Prospects of Monetary Integration in Asia:

Adopting the Yuan and Other Options

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THESIS

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1. INTRODUCTION

1.1 Background

Looking around the world, one can see many examples of movements towards monetary integration in the last couple of decades. Eleven countries in Europe formally adopted a common currency, the *euro*, in 1999 and several others joined later bringing the total as of today to 18[1]. Dollarization has been implemented in some of Latin American countries, such as Ecuador (2000), El Salvador (2001) and Caribbean Netherlands (2011) and is under active consideration by several other Latin American countries, including Mexico, Guatemala and Peru. Six oil-producing countries (Saudi Arabia, United Arab Emirates, Bahrain, Oman, Qatar, and Kuwait) have declared their intention to form a currency union. In addition, several economies have adopted currency boards with either the U.S. dollar or the euro, i.e. Hong Kong, Argentina, and Lithuania with the *dollar* and Estonia and Bulgaria first with the German mark and later with the *euro*.

In comparison with Europe and the North American countries, Asia was late in jumping into the regionalism bandwagon. Several attempts to forge closer economic integration among the East Asian countries during the 1990s were unsuccessful. East Asian region has experienced astonishing economic growth and has widely been cited as an example of sustained economic growth over the past a couple of decades. And to be sure, the absolute trade volume of Asian area continued to expand at a rapid pace due to the high growth rate of the region. Known as the Asian economic miracle, Asia had attracted almost half of worldwide capital inflow to these developing countries by 1997. A mass of hot money flows into this region results in a dramatic

[1] In addition, several smaller economies are also using the euro, such as Andorra, Kosovo, Montenegro, Monaco, San Marino, and the Vatican City are not EU members but do officially use the euro as their currencies.

increase in asset prices. Thailand, Malaysia, Indonesia, Philippines, Singapore, and South Korea experienced high GDP growth rates (8%-12%) in the late 1980s and early 1990s China and India have grown twice the global rate in the past decades.

However, the South East Asian financial crisis started in July 1997 in Thailand, and later on affected many other Asian countries. Western investors lost confidence in securities in this market and massively withdraw their money. Indonesia, South Korea and Thailand were the countries most affected by the crisis, while Hong Kong, Malaysia, Laos and the Philippines are also hit considerably. This crisis is a wake-up call to the Asian governments to prompt economic cooperation and establish a regional self-protection financial mechanism by considering further regional monetary integration.

The idea of a common currency for ASEAN Plus Three (APT) became popular after the Asian financial crisis of 1997-98. ASEAN Plus Three (APT) is a forum that functions as a coordinator of cooperation between the Association of Southeast Asian Nations and the three East Asia nations of China, Japan, and South Korea. To protect themselves against financial crises similar to the Asian financial crisis in 1997, the APT reached an agreement in Chiang Mai in Thailand in May 2000. After its announcement, the idea of a single currency for East Asian was transformed from a "laughable concept" to a "possible policy goal" (Castellano,2000). The first "East Asia Summit" was held in Kuala Lumpur, Malaysia on Dec 14, 2005 and the EAS has been meeting annually since then. The participating countries were the APT members, India, Australia, New Zealand, the United States and Russia. The Hanoi Declaration declared that all the participating countries agreed to strengthen the EAS further in the future on the Fifth Anniversary of the EAS in Oct 2010.

The journey towards economic integration in Asia has begun and monetary integration may be inevitable in the integration process. However, the literature investigating the effects of a common currency on economies of Asia has been virtually nonexistent compared to the extensive research examining the euro project for the European Union or the prospect of dollarization for the Americas.

1.2 Statement of the Problem

A currency union (also known as monetary union) takes place when two or more economies share the same currency. Generally, currency unions take one of two forms. In one, called unilateral adoption, client countries adopt the currency of a (usually larger) large anchor country, e.g. dollarization. In the other case, called multilateral adoption, a group of countries creates a new currency and a new joint central bank, e.g. the Eurozone. Compared to the European experience, regional integration in East Asian is more market driven, which has occurred in the absence of a formal institutional framework. The lack of political links and traditions may obstruct a concerted exchange rate policy to Asian countries so as to impede the formation of a new currency and common central bank. However, both unilateral and multilateral common currency adoptions in Asia have been considered in this study.

Would a common currency be helpful for Asian economies? How large would the gains be? What would the losses be in terms of business cycle volatility? How does trade integration affect business cycle synchronization among Asian countries? What implications this effect brings for a potential Asian currency union?

1.3 Purpose of the Study

As one of the largest economies in Asian, Japan has been considered as an anchor country if a number of Asian countries adopt the yen as their common currency (Karras 2004). Alesina, Barro and Tenreyro (2002) also discussed whether there appears to be reasonably worldwide well-defined dollar, euro, or yen areas. There is the other largest economy in Asia we should absolutely attach importance on when considering an appropriate anchor – China. In terms of both nominal and PPP-adjusted gross domestic product (GDP), China is now the largest economy in Asia and the second largest worldwide right after the United States. Prior to 1979, China was basically a closed economy with strict centralized planning. Since then, China has enforced economic reforms and "open door" gradually to the world, which have led to sharp rise in both growth rate and international linkage. In 2007, China's economic growth rate exceeded 11% and was then maintained around 9.5% in the following years. Moreover, over the past couple of decades, China has been moving from centralized control monetary policy to a more indirect, market-based control.

Therefore, after considering the yen, I would like to answer the question "Is there a yuan optimum currency area?" This study aims to focus on Chinese currency - the Yuan - and examines the main macroeconomic losses and gains of adopting the Yuan for a number of Asian countries. It also discusses the prospects of adopting the yen or the USD in Asia in order to make comparisons among yuanization, yenization and dollarization for these Asian economies. Later on, by adding trade issues into consideration, I want to explore how increasing trade intensity with China affects synchronization of business cycles between China and Asian economies so as to investigate what implications it brings to the formation of yuanization in Asia. Finally, multilateral adoptions of common currency in Asia have also been investigated.

1.4 Structure of the Study

The remainder of this study proceeds as follows: Section 2 reviews existing currency union theories and the empirical literatures. Section 3 uses a recent model of monetary policy in order to illustrate the theoretical determinants of losses and gains from two forms of adoptions: unilateral adoption and multilateral adoption. Section 4 evaluates macroeconomic gains and losses of adoption the yuan as a common currency for Asian economies. Section 5 makes comparisons among the formation of yuanization, yenization, and dollarization in Asia. Section 6 explores how increasing trade intensity with China affects synchronization of business cycles between China and Asian economies. Section 7 discusses the prospects of multilateral adoptions in Asia by measuring the macroeconomic gains and losses from the adoptions. Section 8 concludes.

2. LITERATURE REVIEW

2.1 Original Version of OCA Theory

Mundell (1961), McKinnon (1963) and Kenen (1969) are classic contributions to the Optimum Currency Area theory. Mundell (1961), it was the first time that someone used the phrase "Optimum Currency Areas". Mundell (1961) tried to answer the questions that if not all existing national currencies are flexible, what is the appropriate domain of a currency area is and what the crucial criteria of forming an OCA. He widened the concept of optimum currency area, which is not necessarily equivalent to the geography of a nation, but a region, or "area". To illustrate Mundell's problem, consider an asymmetric demand shock happened between two entities A and B. If these two entities are two countries with national currencies, with limited price and wage flexibility in the short run, a shift of demand from B to A causes unemployment in B and inflationary pressure in A. However, if these two entities are two regions in a common currency area, the monetary authority can increases the money supply to correct unemployment in B, while aggravates inflationary pressure in A. So "the optimum currency area is not the world" since the unemployment cannot be avoided in the world economy unless a world central bank relieves the burden to surplus countries, which inflates until unemployment in deficit countries has been eliminated. Mundell (1961) then illustrates that "the optimum currency area is the region" and *factor mobility* (he addressed mainly labor) is the essential ingredients of creating OCA regions. As in the model, free labor movements from region B to region A can smooth the unemployment in region B at no losses of more inflation pressure in region A. In simple words, Mundell (1961) disputes that the optimum currency area is the region defined in terms of internal

factor mobility and external factor immobility. The regions have fixed exchange rate or hold a common currency with the boarders and flexible exchange rate with the rest of the world.

McKinnon (1963) emphasizes that the *degree of openness* (defined as the ratio of tradable to non-tradable goods) as a crucial criterion in forming the OCA. He argues that the idea of factor mobility has two distinct senses: (1) geographic factor mobility among regions; (2) factor mobility among industries. He believes Mundell (1961) had interpretation in (1) primarily and once we consider problems of factor immobility among industries, it may not be feasible to think of slicing the world into currency areas along industrial grouping. McKinnon (1963) uses a simple model to consider the optimum extent of a currency area in terms of the ratio of tradable to non-tradable goods, in promoting the shifts in resources among industries. He argues that the more open the economy is, the more arguments there are for having a fixed exchange rate. The reason for this is that high openness causes the changes in international prices of tradables more likely to be transmitted to the domestic loss of living. For example, a devaluation under flexible exchange rate system would be more rapidly transmitted to the higher prices of tradables and higher losses of living. Hence, he concludes that a small open economy would find it advantageous to join a large common currency area.

Later on, Kenen (1969) introduced *product diversification* as an important criterion because he believes that the perfect labor mobility rarely exists. He argues "diversity in a nation's product mix, the number of single-product regions contained in a single country may be more relevant than labor mobility". He uses an example to explain how diversification criterion works: if a country is not diversified at all and produces only one product, which also exports, a negative demand shock will affect its exports and reduce export revenue. This fall in export revenue can be attenuated by domestic currency depreciation since domestic currency demand in the

international market has been reduced. However, if the economy has a fixed exchange rate, this mechanism cannot work and the adjustment can only be done by increased unemployment or a reduction of wage rate and price level. By contrast, if we consider a well-defined economy, a positive shock in one industry may be offset by a negative shock in another industry, making total exports stable. Of course, a macroeconomic disturbance will affect the whole export sector anyway and diversification in this case will not help. Therefore, economies that are sufficiently diversified could tolerate small losses of abandonment of their national exchange rates and gain from a single currency.

These three important contributions are not isolated but interrelated to each other. Kenen (1969) deepened the point of factor mobility. He points out that when regions are defined by their activities, not geographically or politically, perfect interregional labor mobility requires perfect occupational mobility (labor is homogeneous) so that Mundell's approach leads to small optimum currency areas. Indeed, small OCA can be coextensive with the less-diversified region, which is considered as crucial criterion of forming OCA by Kenen (1969). Moreover, one could say that smaller economies that are less diversified have to be more open in order to be able to import goods that they need and export goods to acquire money to pay for their imports. Hence, Kenen's diversification criterion can be transformed into McKinnon's openness criterion.

Besides Mundell (1961), Kenen (1963) and McKinnon (1969), more contributions have been made on to OCA theory such as Corden (1972), Mundell (1973), Ishiyama (1975) and so on. The second wave of research on OCA theory broadly analyzed OCA criteria and also introduced some new viewpoints into the theory. Corden (1972) points out that wage and price flexibility are the most important criteria in forming a common currency area because they can respond faster to asymmetric shocks. Ishiyama (1975) was the first one who acknowledge the limitations

of define OCAs based on a single property and postulates that each country should evaluate the losses and gains of participating in a currency area.

2.2 Contemporary Version of OCA Theory

At Mundell's time, OCA was more of an academic problem since it was hard to imagine a country would give up its national currency in favor of some other regime. But 38 years after the establishment of the OCA theory, the *euro* was created as the official currency of the Eurozone in 1999 and came into full force in 2002. Nowadays, the *euro* has been the second largest reserve currency as well as the second most traded currency in the world after the *United States dollar*. The OCA theory has developed so much and got a lot of impulses.

There was a slowdown in the development of OCA theory after the initial impulse of OCA theory in the 1960s and 1970s. The lack of empirical examples of monetary integration in the real world during that time might be the reason. However, in 1990s the theory got its rebirth because of the establishment of European Monetary Union. The debate on EMU attracted more and more interest of researchers again in OCA theory and sparked off a whole series of discussion of this theory. A lot more new issues have been brought into OCA theory: such as effectiveness and credibility of monetary policy, endogeneity vs. specialization hypothesis of OCA; political factors; trade gains; synchronization of business cycle; correlation and variation of shocks and so on.

Corden (1972) argues the explanation of how *effectiveness of monetary policy* affects OCA formations. He argues that joining a currency area causes a loss of direct control over the monetary policy and exchange rate so that if a monetary policy is not effective, the loss of monetary independence is not a high loss. Calvo and Reinhart (2002) supported and emphasized

this point view. Kydland and Prescott (1977) and Barro and Gordon (1983) pioneered the discussion of *the credibility* issue of the government. They believe that for a country with a record of relatively higher inflation and a reputation for breaking low inflation promise, it has the incentive to cheat on economic agents and increase inflation in order to prevent the unemployment. Then a way to immediately gain a low-inflation credibility is to "tie its hands" by adopting a fixed exchange rate regime or joining in a currency union (Edwards, 1997). Therefore, these *Political factors* will inevitably influence the choice of joining/forming the currency union (Collins, 1996).

The discussion of *endogeneity vs. specialization* hypothesis of OCA has arisen in recent years. From Frankel (1999), the endogeneity of OCA criteria means that the parameters such as openness and income correlation are not irrevocably fixed, but instead they can change over time in response to the countries' fundamental policies and exogenous factors. Frankel (1999) uses a downward sloping OCA line to explain that even if the prospective candidates for currency area are below the OCA line at this moment, further trade integration after joining the currency area will increase the income correlation and move that country across the OCA line. Later on, the "endogeneity of OCA" has been extended broadly, as the endogeneity of economic and financial integration, the endogeneity of symmetry of shocks by De Grauwe and Mongelli (2004); Blanchard and Wolfers (2000) points out the endogeneity of labor market institution and Issing (2001) states the endogeneity of political integration. Generally, the endogeneity issue of OCA explains that a country is more likely to satisfy the criteria for entering a common currency area *ex post* than *ex ante* due to increased business cycle correlation.

Synchronization of business cycles is another factor that has quite an influential status in this modern phase. It means that if the business cycles of members of a currency area are

synchronized, the loss of not having its own monetary policy is minimized. It was Alesina and Barro (2002) who first developed a systematic model to quantify the common currency effects on the amount of trade, output and consumption. By comparing the gains (how inflation bias with the anchor economy) and losses (how business cycle correlates with the anchor economy) of joining the currency union, they are able to suggest what types of countries would be more motivated to adopt a common currency. Their analysis is built on the framework of Mundell (1961), which is the pioneer in OCA gains vs. disadvantages discussion. They state that a currency union can reduce the transaction losses of trade and a currency union can commit a country to monetary stability. They argue that the losses of currency adoption are the loss of monetary independence. They also discuss the relationship between the number and the size of countries and the number of currencies in circulation. Alesina and Barro begin with a simple model of the real economy with a role of trade and country size and suppose each of two countries produces a particular intermediate good that the other country cannot produce. Each country has competitive firms and there is only one type of final consumption good. So apparently, both countries have to trade with the other partner. They export the intermediate good that they produce and import the intermediates that they do not produce. Trading loss b emerges for each unit of intermediate good shipped from one country to another, with $0 < b < 1$. They adopt competitive firms' production function proposed by Spence (1976), Dixit and Stiglitz (1977), and Ethier (1982) and each firm maximizes its profit. By doing further deviation and extension, they investigate how output or trade volume change in terms of trading loss (b); how country size affects entering into a currency union; and compare the how outcome varies under independent monetary policy and dollarization. As a result, they conclude that the type of country that has more to gain from giving up its own currency has the following characters: (i) a

small open economy (ii) heavily trading with one particular large partner (iii) with a history of high inflation and (iv) with a business cycle highly correlated with that of the potential "anchor". They also show that, as the number of countries increases, the number of currencies may not only increase less than proportionately but may even fall and this result highlights an important empirical implication of their model.

Alesina and Stella (2010), which prepared for the Handbook of Monetary Economics, developed a simplified version of Alesina and Barro's (2002) model and applied that model to two types of currency unions: unilateral adoption and multilateral adoption. The comparison between inflation bias gains and business-cycle volatility losses are then more simple and intuitive. They then examine the issue of Central Banks independence both in normal times and in times of crisis. At last, a brief review on European experience tells that the financial crisis of 2008/09 has shaken some of the foundations of what people knew about monetary policy and its institutions. They thought that independent central banks targeting inflation were the solution. This model is widely used on the recent empirical OCA literature and my study is built on this model (see section 4).

2.3 Empirical Studies of OCA Theory

This section reviews several recent empirical studies on the diverse OCA properties. The *similarity of shocks* is almost a "catch all" OCA property across all empirical OCA literatures. The intuition is that if the incidence of supply and demand shocks and the speed with which the economy adjusts are similar across partner countries, then the net gains from adopting a single currency might be higher.

Most of Asian OCA literatures focus heavily on this issue and something that has no universal consensus answers is how to measure business cycle synchronization. Simple correlation between countries is mainly used to measure the degree of shock symmetry. Structural VAR approach (SVAR), developed by Blanchard and Quah (1989), is another technique that is widely used in recent literature. Bayoumi and Eichengreen (1994) and (1999) use this SVAR technique by running a national VAR of changes of output and prices for a panel of Asian and Pacific countries from 1972 to 1989 and get the findings as follows: supply shocks are symmetrical for Japan, South Korea, Taiwan (the first group); and Hong Kong, Indonesia, Malaysia, and Singapore (the second group). The demand shocks of the second group are relatively higher than the first group. They conclude that these two groups of countries are likely to form separate OCAs. Later on, Bayoumi and Eichengreen (1999), entitled "Is Asian an Optimum Currency Area? Can It Become One?" , construct an OCA index with four variables: (i) $SD[\ln(y_i) - \ln(y_j)]$, (ii) the dissimilarity of the exports compositions of i and j, (iii) bilateral trade, (iv) average size of the pair of countries. Their OCA index suggests that the very small, open economies, as Hong Kong and Singapore, would find it most appealing to peg to other East Asian countries. There are quite a few country pairs having strong argument for a common external peg, such as Singapore-Thailand, Singapore-Hong Kong, etc. The case for Indonesia, South Korea and Philippines is weaker. In addition, Bacha (2008) uses SVAR technique to investigate 14 East Asian and Pacific countries over 1970-2003 with different variables, real GDP, prices, narrow money and short term deposit rate. He argues that several country pairs show an absence of broad-based common linkage and they are Malaysia-Singapore, Japan-Korea, Indonesia-Thailand; Australia-New Zealand. The reason behind these results maybe the geographic proximity.

Alesina, Barro and Tenreyro (2002) developed a different way of computing the similarity of shocks: they pair all countries with each of the three anchors and calculate their bilateral co-movement of outputs and prices; the higher co-movements of prices and outputs, the more promising candidate the client country is to consider adopting the corresponding large economy's currency. Generally, "the more the shocks are related the more policy selected by the anchor will be appropriate for the client". Alesina, Barro and Tenreyro (2002) uses the framework developed by Alesina and Barro (2002) as a theoretical background and explores the pros and cons for different countries to adopt the US dollar, the euro, or the yen so that it evaluates whether there appear to be reasonably well defined dollar, euro or yen area. Based on the optimum currency area criteria concluded from Alesina and Barro (2002), inflation, trade ratio and co-movements of outputs and prices turn to be the targets that they would like to investigate. Specifically, they compute average annual inflation rate and inflation rate variability of a panel of countries of the world over the period from 1970 to 1990 and rank the results from high to low and as the theory suggests, high inflation countries would be potential clients of adopting an anchor's currency. Alesina, Barro and Tenreyro (2002) then calculate trade volumes as average trade-to-GDP ratios over 1960-97 with three potential anchors for currency areas: the United States, the euro area (based on twelve members) and Japan. The more the small country trades with its large partner, the better candidate it is for considering the adoption. Combining all information delivered by these four criteria, this papers shows that: (i) Africa is more associated with euro-12 and also trades more with the euro zone; (ii) North America is highly associated with the United States; (iii) Latin America trades overall more with the United States while is more associated with the euro area; (iv) In Asia, Hong Kong and Singapore are more associated with the United States than with Japan. Finally, the paper concludes that there seems to be a

fairly clear dollar area and euro area, but not seem to be any clear yen area because fewer countries are associated with Japan in terms of price and output co-movements and trade flows to Japan are more dispersed across partners.

The *synchronization of business cycle* is an important element in the research of OCA theory. A series of G. Karras' literature use business cyclical correlation to measure the macroeconomic losses of adopting a single currency or joining a currency area. G. Karras successively investigate the common currency's role in the macroeconomic performance for Americas region (2002), East Asia (2005), The Middle East (2007) and Europe (2011). He discussed the losses and gains of dollarization for North, Central and South America; the yen for Asian countries; a common currency for the Middle East and the performance of the *euro* for European countries. I would like to review these series of paper parallel since they are using similar theoretical background and similar methodology. As I introduced above, currency union usually takes one of two forms – small economies adopt the currency of a large anchor country or a group of countries creates a new common currency. Dollarization for Americas region and adopting the yen for a number of Asian countries are the empirical examples of the former case, while considering a common currency for the Middle East and the creation of the euro are the applications of the later form. No matter which form was taken, theory suggestions are actually similar. OCA theory suggests that under certain conditions, the main gain for a country joining a monetary union is the enhanced price and exchange-rate stability, and thus lower steady-state inflation rate. At the same time, abandonment of national currency rules out the possibility of independent monetary policy, which means the adoption may contributes to business-cycle volatility if the client country's output is not sufficiently correlated with that of the anchor country or the area as a whole if considering creating common currency for the entire region. In

Karras's early time research on OCA theory, the theoretical framework follows the 'New Keynesian' monetary policy model of Clarida et al. (1999) and focuses on those criteria of determining macroeconomic losses and gains. Later on, he takes advantage of the recent model of Alesina and Stella (2010) instead. The essences of both approaches are the same though:

Monetary authority preferences are given by the loss function:

$$L_i = \frac{b_i}{2}(y_i - k_i)^2 + \frac{1}{2}\pi_i^2$$

This is minimized subjecting to:

$$y_i = \pi_i - \pi_i^e + u_i$$

where u_i is an output shock with zero mean and variance σ_i^2, $u_i \sim iid\ (0,\ \sigma_i^2)$; π_i is the inflation, π_i^e is the expected inflation. In loss function, $k>0$ is the target level of output and b denotes the weight of deviation of output from its target relative to the deviation of inflation from its target (which is assumed to be zero). Apply this mathematics to two conditions - pre-adoption with monetary independence and post-adoption, which rules out this independency. After completing first order condition and some necessary calculation and substitution, average inflation and output volatility expressions are obtained for each distinguish condition. Comparing average inflation formula between pre-adoption and post-adoption condition shows the potential macroeconomic gain of adopting a currency and comparing output volatility between these two conditions gives the potential macroeconomic loss of the adoption.

The common findings in different regions in this series of Karras's OCA literatures are: (1) the estimated losses and gains vary across the countries substantially and they are usually positively correlated; (2) countries that have gained a lot from adopting often have a lot to lose from it,

and meanwhile other countries that have little to lose from adopting a currency usually have little to gain; (3) countries with high positive correlation with the anchor economy gain more from adopting and vice versa.

In particular, this series of empirical results also show that Chile is a better candidate for dollarization than Mexico, while Korea is a better candidate of adopting the yen than Pakistan or Malaysia. Referring to the Middle Eastern countries, many of them have achieved remarkable convergence both in business-cycle synchronization and inflation outcomes. If these cases are more of an academic problem, the creation of the *euro* gives more realistic meaning to the real world since it is the first successful example of a group of countries adopting a newly created currency and joining in a newly established central bank. There have been all kinds of research on the role and performance of the *euro* ever since its creation. In Karras (2011), the most significant contributions are: synchronization of cyclical output was substantially affected by the common currency in Greece, Finland and Ireland; cyclical synchronizations and volatilities appear strong negative relationship, which however is not much stronger under the *euro* than it was during the Maastricht period.

In addition, the synchronization of business cycle is also an important element in the research of the endogeneity of OCA Frankel and Rose (1997), intensity of bilateral trade and correlation of business cycle Frankel and Rose (1996), monetary integration as disciplinary effect Buti and Suardy (2000) and specialization hypothesis (Krugman, 1993).

Openness, firstly established by McKinnon (1963), has always been considered as one of the crucial criterions of forming an OCA. Empirically, Rose (2000) started OCA literature on the trade gains of currency union, using a United Nations panel dataset on trade among around 200

countries. He found that currency unions triple trade among their members. Frankel and Rose (2002) study a large cross-section of countries and find that abandoning the national currency and joining a currency union both enhances trade and income. Glick and Rose (2002) provide some time-series evidence using a panel data set about 217 countries over 1947 to 1997 and argue that leaving a currency union decreases trade. Alesina and Barro (2002) find that the countries that gain the most in joining a currency union are those that trade most with each other.

As above, this section has reviewed and explained many contributions on the OCA theory. APPENDIX A Part A shows the most important attributes on accessing joining a currency area and Part B gives a summary of empirical studies on OCA for different regions in recent years.

3. THEORETICAL BACKGROUND

3.1 Model Setup

Alesina and Stella (2010) developed a simplified version of Alesina and Barro's (2002) model. I borrow their model in this study and focus more on the comparisons of the macroeconomic losses and gains if considering joining the yuan union. The model was generalized for N economies indexed by *i (i=1, 2… N)*. The *ith* economy's monetary authority minimizes the loss function:

$$L_i = \frac{b_i}{2}(y_i - k_i)^2 + \frac{1}{2}\pi_i^2 \tag{3.1}$$

subject to an output (y_i) equation, given by an expectations-augmented Phillips curve:

$$y_i = \pi_i - \pi_i^e + u_i \tag{3.2}$$

Where y_i is the output, market level of output is normalized to be zero; u_i is an output shock with zero mean and variance σ_i^2, $u_i \sim iid\ (0,\ \sigma_i^2)$; π_i is the inflation rate, π_i^e is the expected inflation rate. In the loss function (3.1), k is the target level of output and b denotes the weight of deviation of output from its target relative to the deviation of inflation from its target (which is assumed to be zero)[2].

