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Volume 25

BANKING AND FINANCE ISSUES IN EMERGING MARKETS

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Dedicated to the memory of the brilliant financial macroeconomist, Shu Wu, 1966–2018.

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Introduction

William A. Barnett[a] and Bruno S. Sergi[b]

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Over the past decade, an astounding rate of growth in scientific excitement and empirical research have spanned several fields and subfields of banking and finance, which are now becoming a dominant force in Asia's economic development. A new line of inquiry along the continuous development of innovative technology steered extensive economic literature. Observers reckon that profound changes are afoot, and we need to keep up with such vast Asia's unique fast-expanding reality. With growing economic and social unevenness and upward-trending financial markets, the region has become synonymous with becoming a laboratory for researched-focused, tech-based knowledge. For example, the five largest banks in the world reside in Asia, and they attract now international investors. Their businesses, as well as banks' assets in the region, expanded nonstop, indeed outpacing what has been occurred elsewhere. Countries such as China, Indonesia, Thailand, etc. have among the largest commercial banking assets in the world, that is, an endless scope for credit supply coupled with booming market capabilities ahead. China has the world's highest share of the digitally active population in money transfer and payments, financial planning, savings, investment, and borrowing; India might become one of the leaders in insurance. Traditional commercial banks are being challenged by the adoption of new fintech, and Chinese fintech companies' revenues surpassed that of the United States, having accounted for more than 50% of global revenues. The Asia Pacific bank industry expenditures on new technological solutions ranked first in 2017, although some countries are lagging the fintech development in Asia and trying to catch up.

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Scholars and professionals have become aware of the region's density and capabilities.

A striking example of the region's advancement is the emergence of non-traditional banking, fast-paced banking technology, digital banking, Internet finance, etc. Technology breakthrough opens up new opportunities for the retail banking system, and commercial banks are keen to ease the way people do banking. A full spectrum of innovative and traditional banking is progressing, and banks must make the best use of it. This innovation includes interest rate adjustments to stock market contagion, nonperforming loans, and the loan puzzle in emerging markets, to the impact of information technology on institutional and individual investors on stock markets, to financial, banking, and technology innovation have shaped up and continue to do so in the region. Not least at a single country level, the denseness of China's banking system are key-sources of potential liquidity risk for the Chinese economy.

As the technology revolution has profoundly affected a corresponding scientific ferment, we are now seeing deep changes and advancements in this industry, where selected emerging markets are about credit in online lending, machine learning, and mobile computing devices no second to other countries. Sometimes these markets are even moving ahead of others and injecting the markets with novel issues and intricacy, which need to be explored wholly. In fact, we can expect that more changes and innovations are coming, and more disruptive financial technologies may be added to our society soon.

In response to the impactful dynamics that have been felt in the region and with a general scholar-oriented standpoint in mind, Volume 25 of International Symposia in Economic Theory and Econometrics (ISETE) showcases a road-map and strives to features up-to-date knowledge about Asian markets and advance knowledge that combines, wherever possible, theoretical academics perspectives with real cases. The aim of ISETE's Banking and Finance Issues in Emerging Markets is nothing less than to deliver state-of-the-art, comprehensive coverage of the knowledge developed to date, including the dynamics and prospects of banking and finance. Various contributors' studies are meant for analysis of past and current trends, which shape future lines of inquiry as well. That is, the book provides up-to-date technical portrayals on the recent development of banking issues, stock market contagion, and interest rate adjustment in emerging Asian markets, with an added endeavor of disentangling and breaking the markets down to see what the resulting banking and finance industry in the region would be.

Organized into 11 chapters, we wanted to coherently contribute a new volume to the advancement of contemporary issues in banking and finance literature, with a special focus on Asia. Issues such as banking stability and the adoption of innovative technology in finance, among others, are

emblematic of a vast region that has recently been underpinned by real growth, commerce, and finance. That leads to problems with getting the whole region in focus at the same time and our authors displayed remarkable energy to disentangle and make their knowledge conveniently accessible. The synthesis of the chapters follows here.

Chapter One written by Tatre Jantarakolica and Korbkul Jantarakolic intends to (1) test the existence of exchange rate integration among the ASEAN-5, including Indonesia, Philippines, Malaysia, Singapore, and Thailand, using panel data techniques; and (2) figure out the impact of economic integration on the level of exchange rate integration among the ASEAN-5 countries. The chapter applies Multivariate GARCH (M-GARCH) models using daily data to find the level of exchange rate integration. The results confirm the Purchasing Power Parity (PPP) among the ASEAN-5 countries and the lower transaction costs caused by the ASEAN trade agreements. Moreover, the results of panel cointegration tests using quarterly data of economic integration and exchange rate integration show the positive impact of international trade openness on exchange rate integration. The findings imply that trade liberalization has a significant effect on the real exchange rate. With free trade agreements leading to lower trade barriers, lower transaction costs, and lower transportation costs, the economic integration among the ASEAN countries practically leads to a higher degree of exchange rate integration. The authors, therefore, suggest that the regulators of ASEAN countries should pay more attention to the exchange rate policy coordination among themselves due to the interdependence of their policies.

Chapter Two by Cong Wang and Xue Wang analyzes the macroeconomic effects of the RMB internationalization that has a profound impact on China's domestic macroeconomy. This chapter applies the Gap Estimation approach to estimate the RMB overseas circulation amount from 1997 to 2015, as the indicator of RMB internationalization. The results display contemporaneous causalities from RMB overseas circulation to the inflation rate, from exchange rate to overseas circulation, and from exchange rate to the inflation rate. Such an internationalization of the RMB encourages the currency appreciation. China's central bank passively loses monetary policy to meet the needs of internationalization and reduce the shock of the international hot money, thereby further deepening the domestic inflation. The policymakers should balance the internationalization of the RMB process with the domestic macroeconomic stability and healthy development at the same time. This chapter clarifies that the RMB overseas circulation influences the RMB exchange rate, domestic interest rate, inflation level, and the transmission and dynamic

effect mechanism between them, and it provides some suggestions to the smooth realization of the RMB internationalization and the steady running of China's macroeconomy.

Chapter Three written by Pym Manopimoke, Suthawan Prukumpai, and Yuthana Sethapramote is about the dynamic connectedness in emerging Asian equity markets. During recent decades, the degree of financial market globalization has intensified, particularly as emerging market economies become more deeply integrated into global financial systems. This chapter gives an empirical assessment of the interconnectedness among stock markets of emerging countries in Asia as well as explores their linkages vis-à-vis other major global markets. Using the Generalized Vector Autoregression to compute the connectedness index, the dynamic nature of equity returns and volatility spillovers across international stock markets are studied across time, especially during periods of financial market turbulence. The direction of spillovers is also examined to identify countries that are transmitters versus receivers of shocks. Furthermore, this chapter explores the impact of financial and economic policy uncertainty shocks that emanate from the United States on the intensity of spillovers received by emerging Asian stock markets. The empirical findings in this chapter deliver financial stability implications by yielding new results on the transmission channels of shocks as well as quantifying how external financial and economic policy uncertainty shocks are important drivers of spillovers to emerging Asian stock markets.

Chapter Four by William W. Chow augments a simple income stock price model with spatial structures to evaluate the significance of real and financial linkages in instigating stock market contagion. Financial contagion has a brief history in empirical economics. Testing the presence of contagion or interdependence constitutes an important part of the literature. However, little effort has been extended to empirically cross-validate and compare different transmission channels. This chapter aims to supplement the existing literature by considering a spatial econometric approach to analyze and cross-compare different shock transmission channels in global stock markets. The author explores specifications of explicit interrelated stock price returns and implicit spatial autocorrelation in the error term. The findings show that spatial dependence in either specification is not too sizable confirming that contagion is not spreading fast in the sample period. Of the many factors considered, nonperforming loans, market liquidity, and credit to deposit ratio turns out to be the most important transmission factors. Current account balance, net foreign direct investment flows, and size of GDP is among the least significant media. In sum, these suggest that financial linkages could play a more significant role in easing shock transmission when compared to real linkages like global trade.

