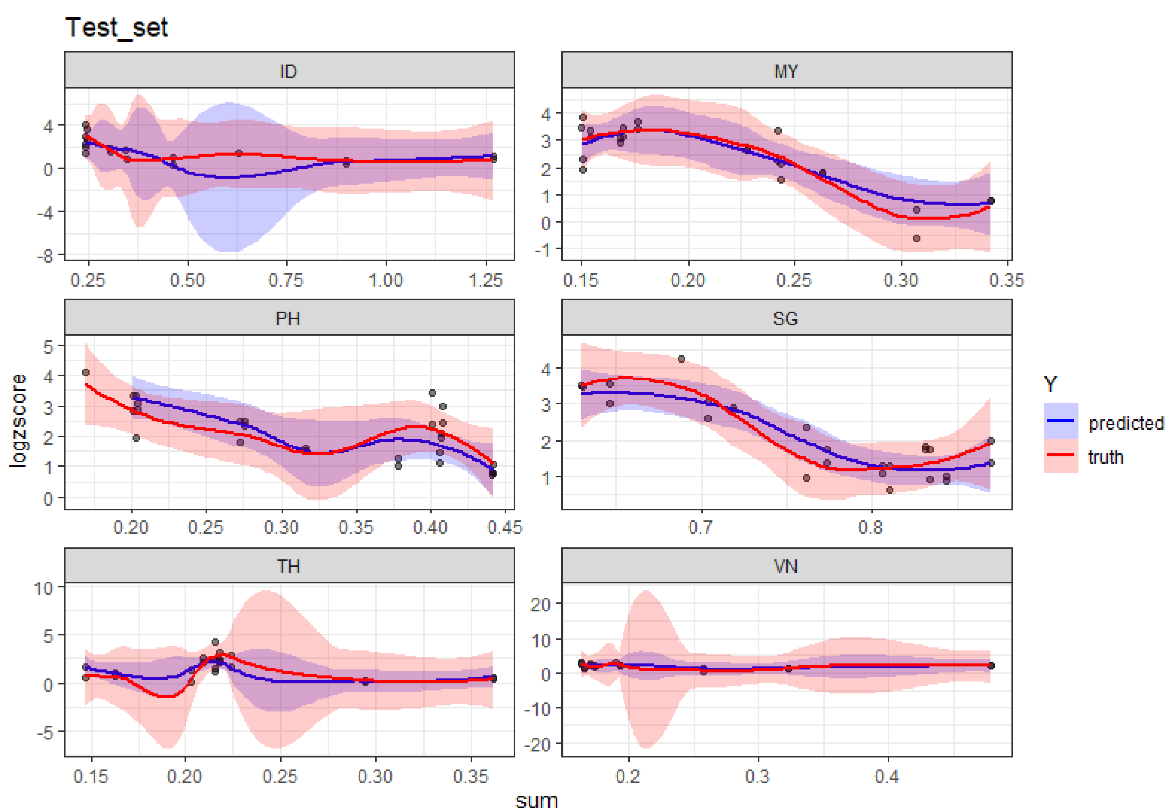


Figure 8: The relationship of The Actual Value - Predicted Value and OPEN

Table 6: Regression with Panel-Corrected Standard Errors Model

	Dependent variable: log(ZSCORE)			
	Estimate	PCSE	t value	$\Pr(>\|t\|)$
lag(log(ZSCORE),1)	0.2035	0.0772	2.6378	9.51E-03
OPEN	-1.1665	0.4645	-2.5112	1.34E-02
REG	1.9377	0.4656	4.1620	6.15E-05
GDPG	-0.0063	0.0186	-0.3359	7.38E-01
FFI	-0.0060	0.0187	-0.3195	7.50E-01
CRISIS	-0.8684	0.2576	-3.3705	1.02E-03
TED	-0.2784	0.1121	-2.4822	1.45E-02
COST	0.2555	0.2451	1.0425	2.99E-01
CON	-1.6190	1.1214	-1.4438	1.52E-01
Spatial Effect	-0.6805	0.2718	-2.5040	1.37E-02
OPEN:REG	-3.0860	0.6621	-4.6606	8.61E-06
Valid Obs = 126; Missing Obs = 0; Degrees of Freedom = 114				

5. Conclusion

This chapter analyses the impacts of three aspects of banking integration on the banking stability in the ASEAN-6 in the period 1996-2018. Moreover, the contagion risk of banking instability and economic uncertainty information through cross-border linkages among banking systems was also investigated.

The results suggest that the effect of integration in international interbank markets on stability is heterogeneous. Firstly, regarding capital banking integration, while the banking openness degree hurts banking stability, the overall balanced degree has a positive impact. This means the more inter-linkages in the banking networks, the less banking stability. However, a more balanced and more diversified country between the inflow and outflow banking capitals can benefit a more stable banking system. Secondly, the foreign banking participant which was used as a proxy for physical banking integration has a positive relationship with the banking integration. The foreign banks with competitive skills and technology helped to improve the local banking performances and reduce the banking default probability.

Moreover, the empirical test also shows the effect of banking integration on credit risk and liquidity risk. The banking openness degree increases the liquidity assets in the local banking system, encouraging these banks to take more new risks. So, the non-performing loans would be increased as a result, and the banking systems would be less stable. However, the overall balanced degree and the foreign participants have the opposite effects on the credit risk and liquidity risk, which help the local banking system more stable.