3.2 No Common Currency: Independent Monetary Policy

The policymaker controls inflation independently if the common currency is not adopted. I use the superscript "IND" to indicate the outcomes under independent monetary policy. Assume each economy's Central Bank minimizes (3.1) subject to (3.2). First order conditions give:

[2] Inflation target is theoretically assumed to be zero in this study for simplicity, though the consensus among scholars today is that a low, but positive inflation rate would be superior to zero inflation.

$$\pi_i^{IND} = \frac{b_i}{1+b_i}(\pi_i^e - u_i + k_i) \tag{3.3}$$

Given $\pi_i^e = E(\pi_i)$,

$$\pi_i^e = E(\pi_i^{IND}) = \frac{b_i}{1+b_i}(\pi_i^e + k_i) \tag{3.4}$$

It follows that

$$\pi_i^e = b_i k_i \tag{3.5}$$

Substitute (3.5) into (3.3), and the inflation under independent monetary policy is:

$$\pi_i^{IND} = b_i k_i - \frac{b_i}{1+b_i} u_i \tag{3.6}$$

and, substituting (3.5) and (3.6) into (3.2), output with monetary independence is:

$$y_i^{IND} = \frac{1}{1+b_i} u_i \tag{3.7}$$

As a result, the average inflation rate of each independent economy *i* can be evaluated as:

$$\bar{\pi}_i^{IND} = b_i k_i \tag{3.8}$$

Obviousely, if the policymaker assigns higher output weight (*b*) relative to inflation rate, the average inflation rate will be large. Oppositely, a smaller *b* gives a lower inflation bias.

From (3.7), ouput volatility equals:

$$Var(y_i^{IND}) = (\frac{1}{1+b_i})^2 \sigma_i^2 \tag{3.9}$$

in which higher (*b*) states a smaller volatility of the *ith*'s output.

As a result, it appears a clear trade off between average inflation rate and output volatility: a higher *b* reduces business-cycle volatility, at the loss of higher inflation bias. Similarly, a lower *b* gives lower average inflation rate, but the output will be unstable.

3.3 Adopting a Common Currency: Sacrificing Independent Monetary Policy

3.3.1 Unilateral Currency Union: Adopting the Yuan as a Common Currency

In Alesina and Stella (2010) unilateral adoption, they consider the world of two countries, a large one (anchor) and a small one (client). In this study, the model was generalized for N economies indexed by *i (i=1, 2… N)*, which consists of one large anchor economy (China) and N-1 smaller economies (the other Asian economies).

Now assume that these N-1 smaller client economies deside to give up their national currencies and adopt the yuan. China, as the large anchor economy, still makes independent monetary policy because the People's Bankd of China, the Chinese Central Bank, determines monetary policy for the entire currency union. Applying (3.8) and (3.9) to China, this anchor economy will control its optimal average inflation rate at:

$$\bar{\pi}_C^{YUAN} = b_C k_C \tag{3.10}$$

And output volatility of China is:

$$Var(y_C^{YUAN}) = (\frac{1}{1+b_C})^2 \sigma_C^2 \tag{3.11}$$

The subscript *C* refers to the anchor country China and the superscript *YUAN* refers to outcomes under the yuan's adoption. Then, at equilibrim , the average inflation rate of the clients country *i* is given by

$$\bar{\pi}_i^{YUAN} = \bar{\pi}_C^{YUAN} = b_C k_C \tag{3.12}$$

Substituting this into equation (3.2), this gives the *i*th economy's output under the yuan monetary integration as:

$$y_i^{YUAN} = u_i - \frac{b_C}{1 + b_C} u_C \tag{3.13}$$

Therefore, the business-cycle volatility of economy *i* who adopts the yuan is:

$$Var\left(y_i^{YUAN}\right) = \sigma_i^2 + \left(\frac{b_c}{1 + b_C}\right)^2 \sigma_C^2 - 2\rho_{i,C}\left(\frac{b_c}{1 + b_C}\right)\sigma_i\sigma_C \tag{3.14}$$

where $\rho_{i,C} \equiv corr(u_i, u_C)$.

After adopting the yuan, client countries lose their independent monetary policy and can only accept monetary policy authorised by the People's Bank of China. Thus Chinese shocks will be "exported" to the client countries. As shown in (3.13), economy *i*'s output is affected by both u_i (its own output shock) and u_C (Chinese shock).

b_c has positive effect on $Var\left(y_i^{YUAN}\right)$ when client economy is negatively correlated with the anchor China ($\rho_{i,C} < 0$). When economy i is positively correlated with China ($\rho_{i,C} > 0$), the affect of b_c on the variance of output under common currency is ambiguous.

Given $\rho_{i,C} < 0$,

$$\Delta Var\left(y_i^{YUAN}\right) > 0, if\ \Delta b_c > 0$$

$$\Delta Var\left(y_i^{YUAN}\right) < 0, if\ \Delta b_c < 0$$

Given $\rho_{i,C} > 0$,

$$\Delta Var\left(y_i^{YUAN}\right) \text{ is ambiguous, if } \Delta b_c > 0 \text{ or } < 0$$

This makes economic sense because when $\rho_{i,C} > 0$, the output shocks that are imported from China by adopting the yuan, component $\left(\frac{b_c}{1+b_C}\right)^2 \sigma_C^2$, will be smoothed by its positive correlation with the base country China, component $-2\rho_{i,C}(\frac{b_c}{1+b_C})\sigma_i\sigma_C$. These two conponents change in different direction so that total effect is ambiguous. By contrast, when $\rho_{i,C} < 0$, these two components are chang in the same way, total effect replies on the change direction of parameter b_c.

Similarly, σ_C has positive affect on $Var\left(y_i^{YUAN}\right)$ when client economy is negatively correlated with the anchor China ($\rho_{i,C} < 0$). When economy *i* is positively correlated with China ($\rho_{i,C} > 0$), the affect is ambiguous.

I would like to illustrate the role of $\rho_{i,C}$ by taking two extreme cases: $\rho_{i,C} = 1$ and $\rho_{i,C} = -1$, for which economy *i* is completely positively and negatively correlated with China, with the same *b*s and σs.

i. $\rho_{i,C} = -1; b_c = b_i; \sigma_C = \sigma_i$

In this case, economy *i* and China are perfectly negatively correlated; I use *b* to represent policy weight on output deviation relative to inflation deviation for both *i* and China since b_i has been standardized to the same with b_c; same with $\sigma = \sigma_C = \sigma_i$.

Equation (3.14) will then derive the following result:

$$Var\left(y_i^{YUAN}\right) = \left(\frac{1+2b}{1+b}\right)^2 \sigma^2 \tag{3.15}$$

Looking at (3.9) and (3.15), country *i*'s output volatility before and after joining the yuan currency union is compared:

$$\left(\frac{1+2b}{1+b}\right)^2 \sigma^2 \gg (\frac{1}{1+b})^2 \sigma^2$$

So that $Var(y_i^{YUAN}) \gg Var(y_i^{IND})$, which means output variance will be greater after adopting the yuan than before. This result makes economic sense because when $\rho_{i,C} = -1$, country *i* and China are totally out of sync, so that China's monetary policy will be the worse substitute for country *i*'s monetary policy. China's output shock will be imported into domestic economy significantly, implying economy *i* as the worst candidate of adopting the yuan.

ii. $\rho_{i,C} = 1; b_c = b_i; \sigma_C = \sigma_i$

In this case, economy *i* and China are perfectly positively correlated; again $b = b_c = b_i; \sigma = \sigma_C = \sigma_i$.

Output fluctuation then takes the expression:

$$Var(y_i^{YUAN}) = \sigma^2 \left(\frac{1}{1+b}\right)^2 \tag{3.16}$$

So that $Var(y_i^{YUAN}) = Var(y_i^{IND})$, which means the domestic output variances are exactly the same with or without independent monetary policy. The economic meaning when $\rho_{i,C} = 1$, country *i* is perfectly positively correlated with China, so that China's monetary policy will be the perfect substitute for country *i*'s monetary policy without importing any of China's output shocks. Hence, economy *i* is the best candidate of adopting the yuan when it is perfectly positively correlated with China.

Sections 3.2 and 3.3.1 give the theoretical outline of the economies' macroeconomic performance before and after adopting the yuan. By comparing these two situations, we are able to investigate the macroeconomic losses and gains of giving up their own currencies and adopting the yuan.

Now the losses and gains of adopting the yuan are able to be identified. Comparing (3.12) and (3.8), the difference between inflation bias before and after the adoption of the economy *i* shows its the potential macroeconomic gain: (i) if $b_C k_C < b_i k_i$, the yuan monetary integration helps reduce the *i*th economy's inflation bias; (ii) if $b_C k_C > b_i k_i$, the client economy *i* will actually ends up with a higher average inflation rate. Hence, countries who have the higher inflation rate than that of China are gainial from the adoption.

Comparing (3.14) and (3.9), output volatility difference between two situations gives the potential macroeconomic losses of the adoption: (i) ($\rho_{i,C}$) is high, *i* and China are highly correlated, the *i*th economy's output will be stabilized. (ii) ($\rho_{i,C}$) is low, *i* and China are poorly (or even negatively) correlated, the *i*th economy's output will be destabilized. So the amplitude of losses of the economy *i* from adopting the yuan depends on how highly it is correlated with China. The higher the correlation, the better candidate it is.

3.3.2 Multilateral Currency Union: Creating a New Common Currency

Now assume that these N member economies deside to give up their national currencies and create a new currency to form a monetry union. The new common Central Bank has the similar loss function, though in union-wide values:

$$L_U = \frac{b_U}{2}(y_U - k_U)^2 + \frac{1}{2}\pi_U^2 \tag{3.15}$$

in which a *U* subscript indicates union-wide values. The common Central Bank minimizes (3.15) subject to a union-wide output (y_U) equation:

$$y_U = \pi_U - \pi_U^e + u_U \tag{3.16}$$

where $u_U \sim iid\ (0,\ \sigma_U^2)$; π_U is the union-wide inflation rate, π_U^e is the given expected inflation rate. The first-order conditions imply:

$$\pi_U = b_U k_U - \frac{b_U}{1+b_U} u_U = \pi_i^{UNION}, \forall i \tag{3.17}$$

where π_i^{UNION} indicates the inflation rate of the economy i under monetary union. Hence, the average inflation is given by:

$$\bar{\pi}_i^{UNION} = b_U k_U \tag{3.18}$$

Substituing (3.17) and (3.18) into (3.2), the ith economy's output under monetary union is:

$$y_i^{UNION} = u_i - \frac{b_U}{1+b_U} u_U \tag{3.19}$$

And output volatility is:

$$Var\left(y_i^{UNION}\right) = \sigma_i^2 + \left(\frac{b_U}{1+b_U}\right)^2 \sigma_U^2 - 2\rho_{i,U}\left(\frac{b_U}{1+b_U}\right)\sigma_i\sigma_U \tag{3.20}$$

where $\rho_{i,U} \equiv corr(u_i, u_U)$.

Comparing (3.18) and (3.8), the difference between inflation bias before and after the adoption of the economy *i* shows its the potential macroeconomic gains: (i) if $b_U k_U < b_i k_i$, the formation of monetary union helps reduce the *i*th economy's inflation bias; (ii) if $b_U k_U > b_i k_i$, the client economy *i* will actually ends up with a higher average inflation rate. Hence, countries who have the higher inflation rate than that of the union are gainial from the adoption.

Comparing (3.20) and (3.9), output volatility difference between two situations gives the potential macroeconomic losses of the adoption: (i) ($\rho_{i,U}$) is high, *i* and union are highly

correlated, the *i*th economy's output will be stabilized. (ii) ($\rho_{i,U}$) is low, *i* and union are poorly (or even negatively) correlated, the *i*th economy's output will be destabilized. So the amplitude of losses of the economy *i* from adopting the common currency depends on how highly it is correlated with the union. The higher the correlation, the better candidate it is.

4. IS THERE A YUAN OPTIMUM CURRENCY AREA IN ASIA?

4.1 Data and Methodology

4.1.1 Data Description and Sources

Data on GDP and exchange rate are obtained from Penn World Tables 8.0 (newly released on July 2013) and The UN National Accounts Main Aggregates Database. Combining both data sources, I build a panel of at most 47 Asian sovereign states and dependent territories with annual data, over the period from 1979 to 2011. I select the year of 1979 as the starting time because China began economic reforms and started to open the Chinese market in that year. TABLE I gives the list of countries in my sample and their data availability for both data sources. Countries with an asterisk have data available only from 1990 to 2011 so that two groups of data are used in this study: (1) the *long group* with data available over the full period (1979-2011) with fewer countries (37 economies) and the *wide group* with shorter period (1990-2011) but more countries (47 economies).

The exchange rate (national currency/USD) of 42 Asia economies over 1997-2011 come from PWT8.0. A small number of them have data only available from 1990-2011, and they are Armenia, Azerbaijan, Georgia, Kazakhstan, Russia, Tajikistan, Turkmenistan, and Uzbekistan. From UN National Accounts, I obtained real and nominal aggregate GDP in national currencies for 45 Asian economies from 1979 to 2011, with exceptions of again those 9 economies I just mentioned above and an extra Timor-Leste, which add the total number up to 10. Data from National Account for these 10 exceptional economies are available from 1990 to 2011.

TABLE I

LIST OF ASIAN ECONOMIES IN SAMPLE

1	Afghanistan	25	Maldives
2	Armenia*	26	Mongolia
3	Azerbaijan*	27	Myanmar
4	Bahrain	28	Nepal
5	Bangladesh	29	Oman
6	Bhutan	30	Pakistan
7	Brunei	31	Papua New Guinea
8	Cambodia	32	Philippines
9	China	33	Qatar
10	Georgia*	34	Russian*
11	Hong Kong SAR, China	35	Saudi Arabia
12	India	36	Singapore
13	Indonesia	37	Sri Lanka
14	Iraq	38	Syria
15	Israel	39	Tajikistan*
16	Japan	40	Taiwan
17	Jordan	41	Thailand
18	Kazakhstan*	42	Timor-Leste*
19	Kuwait	43	Turkey
20	Kyrgyzstan*	44	Turkmenistan*
21	Laos	45	United Arab Emirates
22	Lebanon	46	Uzbekistan*
23	Macao SAR, China	47	Vietnam
24	Malaysia		

*These economies have a shorter period (1990-2011) available.
(Full period is over 1979-2011)

4.1.2 The Data Computation

Percentage change of exchange rate (come from PWT 8.0) gives the depreciation rate, while the percentage change of the GDP deflator[3] (come from UN national account) shows inflation (see also TABLES II and III). Real GDP are in logarithms in order to calculate cyclical component of output $Y_{i,t}$. Letting $y_{i,t} = \ln(Y_{i,t})$, I use lowercase $y_{i,t}$ to represent logarithms throughout this study.

Figures 1, 2 and 3 show that, the relationship between the average depreciation rate and the average inflation rate differential with United States has been almost exactly one-to-one for different samples over different period. This is consistent with the Purchasing Power Parity hypothesis and then it justifies our treatment of price and exchange-rate stability as the same policy goal. The x-axis is the average differences of inflation rate between country *i* and the United States over corresponding period, computed as $\left(\sum_{t=1}^{T}\left(\pi_{i,t} - \pi_{US,t}\right)\right)/T$. Figure 1 provides this scatter plot for the *long group* (31 economies over full period 1979-2011). Figure 2 plot the same two variables for the *wide group* (over a short period 1990-2011 with 40 economies). This figure shows a precise 45-degree fitted line and almost all scattered points are located on this line, which supports the theory very solidly. In particular, Georgia is far away from all the other samples in this figure so that Figure 3 gives the same plotting excluding the observation for Georgia, to demonstrate that the PPP relationship is not due to the outlier but also holds for the moderate- and low-inflation countries.

[3] GDP deflator$_i$ = nominal GDP$_i$ / real GDP$_i$, i=1,2,3,…,N economies

TABLE II

AVERAGE ANNUAL DEPRECIATION AND INFLATION (1979-2011)

i	PWT8.0(1979-2011)		UN(1979-2011)		
	$\overline{\Delta e}^{*}$	$\sqrt{\mathrm{Var}(\Delta e)}$	$\bar{\pi}$	$\sqrt{\mathrm{Var}(\pi)}$	$\bar{\pi}_i - \bar{\pi}_{China}$
China	**5.12**	**11.88**	**5.55**	**5.04**	**0.00**
East Asia					
Brunei	-1.61	4.33	4.82	19.15	-0.74
Cambodia	25.61	45.21	28.93	45.88	23.37
Hong Kong SAR. China	1.48	4.41	4.11	5.50	-1.44
Indonesia	12.73	43.77	12.67	12.59	7.11
Laos	32.19	51.18	36.56	48.09	31.01
Macao SAR. China	1.47	4.48	6.13	5.38	0.58
Malaysia	1.33	8.13	3.37	3.71	-2.19
Mongolia	21.23	56.05	26.24	56.13	20.69
Myanmar	-	-	17.87	13.76	12.32
Nepal	6.10	7.45	8.85	3.97	3.30
Philippines	6.38	13.04	9.33	8.94	3.77
Singapore	-1.61	4.34	1.99	3.13	-3.57
Taiwan	-0.45	5.92	-	-	-
Thailand	1.58	8.60	4.09	2.72	-1.46
Vietnam	50.69	107.66	58.62	108.44	53.06
Other Asia					
Afghanistan	-	-	83.14	280.72	77.58
Bahrain	-0.05	0.22	4.34	8.99	-1.22
Bangladesh	5.12	5.07	6.70	3.52	1.15
Bhutan	5.88	7.73	6.91	3.89	1.35
India	5.88	7.73	7.56	2.57	2.01
Iraq	42.28	111.74	42.87	90.36	37.32
Israel	41.09	93.82	44.27	86.21	38.72
Japan	-2.62	9.72	0.21	1.76	-5.34
Jordan	3.13	10.27	5.56	5.42	0.01
Kuwait	0.03	2.68	5.28	13.59	-0.28
Lebanon	34.59	91.27	40.22	80.95	34.66
Maldives	2.26	6.00	4.47	7.48	-1.08
Oman	0.35	1.87	4.71	14.18	-0.85
Pakistan	7.17	6.16	9.18	4.29	3.63
Papua New Guinea	-	-	5.78	4.95	0.23
Qatar	-0.11	0.55	5.02	14.63	-0.54
Saudi Arabia	-	-	4.22	11.84	-1.33
Sri Lanka	6.42	4.78	10.62	4.57	5.06
Syria	9.76	22.71	10.55	9.09	4.99
Turkey	45.70	41.25	45.73	28.91	40.18
United Arab Emirates	-	-	3.83	6.83	-1.73

[a] $\Delta e_{i,t} = 100 * (e_{i,t} - e_{i,t-1})/e_{i,t-1}$, where $e_{i,t}$ is the nominal exchange rate.

[b] $\bar{\pi}_i$ is the average of percentage change of GDP deflator of economy i.

[c] East Asia contains Myanmar and eastward economies.

TABLE III

AVERAGE ANNUAL DEPRECIATION AND INFLATION (1990-2011)

i	PWT8.0(1990-2011)		UN(1990-2011)		
	$\overline{\Delta e}^{*}$	$\sqrt{Var(\Delta e)}$	$\bar{\pi}$	$\sqrt{Var(\pi)}$	$\bar{\pi}_i - \bar{\pi}_{China}$
China	**3.09**	**12.50**	**5.64**	**5.65**	**0.00**
East Asia					
Brunei	-1.86	5.02	4.66	11.41	-0.98
Cambodia	20.80	42.89	23.41	42.87	17.77
Hong Kong SAR. China	-0.01	0.22	1.92	4.78	-3.73
Indonesia	13.25	52.55	12.98	14.30	7.34
Laos	17.51	41.33	20.25	29.57	14.61
Macao SAR. China	-0.01	0.22	4.72	5.43	-0.92
Malaysia	0.93	9.67	3.64	3.22	-2.00
Mongolia	33.39	64.31	38.62	64.24	32.98
Myanmar	-	-	20.26	11.02	14.62
Nepal	4.94	7.94	8.09	4.30	2.45
Philippines	3.69	10.93	6.80	3.32	1.16
Singapore	-1.86	5.03	1.38	2.65	-4.26
Taiwan	0.63	5.31	-	-	-
Thailand	1.19	9.80	3.61	2.29	-2.03
Vietnam	7.94	14.36	15.33	16.14	9.69
Timor-Leste	-	-	6.46	12.49	0.81
Other Asia					
Afghanistan	-	-	119.72	334.34	114.08
Bahrain	0.00	0.00	3.96	7.18	-1.68
Bangladesh	3.89	2.88	4.90	2.21	-0.74
Bhutan	5.24	8.55	6.88	2.99	1.24
India	5.24	8.55	7.18	2.88	1.54
Iraq	59.98	131.54	58.58	105.48	52.94
Israel	3.13	7.38	5.95	5.63	0.31
Japan	-2.10	8.72	-0.51	1.31	-6.15
Jordan	1.01	3.31	5.05	4.98	-0.59
Kuwait	-0.25	2.51	6.09	12.16	0.44
Lebanon	6.61	20.64	13.71	28.74	8.07
Maldives	2.26	3.57	5.52	5.03	-0.12
Oman	0.00	0.00	5.40	12.30	-0.24
Pakistan	6.91	6.13	9.88	4.68	4.24
Papua New Guinea	-	-	6.51	5.17	0.87
Qatar	0.00	0.00	6.81	14.09	1.17
Saudi Arabia	-	-	5.59	10.32	-0.05
Sri Lanka	5.33	4.73	9.98	3.71	4.34
Syrian Arab Rep	4.46	12.12	7.70	5.95	2.06
Turkey	41.38	44.27	43.69	32.07	38.05
United Arab Emirates	-	-	4.84	7.52	-0.80
Armenia	291.78	901.15	303.22	919.05	297.58
Azerbaijan	178.51	391.45	189.76	397.65	184.12
Georgia	1710.51	6108.99	1751.44	6242.33	1745.80
Kazakhstan	212.30	483.92	223.33	492.65	217.68
Kyrgyzstan	98.48	229.21	103.53	233.56	97.89
Russian	152.29	356.06	158.51	362.63	152.87
Tajikistan	149.96	283.52	157.49	288.32	151.85
Turkmenistan	333.83	720.53	349.36	734.44	343.72

Uzbekistan	188.76	352.57	192.53	360.36	186.89

[a] $\Delta e_{i,t} = 100 * (e_{i,t} - e_{i,t-1})/e_{i,t-1}$, where $e_{i,t}$ is the nominal exchange rate.

[b] $\bar{\pi}_i$ is the average of percentage change of GDP deflator of economy i.

[c] East Asia contains Myanmar and eastward economies.