Chapter Five by Michael K. Fung investigates the Deposit rate asymmetry and Edgeworth cycles after Hong Kong's interest rate deregulation. Over the past few decades, many countries with regulations on bank deposit interest rates have relaxed those regulations to cut market distortions and improve banking efficiency. In 1994, the Hong Kong Monetary Authority, the de facto central bank of Hong Kong, decided to deregulate the deposit market. Eventually, the interest rate rules (IRRs) were totally abolished in 2001. Since then, there is public concern that the deregulation may have forced Hong Kong banks to seek alternative means to preserve market power, such as tacit collusion. In particular, Hong Kong depositors and the public media often accused the banks of adjusting their deposit rates slowly to market interest rate rises, but quickly to falls. A full Edgeworth cycle of deposit rate is divided into two phases: an "overcutting cycle" in which the banks battle for deposits, and a "relenting cycle" in which the banks cease battling and instead choose to restore a temporarily low deposit rate. Such strategies have two testable implications for market movements. First, deposit rate decreases are more likely to be initiated when the deposit rate is near the upper bound of a cycle. Second, deposit rate decreases are more sensitive than increases in market interest rate changes. This chapter empirically confirms this pattern and shows compelling evidence for the presence of Edgeworth cycles in deposit rates after Hong Kong's interest rate deregulation. Dr. Fung not only contributes to the understanding of banks' pricing behavior in Hong Kong after the interest rate deregulation but also provides policymakers with a useful reference for evaluating the effectiveness of similar deregulations in nonbanking industries.

Soumya Bhadury and Bhanu Pratap investigate in **Chapter Six** by examining the international banking crisis, regarding the origin of such crises. Following the literature on banking crises, they have identified various theoretical grounds that have led to such crises around the globe. Such responses may be due to "herd behavior" by banks, "disaster myopia," or short-sightedness in underestimating the likelihood of high-loss; low-probability events is one such bias; "institutional memory hypothesis" posits that banks often have short memory of previous credit booms, aggravating pro-cyclicality in loan growth and risk-taking, principal-agent problem between shareholders and managers. The authors focus on the NPA problems related to India, identify bubble within 10 key growth sectors, time-stamp the run-up phase of the bubbles, and finally analyze the sectoral lending by the scheduled commercial banks during such bubble episodes. This chapter's findings suggest the presence of "bubble loans" in India, and thus, it becomes necessary to maintain adequate growth, guard against its adverse impact by instituting appropriate regulatory and

supervisory policies and strengthen prudential norms. The authors identify steps taken so far by India and investigate the role of Korea Asset Management Corporation (KAMCO) toward a successful nonperforming assets (NPA) resolution in South Korea. Few key takeaways include establishing a Public Asset Management Company (AMC) focused on maximization of recoveries and resolution of stressed assets, the well-defined governance structure for the AMC ensuring it works on market principles, shielded from political interferences, and realistic asset valuation and transfer prices that ensure limited downside risks for the public AMC.

Chapter Seven written by Asli Leblebicioglu and Victor J. Valcarcel explores the issue of the loan puzzle – which heretofore had been studied only in developed economies – in an international perspective with special attention to emerging markets. Typically, if the central bank's intent is to jumpstart activity through a monetary policy expansion, an intermediate goal, in part, should be for intermediaries to increase the supply of loans. Moreover, as the expansion results in a reduction in the cost of financing loans, loan demand should also increase. Both of these effects would translate into increases in the volume of loans. The loan puzzle arises if the volume of loans declines instead. Leblebicioglu and Valcarcel show this "perverse" response of loan volumes following a monetary shock is not exclusive to developed economies but is also pervasive in emerging markets. Importantly, under the paradigm of a big-foreign-economy and small-domestic-economy setting, a preponderance of statistical and structural evidence indicates significant transmissions of this puzzle from the United States to emerging markets.

Chapter Eight by Masaki Yamaguchi examines Japanese banks' overseas investments in emerging markets using data from regional banks' financial reports. Japanese regional banks have actively expanded their overseas business in emerging markets, and this topic is quite important for regional banks that have confronted severe business environments over the decades. An aging population suppresses long-term increases in loan demands, and stagnant economic conditions lead to lowered interest rates in the medium-term. This investigation uses X-means clustering, which is nonhierarchical, as this method automatically presents an optimal number of clusters and sorts regional banks into their right clusters. The results prove that medium-sized banks actively develop security investments, which increases overseas business's contributions to profits. Meanwhile, small banks cannot expand overseas investments, which differ from other banks. These banks must seek other business models to compensate for this decline in their earning power.

Chapter Nine studies the role of Financial Technology (FinTech) in disrupting the existing traditional banking system. Authored by Agrata Gupta and

Chun Xia, the chapter identifies FinTech's evolution in Asia across Deposits & lending, Capital Raising, Investment Management, Market provisioning, Payments, and Insurance. This technology revolution allows us to have a banking system based on values that serve customers better, reduce risk to the society, and improve returns for the shareholders. Data on unbanked population, smartphone, and internet penetration have led to retail side innovations such as Mobile Wallets, P2P Payments, and Real-time Payments in the most of Asia (except China). Forty-nine percent of Global Investments in FinTech are in Asia and the Chinese dragon alone accounts for 46%, the authors say. India is witnessing a substantial amount of FinTech deals in 2017, and it is being driven by payment and lending solutions. ASEAN FinTech industry is dominated by m-wallets and online payments; retail investment and financial comparison follow this. This chapter dives into the challenges Asian banks are facing because of this disruption. Now more than ever is the key role governments and central banks of each nation play to assess the path these start-ups are headed on, and this will unfold the landscape of banking in Asia a few years down the lane.

Chapter Ten by Korbkul Jantarakolica and Tatre Jantarakolica is on the acceptance of financial technology in Thailand, and it intends to design and empirically estimate a model in explaining the acceptance of algorithm trading of Thai investors. The rapid change of technology has significantly affected financial markets in Thailand. To enhance efficiency and liquidity of the market, stock exchange of Thailand has granted Thai stock brokers permission to develop algorithm trading to offer their customers automatic stock trading. The results from this chapter confirm that investors' attitudes toward algorithm stock trading, the subjective norm on stock trading, the perceived risk of stock trading, and investors' trust on stock trading are major factors determining investors' acceptance of algorithm trading. Investors' perception about the trust of using algorithm stock trading as a new trading strategy is a major factor figuring out the perceived behavior, which in turn affects the decision on the use algorithmic trading. The authors conclude that Thai investors are willing to accept algorithm trading as a new financial technology, but they have a concern about a new stock trading strategy. Therefore, algorithm trading can be promoted by building investors' trust on this type of trading as a reliable and profitable trading strategy.

In the same area of technology and finance, **Chapter Eleven** provides an informative description of the recent development of FinTech. Kevin Chen's chapter elaborates on a smart new financial and banking world with machines, where financial innovation and technology firms are shaping up the markets. Many large established technology giants, from Google, Apple to Amazon in the US have been entering the financial service

industry while smaller start-ups – what are known as robotic advisors – are taking market shares from traditional asset management firms. In China, firms such as Tencent or Alibaba have created a whole, new field of online finance. Emerging market countries including India have been rapidly developing financial technologies. The chapter aims to study innovation through several cases (PayPal, AliPay, and PayTM in online payment service, Lending Club, CommonBond, Seaame Credit in online lending, and robo-advisor Betterment), artificial intelligence, and machine learning. A majority of the new technologies are based on cloud-based, mobile computing devices. The chapter's main topics of discussion are to develop a thorough understanding of the art and science of financial innovation, from both bottom-up market indicators and top-down holistic view, and in so doing to incorporate historical and cultural perspectives in the analysis. Dr. Chen's chapter proves recent technology changes and improvements are just the beginning of the new world finance and unprecedented changes are still yet to come, and it is crucially important to be prepared and even embrace the changes.

To conclude, although each chapter here is a stand-alone piece of analysis, the 11 chapters included in this volume 25 of ISETE make up a very best cutting-edge policy. We provide a venue for scholars to communicate new insights that are of value to scholars, students, and readers who are potentially interested in the state of banking and finance issues in emerging markets and eventually concerned with their policy and applications. The volume aims to disentangle the emergence and development of new fields of study and to see what the resulting banking and finance industry in Asia is destined to become in the future.