Furthermore, when taking the network structure into account, I find evidence that ASEAN countries that face foreign interbank exposures to more stable counterparties tend to experience a shift toward a more stable banking system. This highlights that bilateral linkages with stable banking systems can have a beneficial effect on stability, reducing credit risk, and liquidity risk. On the contrary, the instability of the foreign banking system can transmit to the local system through banking connections. However, I find that economic uncertainty information does not spread and affect banking stability via the cross-border linkages.

The different impacts of three aspects of banking integration, as well as the contagion risk on banking stability, suggest a trade-off between stability and systemic risk. This recommends that policymakers should thus take advantage of the benefits of international risk-sharing with the healthy banking systems; while restraining costs when connecting with the less stable ones. It has to be carefully considered in the context which ASEAN want to boost their financial integration degree. In addition, the empirical results suggest that the regulation quality and financial freedom should be enhanced to contribute to the stability of the banking system.

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Table 7: Data distribution by country and year

Year	ID	MY	PH	SG	TH	VN	Observation by year
1996	77	35	12	4	29	8	165
1997	58	30	15	9	8	6	126
1998	23	16	10	8	2	7	66
1999	31	21	6	12	3	9	82
2000	46	17	4	16	10	9	102
2001	38	16	5	10	19	9	97
2002	42	21	5	6	20	12	106
2003	49	18	7	2	22	13	111
2004	54	19	22	12	23	16	146
2005	59	17	32	17	24	18	167
2006	55	17	33	16	18	22	161
2007	57	15	28	15	18	25	158
2008	52	14	28	12	23	25	154
2009	59	17	30	10	27	31	174
2010	60	16	34	10	28	31	179
2011	35	9	13	4	15	8	84
2012	36	9	14	4	15	9	87
2013	63	20	22	8	20	25	158
2014	68	22	21	8	20	25	164
2015	78	23	20	7	22	23	173
2016	79	22	21	8	21	28	179
2017	81	25	22	8	23	28	187
2018	83	25	22	10	22	29	191
Number of bank observations	1283	444	426	216	432	416	3217

Table 8: Pearson correlation matrix analysis

	ZSCORE	FOR	OPEN	OVER	REG	GDPG	FFI	CRISIS	TED	COST	CON
ZSCORE	1	0.212	-0.227	0.208	0.061	0.184	-0.001	-0.454	-0.182	-0.233	0.107
FOR	0.212	1	0.451	0.122	0.696	0.087	0.682	-0.247	0.006	-0.345	0.179
OPEN	-0.227	0.451	1	0.117	0.590	-0.051	0.607	0.226	0.042	-0.080	0.156
OVER	0.208	0.122	0.117	1	0.315	0.153	0.215	-0.261	0.072	-0.082	0.134
REG	0.061	0.696	0.590	0.315	1	0.033	0.955	-0.105	0.002	-0.225	0.218
GDPG	0.184	0.087	-0.051	0.153	0.033	1	-0.042	-0.314	0.057	-0.230	0.234
FFI	-0.001	0.682	0.607	0.215	0.955	-0.042	1	-0.044	-0.010	-0.163	0.200
CRISIS	-0.454	-0.247	0.226	-0.261	-0.105	-0.314	-0.044	1	0.062	0.456	-0.046
TED	-0.182	0.006	0.042	0.072	0.002	0.057	-0.010	0.062	1	0.090	-0.093
COST	-0.233	-0.345	-0.080	-0.082	-0.225	-0.230	-0.163	0.456	0.090	1	-0.078
CON	0.107	0.179	0.156	0.134	0.218	0.234	0.200	-0.046	-0.093	-0.078	1

Table 9: List counter-parties of ASEAN-6 banking systems

Abbreviation	CounterParty
AT	Austria
AU	Australia
BE	Belgium
BR	Brazil
CA	Canada
CH	Switzerland
CL	Chile
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GB	United Kingdom
GG	Guernsey
HK	Hong Kong SAR
IE	Ireland
IM	Isle of Man
IT	Italy
JE	Jersey
JP	Japan
KR	South Korea
LU	Luxembourg
MO	Macao SAR
MX	Mexico
NL	Netherlands
PH	Philippines
SE	Sweden
TW	Chinese Taipei
US	United States
ZA	South Africa

Table 10: T.Test and F.test for actual and predicted values

	value	df	p-value	95 percent confidence interval	
T test	5.62E-15	63	1	-0.1479	0.1479
F test	0.6894	63	0.1427	0.4188	1.1348

Notes. *Paired t-test: alternative hypothesis: true difference in means is not equal to 0. Sample estimates: mean of the differences 4.1633e-16*

F test to compare two variances: alternative hypothesis: true ratio of variances is not equal to 1. Sample estimates:ratio of variances 0.6894

Table 11: Metrics/ Criteria measuring the quality of a regression model

Score	Value	Score	Value	Score	Value
MAE	0.4630	RAE	0.5106	SSE	22.0909
MAPE	0.4891	RMSE	0.5875	PearsonR	0.8303
MEDAE	0.3555	RRSE	0.5573	KendallTau	0.6567
MEDSE	0.1264	RSQ	0.6894	SpearmanRho	0.8415
MSE	0.3452	SAE	29.6326		

Notes: MAE: Mean Absolute Error, MAPE: Mean Absolute Percentage Error, MEDAE: Median of Absolute Errors, MEDSE: Median of Squared Errors, MSE: Mean Squared Error, RAE: Relative Absolute Error, RMSE: Root Mean Squared Error, RSQ: R-Squared, SAE: Sum of Absolute Errors, SSE: the Sum of Squared Estimate of Errors, PearsonR: Pearson, KendallTau: Kendall's Tau, SpearmanRho: Spearman's Rho.