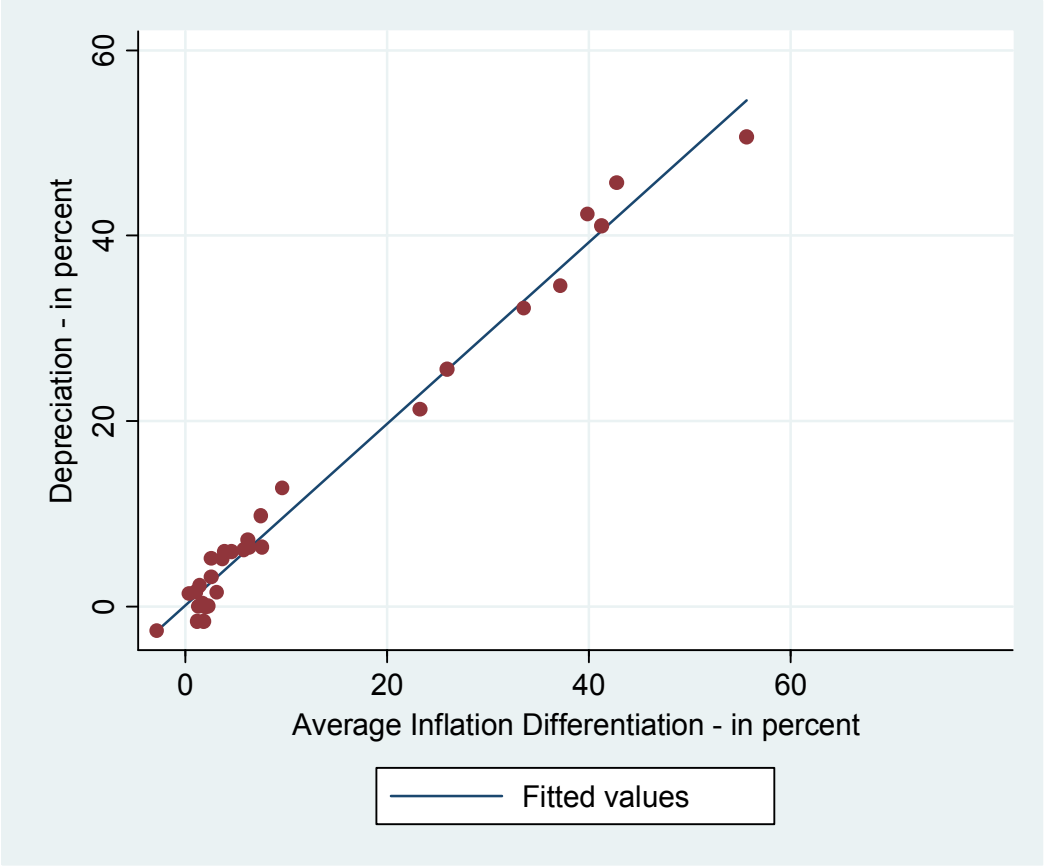


Figure 1. Depreciation and inflation differential[4] with US of 31 economies (1979-2011)

[4] Inflation Differential = $(\sum_{t=1}^{T}(\pi_{i,t} - \pi_{US,t})/T)$

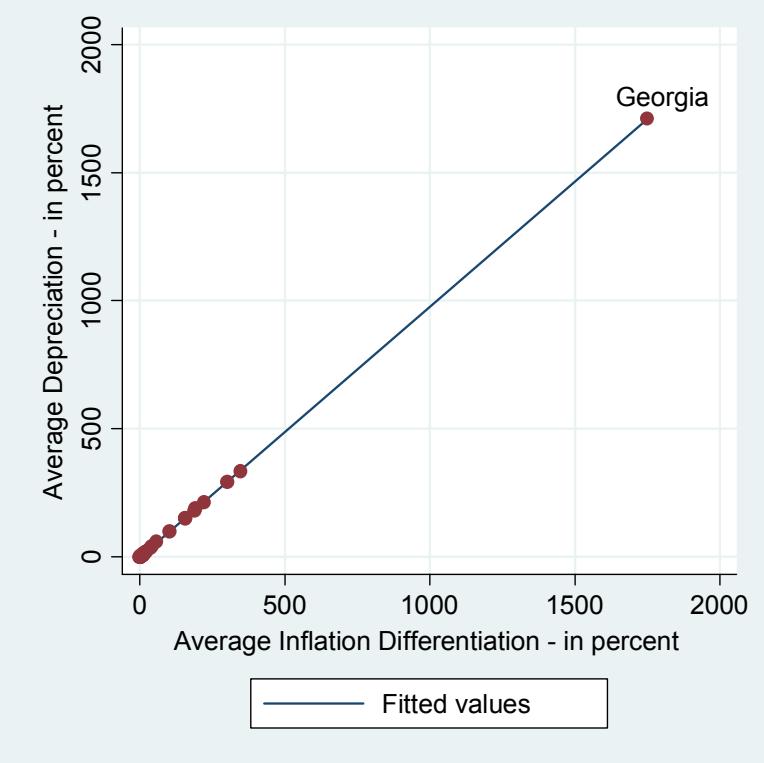


Figure 2. Depreciation and inflation differential with US of 40 economies (1990-2011)

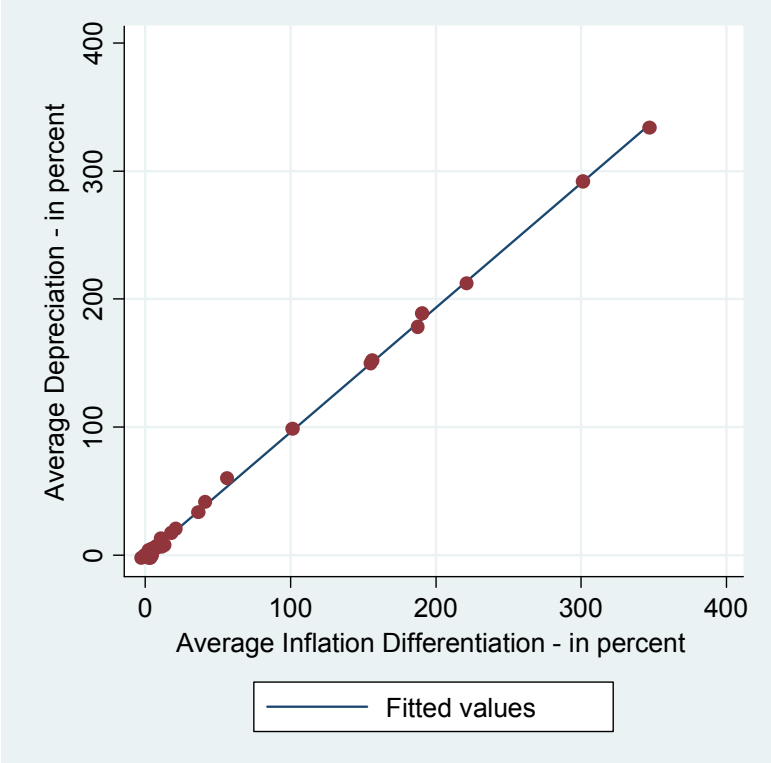


Figure 3. Depreciation and inflation differential with US of 39 economies, excluding Georgia (1990-2011)

By definition, the cyclical component of a time series refers to (regular or periodic) deviations of the series from its trend. In this study, three methods are used to de-trend the output series of each economy and estimate its cyclical component $c_{i,t}$. The first method is just simply differencing the aggregate real GDP for each country (growth rate of the real GDP):

$$c_{i,t} = (Y_{i,t} - Y_{i,t-1})/Y_{i,t-1}$$

The second and the third methods are the Hodrick-Prescott (HP) filter. The Hodrick–Prescott filter was proposed by Hodrick and Prescott in 1990s and then was extensively used in business-cycle literature. It is used to obtain a smoothed-curve representation of a time series, one that is more sensitive to long-term than to short-term fluctuations. Letting $y_{i,t} = \ln(Y_{i,t})$, the HP filter decomposes the series into a cyclical ($c_{i,t} = y_{i,t} - g_{i,t}$) and a trend ($g_{i,t}$) component, by minimizing the following formula with respect to $g_{i,t}$,

$$\sum_{t=1}^{T}\left(y_{i,t} - g_{i,t}\right)^2 + \lambda \sum_{t=2}^{T}[\left(g_{i,t+1} - g_{i,t}\right) - \left(g_{i,t} - g_{i,t-1}\right)]^2$$

The filter involves a smoothing parameter λ, which penalized the acceleration in the trend relative to the business cycle component. When working with quarterly data, researchers typically set λ=1600, while my data comes at annually intervals. Recommended by Kydland and Prescott (1989) for annual data, I select λ=100 as the second method to compute cyclical component. The third method however sets the smoothness parameter (λ) equal to 6.25.

4.2. Empirical Results and Discussion

4.2.1 Macroeconomic Gains of Adopting the Yuan

As discussed in Section 3, participation in a yuan monetary union will reduce a country's average inflation rate, provided China has a more "target conservative" monetary authority than that of domestic country. By definition, adopting the yuan will eliminate the exchange rate variability with respect to the yuan, ruling out depreciation or appreciation against the yuan. As a result, the client economies' exchange rate with respect to other currencies, such as the US dollar or the euro, will exactly follow the pattern set by the yuan. Next, I examine how important such gain would be in practice for those Asian countries in my sample.

My sample countries are divided into two groups East Asia and Other Asia, based on their distance to China. In particular, East Asia Group consists of Myanmar eastwards economies to China, i.e. South-Eastern countries (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, and Timor-Leste) and other adjacent countries (Hong Kong, Macao, Mongolia, Nepal, and Taiwan). These economies are the more plausible candidates of adopting the yuan due to their small or moderate size, geographic location and close trading ties with China[5]. Japan and India are not included in this group since their large size and influential economic role in the world have pledged the possibility of being the yuan OCA members. The rest of economies consists the Other Asian group (i.e., Japan, India, Middle East countries, and former Soviet Union members). Inflation performances for these two groups are reported in Tables II and III.

Generally, TABLE II gives a way to answer this question by looking at the average exchange-rate depreciation and inflation rate over 1979-2011 for 38 Asian economies in the sample. It appears that the extent of depreciation and inflation rate bias varies across countries substantially.

[5]Alesina and Barro (2002) conclude that the type of country that has more to gain from giving up its own currency has the following characters: (i) a small open economy (ii) heavily trading with one particular large partner (iii) with a history of high inflation and (iv) with a business cycle highly correlated with that of the potential "anchor".

Focusing on exchange rates first, the average annual depreciation rate against US dollar over 1979-2011 has varied from as low as -2.62% for the Japanese yen to as high as 50.69% for Vietnamese dong. The standard deviation of the depreciation rates measure exchange rate volatility, which have been ranged from 0.22 for Bahrain to 111.74 for Iraq. Vietnam, and Israel are the other three economies having as high exchange rate volatility as Iraq. Among the rest of economies, Cambodia, Indonesia, Laos, Mongolia, Syria and Turkey have also labored under unstable currencies, but not as much as those four economies mentioned above. As for price stability, the similar picture emerges if again looking at TABLE II. The variation of the average annual inflation rate and its standard deviation over 1979-2011 varies substantially across Asian countries. Average annual inflation rate has ranged from 0.21% in Japan to 83.14% in Afghanistan and the standard deviation of inflation rate was a very similar pattern, with the lowest of 1.76 of Japan and highest of 280.72 of Afghanistan.

I also find that, in East Asia group (see Table II), most developing countries have experienced roaring inflation rate so that large positive ($\bar{\pi}_i$ - $\bar{\pi}_{China}$) values imply them as good candidates of the yuan OCA members in terms of their price stability gains, such as Cambodia, Indonesia, Laos, Mongolia， Myanmar, Nepal, Philippines, and Vietnam. On the contrary, the adoption gain for the rest economies, mostly developed economies, is negligible or even negative since they are having at least the same or even more stable national currencies than the yuan, i.e., Brunei, Hong Kong, Macao, Malaysia, Singapore, and Thailand. This makes sense in terms of both theoretical and empirical explanation. Equation (3.8) shows average inflation rate for each economy equals $b_i k_i$. As discussed by Montiel (1989), inflation in developing countries is often linked to underlying fiscal imbalance, either by triggering high money growth, or by triggering a balance of payment crisis. Another possibility could be changes in the prices of particular goods,

such as oil, that lead to persistent changes in the aggregate price level. Besides, the output gap could be another source of inflation, indicating an overheating economy.

In Table II Other Asia group, Afghanistan, Iraq, Israel, and Turkey have significantly greater average inflation rate than China so that they have the most gain from the yuan monetary integration. Bangladesh, Bhutan, and Syria, have a smaller but still positive ($\bar{\pi}_i$ - $\bar{\pi}_{China}$) value. Hence, they enjoyed a gain that is smaller but still sizable (between 1.15% and 4.99%). The remaining economies are having either negative or negligible inflation gain form the yuan OCA. Nevertheless, I do not discuss this group in detail since they are not considered as plausible yuan OCA members.

4.2.2 Macroeconomic Losses of Adopting the Yuan

Joining a monetary union, however, is costly because the client countries lose the ability of using independent monetary policy to respond to output shocks and thus to smooth the domestic business cycle. The loss of country *i* of adopting the yuan, as discussed in Section 3, is measured by business-cycle volatility $VAR(y_i^{YUAN})$, which is decreasing in the country's cyclical correlation between that country and China. Therefore, the higher that correlation, the smaller the loss is and vice versa.

TABLE IV reports the correlation coefficients of two groups of sample countries' cyclical output component with that of China, for the three methods outlined in Section 4.1.2 (differencing, the Hodrick-Prescott filter 100 and 6.25), corresponding to East Asia and Other Asia. Two periods (1979-2011 and 1990-2011) are considered.

TABLE IV CYCLICAL CORRELATION WITH CHINA

i	1979-2011			1990-2011		
	$\rho_{i,China}^{DIFF}$	$\rho_{i,China}^{HP100}$	$\rho_{i,China}^{HP6.25}$	$\rho_{i,China}^{DIFF}$	$\rho_{i,China}^{HP100}$	$\rho_{i,China}^{HP6.25}$
East Asia						
Brunei	0.300	0.218	0.299	0.154	0.096	0.167
Cambodia	0.404*	0.238	0.498*	0.100	0.119	0.336
Hong Kong SAR, China	0.238	0.351*	0.316	0.499*	0.722*	0.455*
Indonesia	0.056	0.219	0.011	0.460*	0.734*	0.264
Laos	-0.377	-0.169	-0.473	0.290	0.529*	0.482*
Macao SAR, China	0.199	0.179	0.186	0.317	0.549*	0.296
Malaysia	0.079	0.114	0.002	0.451*	0.719*	0.354
Mongolia	-0.026	0.070	-0.043	-0.126	-0.134	0.245
Myanmar	0.047	0.165	0.119	0.081	-0.015	0.553*
Nepal	0.095	0.129	0.060	-0.019	0.073	-0.153
Philippines	-0.297	-0.392	-0.410	0.169	0.228	0.406
Singapore	0.080	0.061	-0.015	0.532*	0.743*	0.491*
Thailand	0.072	0.048	0.042	0.534*	0.664*	0.399
Vietnam	0.429*	0.630*	0.436*	0.686*	0.759*	0.668*
Timor-Leste				0.170	0.570*	0.242
Other Asia						
Afghanistan	0.006	0.041	-0.058	-0.088	-0.114	-0.050
Bahrain	0.156	0.006	0.124	0.509*	0.555*	0.536*
Bangladesh	0.141	0.346*	0.183	-0.044	-0.045	0.328
Bhutan	-0.016	-0.114	-0.034	0.098	-0.202	0.411
India	0.140	0.212	0.029	0.329	0.469*	0.509*
Iraq	0.193	0.267	0.239	0.135	-0.071	0.365
Israel	0.161	0.328	0.154	0.363	0.554*	0.231
Japan	-0.033	-0.152	-0.118	0.230	0.325	0.226
Jordan	0.195	0.327	0.301	0.592*	0.766*	0.603*
Kuwait	0.433*	0.661*	0.551*	0.585*	0.573*	0.632*
Lebanon	0.337	0.549*	0.394*	0.016	0.446*	-0.420
Maldives	0.106	0.217	0.125	0.144	0.224	0.192
Oman	0.102	0.267	0.134	0.352	0.596*	0.216
Pakistan	0.161	0.211	0.185	0.419	0.608*	0.292
Papua New Guinea	0.468*	0.557*	0.565*	0.511*	0.684*	0.246
Qatar	0.095	0.053	-0.010	0.047	0.015	0.132
Saudi Arabia	-0.259	-0.386	-0.404	-0.081	0.148	-0.302
Sri Lanka	0.195	0.408*	0.161	0.367	0.614*	0.332
Syria	0.284	0.373*	0.302	0.464*	0.753*	0.215
Turkey	0.180	0.333	0.161	0.241	0.365	0.215
United Arab Emirates	-0.231	-0.366	-0.330	0.091	0.051	0.362
Armenia				-0.282	-0.365	0.122
Azerbaijan				-0.269	-0.408	-0.111
Georgia				-0.432	-0.562	-0.136
Kazakhstan				-0.295	-0.532	0.034
Kyrgyzstan				-0.537	-0.731	-0.410
Russian				-0.342	-0.517	-0.020
Tajikistan				-0.541	-0.737	-0.607
Turkmenistan				-0.319	-0.497	-0.161
Uzbekistan				-0.418	-0.594	-0.410

[a] DIFF refers to Differencing. HP100 and HP6.25 refers respectively to the Hodrick-Prescott filter using λ= 100 and 6.25.

[b] Correlation coefficients significance has been checked. T-value for a Pearson correlation is $t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}}$. Critical value of r when n=33 for the long period and n=22 for the short period are respectively 0.343 and 0.423, at 95% significant level.

[c] * Correlation coefficients that are at 95% significant level are marked by asterisk.

We can see that the correlations are broadly similar across these three methods, though not entirely. These three methods are not equally valid since they have distinctive filtering properties, which could incur different filtering results for the same time series. For example, differencing is proper for random walk series. Yet there is no way to investigate each time series' properties and then pick an exclusive de-trending method without uncertainty. In this study, I adopt HP λ=6.25 as my preferred de-trending method, with the other two methods serving as robustness checks. It is suggested by Ravn and Uhlig (2002) for annual data. They show that, "the λ parameter should be adjusted according to the fourth power of a change in the frequency". With λ=1600 for quarterly data, it yields a value of approximately $1600/4^4 = 6.25$ for annual data, which is close to the value of 10 given by Baxter and King (1999). HP λ=6.25 is used as preferred method for empirical evaluations throughout this study.

TABLE IV East Asia shows that for 1979-2011, Hong Kong, and Vietnam seem to be the most highly positively correlated with China so that monetary policy conducted by People's Bank may be acceptable substitute for that of their own independent monetary authorities. Therefore, these countries have the lowest stabilization loss of adopting the yuan. The correlations are lower but still positively for Brunei, Cambodia, Macao, and Myanmar. The rest of economies appear to be effectively either uncorrelated or negatively correlated with the Chinese economy, such as Laos, Philippines, and Singapore. The losses of abandoning their national currencies and adopting the yuan will be the highest for these economies and delegating monetary policy of the Bank of China can be destabilizing for them.

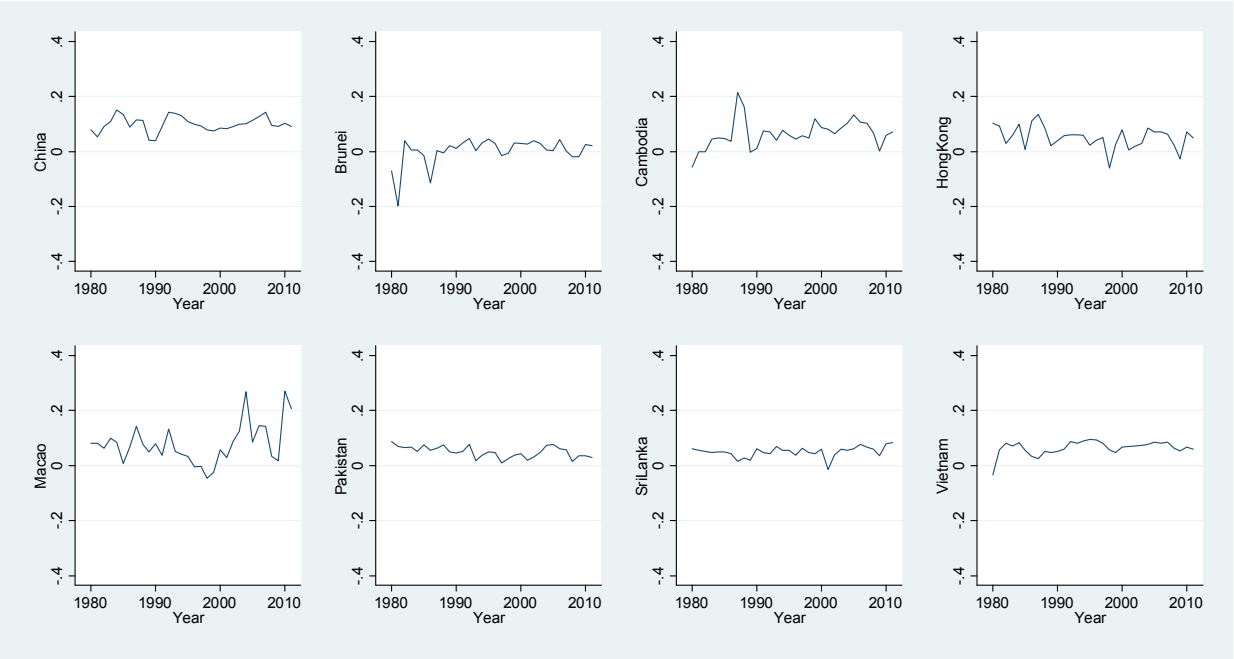


Figure 4. Growth rate for China and countries that are most highly positively correlated with China (1979-2011).

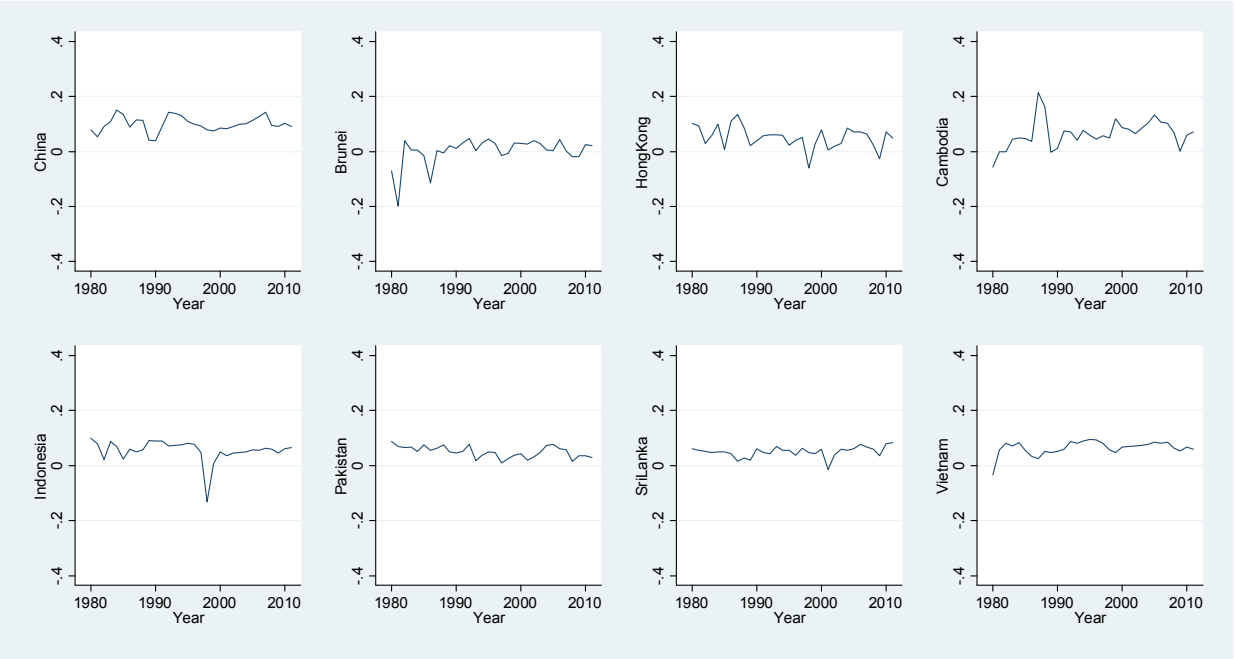


Figure 5. HP (λ=100) cyclical component for China and countries that are most highly positively correlated with China (1979-2011)

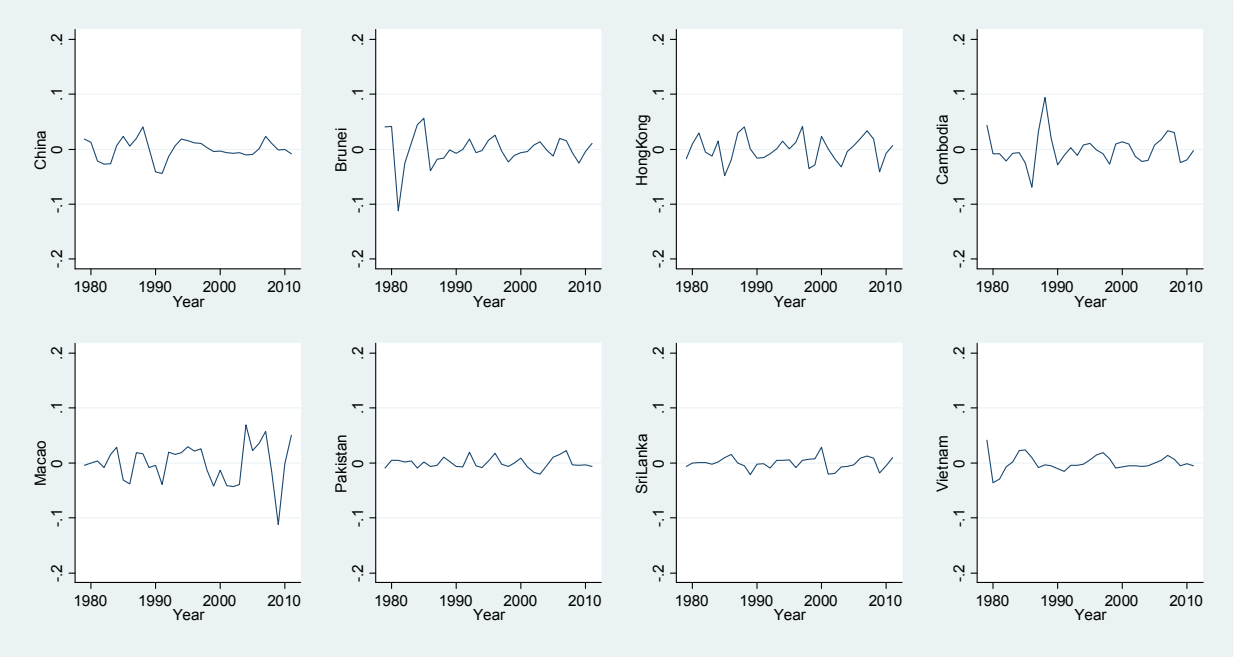


Figure 6. HP (**λ**=6.25) cyclical component for China and countries that are most highly positively correlated with China (1979-2011).

Figures 4, 5 and 6 provide a visual demonstration of cyclical output series of these three methods for China and the other seven economies, which are the most highly correlated with China over 1979-2011. These three figures actually deliver consensus information that all these economies roughly emerge four to five business cycle swings during this period, though their amplitudes of the business cycle are quite different. The business cycles vibrate substantially for Cambodia and Macao, while relatively subdued for China, Hong Kong and Vietnam.

4.3 Relationship between Losses and Gains

How to jointly evaluate losses and gains of joining the yuan monetary integration is the essential problem of assessing whether adopting the yuan finally. Combining the estimates of TABLE II and TABLE IV, it gives reference of answering this question.

For a large subset of the economies in our sample, the relationship between realized gains and losses from the adoption has been positive. It means that high gains, as a result of high depreciation or inflation rate, have often tended to coexist with high losses, in the form of low or negative) cyclical correlations with the benchmark country China; while low (or negative gains) often correspond to low (or negative) losses. This phenomenon makes the loss-gain calculation difficult to implement because it implies that the economies that have great price-stability gains also have a lot of business destabilizing losses and similarly, the countries that have small losses from the adoption will also experience small gains. The examples of the former cases are Afghanistan, Bhutan, Indonesia, Laos, Mongolia, Myanmar, Nepal, Philippines and so on. For instance, Laos has a lot to gain of adopting the yuan due to its giant inflation rate gap with China ($\bar{\pi}_{Laos}$ - $\bar{\pi}_{China}$= 31.01%), meanwhile Laos is negatively cyclical correlated with China so that it has a lot to lose from the adoption at the same time. Brunei, Hong Kong, Papua New Guinea can be

examples for the latter case. Take Hong Kong for example, it is highly positive correlated with China which means adoption the yuan will incur the least loss, while the gain is negligible either due to its negative inflation rate gap with China ($\bar{\pi}_{Kuwait}$ - $\bar{\pi}_{China}$= -0.28%).

However, three countries, Cambodia, Syria and Vietnam, can be excluded from this pattern. If adopting the yuan, these countries will experience large gains, but little losses. Their inflation rates are much greater than that of China (Syria has smaller gap than the other three countries, see also TABLE II) so that they will obtain great price and exchange-rate stability from the adoption. Besides, they have little to lose because their cyclical outputs are highly positively correlated with China (see also TABLE IV) so that monetary policy conducted by Chinese Central Bank may be acceptable substitute for these countries' monetary authorities. Therefore, Cambodia, Syria and Vietnam are suggested as the best candidates of adopting the Chinese yuan in Asian region at current point.

As for other economies in our sample, though loss-gain calculus doesn't demonstrate intuitive information, it is still possible to make statements for individual countries and make unambiguous comparisons between them. For example, Cambodia is a better candidate for adopting the yuan than Myanmar. Cambodia has more to gain, because its inflation bias has been bigger than Myanmar's, and less to lose, as its cyclical correlation with China is higher than Myanmar's.