Chapter 1

ASEAN-5 Economic and Exchange Rate Integration

Tatre Jantarakolica[a] and Korbkul Jantarakolica[b]

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Abstract

For the past decades, issues concerning the impact of economic integration on financial integration, especially exchange rate integration, has been criticized among several regions such as ASEAN. This chapter intends to: (i) test for the exchange rate integration among the ASEAN-5, including Indonesia, Philippines, Malaysia, Singapore, and Thailand, using panel data techniques; and (ii) determine the impact of economic integration on the level of exchange rate integration among the ASEAN-5 countries. The purchasing power parity (PPP) is tested using panel unit root tests on monthly data. The results confirm the PPP among the ASEAN-5 countries due to lower transaction costs from ASEAN agreements. The chapter applies Multivariate GARCH (M-GARCH) models using daily data to determine the level of exchange rate integration among the ASEAN-3, including Malaysia, Singapore, and Thailand. The results of panel cointegration tests using quarterly data of economic integration and exchange rate integration confirm the impact of international trade openness on exchange rate integration. With free trade agreements leading to lower trade barriers, lower transaction costs, and low transportation costs, the economic integration among ASEAN countries practically leads to a higher degree of exchange rate integration. The findings imply that trade liberalization has the strongest effect on the real exchange rate. As such, regulators of ASEAN countries should pay more attention to the exchange

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rate policies of each other because of the interdependence of their exchange rates.

Keywords: Economic integration, exchange rate integration, ASEAN-5, PPP, panel unit root test, panel cointegration test, M-GARCH

1. Introduction

For the past decades, economic integration among countries in the same region has been addressed and examined in many economic literatures. Controversies concerning advantages and disadvantages of the integration have long been studied and criticized, including the integration of the exchange rates of the countries in the same region or those of countries with the free trade agreement. Euro currency, as single currency among EU countries, can be used as an evidence of the exchange rate integration among the countries in Euro zone. For decades, economic integration among 10 Southeast Asia countries, ASEAN, including Brunei, Cambodia, Lao, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam, has resulted in the integration of these countries' economies.

As the founder countries of ASEAN, Indonesia, Philippines, Malaysia, Singapore, and Thailand, also called as ASEAN-5, with the five decades agreement since 1967, invited their neighboring countries, including Brunei, Cambodia, Lao, Myanmar, and Vietnam, to join the free trade agreements among each other. With the goals of being regional single market and production base, ASEAN had set up agreement to continuously lower its tariff with the ultimate target of FTA at 0% tariffs rate. As a results, the tariff among ASEAN-5 have set to 0% since 2010. Petri, Plummer, and Zhai (2012) found that ASEAN market, especially ASEAN-5, had been integrated and converged in term of economic growth, both productivity and unemployment. Trade among ASEAN has increased from about 18% in 1985 to more than 30% in 2015.

According to the theory of purchasing power parity (PPP), with the lower transaction cost based on ASEAN agreements, law of one price of exchange rate among the five countries should hold. Figure 1 and Figure 2 reveal the comovement among the exchange rate indices of ASEAN-5 countries in US dollar and in real effective term during 2005−2017. However, Manzur (2018) claimed that exchange rate is always and everywhere controversial. Hence, question then arises whether the integration also covers exchange rate integration among the currency of these five countries.

During 1980s, PPP were often tested by using time series analysis, such as unit root tests and cointegration test of the real exchange rate (i.e., Enders, 1988). These time series tests had later been criticized on the

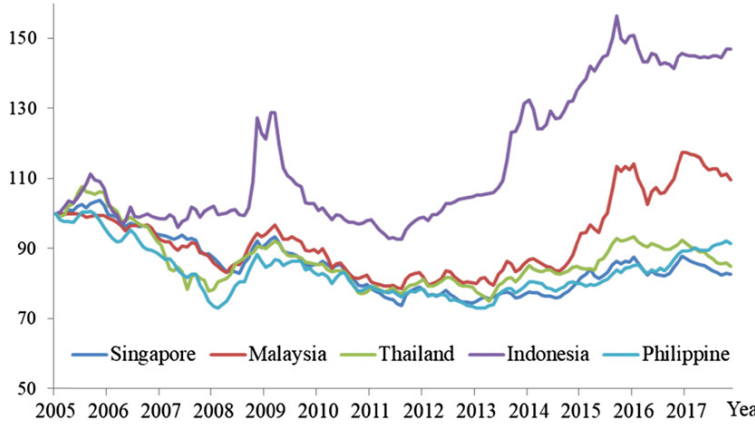

Figure 1: Exchange Rate Indices of ASEAN-5 (USD) 2005–2017.

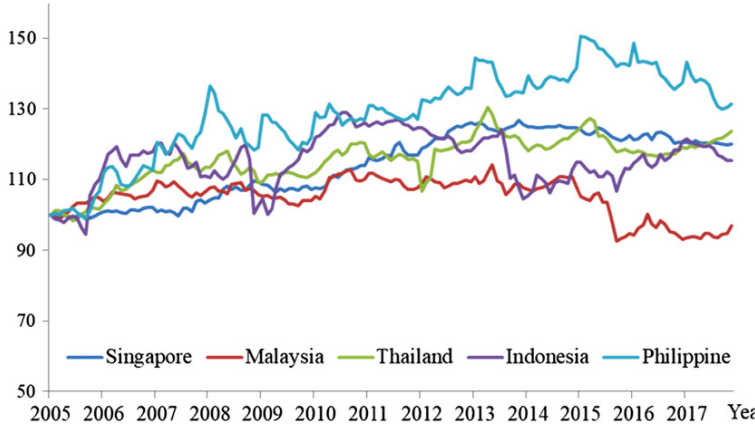

Figure 2: Real Effective Exchange Rates Index of ASEAN-5 2005–2017.

extreme low statistical power which led to unreliable testing results (Edison, Gagnon, & Melick, 1997; Koedijk, Schotman, & Van Dijk, 1998). To overcome the low power problem, the long-horizon time series data of real exchange rate were employed to perform unit root test, which then provide the slow but significant mean reversion of the series indicating that the PPP might be held in the long run (Lothian & Taylor, 1996). However, these results had also been argued as the long-horizon time span covered several different economic structures, thus, the tests should take into

account of the structural change of the economy. Engel (2000) revealed the large size biases in the unit root tests of long-run PPP.

For the past two decades, panel unit root tests had been claimed as the better tests of PPP because of its high power of the test based on larger size of data set (Hooy, Law, & Chan, 2015; Lau, Suvankulov, Su, & Chau, 2012; Matsuki & Sugimoto, 2013; Pontines & You, 2015; and Wu, 1996). The purposes of this chapter intend (i) to test exchange rate integration among ASEAN-5 countries using panel data techniques and (ii) to determine impact of economic integration on the level of integration of the exchange rate among ASEAN-5 countries.

2. Conceptual Framework

The rationale of why exchange rate should be integrated among ASEAN-5 countries can be explained by applying theoretical concepts based on PPP and law of one price.

2.1. Purchasing Power Parity

PPP was first introduced by Cassel (1918) to explain the relationship of the exchange rate among countries after the period of World War I. The concept of PPP has been expanded into two major concepts, including absolute PPP and relative PPP.

First, based on absolute PPP, nominal exchange rate, determined by the rate between domestic per trading country currency, should be equivalent to the price ratio of the domestic product against trading country product. Thus, exchange rate should be the ratio of prices of the two countries.

$$E_t = \frac{P_{Ht}}{P_{Ft}} \tag{1}$$

where E_t is current exchange rate, P_{Ht} is current home country price level, P_{Ft} is current foreign country price level, i represent home country, and j denotes foreign country. This concept of absolute PPP is also called law of one price, which explains that the prices of the same product in two countries after converting by the exchange rates into same currency should be the same. An example of this concept that has long been validated and determined is the prices of Big Mac hamburger from McDonald, which has been used as the proxy and computed every two years by The Economist magazine. Figure 3 shows the comovements of Big Mac prices in US dollar among ASEAN-5 countries during 2001–2017.

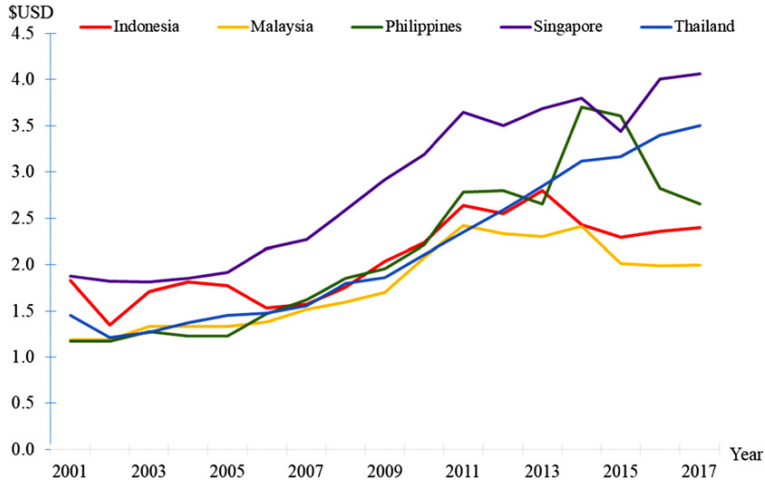

Figure 3: Big Mac Prices in US Dollar in 2001–2017. *Source*: The Economist 2017.

Second, relative PPP claimed that absolute PPP sometimes might not hold because of the different ratio of the inflation in the two countries. Therefore, in order to determine the parity of the purchasing power of the two countries, the testing variables should be in relative term. The nominal exchange rate ratio between domestic and foreign country should be equal to their inflation ratio. In other words, the difference of the inflation ratio of the two countries should be compensated by the change in their exchange rate. Thus,

$$E_t = E_0 \frac{P_{Ht}/P_{H_0}}{P_{Ft}/P_{F_0}} \tag{2}$$

where subscript 0 represents based period and t denotes current period.

Figure 4 illustrates the exchange rate between each ASEAN-5 countries and the United States, and relative price between each ASEAN-5 countries and the United States using ratio between inflation between each ASEAN-5 countries and the United States and proxy during 2005–2015.

However, both absolute PPP (or law of one price) and relative PPP can be held only when assumptions of the theory are satisfied. One important assumption of PPP claims that there must be no transaction costs of the international trade between the two countries, including transportation costs, trade barrier, market power, sticky price, ratio of nontradable goods, and investment flow. Since countries in ASEAN-5 are located in the same region with relatively short distance compare to other countries, therefore,

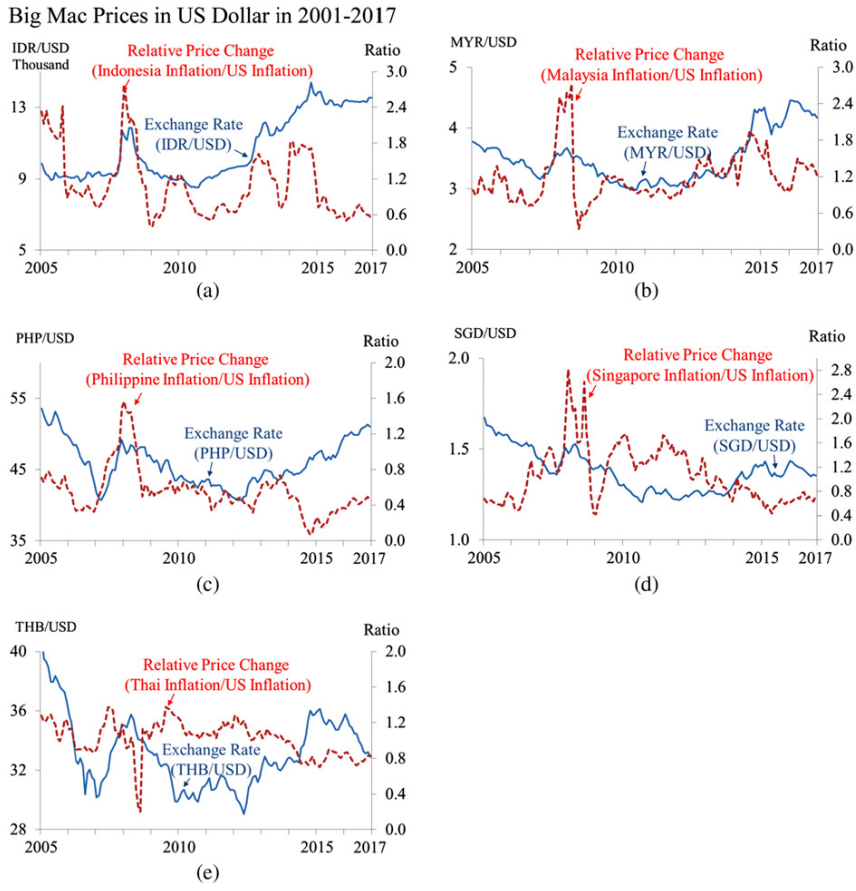

Figure 4: Exchange Rate and Relative Price of ASEAN-5 versus USA.

the transportation costs among these countries should be relatively lower. Consequently, with economic integration of regional countries raised by ASEAN agreements, many transaction costs, especially trade barrier and transportation costs, have been eliminated, thus, PPP should be held among these countries.

2.2. Development of the Testing Methods

Testing PPP concept has long been empirically tested. The first generation employed traditional linear regression model by testing relationship between changes in exchange rate and changes in inflation ratio (Dornbusch, 1976; Frankel, 1981; Melvin & Bernstein, 1984). Based on monetary approach,

the test applied traditional log-linear regression of the determinants of exchange rate, including ratio of nominal money, ratio of nominal interest rate, and ratio of real income.

$$\ln E_t = \beta_0 + \beta_1 \ln\left(\frac{M_H}{M_F}\right)_t + \beta_2 \ln\left(\frac{r_H}{r_F}\right)_t + \beta_3 \ln\left(\frac{Y_H}{Y_F}\right)_t + \varepsilon_t \tag{3}$$

where M denotes nominal money, r represents nominal interest rate, and Y is the real income.

However, several traditional studies employed the tests based on monetary approach failed to confirm the existence of PPP (Dornbusch & Fischer, 1980). By claiming that testing data of the previous tradition tests mostly involved with high-frequency time series data, which mostly are stochastic non-stationary, the second generation performed their tests based on time series properties including stationarity of the exchange rate series using unit root tests and the long-run relationship based on cointegrated relationship using cointegration test of the two countries exchange rates (Dutton & Strauss, 1997; Enders, 1988; Engel, 2000; Engel, Hendrickson, & Rogers, 1997). From absolute PPP in equation (1), the model can be stated as:

$$E_t P_{Ft} - \alpha P_{Ht} = \varepsilon_t \tag{4}$$

where ε_t is a stochastic disturbance term representing a deviation from PPP and α is constant parameter. Using equation (4), long-run PPP can be claimed to hold if $\alpha = 1$ and series of ε_t is stationary (Enders, 1988). Rewrite equation (4) as:

$$\frac{E_t P_{Ft}}{P_{Ht}} = R_t = \alpha + \varepsilon_t \tag{5}$$

where R_t is the "*real*" exchange rate. PPP can then be tested by performing unit root test of the real exchange rate.

Alternative test can also be done by estimating Autoregressive Integrated Moving Average (ARIMA) model. Assume ARIMA(p,0,0), the real rate can be stated as:

$$R_t = \alpha_0 + \sum_{L=1}^{p} \alpha_L R_{t-L} + \varepsilon_t \tag{6}$$

The PPP test is to test whether $\alpha_0 / \left(1 - \sum \alpha_L\right) = 1$ and for all characteristic roots to lie within the unit circle.

Furthermore, the long-run PPP relationship of exchange rate and price can be tested using cointegration test. Rewrite equation (4) for long-run PPP relationship:

$$E_t P_{Ft} = \alpha P_{Ht} + \varepsilon_t \tag{7}$$

Let E_tP_{Ft} and P_{Ht} be nonstationary and integrated of the same order, cointegration test is to test whether ε_t is stationary. If cointegration long-run PPP relationship exists, equation (7) represents long-run cointegrating equation and the short-run error correction mechanism model can then be stated as:

$$\Delta E_tP_{Ft} = \gamma \Delta P_{Ht} + \delta \varepsilon_{t-1} + u_t \tag{8}$$

where Δ denotes the change notation, δ represents error correction parameter, and u_t is stochastic disturbance term.

Although the time-series techniques can be used to overcome the limitations of the previous traditional studies, PPP tests using time series properties, including unit root tests, ARIMA, and cointegration tests had still been criticized that evidences of PPP were inconclusive due to the low power of the test (Edison et al., 1997; Koedijk, Schotman, & Van Dijk, 1998). Although some studies had employed long-horizon time series of real exchange rate in their analysis, the tests were also criticized on the economic structural changes during the period of study, thus, the tests still provided unreliable results (Engel, 2000; Koedijk, 1998).