4.4 Losses and Gains if a Shorter Period is Considered

As showed in Section 4.1.1 and TABLE I, full period data is not available for about 10 countries in our sample. Based on their data availability, TABLE III and TABLE IV present the results for all economies over a shorter period, 1990-2011. By doing this, another interesting question can

be investigated that how the estimated volatilities and correlations have evolved over time. This section discusses this issue by comparing a long period (1979-2011) with less samples and a shorter period (1990-2011) with more samples.

Focusing on average inflation and depreciation rate first, TABLE III indicates that while inflation bias has increased in some countries (such as Afghanistan, Iraq, Mongolia, etc.), it has decreased in others (such as Cambodia, Israel, Laos, Lebanon and Vietnam, etc.). The differences in average depreciation and inflation rate between full period and short period appear to be small for the majority in our samples. Besides, most of the newly add-in countries have much higher inflation than China and it means that they will experience very high price and exchange rate stability if adopting the yuan, with the only exception of Timor-Leste.

Moving on to the losses, again three methods are used to calculate cyclical correlation, i.e. differencing, HP100 and HP6.25. The results are broadly consistent in these three ways, with a few of exceptions such as Bangladesh, Mongolia. I centered my discussion on HP $\lambda = 6.25$ results. The results seem to be sensitive to the time period chosen. I prefer the shorter but more recent period as my discussion center because economic environment has been changed dramatically over time in the world and the more recent period data conveys more information nowadays and reflects somewhat tendency or economic variables evolution in the near future. I use this "focusing on more recent period" rule throughout this study.

TABLE IV suggests that for a short recent period, most economies in East Asia appear higher correlation with China and lots of them become pretty highly positively correlated with China. For example, Laos, Malaysia, and Myanmar, etc., are much more highly correlated with China in the latter period but not so in full period and it means that their losses of adopting the yuan are

decreasing over time and currently they have little to lose from the adoption. The reason might be deeper economic integration in the world and their closer trading ties with China. In East Asia group, Hong Kong, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam are the most highly correlated with China ($\rho_{i,China} \geq 0.35$) . The correlations are also consistently positive for Brunei, Cambodia, Indonesia, Macao, Mongolia, and Timor-Leste($0.1 \leq \rho_{i,\,China} \leq 0.35$), while Nepal appears to be negatively correlated with China. As a result, all economies in East Asia except Nepal are potential candidates of adopting the yuan according to the little losses.

The loss-gain calculus analysis for a shorter but more recent period with more samples verifies the conclusion drawn earlier: the estimated macroeconomic gains and losses are positively correlated, which says that the country gains a lot will also loses a lot from the adoption. Moreover, this relationship is actually even stronger and more prevailing across samples in the more recent period. Firstly, ten newly add-in countries all follow this relationship with large inflation gap ($\bar{\pi}_i$ - $\bar{\pi}_{China} >> 0$) and highly negative correlation with China. Secondly, there are many other countries, which present this relationship in the shorter period but not so in full period and they are Bahrain, Cambodia, Israel, Japan, Jordan, Macao, Malaysia, Oman, Singapore and Thailand. Refer to Figures 10 and 11, the negative sloped fitted lines demonstrate this positive relationship clearly. Figure 11 eliminates Georgia, which is far away from all other samples to illustrate that this relationship is not due to the outlier but also holds smoothly for

Figure 7. Growth rate of China and countries that are most highly positively correlated with China (1990-2011).

Figure 8. HP (**λ**=100) cyclical component for China and countries that are most highly positively correlated with China (1990-2011)

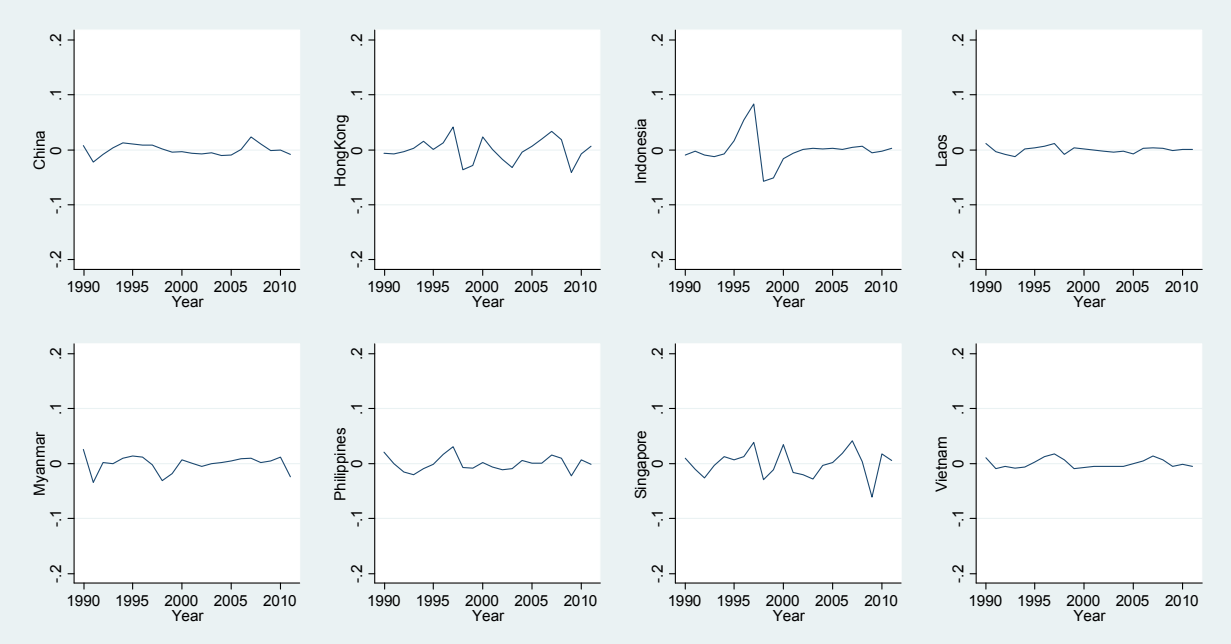


Figure 9. HP (**λ**=6.25) cyclical component for China and countries that are most highly positively correlated with China (1990-2011).

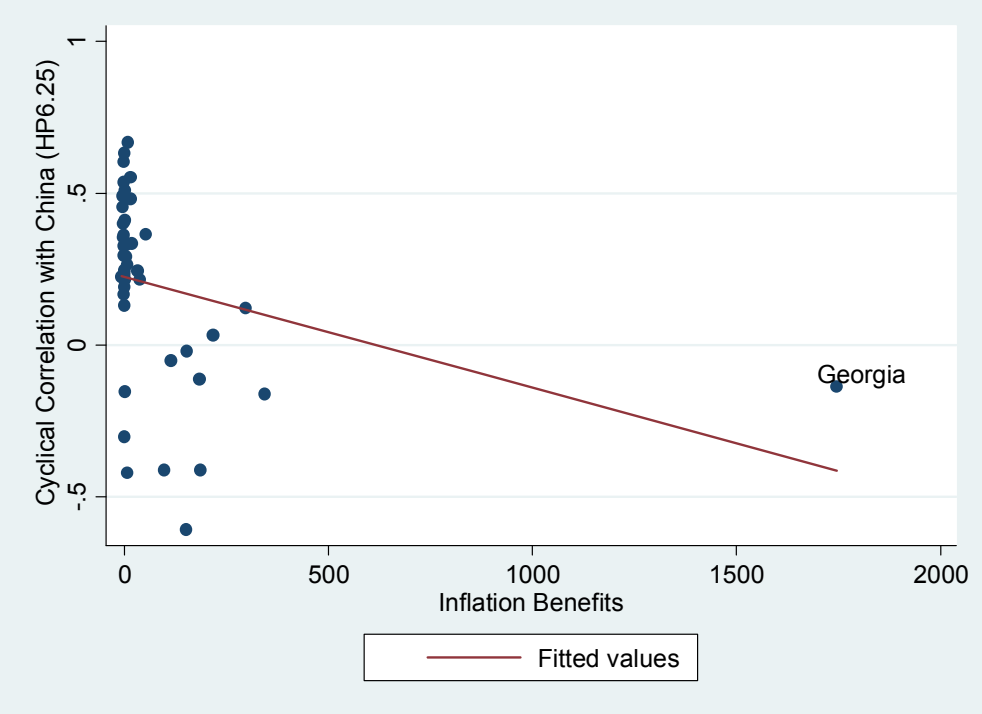


Figure 10. Losses vs. gains if adopting the yuan of 43 economies (1990-2011)

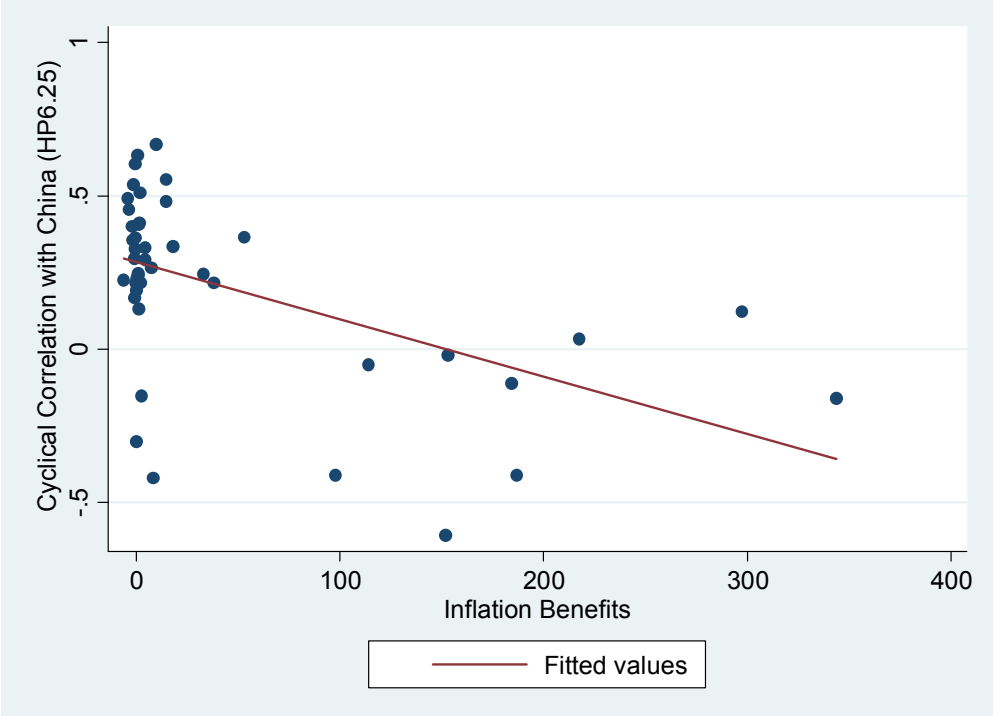


Figure 11. Losses vs. gains if adopting the yuan of 42 economies, excluding Georgia (1990-2011)

moderate- and low-inflation countries. Horizontal axis measures price stability gains ($\bar{\pi}_i$ - $\bar{\pi}_{China}$) and vertical axis measures their corresponding cyclical correlation coefficients with China using the filter HP100. The negative slope fitted lines state that greater x-value (greater gains), often comes with smaller y-value(more losses), and similarly, smaller x-value (smaller gains), usually comes with greater y-value (less losses). Hence again, countries which gain a lot will lose a lot at the same time from the adoption and vice versa.

For individual countries, the estimates for a shorter period also soften some of the conclusion drawn before. For example, the fact that Lao's inflation bias is overestimated when one examines the entire period, which means TABLE II East Asia exaggerates Lao's gains of adopting the yuan. On the other hand, the fact that Cambodia's and Myanmar's (Hong Kong's, Lao's, Singapore's, Thailand's, and Indonesia's) cyclical economic activities are much less (more) correlated with China in the more recent period, which makes the losses of adopting the yuan much higher (lower). As a result, suggested by the shorter period analysis, Cambodia, Indonesia, Laos, Mongolia, Myanmar, Philippines, and Vietnam are very promising candidates for adopting the yuan since they have little to lose and a lot to gain. (See TABLE XI in later section)

4.5 Extension: Discussion in Terms of Parameters *b* and *k*

In model setup (see equations (3.1) and (3.2)), as usual, it is assumed that $k>0$ because of distortions such as imperfect competition, tax, asymmetric information, government failure, and labor union which keep real wage rate above the market clearing full employment level, etc. The policy parameter *b,* specified the precise nature of the monetary policy system. For instance, if $b=0$, it is referred to as strict inflation targeting where the inflation target is achieved at any cost; if $b=0.5$, the central bank is as twice as concerned about inflation than output. In the literature, a

situation with $0<b<1$ is referred to as "flexible" inflation target. Output is secondary to the inflation target, but the weight on the output prevents excessive volatility in output and delays the attainment of the inflation target. Inflation targeting was adopted because of its superiority to monetary targeting, which was used before.

At present, most of the developed countries use inflation targeting framework, in terms of lower weight on output (small b). Central banks set a target for annual inflation rate, usually a low one and endeavor to achieve this goal. In my sample, developed economies (i.e. Hong Kong, Brunei, and Singapore) accord with this standpoint (see TABLE III). In particular, the Hong Kong Monetary Authority puts exclusive emphasis on exchange rate stability (vis-à-vis the US dollar) and pursues this goal by means of a currency board arrangement. The Monetary Authority of Singapore has been considered as inflation targeter, though they pursue price stability by announcing the level as well as the rate of change of the target band for the nominal effective exchange rate of the Singapore dollar. Countries such as Korea, Indonesia, Thailand, and Philippines switched their policy framework from monetary targeting to inflation targeting due to Asian financial crisis and their financial innovation. In Thailand ($\bar{\pi}$=3.61) and Korea, actual inflation has relatively fallen well within the target range, while Indonesia ($\bar{\pi}$=12.98) and Philippines ($\bar{\pi}$=6.8) have quite often failed to meet the target (see TABLE III).

As with inflation targeting the central bankers try to hit a certain value of inflation rate, which output targeting central bankers strive to hit a certain level of output or its growth rate. This can help to stabilize output fluctuations, i.e. business cycle. In terms of parameters b and k, developing countries often emerge superiority of nominal income targeting to inflation targeting and set higher output target, so that greater b and k will generate higher inflation rate in return (see equation (3.8)).

5. IS THERE A YENIZATION OR DOLLARIZATION OPTIMUM CURRENCY AREA IN ASIA?

In the literature, Alesina, Barro and Tenreyro (2002) used the theoretical framework developed by Alesina and Barro (2002) to explore the pros and cons for different countries of adopting as an anchor the dollar, the euro, or the yen. They researched on historical patterns of international trade and co-movements of prices and outputs for different countries with three anchor economies, i.e. United States, Japan and Europe, and they found that there appears to be reasonably well defined euro or dollar areas, but not yen area.

In addition to yuanization, I will now extend my analysis to possible dollarization or yenization in this section. I proceed by analyzing these economies' inflation bias and cyclical correlation with Japan (($\bar{\pi}_i$ - $\bar{\pi}_{Japan}$), ($\rho_{i,Japan}$)) and with the United States (($\bar{\pi}_i$ - $\bar{\pi}_{US}$), ($\rho_{i,US}$)) in order to discuss the prospects of adopting the yen or the USD in Asia. By doing this, I am able to make comparisons among yuanization, yenization and dollarization for these Asian economies.

5.1 Data and Methodology

Same as yuanization, inflation rate is calculated by the percentage change of the GDP deflator, which is nominal aggregate GDP divided by real aggregate GDP. Four methodologies are used to de-trend the real GDP series in order to compute the output cyclical correlations between client and anchor economies; they are (1) First Differencing, (2) HP filter[6] with smoothing parameter $\lambda = 100$, (3) HP filter $\lambda = 6.25$, and (4) the Baxter-King (BK) band-pass filter. The *band-pass* filter, proposed by Baxter and King (1999), takes into account the statistical features

[6] Reference of HP Filter was given in earlier section.

of the business cycle.[7] This filter passes through components of the time series with periodic fluctuations between 6 and 32 quarters, while removing components at higher and lower frequencies. In this study, I filter out stochastic cycles at periods that are smaller than 2 years and larger than 8 years.

I obtained all real and nominal GDP data needed in my study from the *UN National Accounts.* Particularly, I collect real GDP in *2005 constant national currencies* and nominal GDP in *current national currencies* for each member economy *i,* Japan and Unites States in order to calculate the inflation biases (($\bar{\pi}_i$ - $\bar{\pi}_{Japan}$), ($\bar{\pi}_i$ - $\bar{\pi}_{US}$)) and cyclical correlations (($\rho_{i,Japan}$), ($\rho_{i,US}$)), over two periods, 1979-2011 and 1990-2011.

5.2 Empirical Results and Discussion

This section is interested in discussing the pros and cons for Asian economies of adopting as an anchor the yuan, the yen or the U.S. Dollar. TABLEs V and VI report the average and volatility of annual inflation rate for selective Asian economies, as well as their measures of inflation bias with China, Japan, and the United States, respectively over 1979-2011 and 1990-2011. The columns of ($\bar{\pi}_i$ - $\bar{\pi}_{China}$), ($\bar{\pi}_i$ - $\bar{\pi}_{Japan}$), and ($\bar{\pi}_i$ - $\bar{\pi}_{US}$) give the relative size of inflation bias, which will determine the macroeconomic gains for each economy from these three possible currency adoptions. Note that among three benchmarks, China has the highest average inflation rate for both periods (5.55% & 5.64%) followed by the United States (3.04% & 2.25%), then Japan as the lowest (0.21% & -0.51%). It appears that the inflation rate bias varies across countries substantially. The results suggest that economies with extremely high inflation rate (e.g.

[7] The NBER chronology lists 30 complete cycles since 1858. The shortest full cycle (peak to peak) was 6 quarters, and the longest 39 quarters, with 90 percent of these cycles being no longer than 32 quarters (Stock and Watson, 1999).

TABLE V
AVERAGE ANNUAL INFLATION RATE (1979-2011)

i	$\bar{\pi}$	$\sqrt{\mathrm{Var}(\pi)}$	$\bar{\pi}_i$ - $\bar{\pi}_{China}$	$\bar{\pi}_i$ - $\bar{\pi}_{Japan}$	$\bar{\pi}_i$ - $\bar{\pi}_{US}$
Afghanistan	83.14	280.72	77.58	82.93	80.1
Bahrain	4.34	8.99	-1.22	4.13	1.3
Bangladesh	6.7	3.52	1.15	6.49	3.66
Bhutan	6.91	3.89	1.35	6.7	3.87
Brunei	4.82	19.15	-0.74	4.61	1.78
Cambodia	28.93	45.88	23.37	28.72	25.89
China	**5.55**	**5.04**	**0**	**5.34**	**2.51**
Hong Kong SAR. China	4.11	5.5	-1.44	3.9	1.07
India	7.56	2.57	2.01	7.35	4.52
Indonesia	12.67	12.59	7.11	12.46	9.63
Iraq	42.87	90.36	37.32	42.66	39.83
Israel	44.27	86.21	38.72	44.06	41.23
Japan	**0.21**	**1.76**	**-5.34**	**0**	**-2.83**
Jordan	5.56	5.42	0.01	5.35	2.52
Kuwait	5.28	13.59	-0.28	5.07	2.24
Laos	36.56	48.09	31.01	36.35	33.52
Lebanon	40.22	80.95	34.66	40.01	37.18
Macao SAR. China	6.13	5.38	0.58	5.92	3.09
Malaysia	3.37	3.71	-2.19	3.16	0.33
Maldives	4.47	7.48	-1.08	4.26	1.43
Mongolia	26.24	56.13	20.69	26.03	23.2
Myanmar	17.87	13.76	12.32	17.66	14.83
Nepal	8.85	3.97	3.3	8.64	5.81
Oman	4.71	14.18	-0.85	4.5	1.67
Pakistan	9.18	4.29	3.63	8.97	6.14
Papua New Guinea	5.78	4.95	0.23	5.57	2.74
Philippines	9.33	8.94	3.77	9.12	6.29
Qatar	5.02	14.63	-0.54	4.81	1.98
Saudi Arabia	4.22	11.84	-1.33	4.01	1.18
Singapore	1.99	3.13	-3.57	1.78	-1.05
Sri Lanka	10.62	4.57	5.06	10.41	7.58
Syria	10.55	9.09	4.99	10.34	7.51
Thailand	4.09	2.72	-1.46	3.88	1.05
Turkey	45.73	28.91	40.18	45.52	42.69
United Arab Emirates	3.83	6.83	-1.73	3.62	0.79
United States	**3.04**	**1.93**	**-2.51**	**2.83**	**0**
Vietnam	58.62	108.44	53.06	58.41	55.58

TABLE VI
AVERAGE ANNUAL INFLATION RATE (1990-2011)

i	$\bar{\pi}$	$\sqrt{\mathrm{Var}(\pi)}$	$\bar{\pi}_i$ - $\bar{\pi}_{China}$	$\bar{\pi}_i$ - $\bar{\pi}_{Japan}$	$\bar{\pi}_i$ - $\bar{\pi}_{US}$
Afghanistan	119.72	334.34	114.08	120.23	117.47
Bahrain	3.96	7.18	-1.68	4.47	1.71
Bangladesh	4.9	2.21	-0.74	5.41	2.65
Bhutan	6.88	2.99	1.24	7.39	4.63
Brunei	4.66	11.41	-0.98	5.17	2.41
Cambodia	23.41	42.87	17.77	23.92	21.16
China	**5.64**	**5.65**	**0**	**6.15**	**3.39**
Hong Kong SAR. China	1.92	4.78	-3.73	2.43	-0.33
India	7.18	2.88	1.54	7.69	4.93
Indonesia	12.98	14.3	7.34	13.49	10.73
Iraq	58.58	105.48	52.94	59.09	56.33
Israel	5.95	5.63	0.31	6.46	3.7
Japan	**-0.51**	**1.31**	**-6.15**	**0**	**-2.76**
Jordan	5.05	4.98	-0.59	5.56	2.8
Kuwait	6.09	12.16	0.44	6.6	3.84
Laos	20.25	29.57	14.61	20.76	18
Lebanon	13.71	28.74	8.07	14.22	11.46
Macao SAR. China	4.72	5.43	-0.92	5.23	2.47
Malaysia	3.64	3.22	-2	4.15	1.39
Maldives	5.52	5.03	-0.12	6.03	3.27
Mongolia	38.62	64.24	32.98	39.13	36.37
Myanmar	20.26	11.02	14.62	20.77	18.01
Nepal	8.09	4.3	2.45	8.6	5.84
Oman	5.4	12.3	-0.24	5.91	3.15
Pakistan	9.88	4.68	4.24	10.39	7.63
Papua New Guinea	6.51	5.17	0.87	7.02	4.26
Philippines	6.8	3.32	1.16	7.31	4.55
Qatar	6.81	14.09	1.17	7.32	4.56
Saudi Arabia	5.59	10.32	-0.05	6.1	3.34
Singapore	1.38	2.65	-4.26	1.89	-0.87
Sri Lanka	9.98	3.71	4.34	10.49	7.73
Syrian Arab Rep	7.7	5.95	2.06	8.21	5.45
Thailand	3.61	2.29	-2.03	4.12	1.36
Turkey	43.69	32.07	38.05	44.2	41.44
United Arab Emirates	4.84	7.52	-0.8	5.35	2.59
United States	**2.25**	**0.77**	**-3.39**	**2.76**	**0**
Vietnam	15.33	16.14	9.69	15.84	13.08
Armenia	303.22	919.05	297.58	303.73	300.97
Azerbaijan	189.76	397.65	184.12	190.27	187.51
Georgia	1751.44	6242.33	1745.8	1751.95	1749.19
Kazakhstan	223.33	492.65	217.68	223.84	221.08
Kyrgyzstan	103.53	233.56	97.89	104.04	101.28
Russian	158.51	362.63	152.87	159.02	156.26
Tajikistan	157.49	288.32	151.85	158	155.24
Timor-Leste	6.46	12.49	0.81	6.97	4.21
Turkmenistan	349.36	734.44	343.72	349.87	347.11
Uzbekistan	192.53	360.36	186.89	193.04	190.28

Afghanistan, Armenia, Georgia, etc.) will gain a lot from the adoption, regardless of the choice of anchor; economies with low or moderate inflation rate (Cambodia, Mongolia, Myanmar, etc.) will gain the most from the potential yenization, followed by dollarization, then yuanization. In addition, note that the average inflation rate of Japan for the more recent period is as low as negative 0.51%. Given the problems of deflation, Japan might not be a promising anchor for client economies based on her recent economic performance. When there is deflation, consumers are reluctant to spend money since they expect prices to keep falling, which leads to lower consumer spending and lower economic growth. Besides, interest rates cannot fall below zero, in other words saving money gives a reasonable return, so deflation can contribute to an unwanted tightened monetary policy, leading to lower growth and high unemployment. Therefore, in terms of the size of macroeconomic gains, the U.S. Dollar is a better currency to adopt than the yuan for most of Asian economies, due to her better price and exchange rate stability. The economies that gain the most from an OCA are Afghanistan, Cambodia, Iraq, Israel, Laos, Lebanon, Mongolia, Myanmar, Turkey and Vietnam, etc.

TABLEs VII, VIII, IX, and X present cyclical correlation of Asian economies with three anchors, over two periods, respectively using four de-trending methods. Correlation coefficients significance have been checked. T-value for a Pearson correlation is $t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}}$. n=33 for the long period and n=22 for the short period. Critical value of t for the long and the short periods are respectively 2.074 and 2.034 at 95% significant level. Hence, if the correlation coefficient is greater than 0.343 for the long and 0.4207 for the short period, it is statistically significant at least at 95% level.