The third generation has criticized that previous studies mostly performed their tests based on single time series data which might not provide enough power of the test. By adding more observations using more time series with additional cross-sectional (in term of currencies) dimensions as panel data, panel unit root tests, and panel cointegration tests have been claimed as superior and more appropriated tests with optimum. Panel time series properties tests have been performed to validate the existence of PPP among countries within the region and continent (Atjimakul, 2008; Lau et al., 2012; Matsuki & Sugimoto, 2013; Pontines & You, 2015; Reunrojrung, 2008; Wu, 1996). However, based on properties of high frequency time series, it is possible that the series can be time-varying volatility. Therefore, unit root test might result nonstationary since variances of the series are not constant.

3. Methodology

Methods of the study in this chapter consist of (i) testing methods of exchange rate integration and (ii) testing method of the relationship between economic integration and exchange rate integration.

3.1. Testing Methods of Exchange Rate Integration

According to the afore mentioned, in order to improve the power of the test, this study therefore employs panel unit root tests and panel

cointegration tests. Based on PPP concept and economic integration condition of ASEAN-5, this study hypothesizes that exchange rates of the five countries should be integrated. Thus, PPP should be held among the currencies of these five countries. Testing methods in this study include (i) panel unit root tests using panel monthly real exchange rates series and real effective exchange rate series and (ii) panel cointegration test using panel monthly exchange rate and price ratio series.

3.1.1. Panel Unit Root Tests

In order to test absolute PPP, panel unit root tests are employed to test panel of exchange rate series. Panel unit root tests can be divided into two major groups, including panel unit root tests assuming cross-sectional independence and panel unit root tests assuming cross-sectional dependence.

A. Panel Unit Root Tests Assuming Cross-sectional Independence. This group of tests assumes that cross-sectional (countries) in the panel are all independence or there is no relationship among the cross-sectional (countries). The tests include Levin, Lin, and Chu (2002) (LLC) test, Im, Pesaran, and Shin (2003) (IPS) test, Maddala & Wu (MW) (1999) test.

LLC Test

LLC test computes the test statistic by averaging single time-series Augmented Dickey Fuller (ADF) *t*-tests of all cross-sectional units (countries) assuming homogenous across cross-sectional units (countries). The null hypothesis is that each individual country currency time series contains a unit root against the alternative that each country currency time series is stationary. The testing model is

$$\Delta R_{it} = \rho_i R_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta R_{it-L} + \alpha_{im} d_{imt} + \varepsilon_{it} \tag{9}$$

where i represents ASEAN-5 countries in which $i = 1, 2, 3, 4, 5$, d_{mt} is vector of deterministic variables, $m = 1, 2, 3$, $d_{1t} = \{empty\ set\}$, $d_{2t} = \{1\}$, $d_{3t} = \{1, t\}$, and α_{mi} is the vector of coefficients.

The test procedures can be divided into three steps. The first step begins by perform separate augmented Dickey-Fuller (ADF) (equation (9)) for each i cross-sectional country currency where lag order p_i can be varied across i. For given time T, optimal lag p_i can be determined. The two regression models are then estimated (i) using ΔR_{it} as dependent variable and ΔR_{it-L} (for all $L = 1,\ldots, p_i$) and d_{imt} as independent variables to obtain residual $\hat{e}_{it}$ and (ii) using R_{it-1} as dependent variable and ΔR_{it-L} (for all $L = 1,\ldots, p_i$) and d_{imt} as independent variables to get residual $\hat{v}_{it-1}$. Then,

standardized values of the two residuals should be computed as $\tilde{e}_{it} = \hat{e}_{it}/\hat{\sigma}_{\varepsilon i}$ and $\tilde{v}_{i,t-1} = \hat{v}_{it}/\hat{\sigma}_{\varepsilon i}$, where $\hat{\sigma}_{\varepsilon i}$ is standard error from each ADF test.

The second step is to compute the ratio of long-run to short-run standard deviations. The long-run variance can be computed as:

$$\hat{\sigma}^2_{R_i} = \frac{1}{T-1}\sum_{t=2}^{T} \Delta R^2_{it} + 2\sum_{L=1}^{\overline{K}} w_{\overline{K}L}\left[\frac{1}{T-1}\sum_{t=2+L}^{T} \Delta R_{it}\Delta R_{i,t-1}\right] \tag{10}$$

where $\overline{K}$ is optimal truncated lag and $w_{\overline{K}L} = 1 - \left(L/\left(\overline{K}+1\right)\right)$. Then, ratio of long-run standard deviation to innovation standard deviation can be computed as $\hat{s}_i = \hat{\sigma}_{R_i}/\hat{\sigma}_{\varepsilon_i}$ and average standard deviation can also be computed as $\overline{S} = 1/N\left(\sum_{i=1}^{N} \hat{s}_i\right)$ which $N = 5$ countries.

The last step is to compute the panel unit root test statistics by estimating pooled regression based on $N\tilde{T}$ observations of

$$\tilde{e}_{it} = \rho\tilde{v}_{i,t-1} + \tilde{\varepsilon}_{it} \tag{11}$$

where $\tilde{T} = T - \overline{p} - 1$ and $\overline{p} = \sum_{i=1}^{N} p_i/N$.

Then, the panel unit root t-test for $H_0 : \rho = 0$ can be computed:

$$t_\rho = \frac{\hat{\rho}}{\hat{\sigma}_{\hat{\rho}}} \tag{12}$$

where

$$\hat{\rho} = \sum_{i=1}^{N}\sum_{t=2+p_i}^{T} \tilde{v}_{i,t-1}\tilde{e}_{it} \Bigg/ \sum_{i=1}^{N}\sum_{t=2+p_i}^{T} \tilde{v}^2_{i,t-1}$$

and

$$\hat{\sigma}_{\hat{\rho}} = \hat{\sigma}_\varepsilon \Bigg/ \left[\sum_{i=1}^{N}\sum_{t=2+p_i}^{T_i} \tilde{v}^2_{i,t-1}\right]^{1/2}$$

and

$$\hat{\sigma}^2_{\tilde{\varepsilon}} = \frac{1}{N\tilde{T}}\sum_{i=1}^{N}\sum_{t=2+p_i}^{T} \left(\tilde{e}_{it} - \hat{\rho}\tilde{v}_{i,t-1}\right)^2$$

Finally, to obtain asymptotic property, the adjusted t-statistic can be computed:

$$t^*_\rho = \frac{t_\rho - N\tilde{T}\hat{S}_N\hat{\sigma}^{-2}_{\tilde{\varepsilon}}\hat{\sigma}_{\hat{\rho}}\mu^*_{m\tilde{T}}}{\sigma^*_{m\tilde{T}}} \quad \Rightarrow N(0,1) \tag{13}$$

where $\mu^*_{m\tilde{T}}$ and $\sigma^*_{m\tilde{T}}$ are the mean and standard deviation adjustments obtained from LLC computations. As a result, the t^*_ρ is asymptotically distribution as $N(0,1)$.

However, LLC test has also been claimed that its limitations are caused by cross-sectional independent assumption and test only no unit-root of all cross-sectional units.

IPS Test

According to the limitation of LLC that requires ρ to be homogenous across *i*. IPS test determines the test statistic by averaging single time-series ADF *t*-tests of all cross-sectional units (countries) allowing heterogeneity of the cross-sectional units (countries). The hypotheses can be stated as:

$$H_1 : \begin{cases} \rho_i < 0 & for \;\; i = 1, 2, \ldots, N_1 \\ \rho_i = 0 & for \;\; i = 1, 2, \ldots, N_1 \end{cases}$$

IPS $\bar{t}$ is defined as average of individual ADF test

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{p_i} \tag{14}$$

Then, to obtain asymptotic property, the adjusted *t*-statistic can be computed as:

$$t_{\text{IPS}} = \frac{\sqrt{N}\left(\bar{t} - \frac{1}{N} \sum_{i=1}^{N} E\left[t_{iT} | \rho_i = 0 \right] \right)}{\sqrt{\frac{1}{N} \sum_{i=1}^{N} \text{var}\left[t_{iT} | \rho_i = 0 \right]}} \Rightarrow N(0, 1) \tag{15}$$

The t_{IPS} is asymptotically distribution as $N(0, 1)$.

MW Test

Unlike LLC and IPS test, MW test, also called as Fisher-type test, computes the test by geometrically averaging single time-series *p* values of ADF tests of all cross-sectional units (countries).

$$P_{\text{MW}} = -2 \sum_{i=1}^{N} \ln p_{\text{ADF}_i} \tag{16}$$

where $\ln \; p_{\text{ADF}_i}$ is natural logarithm of *p*-value of each ADF test.

The modified *P* test proposed by Choi (2001) can be calculated as:

$$P_m = \frac{1}{2\sqrt{N}} \sum_{i=1}^{N} \left(-2 \ln p_{\text{ADF}_i} - 2 \right) \tag{17}$$

The P_m is inverse-chi-squares distribution. In term of size-adjusted power, MW test seems to be conceptually superior to IPS test.

B. Panel Unit Root Test Assuming Cross-sectional Dependence. Due to limitation of cross-sectional independence assumption, Pesaran (2003) constructed cross-sectional Im-Pesaran-Shin (CIPS) test which allows cross-sectional dependence among cross-section units (countries). Based on simple cross-section augmented Dickey-Fuller (CADF) test of

$$\Delta R_{it} = \alpha_i + \rho_i^* R_{it-1} + d_0 \overline{R}_{t-1} + d_1 \Delta \overline{R}_t + \varepsilon_{it} \tag{18}$$

To take into account of cross-sectional dependency, the test model is extended by adding lagged cross-sectional average and its first difference for the cross-sectional dependence.

$$\Delta R_{it} = \alpha_i + \rho_i^* R_{it-1} + d_0 \overline{R}_{t-1} + \sum_{j=0}^{p} d_{j+1} \Delta \overline{R}_{t-j} + \sum_{k=1}^{p} c_k \Delta R_{it-k} + \varepsilon_{it} \tag{19}$$

To obtain CADF of each cross-sectional country currency, cross-sectional i models of equation (19) are estimated to get N values of t-test of $\hat{\rho}_i^*$ as CADF test (t_{CADF_i}). Then, CIPS test can be computed as average of all CADF t-tests (t_{CADF_i}):

$$t_{\mathrm{CIPS}} = \frac{1}{N} \sum_{i=1}^{N} t_{\mathrm{CADF}_i} \tag{20}$$

3.1.2. Panel Cointegration Test

In order to test relative PPP, panel cointegration test between panel of exchange rate series and price ratio is applied to test the existence of long-run relationship between the two variables. Pedroni (2004) test based on Engle-Granger is employed to test the long-run cointegrated relationship between exchange rate and price ratio by assuming asymptotic and finite sample properties of the panel data. Consider the long-run relationship

$$\ln E_{it} = \alpha_i + \beta_i \ln P_{it} + \varepsilon_{it} \tag{21}$$

where α_i and β_i are cointegrating equation parameters, which may or may not be homogeneous across i.

In this case, the strong PPP holds if hypothesis that $H_0: \beta_i = 1$ for all i should not be rejected. Based on Pedroni (1996, 2000), the between-dimension, group-mean panel Fully Modified Ordinary Least Squares (FMOLS) can be estimated as

$$\hat{\beta}_{\mathrm{GFM}} = N^{-1} \sum_{i=1}^{N} \hat{\beta}_{\mathrm{FMOLS}_i} \tag{22}$$

where $\hat{\beta}_{\text{FMOLS}_i}$ is the conventional time series FMOLS estimator (Phillips & Hansen, 1990) for country *i*. Then, *t*-statistic for the between-dimension estimator can be computed as

$$t_{\hat{\beta}_{\text{GFM}}} = N^{-1/2} \sum_{i=1}^{N} t_{\hat{\beta}_{\text{FMOLS}_i}} \tag{23}$$

where $t_{\hat{\beta}_{\text{FMOLS}_i}}$ is *t*-statistic of FMOLS estimator $\hat{\beta}_{\text{FMOLS}_i}$.

3.2. Testing Methods of the Relationship between Economic Integration and Exchange Rate Integration

Due to the limitation of the daily data of exchange rate and quarterly data of trading volume among ASEAN countries, the test of the relationship between economic integration and exchange rate integration only cover data of ASEAN-3, including Malaysia, Singapore, and Thailand. In order to perform test of the relationship between economic integration and exchange rate integration, this study first employs high-frequency time series analysis method using multivariate generalized autoregressive conditional heteroscedasticity (MGARCH) to determine level integration of exchange rate among ASEAN-3 countries. MGARCH models assume the time-varying volatility behavior and dynamic relationship of the exchange rates among the three countries by employing vector autoregressive (VARs) models combined with generalized autoregressive conditional heteroscedasticity (GARCH) models. The models can help capturing the level of integration of the exchange rates among countries. Data using in these models are daily data of real effective exchange rate during 2005−2015 of the ASEAN-3 countries.

The constant conditional correlation multivariate generalized autoregressive conditional heteroscedasticity (CCC-MGARCH) is employed using daily data. These high frequency time series models assuming interdependence and dynamic relationship among exchange rate and time-varying volatility can be stated as follows:

$$\begin{bmatrix} E_{THt} \\ E_{SGt} \\ E_{MYt} \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \\ a_{30} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} E_{THt-1} \\ E_{SGt-1} \\ E_{MYt-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \tag{24}$$

where

$$\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \sim IID \left[\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, H_t \right], \quad H_t = \begin{bmatrix} \sigma_{1t}^2 & \sigma_{12t} & \sigma_{13t} \\ \sigma_{21t} & \sigma_{2t}^2 & \sigma_{23t} \\ \sigma_{31t} & \sigma_{32t} & \sigma_{3t}^2 \end{bmatrix},$$

$$h_t = vech(H_t) = \begin{bmatrix} \sigma_{1t}^2 & \sigma_{21t} & \sigma_{2t}^2 & \sigma_{31t} & \sigma_{32t} & \sigma_{3t}^2 \end{bmatrix}',$$

and

$$\begin{aligned} \sigma_{1t}^2 &= c_{11} + \alpha_{11}\varepsilon_{1t-1}^2 \\ \sigma_{21t} &= \rho_{21} \\ \sigma_{2t}^2 &= c_{22} + \alpha_{22}\varepsilon_{2t-1}^2 \\ \sigma_{31t} &= \rho_{31} \\ \sigma_{32t} &= \rho_{32} \\ \sigma_{2t}^2 &= c_{33} + \alpha_{33}\varepsilon_{3t-1}^2, \end{aligned}$$

E_{THt} is daily real effective exchange rate of Thai Baht
E_{SGt} is daily real effective exchange rate of Singapore Dollar
E_{MYt} is daily real effective exchange rate of Malaysian Ringkit
ε_{jt} is stochastic error term of equation j and $j = 1, 2, 3$
σ_{jt}^2 is time-varying variance which follows ARCH(1) process of equation j and $j = 1, 2, 3$
ρ_{ji} is constant conditional correlation of equation j and $j = 2, 3$ and $i = 1, 2$ and $i \neq j$

This ρ_{ji} represents level of integration of exchange rate between country j and i at period t. The model can be estimated by using maximum simulated likelihood estimation method. The 11-year daily data (2005−2015) is divided into 44 groups with the length of one-quarter each group. The quarterly series of levels of integration of exchange rate among three countries can be determined by separately estimate the CCC-MGARCH models 44 times using the daily data of 44 quarter data groups during 2005−2015.

Economic integration between two countries can be measured by the ratio of trading value between the two countries to the total international trading value of the two countries. Then, the test of the relationship between economic integration and exchange rate integration can be performed by using panel cointegration test (equation (23)) of the estimated level of integration of exchange rate between country i and country j at quarter t (σ_{ijt}) and the ratio of trading value between country i and country j at quarter t (TV_{ijt}) during 2005−2015.

4. Empirical Results

Monthly data of ASEAN-5 exchange rates and inflation using in this study covers period between 2005–2015, including both real US dollar numeraire and real effective exchange rate, and price ratio determined by ratio between two countries inflation computed by consumer price index (CPI).

4.1. Results of Exchange Rate Integration Tests

4.1.1. Results of Panel Unit Root Tests

Panel unit root tests of real exchange rate based on US Dollar numeraire all indicate significant stationary, which means that exchange rate of ASEAN-5 countries have mean-reversion property. Constant mean of the exchange rate implies that absolute PPP has been held among ASEAN-5 countries. Additionally, the tests with and without time trend of all methods, including LLC, IPS, MW, and CIPS, also result the same conclusion of stationary.

This conclusion is also supported by the test results using real effective exchange rate. All panel unit root tests, LLC, IPS, MW, and CIPS, both with and without time trend, reveal stationary of the real effective exchange rate of ASEAN-5 countries.