TABLE VII

CYCLICAL CORRELATION WITH CHINA, JAPAN, AND U.S. (DIFFERENCING)

i	1979-2011			1990-2011		
	$\rho^{DIFF}_{i,China}$	$\rho^{DIFF}_{i,Japan}$	$\rho^{DIFF}_{i,US}$	$\rho^{DIFF}_{i,China}$	$\rho^{DIFF}_{i,Japan}$	$\rho^{DIFF}_{i,US}$
Afghanistan	0.006	-0.197	-0.193	-0.088	-0.072	-0.250
Bahrain	0.156	-0.282	0.128	0.509	0.155	0.040
Bangladesh	0.141	-0.385	0.169	-0.044	-0.084	-0.094
Bhutan	-0.016	0.198	0.119	0.098	0.147	0.022
Brunei	0.300	-0.126	0.042	0.154	0.476	0.282
Cambodia	0.404	0.063	0.342	0.100	0.460	0.424
China	1.000	-0.033	0.270	1.000	0.230	0.089
Hong Kong SAR, China	0.238	0.511	0.260	0.499	0.720	0.294
India	0.140	-0.007	0.112	0.329	0.033	0.142
Indonesia	0.056	0.364	-0.123	0.460	0.413	-0.264
Iraq	0.193	-0.234	0.276	0.135	-0.178	0.415
Israel	0.161	0.128	0.197	0.363	0.472	0.354
Japan	-0.033	1.000	0.361	0.230	1.000	0.438
Jordan	0.195	-0.302	-0.239	0.592	-0.064	-0.019
Kuwait	0.433	-0.215	0.375	0.585	-0.038	0.376
Laos	-0.377	-0.091	-0.152	0.290	0.027	-0.080
Lebanon	0.337	-0.050	0.152	0.016	0.178	-0.492
Macao SAR, China	0.199	0.211	-0.017	0.317	0.412	-0.029
Malaysia	0.079	0.424	0.144	0.451	0.674	0.256
Maldives	0.106	0.397	0.439	0.144	0.322	0.295
Mongolia	-0.026	0.057	0.057	-0.126	0.030	0.091
Myanmar	0.047	-0.522	-0.148	0.081	0.004	0.065
Nepal	0.095	0.170	0.218	-0.019	0.155	-0.011
Oman	0.102	0.331	0.005	0.352	0.224	-0.204
Pakistan	0.161	0.528	0.054	0.419	0.354	0.126
Papua New Guinea	0.468	-0.312	-0.139	0.511	-0.123	-0.240
Philippines	-0.297	-0.012	-0.201	0.169	0.535	0.259
Qatar	0.095	-0.304	0.080	0.047	0.009	0.039
Saudi Arabia	-0.259	-0.018	-0.066	-0.081	0.412	-0.065
Singapore	0.080	0.529	0.250	0.532	0.732	0.438
Sri Lanka	0.195	-0.051	0.004	0.367	0.277	0.201
Syria	0.284	-0.087	-0.216	0.464	0.098	-0.076
Thailand	0.072	0.663	0.115	0.534	0.595	0.055
Turkey	0.180	0.329	0.336	0.241	0.505	0.356
United Arab Emirates	-0.231	0.108	0.072	0.091	0.525	0.654
Vietnam	0.429	-0.138	0.239	0.686	0.491	0.362
Armenia				-0.282	0.198	0.187
Azerbaijan				-0.269	0.019	-0.131
Georgia				-0.432	0.101	0.084
Kazakhstan				-0.295	0.067	-0.030
Kyrgyzstan				-0.537	-0.042	-0.083
Russian				-0.342	0.279	0.068
Tajikistan				-0.541	-0.099	-0.201
Timor-Leste				0.170	0.256	0.109
Turkmenistan				-0.319	-0.162	-0.174
Uzbekistan				-0.418	-0.116	-0.284

TABLE VIII

CYCLICAL CORRELATION WITH CHINA, JAPAN, AND U.S. (HP $\boldsymbol{\lambda = 100}$)

i	1979-2011			1990-2011		
	$\rho_{i,China}^{HP100}$	$\rho_{i,Japan}^{HP100}$	$\rho_{i,US}^{HP100}$	$\rho_{i,China}^{HP100}$	$\rho_{i,Japan}^{HP100}$	$\rho_{i,US}^{HP100}$
Afghanistan	0.041	0.134	0.003	-0.114	0.198	-0.092
Bahrain	0.006	0.195	-0.096	0.555	0.330	-0.041
Bangladesh	0.346	0.104	0.452	-0.045	-0.011	0.251
Bhutan	-0.114	0.440	0.264	-0.202	0.077	0.206
Brunei	0.218	0.188	0.123	0.096	0.559	0.128
Cambodia	0.238	0.533	0.523	0.119	0.588	0.515
China	1.000	-0.152	0.281	1.000	0.325	-0.245
Hong Kong SAR, China	0.351	0.506	0.120	0.722	0.745	0.058
India	0.212	0.317	0.194	0.469	0.280	0.271
Indonesia	0.219	0.254	-0.462	0.734	0.428	-0.483
Iraq	0.267	-0.228	0.517	-0.071	-0.258	0.491
Israel	0.328	-0.047	-0.044	0.554	0.279	0.075
Japan	-0.152	1.000	0.271	0.325	1.000	0.379
Jordan	0.327	-0.431	-0.315	0.766	0.295	-0.178
Kuwait	0.661	-0.055	0.482	0.573	0.159	0.199
Laos	-0.169	-0.294	-0.407	0.529	0.048	-0.144
Lebanon	0.549	-0.299	0.130	0.446	0.061	-0.734
Macao SAR, China	0.179	0.518	-0.148	0.549	0.573	-0.148
Malaysia	0.114	0.218	-0.335	0.719	0.646	-0.114
Maldives	0.217	0.268	0.440	0.224	0.298	0.307
Mongolia	0.070	0.230	0.434	-0.134	0.232	0.482
Myanmar	0.165	-0.370	-0.105	-0.015	0.282	0.243
Nepal	0.129	0.072	0.118	0.073	-0.206	-0.266
Oman	0.267	-0.324	-0.263	0.596	-0.043	-0.540
Pakistan	0.211	0.561	0.036	0.608	0.642	0.104
Papua New Guinea	0.557	-0.316	-0.316	0.684	-0.089	-0.561
Philippines	-0.392	0.312	-0.302	0.228	0.581	0.353
Qatar	0.053	0.144	0.245	0.015	-0.063	0.193
Saudi Arabia	-0.386	0.390	-0.287	0.148	0.522	-0.025
Singapore	0.061	0.303	-0.204	0.743	0.632	0.128
Sri Lanka	0.408	-0.257	-0.116	0.614	0.216	0.060
Syria	0.373	-0.349	-0.373	0.753	0.269	-0.332
Thailand	0.048	0.588	-0.238	0.664	0.563	-0.258
Turkey	0.333	0.488	0.406	0.365	0.675	0.385
United Arab Emirates	-0.366	0.254	-0.166	0.051	0.659	0.734
Vietnam	0.630	-0.161	0.165	0.759	0.595	0.112
Armenia				-0.365	0.274	0.554
Azerbaijan				-0.408	0.142	0.372
Georgia				-0.562	0.088	0.495
Kazakhstan				-0.532	0.209	0.367
Kyrgyzstan				-0.731	-0.080	0.359
Russian				-0.517	0.301	0.471
Tajikistan				-0.737	-0.046	0.303
Timor-Leste				0.570	0.626	0.148
Turkmenistan				-0.497	-0.204	0.222
Uzbekistan				-0.594	-0.154	0.223

TABLE IX

CYCLICAL CORRELATION WITH CHINA, JAPAN, AND U.S. ((HP λ =6.25)

i	1979-2011			1990-2011		
	$\rho_{i,China}^{HP6.25}$	$\rho_{i,Japan}^{HP6.25}$	$\rho_{i,US}^{HP6.25}$	$\rho_{i,China}^{HP6.25}$	$\rho_{i,Japan}^{HP6.25}$	$\rho_{i,US}^{HP6.25}$
Afghanistan	-0.058	0.087	-0.199	-0.050	0.198	-0.330
Bahrain	0.124	-0.089	0.184	0.536*	0.330	0.201
Bangladesh	0.183	0.097	0.515*	0.328	-0.011	0.633*
Bhutan	-0.034	0.100	0.034	0.411	0.077	0.112
Brunei	0.299	0.186	0.124	0.167	0.559*	0.142
Cambodia	0.498*	0.158	0.391*	0.336	0.588*	0.630*
China	1.000	-0.118	0.424*	1.000	0.325	0.371
Hong Kong SAR, China	0.316	0.333	0.338	0.455*	0.745*	0.551*
India	0.029	0.378*	0.396*	0.509*	0.280	0.590*
Indonesia	0.011	0.356*	-0.103	0.264	0.428*	-0.194
Iraq	0.239	-0.102	0.388*	0.365	-0.258	0.502*
Israel	0.154	0.195	0.195	0.231	0.279	0.535*
Japan	-0.118	1.000	0.376*	0.226	1.000	0.459*
Jordan	0.301	-0.324	-0.219	0.603*	0.295	0.065
Kuwait	0.551*	-0.172	0.489*	0.632*	0.159	0.483*
Laos	-0.473	0.168	-0.041	0.482*	0.048	0.349
Lebanon	0.394*	-0.164	0.170	-0.420	0.061	-0.622
Macao SAR, China	0.186	0.421*	0.318	0.296	0.573*	0.484*
Malaysia	0.002	0.544*	0.096	0.354	0.646*	0.238
Maldives	0.125	0.271	0.482*	0.192	0.298	0.320
Mongolia	-0.043	0.426*	0.388*	0.245	0.232	0.555*
Myanmar	0.119	-0.142	-0.013	0.553*	0.282	0.166
Nepal	0.060	0.195	0.158	-0.153	-0.206	-0.097
Oman	0.134	0.143	0.106	0.216	-0.043	-0.089
Pakistan	0.185	0.348*	0.212	0.292	0.642*	0.386
Papua New Guinea	0.565*	-0.484	0.017	0.246	-0.089	0.000
Philippines	-0.410	0.334	-0.203	0.406	0.581*	0.442*
Qatar	-0.010	0.190	0.369*	0.132	-0.063	0.363
Saudi Arabia	-0.404	0.262	-0.046	-0.302	0.522*	0.222
Singapore	-0.015	0.582*	0.330	0.491*	0.632*	0.680*
Sri Lanka	0.161	0.234	0.408*	0.332	0.216	0.762*
Syria	0.302	-0.100	-0.282	0.215	0.269	-0.291
Thailand	0.042	0.493*	-0.010	0.399	0.563*	-0.001
Turkey	0.161	0.436*	0.435*	0.215	0.675*	0.588*
United Arab Emirates	-0.330	0.433*	0.119	0.362	0.659*	0.641*
Vietnam	0.436*	0.190	0.272	0.668*	0.595*	0.291
Armenia				0.122	0.274	0.237
Azerbaijan				-0.111	0.142	0.079
Georgia				-0.136	0.088	0.180
Kazakhstan				0.034	0.209	0.222
Kyrgyzstan				-0.410	-0.080	-0.071
Russian				-0.020	0.301	0.358
Tajikistan				-0.607	-0.046	-0.114
Timor-Leste				0.242	0.626*	0.362
Turkmenistan				-0.161	-0.204	0.222
Uzbekistan				-0.410	-0.154	0.038

*Correlation coefficient at 95% significant level. Critical value is 0.343 (n=33) and 0.423(n=22).

TABLE X

CYCLICAL CORRELATION WITH CHINA, JAPAN, AND U.S. (BP)

	1979-2011			1990-2011		
i	$\rho^{BP}_{i,China}$	$\rho^{BP}_{i,Japan}$	$\rho^{BP}_{i,US}$	$\rho^{BP}_{i,China}$	$\rho^{BP}_{i,Japan}$	$\rho^{BP}_{i,US}$
Afghanistan	-0.084	0.125	-0.192	-0.037	0.164	-0.292
Bahrain	0.185	-0.065	0.310	0.509	0.139	0.251
Bangladesh	0.128	0.119	0.466	0.240	0.501	0.570
Bhutan	0.004	0.056	-0.014	0.351	0.328	0.071
Brunei	0.201	0.276	0.223	0.214	0.388	-0.051
Cambodia	0.497	0.153	0.325	0.363	0.500	0.712
China	1.000	-0.074	0.460	1.000	0.455	0.113
Hong Kong SAR, China	0.422	0.269	0.233	0.533	0.775	0.378
India	0.109	0.320	0.403	0.370	0.369	0.485
Indonesia	0.062	0.458	-0.115	0.366	0.622	-0.305
Iraq	0.200	-0.159	0.409	-0.111	-0.084	0.323
Israel	0.160	0.130	0.028	0.314	0.483	0.533
Japan	-0.074	1.000	0.234	0.455	1.000	0.383
Jordan	0.441	-0.347	-0.245	0.667	0.359	0.096
Kuwait	0.476	-0.250	0.494	0.518	-0.006	0.105
Laos	-0.400	0.125	-0.066	0.431	0.487	0.174
Lebanon	0.378	-0.113	0.167	0.152	-0.198	-0.559
Macao SAR, China	0.285	0.216	0.097	0.502	0.519	0.155
Malaysia	0.087	0.490	0.050	0.391	0.750	0.048
Maldives	0.199	0.297	0.509	0.235	0.263	0.304
Mongolia	-0.061	0.327	0.258	0.194	0.536	0.443
Myanmar	0.032	-0.119	0.065	0.218	0.521	0.258
Nepal	0.104	0.298	0.123	-0.064	0.124	0.041
Oman	0.158	0.124	0.019	0.290	0.127	-0.291
Pakistan	0.243	0.419	0.179	0.384	0.605	0.528
Papua New Guinea	0.535	-0.536	-0.063	0.336	-0.395	-0.236
Philippines	-0.349	0.226	-0.262	0.339	0.900	0.271
Qatar	0.096	0.189	0.381	0.134	0.198	0.414
Saudi Arabia	-0.261	0.341	-0.127	0.002	0.357	0.360
Singapore	0.120	0.403	0.252	0.579	0.698	0.477
Sri Lanka	0.174	0.050	0.230	0.434	0.236	0.602
Syria	0.426	-0.082	-0.262	0.256	0.125	-0.297
Thailand	0.065	0.509	-0.039	0.443	0.535	-0.173
Turkey	0.174	0.259	0.226	0.219	0.531	0.329
United Arab Emirates	-0.200	0.573	0.268	0.225	0.771	0.598
Vietnam	0.505	0.215	0.268	0.580	0.796	0.051
Armenia				0.114	0.523	0.373
Azerbaijan				0.081	0.455	0.653
Georgia				-0.172	0.512	0.360
Kazakhstan				-0.062	0.534	0.2
Kyrgyzstan				-0.356	0.377	0.215
Russian				0.048	0.702	0.484
Tajikistan				-0.445	-0.088	0.323
Timor-Leste				0.232	0.472	0.307
Turkmenistan				-0.118	0.014	0.332
Uzbekistan				-0.318	0.226	0.496

Taking the results of HP6.25 for center discussion, I find that: (1) Cyclical correlation with either China or the U.S. varies substantially across countries. (2) Most client economies become more business cycle synchronized with China over time, e.g. Hong Kong, Laos, and Macao. (3) The changes in cyclical correlation with the United States are mild for most member economies; generally, the Asian economies are less cyclical correlated with the United States than that with China, implying adopting yuan will cause fewer losses than adopting the U.S. Dollar.

Focusing on the more recent period (1990-2011) and HP λ=6.25 results, Bahrain, Bhutan, Jordan, Kuwait, Laos, Myanmar, and Vietnam are high positively correlated with China; Cambodia, Iraq, Mongolia, and Sri Lanka are more correlated with the United States. Top 5 economies that are the most highly correlated respectively with China and the U.S. are listed in in TABLE XI.

When jointly evaluate macroeconomic gains and losses among three anchors, I summarize as follows: (1) the economies that are the best candidates to form a yuanization are Bhutan, Indonesia, Kuwait, Laos, Myanmar, Papua New Guinea, Syria, and Vietnam, since they gain price stability and have little to lose from the yuan adoption. (2) For Bangladesh, India Cambodia, Iraq, Israel, Mongolia, Pakistan, Philippines, United Arab Emirates, Armenia and Georgia, the U.S. Dollar is a better currency to adopt because they are higher business cycle synchronized with United States than with China. (3) I do not consider yen as a promising Optimum Currency Area due to Japanese deflation during the recent period.

TABLE XI

TOP 5 ECONOMIES HIGHLY CORRELATED WITH CHINA AND U.S.

With China	$\boldsymbol{\rho_{i,China}^{HP6.25}}$	$\rho_{i,Japan}^{HP6.25}$	$\rho_{i,US}^{HP6.25}$
Vietnam	**0.668**	0.595	0.291
Kuwait	**0.632**	0.159	0.483
Jordan	**0.603**	0.295	0.065
Myanmar	**0.553**	0.282	0.166
Bahrain	**0.536**	0.33	0.201
With the US	$\rho_{i,China}^{HP6.25}$	$\rho_{i,Japan}^{HP6.25}$	$\boldsymbol{\rho_{i,US}^{HP6.25}}$
Sri Lanka	0.332	0.216	**0.762**
Singapore	0.491	0.632	**0.68**
Bangladesh	0.328	-0.011	**0.633**
Cambodia	0.336	0.588	**0.63**
India	0.509	0.28	**0.59**

5.3 Cyclical Correlation Comparisons among OCAs

Focusing on the shorter period, using the HP ($\lambda = 6.25$) de-trending method, my cyclical correlation coefficients for East Asia group are mostly positive with China, ranging from 0.167 (Brunei) to 0.668 (Vietnam), with the medium of 0.354. The only exception is Nepal (-0.153). In order to put these correlations into perspective, I will compare them with correlations for other (potential) OCAs obtained by the literature (See TABLE XII).

For the euro, Baoyoumi and Eichengreen (1992) reported similar correlation range with a potential yuan OCA in Asia. Afterwards, Bayoumi and Eichengreen (1994) present EC countries' correlations of growth with Germany before the adoption of the euro. The correlations range broadly from 0.42 up to 0.78 (with exceptions of 0.14 for Ireland, and 0.12 for Norway), so they are generally higher than my estimates. Business cycle synchronization in the EMU after adopting the euro are reported in Furceri and Karras (2008) and Karras (2011). They find that all countries in the sample were better synchronized with the EMU-wide economy in Post-EMU period than that in Pre-EMU period. Most countries are very highly correlated with EMU-wide economy, with correlations ranging from 0.7 up to 0.98, with the only exception of 0.2 for Greece. Hence, correlation coefficients are obviously higher here than in a potential yuan OCA in Asia in my study.

Regarding dollarization and other potential OCAs in Asia, Bayoumi and Eichengreen (1992) find that US regions are better suited to a monetary union than EC countries. However, Bayoumi and Eichengreen (1994) conclude that a European monetary union might run more smoothly if limited to a subset of EU members, and East Asia is more conductive to monetary unification than the Americas. The correlations (Bayoumi and Eichengreen, 1994) between Asian countries

and Japan vary broadly between 0.13 (Indonesia) and 0.62 (Taiwan), with medium of 0.38 and a couple of exceptions (-0.08 for New Zealand and 0.06 for Korea). These results are broadly similar to my estimates for a potential yuan OCA.

Karras (2005, 2002) also presents prospects of adopting the yen in Asia and dollarization in American countries. Compared with my estimates, it seems that I obtained higher correlation for East Asia countries with China than that with Japan (Karras, 2005). In Karras (2002) for dollarization, Canada (0.84) is the most highly correlated with the U.S., followed by Honduras, El, Salvador, and Costa Rica as the next group, with correlations coefficients around between 0.4 and 0.6. The correlations are also consistently positive for some other American countries. These results are similar (though slightly better) than my estimates in a yuan OCA in Asia.

TABLE XII
CYCLICAL CORRELATION COMPARISONS AMONG OCAS

OCA	Author(Year)	Broad Range	Medium	Compare with my results	Exceptions
Yuanization	Wenwen	(0.167, 0.668)	0.354	-	Nepal (-0.153)
the euro	Bayoumi and Eichengreen (1992)	(0.11,0.61)	0.31	Similar	Ireland(-0.06)
	Bayoumi and Eichengreen (1994)	(0.42,0.78)	0.55	Higher	Ireland (0.14) Norway (0.12)
	Karras (2011)	(0.79,0.95)	0.86	Higher	Greece(-0.01)
	Furceri and Karras (2008)	(0.72, 0.98)	0.89	Higher	Greece (0.2)
Dollarization	Bayoumi and Eichengreen (1994)	(0.15, 0.78)	0.42	Higher	-
	Bayoumi and Eichengreen (1992)	(0.18,0.86)	0.52	Higher	South West(-0.12)
	Karras (2002)	(-0.36,0.84)	0.16	Lower	-
Yenization	Bayoumi and Eichengreen(1994)	(0.13, 0.62)	0.38	Similar	New Zealand(-0.08)
	Karras (2002)	(-0.24, 0.45)	0.10	Lower	-

6. TRADE INTENSITY AND BUSINESS CYCLE SYNCHRONIZATION: THE CASE OF CHINA WITH OTHER ASIAN ECONOMIES

6.1 Background

McKinnon (1963) introduced the *degree of openness*, defined as the ratio of tradable to non-readable goods, as a crucial criterion in forming an Optimum Currency Area (OCA). He argues that small open economy would find it advantageous to join a large common currency area. Because international prices of tradables are more likely to be transmitted to the domestic cost of living for higher openness economy. The changes in exchange rate cause adjustments in variables such as wage rate and prices, implying changes in exchange rate less useful as an adjustment mechanism. Alesina and Barro (2002) investigated the relationship between currency unions and trade flows and found that countries with more bilateral trade are more likely to form currency unions. Empirically, Rose (2000) initiated a large literature on the trade benefits of currency unions. Using a United Nations panel dataset on trade among around 200 countries, he found that currency unions triple trade among their members. Frankel and Rose (2002) study a large cross-section of countries and find that abandoning a national currency and joining a currency union enhances both trade and income. Glick and Rose (2002) provide some time-series evidence using a panel data set about 217 countries over 1947 to 1997 and argue that leaving a currency union decreases trade.

In the last two decades, world trade has grown much faster than world output, which deepened economic integration considerably. With increased trade integration, external disturbances will influence trading countries' macroeconomic fluctuations more than before. Particularly, shocks initiated by trade occurring in one country would be transmitted to another country through three

basic channels: international trade in merchandises, international trade of financial assets, and direct linkages between sectors of production across countries. (Calderón, 2007, The World Bank). The OCA literature has shown that countries are more likely to benefit from a currency union if they have higher trade integration and high cyclical correlations (more synchronized business cycle (BSC)) (Mundell, 1961; Frankel and Rose, 1998). Moreover, international trade plays important role in transmitting business cycle fluctuations across countries. Hence, to form an OCA, in addition to considering the degree of trade and cyclical correlation between anchor and client economies separately, the internal relationship between these two factors is another crucial issue to investigate.

This study focuses solely on the prospect of a Yuan optimum currency union. The economic role and international status of China have been increasing sharply in last few decades. China has opened her trade market step-by-step after accessing WTO since Dec 2001, such as cutting import tariffs on agricultural products and eliminating export subsidies. In addition, in 2005, China reformed the exchange rate regime by moving into a managed floating exchange rate system based on market supply and demand relative to a basket of currencies. China's fast growth and deeper integration into the world economy may affect the business cycle of other economies. My main goal is to analyze the relationship of trade integration and Business Cycle Synchronization (BCS) among China and her trading partners in Asia. Will closer trade with China result in tighter or looser correlations of national business cycle between them?

The remainder of this section proceeds as follows: Section 6.2 presents literature review regarding the relationship of trade integration and Business Cycle Synchronization (BCS) among China and her trading partners in Asia. Section 6.3 discuss the data and presents the econometric methodology used in my empirical analysis. Section 6.4 discusses the regression results. Section

6.5 discusses the implication on the prospects of a Yuan Currency Union. Section 6.6 concludes. Section 6.7 extends the discussion of the constraints of a yuan OCA in Asia in reality.

6.2. Literature Review on "Trade Integration vs. Business Cycle Synchronization"

6.2.1 Theoretical Literature

From a theoretical viewpoint, the relationship in question could go either way. On the one hand, we expect trade integration to decrease BCS if industry-specific shocks are the dominant force driving the business cycle. In particular, closer trade ties could result in countries becoming more specialized in the goods in which they have comparative advantage. If inter-industry trade prevails, it leads to asymmetric effects of industry-specific shocks, which in turn causes idiosyncratic business cycles (Eichengreen, 1992; Kenen, 1969; and Krugman, 1993). On the other hand, if the demand channel is the dominant force explaining business cycles, BSC will be increased by trade integration. The reason is that deeper trader links will not necessarily result in deeper specification along industry lines so that industry-specific shocks will not affect country pairs more asymmetrically. Then the relationship between trade integration and BSC is positive. In this case, a positive output shock in a country may increase its demand for foreign goods. The depth of the trade link between this country and her partner determines the size of impact of this shock on the cycle of her partner. Hence, the business cycles may become more similar across these two countries when they trade more (Frankel and Rose, 1998) (See APPENDIX B for deductive theoretical approach).

In summary, the total effect of trade integration on BSC is theoretically ambiguous. Differences in the pattern of trade and specialization among trading partners suggest different impact of trade intensity on cyclical correlation. Generally, if inter-industry trade is the dominant pattern across

countries, more trade leads to lower cyclical correlation. However, if intra-industry trade accounts for most trade, the relationship between trade intensity and BSC would be positive (Calderon, 2007).

6.2.2 Empirical Literature

To solve the theoretical ambiguity, an empirical investigation is in order. Based on 21 industrialized countries, Frankel and Rose (1998) clearly indicate that closer international trade links result in more closely correlated business cycles across countries. Since then, many scholars have focused on the empirical study of trade intensity and business cycle synchronization and a wide range of papers have confirmed Frankel and Rose's finding (e.g., Otto, 2001; Gruben, 2002; Baxter and Kouparitsas, 2005; Shin and Wang, 2002, 2004, and 2005; Calderón, 2007; Inklaar and others, 2008).

Gruben (2002) includes inter-industry and intra-industry trade in their business cycle synchronization model finds that the effects of both variables are different. Imbs (2004) claims that only when increased trade is accompanied by more intra-industry trade, business cycle co-movements will be strengthened. Calderón (2007), using annual data for 147 countries for the period 1960-99, find that the impact of trade integration on business cycle correlation among developing countries is positive and significant, but substantially smaller than that among industrial countries. Inklaar (2008) re-examines this relationship for 21 OECD countries during 1970-2003 and they confirm that trade intensity affects business cycle synchronization, but the effect is much smaller than previously reported.