Table 1 shows results of panel unit root tests of real exchange rate based on US Dollar numeraire and real effective exchange rate of ASEAN-5 countries using LLC, IPS, MW, and CIPS tests.

Based on panel unit root tests of real exchange rates and real effective exchange rates, the results confirm that real exchange rate among ASEAN-5

Table 1: Results of Panel Unit Root Tests of Exchange Rate

Method	W/o Trend	With Trend
Real Exchange Rate Based on US Dollar Numeraire		
LLC test	−5.2571**	−6.7450***
IPS test	−5.3980**	−6.9275***
MW test	−8.9543***	−9.7286***
CIPS test	−4.0798*	−5.9487**
Real Effective Exchange Rate		
LLC test	−3.5786*	−5.3548**
IPS test	−3.4111*	−5.1457**
MW test	−5.7156**	−6.0489**
CIPS test	−3.7848*	−4.9548**

Note: *significant at 0.1, **significant at 0.05, and ***significant at 0.01.

countries have been constant for more than decade after the agreement of ASEAN. Absolute PPP has been held among ASEAN-5 countries. However, these panel unit root tests can only confirm the absolute PPP property but not relative PPP since the tests only measure real exchange rate without inflation or price effects. Therefore, in order to further test whether PPP held among ASEAN-5 during 2005−2015, this study performs panel cointegration tests or long-run relationship between nominal exchange rates and inflation ratio between each pair of the two countries among ASEAN-5.

4.1.2. Results of Panel Cointegration Tests

Panel cointegration tests of exchange rate, both nominal exchange rate based on US Dollar numeraire and nominal effective exchange rate, and price ratio computed by inflation ratio between the two countries indicate that there exists long-run relationship between the two variables. The test results imply that the variation of nominal exchange rates among ASEAN-5 countries were determined by inflation ratio between the two countries. As a result, the relative PPP has been held among ASEAN-5 countries during 2005−2015. Economic integration of ASEAN countries leads to integration of exchange rate among countries.

Table 2 reveals the results of panel cointegration tests of exchange rate and price ratio using Pedroni method. All tests are rejected indicating that panel cointegrating relationship between nominal exchange rate and inflation exists.

According to panel unit root tests and panel cointegration tests, the existence of absolute PPP and relative PPP among ASEAN-5 is confirmed during 2005−2015, thus, exchange rate integration among ASEAN-5 does exist. In order to determine whether this exchange rate integration is caused by economic integration, this study employs panel cointegration test to test

Table 2: Results of Panel Cointegration Tests of Exchange Rate and Price Ratio

Cointegration	1	2
Pedroni test		
Modified Phillips-Perron *t*-test	1.7775**	1.5592*
Phillips-Perron *t*-test	2.2063**	1.4929*
Augmented Dickey-Fuller *t*-test	2.7985***	1.2201*

Note: *significant at 0.1, **significant at 0.05, and ***significant at 0.01.
1 = Nominal exchange rate based on the US Dollar Numeraire.
2 = Nominal effective exchange rate.

the long-run relationship between level of economic integration and level of exchange rate integration.

4.2. Testing Results of the Relationship between Economic Integration and Exchange Rate Integration

The processes of testing relationship between economic integration and exchange rate integration include (i) determination of levels of integration, both economic integration and exchange rate integration among ASEAN-3; and (ii) panel cointegration test between level of economic integration and level of exchange rate integration among ASEAN-3.

4.2.1. Measuring Level of Exchange Rate Integration

Unlike Genberg (2017),[1] this study employs CCC-MGARCH models to determine level of exchange rate integration. First, the study determine whether there exists exchange rate integration among ASEAN-3 using time series data. CCC-MGARCH models of real effective exchange rate of the ASEAN-3 countries, Malaysia, Singapore, and Thailand, are estimated using all daily data during 2005−2015.

Table 3 shows the estimated results of MGARCH models using all daily data (2005−2015) of real effective exchange rate of Malaysia, Singapore, and Thailand estimated by maximum simulated likelihood. The statistical significant estimated average values of constant conditional correlations during 2005−2015 between Thailand and Singapore (0.2251), Thailand and Malaysia (0.2219), and Singapore and Malaysia (0.4107) can help reconfirm the integration of exchange rates of the three countries.

Later, the quarterly series of levels of integration of exchange rate between each pair of the three countries, including Singapore−Malaysia, Singapore−Thai, and Malaysia−Thai, are determined by separately estimate 44 CCC-MGARCH models using the daily data of 44 quarter data groups during 2005−2015. Then, the quarterly series of levels of economic integration between each pair of the three countries are then measured by the ratio of trading value between the two countries to the total international trading value of the two countries. Finally, the relationship between economic integration and exchange rate integration is tested by using panel cointegration.

[1] Genberg (2017) determined level of financial integration by using degree of financial openness based on actual holding of foreign asset. However, the degree of financial openness does not truly capture the level of exchange rate integration since it just determine degree of financial dependency between the two countries.

Table 3: Estimated Results of CCC-MGARCH Models Using 11-year Data (2005−2015)

	E_{THt}	E_{SGt}	E_{MYt}
E_{THt-1}	0.9962***	0.0001	0.0002***
E_{SGt-1}	0.0330	0.9966***	−0.0176***
E_{MYt-1}	0.0362***	0.0019***	1.0118***
Constant	−0.0435**	−0.0032***	−0.0122***
$ARCH_{t-1}$	0.4022***	0.1312***	2.5753***
Constant	0.0099***	0.0001***	0.0001***
corr(th, sg)	**0.2251****		
corr(th, mal)	**0.2219****		
corr(sg, mal)	**0.4107****		
N	4573		
Log-likelihood	35922.47		
Chi-squares	18700000***		

Note: *significant at 0.1, **significant at 0.05, and ***significant at 0.01.

Table 4: Results of Panel Cointegration Tests of Level of Economic Integration and Level of Exchange Rate Integration among ASEAN-5

Cointegration	
Pedroni test	
Modified Phillips-Perron *t*-test	1.6327*
Phillips-Perron *t*-test	1.8126**
Augmented Dickey-Fuller *t*-test	1.9982**

Note: *significant at 0.1, **significant at 0.05, ***significant at 0.01.

4.2.2. Panel Cointegration Tests between Level of Economic Integration and Level of Exchange Rate Integration

Panel cointegration tests of level of economic integration and level of exchange rate integration of the ASEAN-3 countries indicate that there exists long-run relationship between the two measurements. Table 4 reveals the results of panel cointegration tests of level of economic integration and level of exchange rate integration among ASEAN-3 using Pedroni method. All tests are rejected indicating that panel cointegrating relationship between level of economic integration and level of exchange rate integration of the ASEAN-3 countries exists.

The test results indicate that changing in level of economic integration leads to changing in level of exchange rate integration of the ASEAN-3 countries. Accordingly, this study concludes that economic integration of ASEAN-3 countries leads to integration of exchange rate among these countries.

5. Conclusion

Similar to Lopez and Papell (2007), Lopez (2008), Engel (2000, 2014), and Engel and West (2005, 2006), with longer time period, and hence increased power of the tests, results of panel unit root tests, and panel cointegration tests of this study confirm the validity of both absolute PPP and relative PPP among ASEAN-5 countries. Additionally, the findings are conceptually in line with Lau et al. (2012), Matsuki and Sugimoto (2013), Sarno and Schmeling (2014), Pontines and You (2015), Kar (2018), and Soon, Baharumshah, and Wohar (2018). However, the panel cointegration test results do not provide strong evidence support PPP because of low significant level of the panel cointegration test of nominal effective exchange rate and inflation ratio. Kakkar and Yan (2012) found strong evidences of PPP for the tradable goods. Therefore, the aggregate tests in this study that cover both tradable and nontradable prices might not be able to fully reveal the validity of relative PPP among ASEAN-5.

Consistent with the findings of Wu, Cheng, and Hou (2011), Hooy et al. (2015), Lee, Wu, and Yang (2016), and Wardhono, Dana, and Nasir (2017), the panel cointegration tests between level of economic integration and level of exchange rate integration reveal the relationship between the two factors. The results support hypothesis that PPP tends to be supported for countries with similar country characteristics, especially in terms of degree of international trade openness and economic growth rates. With freer-trade agreement lead to less trade barrier, less transaction costs, and low transportation cost, economic integration among ASEAN countries practically leads to exchange rate integration (Alba & Papell, 2007; Basnet & Upadhyaya, 2015; Lopez & Papell, 2007; and Soleymani, Chua, & Hamat, 2017). The findings imply that trade liberalization has the strongest effects toward the real exchange rate. Thus, regulators of ASEAN countries should also pay more attention to exchange rate policies of other countries in ASEAN since exchange rates of ASEAN also have impacts on each other.

The findings reveal that the integration of exchange rate of the five countries exists. The test helps confirm the hypothesis of PPP that law of one prices is feasible when no or less transaction cost exists. The findings imply that trade liberalization has the significant effects toward the real exchange rate.

References

Alba, J. D., & Papell, D. H. (2007). Purchasing power parity and country characteristics: Evidence from panel data tests. *Journal of Development Economics*, *83*, 240–251.

Atjimakul, P. (2008). *Purchasing power parity and country characteristics: The evidence of Thailand*. Unpublished Master Thesis, Faculty of Commerce and Accountancy, Thammasat University.

Basnet, H. C., & Upadhyaya, K. P. (2015). Impact of oil price shocks on output, inflation and the real exchange rate: Evidence from selected ASEAN countries. *Applied Economics*, *47*(28), 3078–3091. doi:10.1080/00036846.2015.1011322

Cassel, G. (1918). Abnormal deviations in international exchanges. *Economic Journal*, *28*, 413–415.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of Political Economy*, *84*, 1161–1176.

Dornbusch, R., & Fischer, S. (1980). Exchange rates and the current account. *American Economic Review*, *70*(5), 960–971.

Dutton, M., & Strauss, J. (1997). Cointegration tests of purchasing power parity: The impact of non-traded goods. *Journal of International Money and Finance*, *16*(3), 433–444.

Edison, H. J., Gagnon, J. E., & Melick, W. R. (1997). Understanding the empirical literature on purchasing power parity: The post-Bretton woods era. *Journal of International Money and Finance*, *16*(1), 1–17.

Enders, W. (1988). ARIMA and cointegration tests of PPP under fixed and flexible exchange rate regimes. *The Review of Economics and Statistics*, *70*(3), 504–508.

Engel, C. (2000). Long-run PPP may not hold after all. *Journal of International Economics*, *57*, 243–273.

Engel, C. (2014). Exchange rates and interest parity. *Handbook of International Economics*, *4*, 453.

Engel, C., Hendrickson, M. K., & Rogers, J. H. (1997). Intranational, intracontinental, and intraplanetary PPP. *Journal of the Japanese and International Economies*, *11*, 480–501.

Engel, C., & West, K. (2005). Exchange rates and fundamentals. *Journal of Political Economy*, *113*, 485–517. doi:10.1086/429137

Engel, C., & West, K. (2006). Taylor rules and the Deutschmark-Dollar real exchange rate. *Journal of Money Credit and Banking*, *38*, 1175–1194. doi:10.1353/mcb.2006.0070

Frankel, J. (1981). The collapse of purchasing power parity during the 1970s. *European Economic Review*, *16*, 145–165.

Genberg, H. (2017). *Financial Integration in ASIA*. Working Paper 22/2017. The South East Asian Central Banks (SEACEN) Research and Training Centre (80416-M), Kuala Lumpur, Malaysia.

Hooy, C. W., Law, S. H., & Chan, T. H. (2015). The impact of the renminbi real exchange rate on ASEAN disaggregated exports to China. *Economic Modelling*, *47*, 253–259.

Im, K. S., Pesaran, H. M., & Shin, Y. (2003). Testing for unit roots in heterogenous panels. *Journal of Econometrics*, *115*, 53–74.

Kakkar, V., & Yan, I. (2012). Real exchange rates and productivity: Evidence from Asia. *Journal of Money, Credit and Banking*, *44*, 301–322.

Kar, M. (2018). Economic integration and trade protection: Policy issues for South ASIAN countries. *Contemporary Economic Policy*, *36*(1), 167−182. doi:10.1111/coep.12239

Koedijk, K. G. (1998). The pendulum of exchange rate economics. *Journal of International Money and Finance*, *17*(1), 1−3.

Koedijk, K. G., Schotman, P. C., & Van Dijk, M. A. (1998). The re-emergence of PPP in the 1990s. *Journal of International Money and Finance*, *17*(1), 51−61.

Lau, C. K. M., Suvankulov, F., Su, Y., & Chau, F. (2012). Some cautions on the use of nonlinear panel unit root tests: Evidence from a modified series-specific non-linear panel unit-root test. *Economic Modelling*, *29*, 810−816.

Lee, C., Wu, J. L., & Yang, L. (2016). A simple panel unit-root test with smooth breaks in the presence of a multifactor error structure. *Oxford Bulletin of Economics and Statistics*, *78*(3), 365−393.

Levin, A., Lin, C. F., & Chu, J. C. S. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, *108*, 1−24.

Lopez, C. (2008). Evidence of purchasing power parity for the floating regime period. *Journal of International Money and Finance*, *27*(1), 156−164.

Lopez, C., & Papell, D. H. (2007). Convergence to purchasing power parity at the commencement of the Euro. *Review of International Economics*, *15*(1), 1−16.

Lothian, J. R., & Taylor, M. P. (1996). Real exchange rate behavior: The recent float from the perspective of the past two centuries. *Journal of political economy*, *104*(3), 488−509.

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, *61*, 631−653.

Manzur, M. (2018). Exchange rate economics is always and everywhere controversial. *Applied Economics*, *50*(3), 216−232. doi:10.1080/00036846.2017.1313960

Matsuki, T., & Sugimoto, K. (2013). Stationarity of Asian real exchange rates: An empirical application of multiple testing to nonstationary panels with a structural break. *Economic Modelling*, *34*, 52−58.

Melvin, M., & Bernstein, D. (1984). Trade concentration, openness, and deviations from purchasing power parity. *Journal of International Money and Finance*, *3*, 369−376.

Pedroni, P. (1996). *Fully modified OLS for heterogeneous cointegration panels and the cas of purchasing power parity*. Indiana University Working Papers in Economics, No. 96-020 (June 1996).

Pedroni, P. (2000). Fully modified OLS for heterogeneous cointegrated panels. *Advances in Econometrics*, *15*, 93−130.

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, *20*, 597−625.

Pesaran, M. H. (2003). *A simple panel unit root test in the presence of cross section dependence*. Faculty of Economics, University of Cambridge: Working Papers in Economics, No. 0346.

Petri, P. A., Plummer, M. G., & Zhai, F. (2012). ASEAN economic community: A general equilibrium analysis. *Asian Economic Journal*, *26*(2), 93−118.

Phillips, P., & Hansen, B. (1990). Statistical inference in instrumental variable regression with I(1) processes. *Review of Economic Studies*, *57*, 99−125.

Pontines, V., & You, K. (2015). Asian currency unit (ACU), deviation indicators and exchange rate coordination in East Asia: A panel-based convergence approach. *Japan and the World Economy*, *36*, 42−55.

Reunrojrung, T. (2008). *Testing the purchasing power parity: Evidence of Thailand and Trade Partners*. Unpublished Master Thesis, Faculty of Economics, Thammasat University.

Sarno, L., & Schmeling, M. (2014). Which fundamentals drive exchange rates? A cross-sectional perspective. *Journal of Money Credit and Banking*, *46*, 267−292. doi:10.1111/jmcb.2014.46.issue-2−3

Soleymani, A., Chua, S. Y., & Hamat, A. F. C. (2017). Exchange rate volatility and ASEAN-4's trade flows: Is there a third country effect? *International Economics and Economic Policy*, *14*(1), 1−27. doi:10.1007/s10368-015-0328-9

Soon, S. V., Baharumshah, A. Z., & Wohar, M. E. (2018). Exchange rate pass-through in the Asian countries: Does inflation volatility matter? *Applied Economics Letters*, *25*(5), 309−312.

Wardhono, A., Dana, B. S., & Nasir, M. A. (2017). Rethinking the exchange rate disconnect puzzle theory in ASEAN-6. *Economic Journal of Emerging Markets*, *9*(1), 98−103.

Wu, J. L., Cheng, S. Y., & Hou, H. (2011). Further evidence on purchasing power parity and country characteristics. *International Review of Economics and Finance*, *20*, 257−266.

Wu, Y. (1996). Are real exchange rates nonstationary? Evidence from a panel-data test. *Journal of Money, Credit and Banking*, *28*(1), 54−63.