In the case of Asia, Chole (2001) states that economic fluctuations are more synchronized as trade interdependence deepens in the region, based on 10 East Asian countries. Loayza, Lopez,

and Ubide (2001) show that the co-movement of East Asia as a region is based on the countries' highly similar trade structures. Shin and Wang (2004) and (2004) find that intra-trade is important determinant on BSC rather than inter-industry trade, corresponding to the case of Korea and 12 East Asian countries. Shin and Wang (2005) extend this study and focus on Europe. Rana (2008) extends the work of Shin and Wang (2004) and finds that intra-industry trade is the major factor explaining business cycle co-movements in East Asia, implying the importance of the prospects for a single currency in the region. More recently, Duval and others (2014) indicates that not only trade intensity but also the type of trade (trade specialization correlation) appears to increase co-movements.

The focus of most of the literature has been on Europe or Asia, while this study is the first one to target entirely on China and prospect of a Yuan currency union. I am interested in investigating how trade integration between China and other Asian countries affect their BCSs in order to help analyzing construction Yuan Optimum Currency Union in Asian region.

6.3 Data and Methodology

6.3.1 Definitions and Measurement

Bilateral correlations of real economic activity between Asian country *i* and China and their bilateral trade intensity are the two core variables in my empirical analysis. I am interested in investigating the relationships between these two variables.

My dependent variable is the *degree of business cycle synchronization* between economy *i* and China over a given length of time τ. To measure it, I follow Frankel and Rose (1997,1998) and compute the correlation between cyclical components of output for country *i* and China,

$$\rho(c_i, c_{China})_\tau = \frac{cov(c_i, c_{China})_\tau}{\sqrt{var(c_i) * var(c_{China})}} \quad (6.1)$$

where $c_{i,t}$ is the cyclical component of real output (y) of country *i* at time *t* and similarly $c_{China,t}$ is the cyclical component of China's real output. The measure of real output is the (log of) real GDP in USD at 2005 constant prices, obtained from the *UN national accounts*. Given the lack of consensus about the optimal de-trending techniques (and for robustness purposes), again four methodologies have been used to decompose real GDP into trend and cyclical components: (1) simple first differencing, (2) the Hodrick-Prescott filter with smoothing parameter λ=100, (3) the Hodrick-Prescott filter with λ=6.25, and (4) the Baxter and King band-pass filter.

In order to measure the *bilateral trade intensity* between country *i* and China, two different proxies for trade ratios have been considered: $\frac{EX_{ict}+IM_{ict}}{EX_{iwt}+IM_{iwt}}$ and $\frac{EX_{ict}+IM_{ict}}{GDP_{it}}$. EX_{ict} denotes nominal exports from country *i* to China at time t; EX_{iwt} denotes total global exports from country *i* to the world at time t; IM denotes imports; and GDP_{it} denotes nominal GDP of country *i* at time *t*. The former ratio, therefore, measures how much trade weight country *i* puts on China over its entire world trade. The latter ratio shows country *i*'s bilateral trade with China as a share of country *i*'s output at time t. The independent variable, *bilateral trade intensity* between country *i* and China, then is approximated by these two ratios with the following measures:

$$Trade_{ic\tau}{}^{F} = \frac{1}{T}\sum_{t}\frac{EX_{ict} + IM_{ict}}{EX_{iwt} + IM_{iwt}} \quad (6.2)$$

and

$$Trade_{ic\tau}{}^{Y} = \frac{1}{T}\sum_{t}\frac{EX_{ict} + IM_{ict}}{GDP_{it}} \quad (6.2)^*$$

$Trade_{ic\tau}{}^{F}$ and $Trade_{ic\tau}{}^{Y}$ represent the average bilateral trade intensity between country i and China over a given time span τ using two trade ratio proxies. Higher value illustrates higher integration degree. In practice, I take natural logarithms of both these ratios.

6.3.2 The Data

I have collected annual data for 43 Asian economies over the period from 1982 to 2011 on both real GDP and their bilateral trade with China (see TABLE XIII for the list of sample economies). Nine of them (formerly parts of the Soviet Union) are indicated by an asterisk and have a shorter data period available, 1992-2011. I form a panel data set by splitting the full sample of 30 years into three equally sized and non-overlapping ten-year sub-periods: 1982-1991, 1992-2001, and 2002-2011. Then, dependent and independent variables are calculated over each of these decades. This panel data set is unbalanced because the first sub-period data are missing for the former Soviet Union members.

The (log of) real GDP in USD at 2005 constant prices is taken from the *UN national accounts*. Four de-trending methodologies have been employed to compute cyclical component of these economies' output, as described above. After the appropriate transformation, I am able to estimate cyclical correlations between country i and China $\rho(c_i, c_{China})_\tau$ over a given span of time τ (10-year periods), following equation (6.1).

TABLE XIII

LIST OF ASIAN ECONOMIES IN SAMPLE

1	Afghanistan	23	Maldives
2	Armenia*	24	Mongolia
3	Azerbaijan*	25	Myanmar
4	Bahrain	26	Nepal
5	Bangladesh	27	Oman
6	Brunei	28	Pakistan
7	Cambodia	29	Papua New Guinea
8	Georgia*	30	Philippines
9	Hong Kong SAR, China	31	Qatar
10	India	32	Russian*
11	Indonesia	33	Saudi Arabia
12	Iraq	34	Singapore
13	Israel	35	Sri Lanka
14	Japan	36	Syria
15	Jordan	37	Tajikistan*
16	Kazakhstan*	38	Thailand
17	Kuwait	39	Turkey
18	Kyrgyzstan*	40	Turkmenistan*
19	Laos	41	United Arab Emirates
20	Lebanon	42	Uzbekistan*
21	Macao SAR, China	43	Vietnam
22	Malaysia		

[a] Full period: 1982-2011

[b] Economies with * have a shorter period (1992-2011)

The annual bilateral trade data are obtained from the International Monetary Fund's *Direction of Trade Statistics.* For these 43 economies in my sample, I collected their nominal bilateral flows in USD with China, EX_{ict} and IM_{ict}, as well as with the entire world EX_{iwt} and IM_{iwt}. Combined with nominal GDP data from *UN national accounts*, trade ratios mentioned above are able to compute in two different proxies. Then the averages of these two ratios over a given time span τ are used to construct my independent variable, average bilateral trade intensity ${Trade_{ic\tau}}^{F}$ and ${Trade_{ic\tau}}^{Y}$, followed by equations (6.2) and (6.2)*.

6.3.3 Descriptive Statistics

I begin the analysis with statistics descriptions on my independent variable and dependent variable. TABLE XIV shows the averages of my measures of these two main variables, i.e. *business cycle synchronization* with China and *bilateral trade intensity* with China over the 1982-2011 period. Four methodologies have been used to de-trend output cyclical components. The averages of 10-year sub-periods cyclical correlation with China induced by these four methodologies are listed in TABLE XIV and marked as DIFF, HP100, HP6.25, and BP. Last two columns list averages of variable bilateral trade intensity with China computed by two trade ratio proxies: as a share of total trade and as a share of GDP. At the first glance of this table, I find that: first, averages of these two variables vary dramatically across countries. For example, taking HP λ=6.25 for discussion, Hong Kong is positively cyclical correlated with China as highly as 0.482, while Nepal is as low as 0.006; Hong Kong trades very intensively with China over 1982-2011(47.09% by GDP), while Nepal has it as low as 0.82% by GDP. Secondly, the economies

TABLE XIV

BASIC STATISTICS SUMMARY (1982-2011)

	Cyclical Correlation with China				Bilateral Trade Intensity	
i	DIFF	HP100	HP6.25	BP	%Trade	%GDP
Afghanistan	-0.037	0.133	-0.160	-0.115	3.33%	0.54%
Bahrain	0.276	0.142	0.221	0.241	1.12%	0.64%
Bangladesh	-0.071	0.220	0.127	0.099	5.48%	0.84%
Brunei	0.070	-0.041	0.146	0.144	2.30%	1.03%
Cambodia	0.212	0.097	0.340	0.328	4.32%	1.95%
Hong Kong	0.489*	0.494*	0.482*	0.460*	35.53%	47.09%
India	0.203	0.422*	0.202	0.190	3.27%	0.46%
Indonesia	0.170	0.302	0.122	0.186	4.92%	1.14%
Iraq	0.097	0.202	0.141	0.092	1.80%	0.96%
Israel	0.305	0.392*	0.238	0.195	*2.23%	*0.66%
Japan	0.204	-0.058	-0.023	0.031	10.02%	1.11%
Jordan	0.512*	0.760*	0.441*	0.467*	3.65%	1.66%
Kuwait	0.373*	0.609*	0.534*	0.538*	2.51%	0.91%
Laos	0.039	0.442*	0.212	0.218	8.73%	2.07%
Lebanon	0.300	0.565*	0.128	0.029	3.42%	1.06%
Macao	0.311	0.161	0.344	0.350	20.00%	7.04%
Malaysia	0.171	0.273	0.191	0.224	4.95%	3.74%
Maldives	0.176	0.149	0.084	0.090	0.98%	0.32%
Mongolia	-0.060	0.290	0.127	0.174	22.28%	10.22%
Myanmar	-0.026	0.412*	0.287	0.272	20.21%	3.47%
Nepal	0.105	0.027	0.006	-0.024	5.21%	0.87%
Oman	0.403*	0.470*	0.086	0.127	8.11%	3.62%
Pakistan	0.461*	0.286	0.211	0.280	5.47%	0.82%
Papua New Guinea	0.315	0.500*	0.382*	0.413*	3.97%	1.88%
Philippines	-0.076	0.186	0.092	0.128	3.92%	1.26%
Qatar	0.004	0.076	0.076	0.125	1.79%	0.69%
Saudi Arabia	-0.084	-0.079	-0.280	-0.183	3.48%	1.17%
Singapore	0.274	0.315	0.258	0.288	5.38%	7.98%
Sri Lanka	0.267	0.575*	0.296	0.297	3.06%	0.87%
Syria	0.395*	0.655*	0.263	0.275	3.51%	0.96%
Thailand	0.160	0.027	0.121	0.175	5.32%	2.55%
Turkey	0.187	0.339	0.175	0.187	2.19%	0.40%
United Arab Emirates	-0.069	-0.017	-0.013	0.044	3.30%	1.72%
Vietnam	0.419*	0.630*	0.435*	0.409*	9.70%^	5.65%^
Armenia^	-0.126	0.248	0.502*	0.699*	2.59%	0.67%
Azerbaijan^	-0.089	-0.049	-0.057	0.839*	1.22%	0.42%
Georgia^	-0.089	-0.042	0.293	0.776*	1.76%	0.45%
Kazakhstan^	-0.165	-0.350	-0.019	0.600*	8.09%	2.55%
Kyrgyzstan^	-0.349	-0.375	-0.284	0.219	21.49%	10.07%
Russian^	-0.159	-0.264	0.104	0.673*	5.40%	1.15%
Tajikistan^	-0.436	-0.623	-0.418	-0.051	6.35%	2.51%
Turkmenistan^	-0.178	0.000	0.100	0.597*	3.45%	1.16%
Uzbekistan^	-0.277	-0.019	0.049	0.536*	4.85%	1.37%

[a] This table reports mean of the variables of their three sub-period values (1982-1991, 1992-2001, and 2002-2011).

[b] Data for economies with ^ are only available for the 2nd and the 3rd sub-periods. For Israel and Vietnam, their trade with China data for the 1st sub-period is missing too.

[c] Last two columns give the bilateral trade with China, as a share of total trade as well as the output.

[d] *Correlation coefficient at 95% significant level, when using filter method HP λ=6.25. Critical value is 0.361.

who have been highly positively correlated with China over 1982-2011 are Cambodia, Hong Kong, Jordan, Kuwait, Macao, Papua New Guinea, Vietnam, and Armenia. Thirdly, economies that most intensively trade with China are Hong Kong, Macao, Mongolia, Myanmar, Vietnam, and Kyrgyzstan. At last, it appears roughly positive relationship between these two averages of the variables. For instance, both values are high for Hong Kong, Macao, Vietnam and Myanmar. Of course, precise relationship will be discussed after obtaining regression results.

In addition, I present the evolution of these variables for some particular economies. Figure 12 shows 10-year window rolling correlation of real output fluctuations (DIFF) between eight selective economies and China. These economies are Hong Kong, Mongolia, Singapore, Laos, Malaysia, Philippines, Thailand, and Sri Lanka; they evolve higher and higher business cycle synchronizations with China and present convergence over period 1982-2011. Typically, the output fluctuation correlation between China and Hong Kong rises sharply over time from 0.265 in 1990 to 0.572 in 2011; for Singapore, it evolves from -0.334 in 1990 to 0.560 in 2011.

TABLEs XV and XVI report all economies' average bilateral trade flows with China for each sub-period, respectively as a share of total trade and as a share of GDP. Trade flow is the average of imports and exports. These two tables list all independent variable values for two of my regressions. Figure 13 depicts the evolution of the bilateral trade intensity with bars, normalized by total trade and by GDP. Seven economies that experience the largest increase in their trade link with China during three sub-periods are shown on this figure. I choose to center my analysis on TABLE XV and Figure 13 Part A (normalized by total trade), since these two trade ratio proxies deliver consistent information. My findings are:

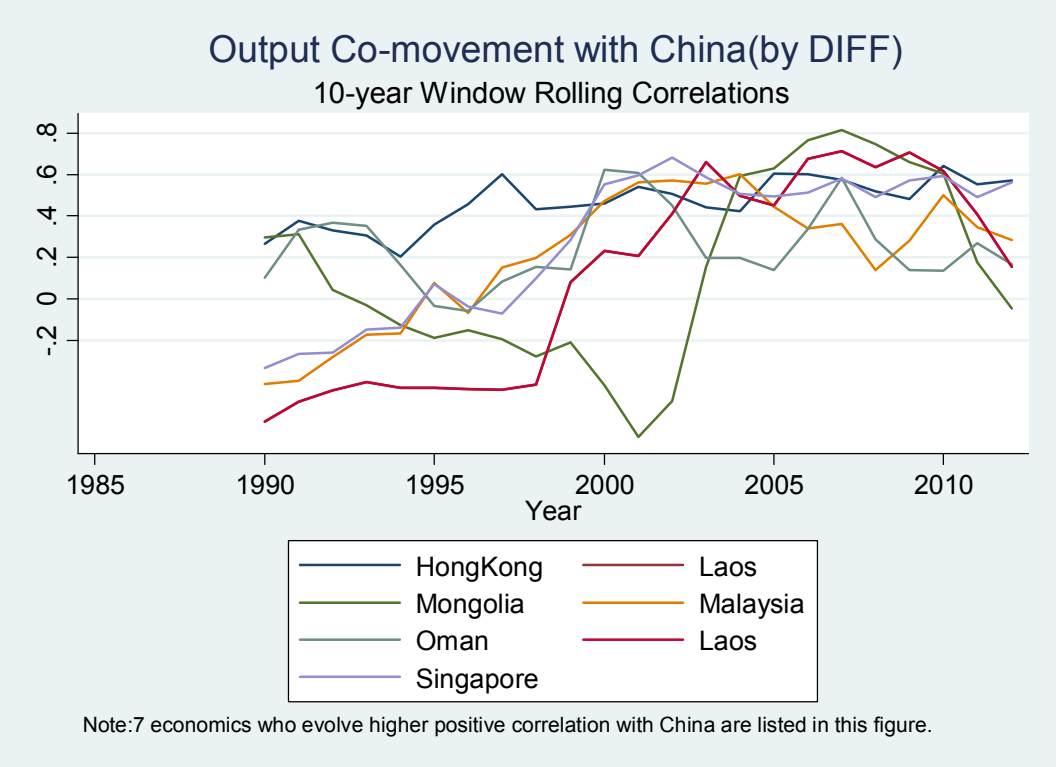


Figure 12. Output co-movement evolution with China

TABLE XV

AVERAGE SUB-PERIODS TRADE INTENSITY WITH CHINA (%TOTAL TRADE)

i	1982-1991	1992-2001	2002-2012
Afghanistan	2.14%	4.42%	3.41%
Bahrain	0.24%	0.87%	2.25%
Bangladesh	3.07%	4.69%	8.67%
Brunei	0.61%	1.48%	4.80%
Cambodia	0.68%	3.90%	8.38%
Hong Kong	25.00%	36.27%	45.32%
India	0.40%	1.84%	7.55%
Indonesia	1.97%	3.75%	9.06%
Iraq	0.49%	0.95%	3.97%
Israel	-	0.69%	3.77%
Japan	4.22%	8.17%	17.67%
Jordan	1.66%	2.41%	6.87%
Kuwait	1.01%	1.53%	4.99%
Laos	4.67%	4.43%	17.07%
Lebanon	0.90%	2.89%	6.47%
Macao	12.54%	18.71%	28.76%
Malaysia	1.88%	2.89%	10.08%
Maldives	0.22%	0.26%	2.47%
Mongolia	1.58%	21.23%	44.04%
Myanmar	8.47%	25.89%	26.27%
Nepal	4.18%	4.31%	7.15%
Oman	0.65%	7.60%	16.08%
Pakistan	2.91%	3.33%	10.16%
Papua New Guinea	1.67%	2.57%	7.67%
Philippines	2.05%	1.87%	7.83%
Qatar	0.92%	1.69%	2.75%
Saudi Arabia	0.63%	1.78%	8.05%
Singapore	3.19%	3.56%	9.39%
Sri Lanka	2.49%	1.94%	4.75%
Syria	0.80%	1.94%	7.79%
Thailand	2.88%	3.30%	9.78%
Turkey	0.74%	1.32%	4.51%
United Arab Emirates	1.10%	2.87%	5.93%
Vietnam	-	5.34%	14.07%
Armenia	-	0.40%	4.78%
Azerbaijan	-	0.48%	1.96%
Georgia	-	0.58%	2.94%
Kazakhstan	-	4.92%	11.26%
Kyrgyzstan	-	6.27%	36.71%
Russian	-	3.99%	6.82%
Tajikistan	-	0.75%	11.95%
Turkmenistan	-	0.56%	6.34%
Uzbekistan	-	1.50%	8.21%

[a] Trade is the average of imports and exports with China.

[b] This table reports country i's the average trade flow with China divided by its total trade for three sub-periods.

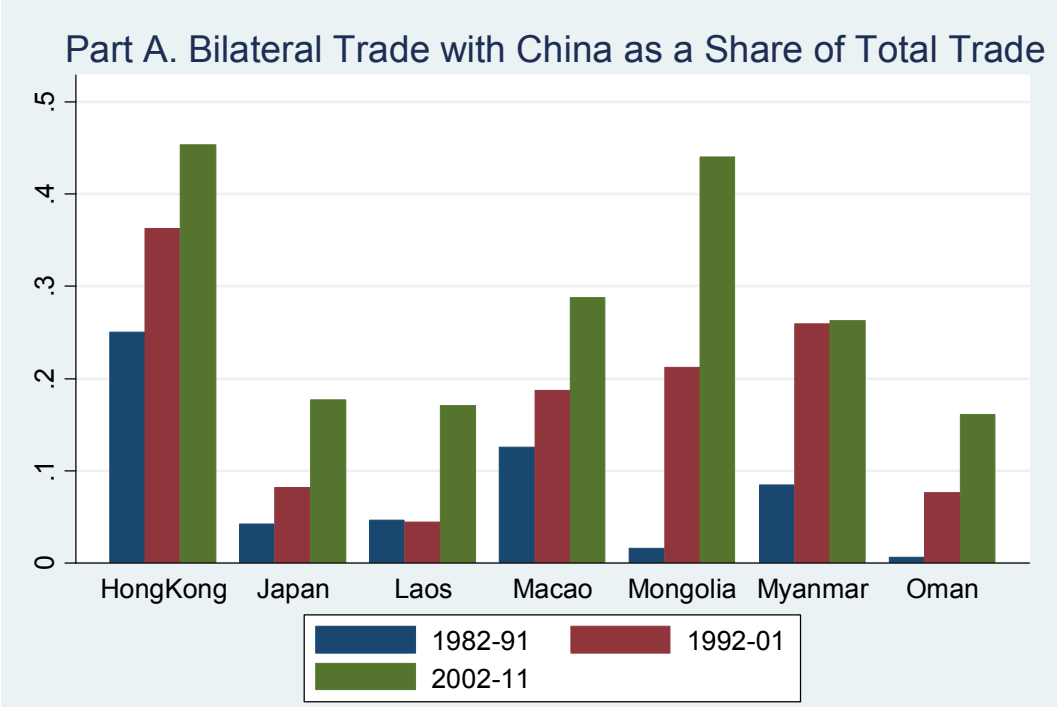
TABLE XVI

AVERAGE SUB-PERIODS TRADE INTENSITY WITH CHINA (%GDP)

i	1982-1991	1992-2001	2002-2011
Afghanistan	0.46%	0.55%	0.62%
Bahrain	0.17%	0.49%	1.26%
Bangladesh	0.25%	0.58%	1.69%
Brunei	0.29%	0.68%	2.13%
Cambodia	0.06%	1.17%	4.63%
Hong Kong	24.51%	42.12%	74.64%
India	0.02%	0.17%	1.20%
Indonesia	0.35%	0.93%	2.13%
Iraq	0.36%	0.70%	1.82%
Israel	-	0.18%	1.14%
Japan	0.40%	0.67%	2.26%
Jordan	0.60%	0.95%	3.43%
Kuwait	0.36%	0.54%	1.83%
Laos	0.82%	1.14%	4.24%
Lebanon	0.52%	0.79%	1.88%
Macao	7.78%	6.35%	6.98%
Malaysia	0.93%	2.27%	8.02%
Maldives	0.06%	0.08%	0.83%
Mongolia	0.76%	8.22%	21.68%
Myanmar	0.64%	4.28%	5.51%
Nepal	0.47%	0.80%	1.33%
Oman	0.24%	3.08%	7.54%
Pakistan	0.34%	0.43%	1.70%
Papua New Guinea	0.63%	1.10%	3.92%
Philippines	0.36%	0.67%	2.75%
Qatar	0.30%	0.67%	1.10%
Saudi Arabia	0.17%	0.48%	2.87%
Singapore	4.51%	4.78%	14.66%
Sri Lanka	0.66%	0.64%	1.30%
Syria	0.16%	0.49%	2.22%
Thailand	0.71%	1.40%	5.53%
Turkey	0.07%	0.18%	0.96%
United Arab Emirates	0.34%	1.21%	3.61%
Vietnam	-	2.11%	9.19%
Armenia	-	0.11%	1.24%
Azerbaijan	-	0.12%	0.73%
Georgia	-	0.05%	0.85%
Kazakhstan	-	1.18%	3.92%
Kyrgyzstan	-	1.87%	18.26%
Russian	-	0.74%	1.55%
Tajikistan	-	0.38%	4.64%
Turkmenistan	-	0.24%	2.09%
Uzbekistan	-	0.36%	2.38%

[a] Trade is the average of imports and exports with China.

[b] This table reports country i's the average trade flow with China divided by its output for three sub-periods.



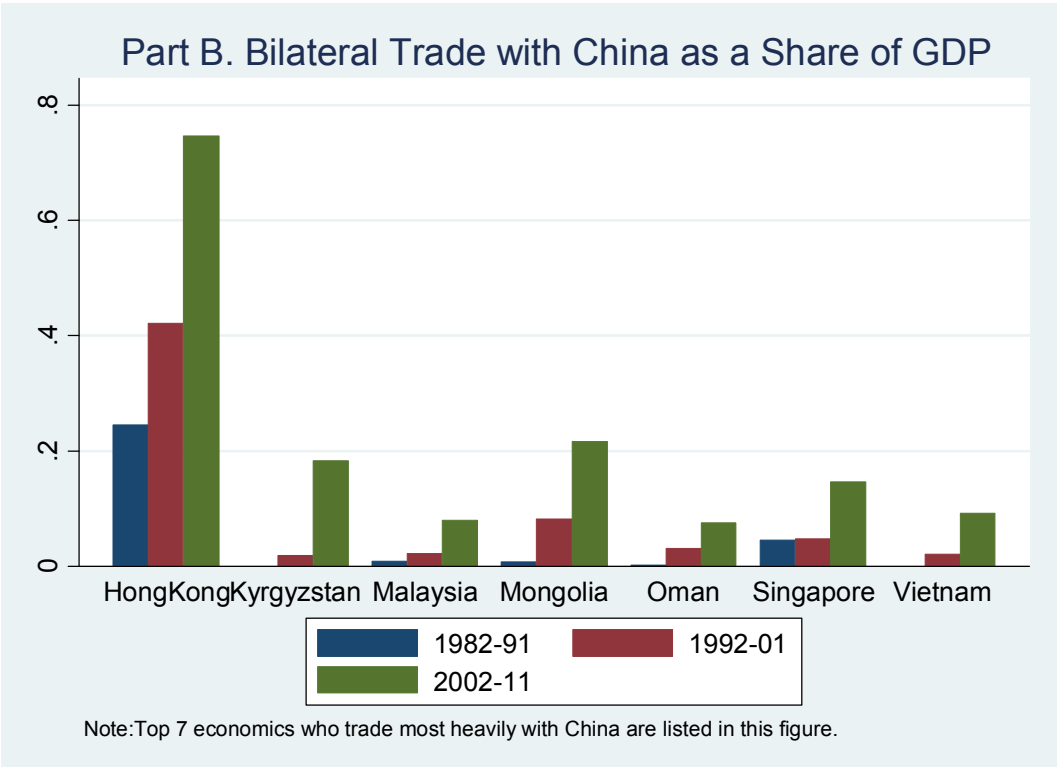


Figure 13. Trade integration with China of selective economies

(1) All Asian economies show an increasing trend in bilateral trade intensity with China, which means they develop closer trading ties with China over these three sub-periods, with the only exception of Afghanistan (see TABLE XV). Magnitude increasing for most economies happens in the last sub-period, 2002-2011, which implies the impact of China's entering the WTO since Dec 2001.

(2) The magnitude of the increasing in trade intensity varies substantially across countries. Hong Kong, Japan, Laos, Macao, Mongolia, Myanmar and Oman show the largest increasing in trade intensity with China (see Figure 13 Part A). For example, this trade link between Hong Kong and China has grown approximately twice closer during 1982-2011, 25% in the 1st sub-period (1982-1991), 36.27% in the 2nd (1992-2001), and then grown up to 45.32% in the last sub-period (2002-2011). For Mongolia, this trade ratio has raised even faster, sharply from 1.58% through 21.23% up to 44.04%. Additional examples could be Laos (4.67% to 17.07%); Oman (0.65% to 16.08%) and so on. Figure 13 Part B illustrates similar evolution when trade intensity is computed as a share of GDP. Top seven economies that evolve the largest raises are Hong Kong, Kyrgyzstan, Malaysia, Mongolia, Oman, Singapore, and Vietnam. Yet these raises are relatively mild compared with those in Figure 5.2(a). Particularly, I have Afghanistan (2.14% to 3.41%), Bahrain (0.24% to 2.25%), Iraq (0.49% to 3.97%), Maldives (0.22% to 2.47%), Qatar (0.92% to 2.75%), Turkey (0.74% to 4.51%), etc. In summary, I observe that the countries with sharp rising in trade share with China are most likely to be East Asian or South-East Asian economies, while most Middle East economies have this increasing in much lower speed.

(3) In the most recent sub-period (2002-2012), Hong Kong and Mongolia allocated the largest magnitude of trade share with China, respectively 45.32% and 44.04%, which means that they

have being trading extremely heavily with China in recent decade, almost half share of their total trade; followed by Kyrgyzstan (36.71%), Macao (28.76%), Myanmar (26.27%) and so on.

6.3.4 Econometric Methodology

My goal is to test the impact of trade integration on business cycle synchronization of country *i* with China. I want to know what happens to the business cycle correlation between country *i* and China when the trade flow between the two economies increases. Is country *i* becoming more cyclically correlated with China, or less? If my results present a positive relationship between these two variables, as in the other empirical assessment (Frankel and Rose, 1998; Calderon, 2007), client countries that trade heavily with China will be considered as good candidates of joining a Yuan currency union. Because for these economies, more intensive trade with China brings about higher cyclical correlation with it, these economies will have less to lose if they adopt Chinese currency.

The baseline model of my regressions is:

$$Corr_{i\tau} = \mu_i + \lambda_\tau + \beta \ln(Trade_{i\tau}{}^{K}) + e_{i\tau} \tag{6.3}$$

$Corr_{i\tau}$ denotes the business-cycle correlation between country *i* and China over time span τ(of length T=10 years) for economic activity. The four methodologies that have been used to de-trend output, as mentioned above, are: first differencing, HP filter $\lambda = 100$, HP filter $\lambda = 6.25$ and BK band-pass filter. $\ln(Trade_{i\tau}{}^{K})$ denotes the natural logarithm of the average bilateral trade intensity between country *i* and China over time span τ, either normalized by global trade (K=F) or output (K=Y). In addition, μ_i represents country pair-specific effect; while $\lambda_\tau$is time effect (decade dummies), which accounts for time-varying common factors affecting all

countries. Last, $e_{i\tau}$ represents the myriad influence on real activity correlations and beyond the influences of international trade. β is the regression coefficient to be estimated.

Fixed effects help to largely reduce (but do not completely eliminate) the chance that a relationship is driven by an omitted variables. It explores the relationship between predictor and outcome variables with an entity (country, person, company, etc.) Each entity has its own individual characteristics that may or may not influence the predictor variables. When using time fixed effect and country-specific fixed effect in equation (6.3), I assume that something within a given time span or with a specific country pair may affect or bias the predictor or outcome variables and we need to control for this.

Afterwards I drop time fixed effect and estimate the models with solely country pair-specific effect:

$$Corr_{i\tau} = \mu_i + \beta \ln(Trade_{i\tau}{}^{K}) + e_{i\tau} \tag{6.4}$$

By including μ_i, I am able to control for all the time-invariant, country pair-specific variables that may have an impact on output correlation. Because what I want to know is what happens to the output correlation between an economy i and China when their bilateral trade intensity increases. This is different with asking whether country pairs with higher bilateral trade intensity have higher output correlation than other country pairs. Therefore, the inclusion of country-pair fixed effect soaks up cross-group action and leaves over within-group action, which allows me to focus on the time-series dimension and, thus, on the right policy question.

Besides, models with random effects are also estimated:

$$Corr_{i\tau} = \alpha + \beta \ln(Trade_{i\tau}{}^{K}) + \nu_{i\tau} \tag{6.5}$$

In this random effects model, I assume that the country-specific effect is a random variable that is uncorrelated with the explanatory variables of all past, current and future time periods of the same country pair.

My main interest lies on the sign and magnitude of the coefficient β. Negative β tells us more intensive trade relations with China is expected to lead to less business cycle synchronization and thus a lower economic activity correlation with China. In this case, the Eichengreen-Krugman industry specialization effect dominates. Otherwise, if more intra-industry trade prevails between i and China, we would expect β to be positive for which global shocks dominate economic fluctuations.

In addition to fixed effects and random effects, I lastly employ first differencing method to variables to remove unobserved effects in the model and run regression for the following equation:

$$\Delta Corr_{i\tau} = \beta \Delta \ln({Trade_{i\tau}}^{K}) + \varepsilon_{i\tau} \tag{6.6}$$

where

$$\Delta Corr_{i\tau} = Corr_{i\tau} - Corr_{i\tau-1}, \tau = 2,3$$

$$\Delta \ln({Trade_{i\tau}}^{K}) = \ln({Trade_{i\tau}}^{K}) - \ln({Trade_{i\tau-1}}^{K}), \tau = 2,3$$

$$\varepsilon_{i\tau} = e_{i\tau} - e_{i\tau-1}, \tau = 2,3$$

By doing this, I am able to check how the changes in trade integration from decade to decade affect the changes in correlation with China from decade to decade. Note that the individual-specific effect α_{iC} cancels. The first-difference estimator of the slope coefficient βestimates the first difference model by pooled OLS. In the special case T=2, the first difference estimator will

be numerically identical to the fixed effects estimator. We are expecting different results between first difference and fixed effects regressions since 3 sub-periods are conducted in my case, τ=3.

6.4 Empirical Evaluation

In order to evaluate the impact of country i's trade integration with China on its cyclical correlation with China, I present panel regression estimates of three of my models (i.e., Equation 6.3, 6.4, and 6.5) in TABLEs XVII and XVIII. TABLEs XVII and XVIII are corresponding to the two different measures of bilateral trade intensity, percentage by total trade (K=F) and by GDP (K=Y). In each table, estimates of coefficient βs, intercepts, significance levels, and standard errors (in parentheses) are reported when they are estimated respectively with random effects, with country pair fixed effects and with both country pair and time fixed effects. Four de-trending estimates are presented in the rows, marked as DIFF, HP100, HP6.25 and BP.

TABLEs XVII and XVIII suggest that, regardless of the independent variable we use, normalization factors and the controlled effects, there exists positive and significant relationship between bilateral trade intensity and output correlation for these Asian economies. It implies that the countries with higher bilateral trade intensity with China, either normalized by total trade or GDP, show higher business cycle synchronization with China. Simply put, more trade intensity is combined with more similar business cycle. For example, the estimated coefficient for the impact of the trade intensity on cycle correlation with random effects would be 0.0874**, when using DIFF methodology and normalizing by total trade. In each table, filtering the dependent variable yields higher coefficients; HP100 gives the highest coefficients with random effects (0.1231**) and with country specific effects (0.2310***). These results suggest that the use of

TABLE XVII
REGRESSION ANALYSIS: TRADE INTENSITY (%TOTAL TRADE) AND CYCLE SYNCHRONIZATION

Dependent Variable: Cyclical Correlation with China

	DIFF b/se	HP100 b/se	HP6.25 b/se	BP b/se
With **Random effects**				
Bilateral Trade Intensity	0.0874** (0.0321)	0.1231** (0.0373)	0.0876** (0.0287)	0.1143*** (0.0289)
_cons	0.4306*** (0.1158)	0.6415*** (0.1355)	0.4598*** (0.1038)	0.5614*** (0.1045)
With Country-specific Fixed Effects				
Bilateral Trade Intensity	0.1770*** (0.0457)	0.2310*** (0.0493)	0.1654*** (0.0417)	0.2044*** (0.0430)
_cons	0.7355*** (0.1604)	1.0117*** (0.1731)	0.7245*** (0.1463)	0.8681*** (0.1508)
F-test	14.99	21.92	15.73	22.62
Prob > F	0.0002	0.0000	0.0002	0.0000
F-test for pure Country-specific Effects	0.97	1.34	0.88	0.75
Prob > F	0.5341	0.1358	0.6765	0.8405
With Country-specific Fixed Effects and Time Fixed Effects				
Bilateral Trade Intensity	0.0266 (0.0851)	0.0341 (0.091)	0.0217 (0.0757)	0.0421 (0.0764)
_cons	0.0698 (0.3755)	0.081 (0.4016)	0.1293 (0.3334)	0.2055 (0.3370)
F-test	6.90	9.92	8.78	12.83
Prob > F	0.0004	0.0000	0.0000	0.0000
F-test for pure Country-specific Effects	0.92	1.32	0.81	0.67
Prob > F	0.6144	0.1501	0.7617	0.9217
F-test for pure Time Effects	2.55	3.26	4.56	6.32
Prob > F	0.0849	0.0440	0.0136	0.0029
N	119	119	119	119

[a] * p<0.05, ** p<0.01, *** p<0.001

[b] Standard errors are given in parenthesis.

[c] Time fixed effects are included by dummies for the period 1982-1991, 1992-2001, and 2002-2011.

TABLE XVIII
REGRESSION ANALYSIS: TRADE INTENSITY (%GDP) AND CYCLE SYNCHRONIZATION

Dependent Variable: Cyclical Correlation with China

	DIFF b/se	HP100 b/se	HP6.25 b/se	BP b/se
Random effects				
Bilateral Trade Intensity	0.0892*** (0.0263)	0.1116*** (0.0305)	0.0909*** (0.0237)	0.1263*** (0.0252)
_cons	0.5426*** (0.1266)	0.7309*** (0.1475)	0.5876*** (0.1143)	0.7821*** (0.1215)
With Country-specific Fixed Effects				
Bilateral Trade Intensity	0.1673*** (0.0385)	0.2091*** (0.0413)	0.1680*** (0.0352)	0.2192*** (0.0383)
_cons	0.9009*** (0.1806)	1.1815*** (0.1937)	0.9412*** (0.1652)	1.2090*** (0.1800)
F-test	18.92	25.68	22.81	32.73
Prob > F	0.0000	0.0000	0.0000	0.0000
F-test for pure Country-specific Effects	1.00	1.36	0.93	0.80
Prob > F	0.4915	0.1206	0.5939	0.7872
With Country-specific Fixed Effects and Time Fixed Effects				
Bilateral Trade Intensity	0.0777 (0.0753)	0.0750 (0.0803)	0.0847 (0.067)	0.0827 (0.07)
_cons	0.3963 (0.4348)	0.3604 (0.4635)	0.5192 (0.3865)	0.4950 (0.4045)
F-test	7.32	10.03	10.56	17.32
Prob > F	0.0002	0.0000	0.0000	0.0000
F-test for pure Country-specific Effects	0.91	1.27	0.81	0.66
Prob > F	0.6291	0.1845	0.7717	0.9269
F-test for pure Time Effects	1.41	1.89	3.63	7.00
Prob > F	0.2503	0.1579	0.0314	0.0017
N	119	119	119	119

[a] * p<0.05, ** p<0.01, *** p<0.001

[b] Standard errors are given in parenthesis.

[c] Time fixed effects are included by dummies for the period 1982-1991, 1992-2001, and 2002-2011.

transformed dependent variable leads to a somewhat stronger impact of trade on business cycle synchronization.

In addition, the size of this effect does not sensitively depend on the exact de-trending method or the measure of bilateral trade intensity. For example, with random effects and DIFF methodology, coefficients estimates $\hat{\beta}$ equals 0.0874(see TABLE XVII) and 0.0892(see TABLE XVIII) with two trade ratio proxies; HP100 filter suggests a bit stronger positive relationships, 0.1231(see TABLE XVII) and 0.1116(see TABLE XVIII), which are close to each other still. Analyzing the value of coefficients estimates $\hat{\beta}$s, I am able to illustrate the exact size of economic effect trade links bring on cyclical correlation. For instance, the value of 0.0874 means that if my measure of bilateral trade intensity doubles, the output correlation between this economy and China will increase by 0.0603.[8]

This positive relationship is stronger when adding country pair-specific fixed effects into equation (e.g., 0.1770***>0.0874**), but weaker when considering both entity and time fixed effects (e.g., 0.0266<0.0874**). F-tests for the regression of equation (6.4) with solely country-specific fixed effects are highly statistically significant over all four de-trending methodologies. Yet, F-tests for its country-specific fixed effects are statistically insignificant, which means that we cannot reject the null that country dummies are jointly zero.

The regression results of equation (6.3) with both country-specific and time fixed effects are also shown in TABLEs XVII and XVIII. I find that though the all coefficient estimates become statistically insignificant after adding time-fixed effects on top of entity fixed effects. This indicates some sort of regime shift and suggests that most of the identified relationship between

[8] My trade measure is in logs. If the coefficient doubles, it increases by $\ln(2) = 0.69$. Then output correlation increases by 0.0874*0.69=0.0603.

cyclical synchronization and trade is due to their variation over time. As an independent confirmation of this, I also run cross-sectional regressions within each sub-periods, with % total trade as independent variable and HP ($\lambda = 6.25$) filtered correlation as dependent variable, and I find that the estimated coefficients are negative (but close to zero and statistically insignificant) for the 1st and the 3rd sub-periods, and significantly positive for the 2nd period.

F-tests for the entire model (6.3) are highly statistically significant over four de-trending methodologies. It means that all coefficients including dummies cannot be jointly zero in this model. Moreover, joint coefficients for entity dummies are statistically insignificant, but time effects joint coefficients are statistically significant after being filtered. F-tests results for pure time fixed effects reject the null that time dummies are jointly zero. The analysis is similar for both TABLEs XVII and XVIII, when normalized by total trade and GDP.

Considering the serial correlation nature of the panel data set, I also modify all my models with first order autocorrelation AR(1) error terms and then re-estimate coefficients. Modified Bhargava et al. Durbin–Watson statistics[9] have been then used to test the null of "no first order autocorrelation" for the equations. Baseline model has been modified as:

$$Corr_{i\tau} = \mu_i + \lambda_\tau + \beta \ln(Trade_{i\tau}{}^{K}) + e_{i\tau}$$

$$e_{i\tau} = \rho e_{i\tau-1} + \eta_{i\tau}$$

[9] I have also done Wooldridge's test to check first order autocorrelation for my models. However, this test "is found to have good size and power properties with samples of moderate size" (Drukker, 2003, p.168). Moreover, "When the errors are conditionally heteroscedastic, the test may have less power in the fixed effects case than in the random effects case in small samples with low levels of serial correlation" (Drukker, 2003, p. 173). I didn't adopt Wooldridge's results since my panel regression are designed with fixed and random effects and only with 119 observations (Drukker's experiments contain samples of at least N=500, T=5).

The results are presented in APPENDIX C and D and I find that: (1) the estimated ρs are very small and statistically insignificant. (2) All of the modified Bhargava et al. Durbin–Watson statistics results are very close to 2.0, which implies that the null hypothesis of no serial correlation cannot be rejected or strongly be rejected. For example, modified Bhargava et al. Durbin–Watson statistics is 2.08 when trade ratio is a share of total and cyclical correlation is de-trended by differencing. When the cyclical correlation variables have been de-trended by Baxter-King filter, modified Bhargava et al. Durbin–Watson statistics become lower, i.e. 1.72 with random/fixed effects (see APPENDIX D last column). Nevertheless, with AR(1) error terms, the changes to my model are minimal; There exists consistent positive relationships between bilateral trade with China and output correlation with China for these sample economies.

TABLE XIX reports the results of regressions of the first differences model (see equation (6.6)). Coefficients estimators $\hat{\beta}$ and R-squared values are given in the table, given constants of the model drop during first differences transformation. It seems that all estimated coefficients are still significantly positive, which implies that for an economy i, positive changes in trade integration with China from decade to decade increase her correlation with China from decade to decade.

I have checked these results in some other ways, and they seem to be robust (see APPENDIX E) for both fixed effects and random effects models. For example, when trade intensity measure is not transformed by natural logarithms, estimate of β appears to be consistently positive. Moreover, I split my data set into two sub-periods across time (instead of three), 1982-1996 and 1997-2011, and re-estimated my equation, corresponding to two measures of independent variables. The results remain close to those recorded in TABLEs XVII and XVIII.

TABLE XIX
FIRST DIFFERENCES REGRESSION ANALYSIS

Dependent Variable: Changes in Cyclical Correlation with China

	DIFF b/se	HP100 b/se	HP6.25 b/se	BP b/se
Changes in Bilateral Trade Intensity (% Total Trade) (without constant)	0.1929** (0.0572)	0.2278*** (0.0585)	0.1851*** (0.0501)	0.2288*** (0.0499)
R-squared	0.120	0.157	0.143	0.209
Changes in Bilateral Trade Intensity (%GDP) (without constant)	0.1884*** (0.0495)	0.2131*** (0.0503)	0.1914*** (0.0434)	0.2484*** (0.0447)
R-squared	0.151	0.183	0.195	0.282

[a] * p<0.05, ** p<0.01, *** p<0.001

[b] Standard errors are given in parenthesis.

6.5 Implications for a Yuan Currency Union

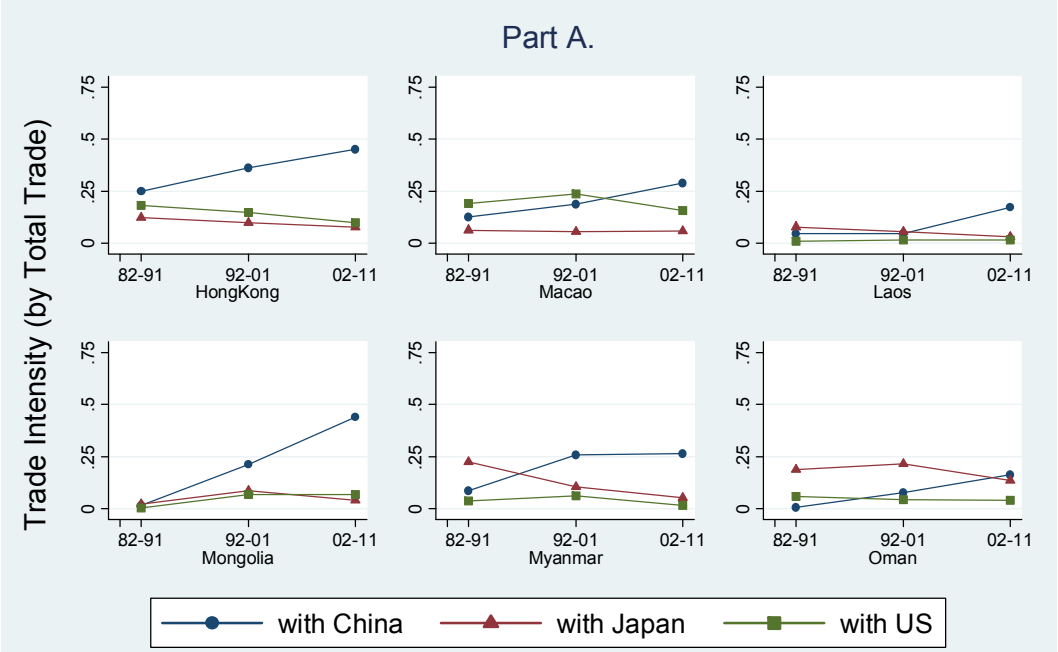
The Asian Currency Crisis has induced Asian countries to seriously consider forming a common currency union. Trade has been emphasized as a crucial criterion of forming an OCA in many strands of the literature, theoretically as well as empirically. Alesina and Barro (2002) investigate the relationship between currency unions and trade flows and they find that countries with more bilateral trade are more likely to form currency unions. TABLEs XV and XVI present the evolution of trade intensity with China of sample economies. In my opinion, it will be worthwhile comparing this trade tendency among with China, Japan, and United States, since China and Japan are top two economies in Asia and US is the biggest economy around the world. Crosswise discussion might inspire us a better idea of the currency union formation in Asia region. Hence, besides China, I also compute the sample economies' average bilateral trade intensity (normalized by total trade) with Japan and US for each sub-period. TABLE XX lists all these average sub-period bilateral trade ratios with three partners. By contrary of with China, most Asia economies decreased their trading shares with Japan over period 1982-2011, e.g. Hong Kong (from 12.2% to 7.49%), Myanmar (from 22.35% to 5.1%), Nepal (from 10.79% to 1.27%), etc. The rest of Asian economies increased trade intensity with Japan from the 1st to the 2nd period temporarily, while they decreased the share later on in the last sub-period, e.g. Mongolia (from 1.94% to 8.44%, then drop to 3.91%), Vietnam (from 8.17% to 16.84%, then 11.71%), Cambodia (from 2.56% to 8.43%, then 2.12%), etc. There is no economy that presents consistent increasing trade tendency with Japan. The case of US is similar to the case of Japan. Figure 14 depicts the evolution of trade intensity with China, Japan and US over three sub-periods for some particular economies. Figure 14 Part A lists six economies (Hong Kong, Macao,

TABLE XX

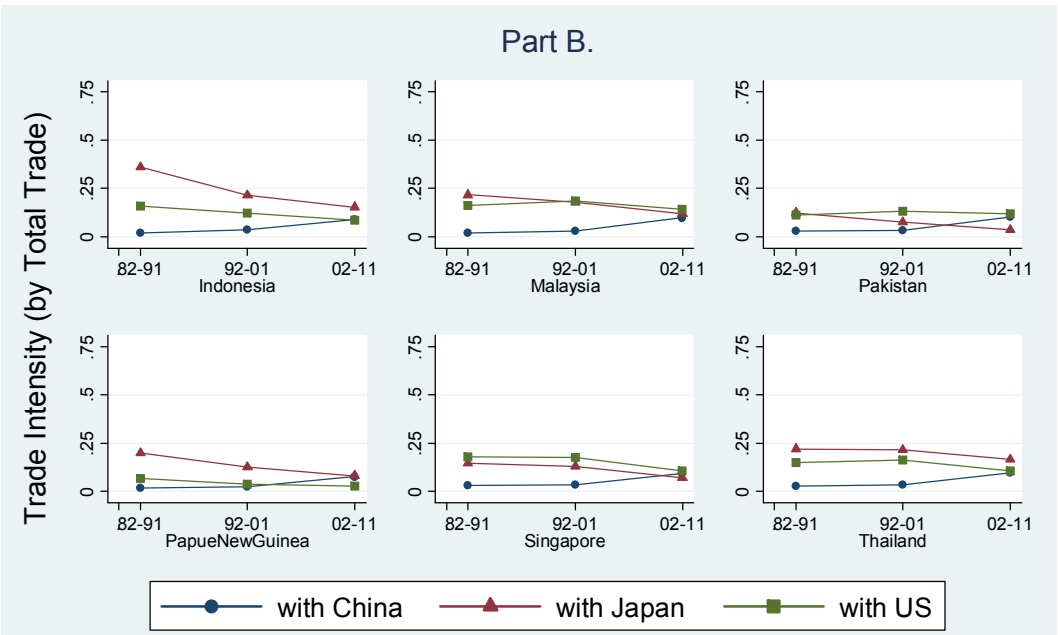
BILATERAL TRADE INTENSITY COMPARISONS AMONG WITH CHINA, JAPAN, AND U.S.

	With China			*With Japan*			*With US*		
i	1982-1991	1992-2001	2002-2011	1982-1991	1992-2001	2002-2011	1982-1991	1992-2001	2002-2011
Afghanistan	2.14%	4.42%	3.41%	9.70%	11.40%	3.07%	0.97%	2.14%	21.90%
Bahrain	0.24%	0.87%	2.25%	8.17%	5.37%	4.26%	7.24%	7.27%	5.62%
Bangladesh	3.07%	4.69%	8.67%	10.15%	6.07%	3.10%	12.10%	13.61%	9.71%
Brunei	0.61%	1.48%	4.80%	51.98%	44.27%	30.55%	7.54%	11.58%	4.71%
Cambodia	0.68%	3.90%	8.38%	2.56%	8.43%	2.12%	0.42%	8.93%	21.23%
China	-	-	-	20.79%	18.64%	12.24%	10.81%	14.96%	14.08%
HongKong	25.00%	36.27%	45.32%	12.20%	9.84%	7.49%	18.02%	14.65%	9.71%
India	0.40%	1.84%	7.55%	9.31%	5.70%	2.57%	13.16%	13.42%	9.81%
Indonesia	1.97%	3.75%	9.06%	36.03%	21.56%	15.36%	15.99%	12.32%	8.57%
Iraq	0.49%	0.95%	3.97%	6.93%	0.86%	2.11%	7.92%	7.24%	19.73%
Israel	-	0.69%	3.77%	3.65%	3.97%	2.24%	21.24%	24.18%	23.58%
Japan	4.22%	8.17%	17.67%	-	-	-	28.23%	26.16%	16.84%
Jordan	1.66%	2.41%	6.87%	5.00%	3.81%	2.37%	8.98%	7.57%	10.03%
Kuwait	1.01%	1.53%	4.99%	18.13%	16.13%	14.15%	8.23%	12.80%	9.64%
Laos	4.67%	4.43%	17.07%	7.75%	5.38%	2.88%	0.83%	1.33%	1.52%
Lebanon	0.90%	2.89%	6.47%	3.62%	3.21%	2.68%	6.69%	8.10%	6.85%
Macao	12.54%	18.71%	28.76%	6.20%	5.53%	5.68%	19.00%	23.65%	15.56%
Malaysia	1.88%	2.89%	10.08%	21.68%	17.84%	11.94%	16.16%	18.55%	14.09%
Maldives	0.22%	0.26%	2.47%	10.90%	3.83%	2.44%	5.50%	4.44%	3.30%
Mongolia	1.58%	21.23%	44.04%	1.94%	8.44%	3.91%	0.31%	6.79%	6.72%
Myanmar	8.47%	25.89%	26.27%	22.35%	10.45%	5.10%	3.65%	6.08%	1.39%
Nepal	4.18%	4.31%	7.15%	10.79%	3.87%	1.27%	7.24%	8.00%	3.98%
Oman	0.65%	7.60%	16.08%	18.75%	21.36%	13.45%	5.66%	4.29%	3.78%
Pakistan	2.91%	3.33%	10.16%	12.41%	7.57%	3.70%	11.34%	13.33%	11.84%
PapuaNewGuinea	1.67%	2.57%	7.67%	19.88%	12.72%	8.17%	6.76%	3.69%	2.86%
Philippines	2.05%	1.87%	7.83%	18.26%	18.38%	15.22%	28.16%	25.16%	16.25%
Qatar	0.92%	1.69%	2.75%	37.75%	37.33%	28.58%	3.47%	5.80%	3.97%
SaudiArabia	0.63%	1.78%	8.05%	20.02%	13.93%	12.34%	16.75%	18.62%	14.31%
Singapore	3.19%	3.56%	9.39%	14.78%	13.15%	7.15%	17.81%	17.50%	10.80%
SriLanka	2.49%	1.94%	4.75%	10.76%	7.47%	3.61%	13.14%	18.08%	12.68%
Syria	0.80%	1.94%	7.79%	3.01%	3.28%	2.06%	3.76%	3.88%	3.80%
Thailand	2.88%	3.30%	9.78%	22.10%	21.63%	16.62%	15.13%	16.40%	10.63%
Turkey	0.74%	1.32%	4.51%	3.23%	2.75%	1.51%	8.59%	8.76%	5.52%
UnitedArabEmirates	1.10%	2.87%	5.93%	29.17%	19.82%	12.15%	6.01%	4.62%	4.20%
Vietnam	-	5.34%	14.07%	8.17%	16.84%	11.71%	0.40%	2.45%	10.40%
Armenia	-	0.40%	4.78%	-	0.19%	1.42%	-	10.75%	5.99%

Azerbaijan	-	0.48%	1.96%	-	0.56%	1.05%	-	2.81%	5.11%
Georgia	-	0.58%	2.94%	-	0.52%	1.00%	-	6.82%	5.39%
Kazakhstan	-	4.92%	11.26%	-	1.07%	1.46%	-	2.54%	2.78%
Kyrgyzstan	-	6.27%	36.71%	-	0.55%	0.90%	-	4.32%	3.21%
Russian	-	3.99%	6.82%	-	2.74%	2.77%	-	5.98%	3.70%
Tajikistan	-	0.75%	11.95%	-	0.86%	0.14%	-	2.10%	1.68%
Turkmenistan	-	0.56%	6.34%	-	1.22%	0.50%	-	4.58%	2.75%
Uzbekistan	-	1.50%	8.21%	-	1.52%	1.62%	-	3.26%	2.64%



Note:
1.Knots on each line present the average value of trade intensity for each sub-periods.
2.Trade intensity with China has grown sharply for these economies over three sub-periods.
3.They RECENTLY traded the MOST with China, compared with Japan and US.



Note:
1.Knots on each line present the average value of trade intensity for each sub-periods.
2.Trade intensity with China has grown sharply for these economies over three sub-periods.
3.Trade intensity with Japan and US has dropped sharply for these economies over three sub-periods.
4.Their recent trade intensity with China are still lower than with Japan and US.

Figure 14. Evolution of trade intensity with China, Japan, and U.S.

Laos, Mongolia, Myanmar, and Oman) that trade intensity with China has grown dramatically over these thirty years and what's more, they are recently trading the most with China compared with Japan and US. Figure 14 Part B shows another six economies (Indonesia, Malaysia, Pakistan, Papua New Guinea, Singapore and Thailand) that are shifting trade focus from with Japan and US to with China gradually. Though their trade share with China in the 3rd sub-period is still a bit lower than with the other two, it appears consistent increasing tendency with China, not so with Japan nor US. In summary, for most Asian economies, considering trade criteria solely, Yuan will be a better potential common currency than Yen and US. Dollar, since their trade ties with China have been closer and closer than with Japan and US over the past couple of decades.

My study focuses on the prospects of formatting the Yuan Optimum Currency Area in Asia region. In literature, Frankel and Rose (1998) find that the level of trade integration increases significantly after the formation of a currency union; increased trade affects the nature of co-movements among member countries, which is the most important loss when of joining a currency union. Theoretically, the direction of the effect could be either way: (1)Business cycle co-movements are strengthened when trade integration is dominated by intra-industry trade; the losses of adopting a monetary union is small because more intensive trade lead to lower asymmetric shocks; these countries are encouraged to form a currency union. (2)If inter-industry accounts for most of trade intensity, business cycle co-movements are weakened due to deeper specialization; the losses is big because more trade induces higher business fluctuations; a currency union is not encouraged in this case. However, in order to test the validity of this theory, a wide range of scholars focused on the relationship between trade intensity and Business Cycle

Synchronization empirically and they confirmed that the relationship is mostly positive. (see Literature Review in Section 6.2.)

I have investigated the macroeconomic gains and losses of adopting Chinese Yuan as common currency for most Asian economies in previous sections, by looking at their inflation stability gains and output fluctuation losses caused form the adoption. This section extends the Yuan OCA discussion by adding trade ratio criterion and analyzing the impact of higher trade intensity with China on business correlation with China.

I have examined the relationship between trade intensity and business cycle synchronization for a sample of 43 Asian economies over the period 1982-2011, using the bilateral correlation of de-trended trade economic activity (GDP) as dependent variable and two trade ratio proxies (normalized by either total trade or GDP) as independent variable. My empirical results confirm the finding that trade intensity affects business cycle synchronization in positive way. The estimated coefficients of bilateral trade intensity are significantly positive, which is not sensitive to the exact de-trending method or the measures of trade ratio. It implies that for economies that trade more with China are higher positively cyclical correlated with China. In addition, my results seem to be robust since the estimated coefficient appears to be consistently positive when trade intensity measures are not transformed by natural logarithms and when I split my data period in a different way. TABLE XV and XVI report that most of Asian economies show an increasing trend in bilateral trade intensity with China over period 1982-2011; this is good news for the formation of Yuan OCA in Asia region because if this tendency continues, the business cycle co-movements between these economies and China can be strengthened, which results in little adoption losses. In particular, combining two measures of trade ratio, the economies that present the largest trade flow increasing with China are Hong Kong, Japan, Laos, Macao,

Mongolia, Myanmar, Oman, Kyrgyzstan, Malaysia, Singapore, and Vietnam-suggest that they might be best candidates for a Yuan currency union.

6.6 Conclusion: Is There a Yuan OCA in Asia?

Section 6 considered the relationship between two of the criteria used to determine whether there is a Yuan Optimum Currency Area. From a theoretical viewpoint, the effect of increased trade integration on the cross-country business correlation is ambiguous. To solve the ambiguity, I use a panel of thirty years of data from 43 Asian economies, and find a strong positive relationship between the degree of bilateral trade intensity and business cycle synchronization. This implies that closer trade ties with China have resulted in more highly synchronized business cycles with China. Besides, I also find that trade shares with China have grown sharply for all Asian economies over 1982-2011. Since China has entered the WTO in December 2001, most Asian economies have shifted their trading focus away from Japan and the US towards China, and many of them were trading the most with China during the most recent sub-period, 2001-2011.

The positive relationship I find between trade intensity and BCS suggests that economies that trade more with China would be better candidates of adopting the yuan. These economies are Hong Kong, Japan, Laos, Macao, Mongolia, Myanmar, Oman, Kyrgyzstan, Malaysia, Singapore, and Vietnam.

I am interested in answering the question: is there a yuan OCA in Asia? Macroeconomic gains and losses of the adoption for countries are discussed in Section 4. Combined with the trade integration information, potential yuan OCA members' characters are summarized as follows: (i) small or moderate open economies; (ii) heavily trading with China; (iii) with a history of high inflation; (iv) with a highly positively business cyclical correlation with China. TABLE XXI

TABLE XXI

CANDIDATES OF THE POTENTIAL YUAN OCA IN ASIA

	1990-2011	1990-2011	1992-2001	2002-2011
East Asia	$\rho_{i,China}^{HP6.25}$	$\bar{\pi}_i$ - $\bar{\pi}_{China}$	$Trade_{ic\tau}{}^{F}$	$Trade_{ic\tau}{}^{F}$
Brunei	0.167	-0.98	1.48%	4.80%
Cambodia	**0.336**	**17.77**	**3.90%**	**8.38%**
Hong Kong SAR, China	0.455	-3.73	36.27%	45.32%
Indonesia	**0.264**	**7.34**	**3.75%**	**9.06%**
Laos	**0.482**	**14.61**	**4.43%**	**17.07%**
Macao SAR, China	0.296	-0.92	18.71%	28.76%
Malaysia	0.354	-2	2.89%	10.08%
Mongolia	**0.245**	**32.98**	**21.23%**	**44.04%**
Myanmar	**0.553**	**14.62**	**25.89%**	**26.27%**
Nepal	-0.153	2.45	4.31%	7.15%
Philippines	**0.406**	**1.16**	**3.33%**	**10.16%**
Singapore	0.491	-4.26	1.87%	7.83%
Thailand	0.399	-2.03	3.56%	9.39%
Vietnam	**0.668**	**9.69**	**1.94%**	**4.75%**

[a] Economies in bold are considered as good candidates of adopting the yuan, with positive inflation bias, high cyclical correlation and increasing bilateral trade intensity with China.

[b] HP 6.25 de-trending method and shorter but more recent periods are employed in this table.

[c] $Trade_{ic\tau}{}^{F} = \frac{1}{T}\sum_t \frac{EX_{ict}+IM_{ict}}{EX_{iwt}+IM_{iwt}}$

shows the list of good candidates (in bold) of a potential yuan OCA in Asia since these economies have great price stability gains and little business fluctuation losses from the adoption and their trading ties are getting closer with China over time. In particular, these economies are Cambodia, Indonesia, Laos, Pakistan, Philippines, Sri Lanka, and Vietnam.

6.7 Extensions: Constraints of a Yuan OCA in Asia

China's economy has transferred from a centralized planning to a market based planning gradually since her initiating market reforms in 1978. After three decades of reform and opening-up, China has experienced rapid economic and social development and become one of the most dynamic economies in the world. With a population of 1.3 billion, China recently became the second largest economy in the world and the largest economy in Asia. The growing size of the Chinese economy will strongly support Chinese yuan playing influential role in the global economy.

However, given that China's GDP per capita is still a fraction of that of developed countries, China remains being a developing country and her market reforms are still incomplete. The formal launch of the renminbi trade settlement scheme in 2009 has made impressive progress on renminbi internationalization. Yet Hong Kong, China's offshore renminbi deposits failed to make significant progress as expected. This study solely focuses on the prospects of the formation of yuanization in Asia. In reality, the renminbi can and will probably become a major international currency or even a common currency eventually, but the road is bound to be long and bumpy, due to her current institutional and political constraints.

A fundamental constraint for renminbi internationalization is China's capital controls. China has maintained a "closed" capital account for years, with which companies, banks and individuals

can only move money in or out of the country according to strict rules. Though China has pledged to drop controls on the movement of her capital and make the yuan fully convertible, we cannot foresee any complement on liberalization in the near future. Reform is risky because it leads to unwanted swings in assets prices as speculative money in and out of the country. The People's Bank of China circulated a study that recommends opening up the financial system with a long term time table for easing capital restrictions in 2012. At this stage of China's development, though her financial reforms get a move, its capital account is still controlled in many aspects, mainly with regard to securities and assets, and short-term flows.

Besides, a further liberalized domestic financial market has not been developed for China. Interest rates are partially liberalized, with limited influence on the economy's interest rate structure as a whole, which means that the People's Bank's risk management capacity is still weak.

Moreover, the exchange rate is still subject to frequent intervention by the People's Bank. After keeping the yuan stable for a decade, China allowed its currency to strengthen 21 percent from July 2005 to July 2008. Then Appreciation was halted for almost two years in order to pull exporters through a global recession. Controls were loosened again on June 19, 2010 and the currency has advanced 10 percent against the dollar since then. People's Bank of China reiterated plans to gradually reform the exchange rate in 2013 and the yuan has been foreseen to become fully convertible within five years.

Last but not least, macroeconomic stability has to be achieved when being considered as an OCA anchor. If the economy suffers from high inflation and serious asset bubbles, short-term capital free flows will create large volatility and therefore destabilize the economy. Since early 2012,

inflation has fallen rapidly in China and her economic growth has also slowed down. In particular, the downside risks to economic growth have increased for China.

For all of these reasons, Asia economies might not have pressing desire to adopt Chinese yuan as common currency in the near future, based on current stage of China's development. This issue is not an immediate one because the yuan is not freely convertible into other currencies yet. However, there are good reasons to look ahead. It is still worthwhile discussing the prospects of a potential yuanization in Asia with only economic criteria instead of political criteria since China has been playing more important role in the global economy and currently experiencing significant policy adjustments. I am aware of that the correlation coefficients could change if China removed the peg or the controls, which it could presumably do if it became the base currency for an Asia currency area in the far future.

7. THE PROSPECTS OF MULTILATERAL ADOPTIONS IN ASIA

In addition to unilateral adoptions, this study addresses the prospects of two forms of multilateral adoptions, corresponding to Asia as a whole (46 economies) and eleven South Eastern Asia as a whole. In particular, my goal is to measure macroeconomic gains and losses for the potential formations of these two Asian currency unions. From the same data sources, I collect real GDP in *2005 constant USD* and nominal GDP in *current USD* for each member economy, Asia as a whole, and South Eastern Asia as a whole and then compute inflation biases (($\bar{\pi}_i$ - $\bar{\pi}_{Asia}$), ($\bar{\pi}_i$ - $\bar{\pi}_{SEAsia}$)) and cyclical correlation (($\rho_{i,Asia}$), ($\rho_{i,SEAsia}$)) between *i* and the entire region, over the two periods 1979-2012 and 1995-2012.

7.1 Multilateral Adoption for Entire Asia

TABLEs XXII and XXIII help to explain how important gains or losses would be for joining a common Asia monetary union. TABLE XXII presents the average annual inflation rates and inflation rate variability for economies in sample as well as for Asia as a whole. The two columns of ($\bar{\pi}_i$ - $\bar{\pi}_{Asia}$) illustrate the differences in inflation bias between each economy *i* and entire Asia, over two periods 1979-2012 and 1995-2012. In term of the long period 1979-2012 result, it is clear that Brunei (3.393), Iraq (4.324), Kuwait (2.111) and Lebanon (4.585) have the most to gain from the monetary union, while gains can also be sizeable for Laos, Macao, Mongolia, Qatar and Vietnam. When moving onto the short period 1995-2012, it appears that many countries have experienced increased inflation rate, and the rest economies that have disinflations have driven a lower inflation rate for Asia as whole (from 3.299 to 2.43). As a result, a lot more economies present sizeable gains from an Asia monetary union, e.g. most dissolved Soviet Union countries (except Uzbekistan), most Middle East Countries (Iraq, Kuwait,

TABLE XXII INFLATION PERFORMANCE

	1979-2012			1995-2012		
i	$\bar{\pi}$	$\sqrt{Var(\pi)}$	$\bar{\pi}_i - \bar{\pi}_{Asia}$	$\bar{\pi}$	$\sqrt{Var(\pi)}$	$\bar{\pi}_i - \bar{\pi}_{Asia}$
Afghanistan	4.231	11.819	0.932	5.860	13.133	3.429
Asia	**3.299**	**6.710**	**-**	**2.430**	**6.573**	**-**
Bahrain	4.310	8.801	1.011	4.402	7.323	1.972
Bangladesh	1.611	5.010	-1.688	1.246	4.189	-1.184
Bhutan	1.372	7.257	-1.927	3.557	5.566	1.126
Brunei	6.692	20.258	3.393	7.548	14.795	5.118
Cambodia	3.189	6.496	-0.110	2.154	6.681	-0.277
China	1.476	9.346	-1.823	5.780	5.859	3.349
Hong Kong	2.814	5.920	-0.485	0.325	3.593	-2.106
India	1.820	6.717	-1.479	3.377	6.527	0.946
Indonesia	4.378	15.692	1.079	6.222	18.650	3.792
Iraq	7.623	18.814	4.324	15.460	18.477	13.030
Israel	3.946	7.138	0.647	2.595	5.709	0.165
Japan	3.807	10.927	0.508	0.656	8.529	-1.774
Jordan	2.945	7.867	-0.354	4.171	5.089	1.741
Kuwait	5.410	14.707	2.111	7.786	14.088	5.355
Laos	4.764	8.682	1.465	4.084	11.506	1.654
Lebanon	7.884	27.895	4.585	5.308	6.925	2.877
Macao	4.814	5.991	1.515	3.090	4.527	0.660
Malaysia	2.549	7.871	-0.750	3.144	9.409	0.713
Maldives	2.471	8.070	-0.828	3.128	5.267	0.698
Mongolia	5.221	10.261	1.922	6.190	14.042	3.760
Myanmar	1.671	12.867	-1.628	3.711	16.366	1.281
Nepal	3.006	6.930	-0.293	4.788	7.369	2.358
Oman	4.264	14.327	0.964	6.569	12.430	4.139
Pakistan	1.958	6.326	-1.341	2.996	6.605	0.566
Papua New Guinea	2.399	10.535	-0.900	3.189	12.740	0.759
Philippines	3.505	8.425	0.206	2.988	9.575	0.557
Qatar	5.135	14.950	1.836	8.692	15.312	6.261
Saudi Arabia	4.264	12.129	0.965	7.124	10.857	4.694
Singapore	3.948	6.098	0.649	2.252	6.656	-0.178
Sri Lanka	4.088	5.285	0.789	4.366	5.938	1.935
Syria	2.994	12.977	-0.305	5.898	7.456	3.468
Thailand	3.003	7.505	-0.296	2.518	9.216	0.087
Turkey	2.513	13.064	-0.786	5.211	12.147	2.780
United Arab Emirates	4.078	7.303	0.779	6.144	8.781	3.714
Vietnam	5.153	18.105	1.854	5.857	6.952	3.427
Armenia				5.778	10.974	3.348
Azerbaijan				8.831	12.748	6.400
Georgia				5.020	11.524	2.589
Kazakhstan				8.266	14.401	5.835
Kyrgyzstan				5.190	13.309	2.760
Russian				7.749	18.496	5.319
Tajikistan				6.429	16.708	3.999
Timor-Leste				5.907	14.604	3.476
Turkmenistan				9.659	12.580	7.229
Uzbekistan				2.762	13.920	0.332

[a] $\bar{\pi}$ is the average of percentage change of GDP deflator of economy i.

[b] GDP deflator is nominal GDP (at current price in USD) divided by real GDP (at constant price in USD).

TABLE XXIII BUSINESS CYCLE SYNCHRONIZATION WITH ASIA

	1979-2012				1995-2012			
i	DIFF	HP100	HP6.25	BK	DIFF	HP100	HP6.25	BK
Asia	1	1	1	1	1	1	1	1
Afghanistan	0.0054	0.049	0.1153	0.1226	0.0546	0.3181	-0.1537	-0.1078
Bahrain	0.1066	0.356*	0.0556	0.1266	0.3823	0.5758*	0.2817	0.7956*
Bangladesh	0.2169	0.3107	0.2867	0.3588*	0.442	0.5717*	0.368	0.696*
Bhutan	0.3231	0.353*	0.2057	0.1878	0.437	0.3008	0.2996	0.3725
Brunei	0.1034	0.2545	0.2093	0.3191	0.3445	0.2566	0.4936*	0.4143
Cambodia	0.3162	0.5054*	0.2358	0.2261	0.4598	0.6177*	0.5211*	0.8022*
China	0.1429	0.1047	0.0037	0.0606	0.7061*	0.7785*	0.649*	0.7289*
Hong Kong	0.542*	0.6535*	0.487*	0.4756*	0.9042*	0.9471*	0.9271*	0.9145*
India	0.3648*	0.4614*	0.4363*	0.3899*	0.5179*	0.6935*	0.4393	0.4578
Indonesia	0.5024*	0.5353*	0.4817*	0.5897*	0.6598*	0.711*	0.5737*	0.5286*
Iraq	-0.0695	-0.2072	0.0125	-0.0361	-0.0672	-0.1121	0.1582	0.0177
Israel	0.3288	0.25	0.3215	0.2912	0.4944*	0.3231	0.5555*	0.6517*
Japan	0.7327*	0.8726*	0.9223*	0.9167*	0.8311*	0.8014*	0.9461*	0.9667*
Jordan	-0.1909	-0.3176	-0.2282	-0.2142	0.2474	0.5863*	0.0167	0.663*
Kuwait	-0.0182	0.07	-0.0743	-0.13	0.556*	0.7174*	0.5616*	0.637*
Laos	-0.0605	-0.2276	0.1262	0.0763	0.6011*	0.5689*	0.6174*	0.5164*
Lebanon	0.0649	-0.1432	-0.05	0.0144	0.0175	0.0279	-0.3658	-0.3578
Macao	0.5802*	0.6578*	0.5109*	0.4063*	0.7379*	0.7892*	0.7281*	0.6812*
Malaysia	0.5259*	0.4452*	0.6552*	0.6364*	0.7548*	0.8024*	0.8349*	0.7666*
Maldives	0.3209	0.2767	0.3236	0.3347	0.2803	0.2956	0.2934	0.2942
Mongolia	0.1975	0.0863	0.4259*	0.2778	0.4983*	0.7488*	0.4822*	0.5615*
Myanmar	-0.1697	-0.3888	-0.0647	-0.036	0.3557	0.4927*	0.2091	0.7091*
Nepal	0.1576	0.1389	0.1209	0.1698	0.0458	-0.2804	0.078	0.0162
Oman	0.1382	-0.2314	0.0867	0.0656	0.323	0.1542	0.1436	-0.0185
Pakistan	0.3741*	0.6034*	0.4255*	0.482*	0.5594*	0.7748*	0.5924*	0.8*
Papua New Guinea	-0.1304	0.0225	-0.4433	-0.4365	0.0945	0.1546	-0.1238	-0.3632
Philippines	0.2762	0.3482*	0.3383*	0.267	0.9464*	0.9603*	0.9378*	0.9283*
Qatar	0.1599	0.2605	0.1934	0.1782	0.2877	0.3079	0.2522	0.2777
Saudi Arabia	0.2481	0.466*	0.2228	0.2768	0.4635	0.6801*	0.5165*	0.3757
Singapore	0.6343*	0.5181*	0.6855*	0.6002*	0.9016*	0.8659*	0.9362*	0.8917*
Sri Lanka	0.2849	0.0193	0.3371	0.2074	0.6*	0.5361*	0.547*	0.532*
Syria	-0.04	-0.1668	-0.0669	-0.0405	0.0112	0.341	0.0082	-0.1576
Thailand	0.6244*	0.7218*	0.5602*	0.609*	0.7018*	0.669*	0.6731*	0.6436*
Turkey	0.5611*	0.5793*	0.5446*	0.4308*	0.7045*	0.7701*	0.753*	0.6277*
United Arab Emirates	0.2316	0.2619	0.4643*	0.5877*	0.4762*	0.5704*	0.7544*	0.8491*
Vietnam	0.1146	0.0036	0.2445	0.3033	0.5701*	0.7579*	0.7075*	0.6608*
Armenia					0.405	0.608*	0.5246*	0.614*
Azerbaijan					0.2217	0.5812*	0.1709	0.6638*
Georgia					0.605*	0.7562*	0.7333*	0.6121*
Kazakhstan					0.3597	0.5451*	0.4927*	0.5712*
Kyrgyzstan					0.0236	0.0754	0.1128	0.1969
Russian					0.5661*	0.5887*	0.6011*	0.7972*
Tajikistan					-0.006	0.1413	-0.3226	0.3071
Timor-Leste					0.3836	0.7361*	0.457	0.4598
Turkmenistan					0.1057	0.1919	-0.0066	0.3305
Uzbekistan					0.2433	0.4012	-0.0477	0.2763

* Critical value of correlation coefficients is respectively 0.338 for the full (n=34) and 0.468 (n=18) for the half periods, at least 95% significant level.

Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, and United Arab Emirates), Mongolia, and Vietnam. On the contrary, gains will be negligible for Israel and Thailand and negative for some other economies such as Hong Kong and Singapore with already stable currencies.

TABLE XXIII reports the correlation coefficients of each economy's cyclical output component with that of the Asia's, employing four de-trending methods (i.e., Differencing, HP100 filter, HP6.25 filter, and BK filter) and over the same two periods. Looking at the results for the entire period 1979-2012 with HP λ=6.25, the economies with high positive business cycle synchronization with Asia as a whole are Hong Kong, Indonesia, Japan, Macao, Malaysia, Pakistan, Singapore, Turkey, and the United Arab Emirates; while the economies with the lowest or negative degree of synchronization are Jordan and Myanmar, etc. As for the more recent period 1995-2012, it seems that many economies' cyclical correlation has increased substantially. Economies such as Hong Kong, Japan, Philippines, Singapore, and Malaysia have a near perfect synchronization with Asia as a whole. Many other economies such as Macao, Turkey, Vietnam, and Georgia, etc. are a bit lower but still highly positively correlated with Asia. This suggests that for these countries the losses of adopting a common Asian currency is low and decreasing. By contrast, for a minority economies such as Maldives and Nepal, the business cycle has become less synchronized with Asia over time, which implies that adoption losses will be high and increasing.

Jointly evaluating gains and losses is the essential problem of assessing whether forming multilateral Asia OCA is beneficial for each member economy. In fact, a large subset of the economies in my sample present positive relationship between realized gains and losses from the adoption. This means that greater gains, i.e. larger inflation bias with the Asia union, often coexist with high losses, in the form of low (or negative) cyclical correlations with the union. On

the other hand, member countries that have little to lose will also experience small gains from the adoption. Particularly, in terms of the short period results, I find that most Middle East countries apply to the case of great gains combined with great losses, e.g. Iraq, Lebanon, Oman, Qatar, Saudi Arabia and Syria. These economies have higher average inflation rate than Asia as a whole so that they obtain exchange rate or price stability by joining Asian monetary union, however, their losses will be sizeable since their cyclical correlation with Asia is low, or even negative. This phenomenon might be because of diversity of economic structures and development between East Asia and the Arab world. At the other extreme, some economies (such as Hong Kong, Cambodia, Macao, Malaysia, Pakistan, Philippines, Singapore, and Thailand) that have little to lose by adopting the common Asia currency also have little to gain by it. They are not good candidates of Asian monetary union neither.

Refer to Figures 15 and 16, where the negative sloped fitted lines demonstrate this positive relationship broadly, respectively for the long period 1979-2012 and the short period 1995-2012. Figure 16 for the more recent period shows an even stronger positive relationship between the two variables, though some exceptional economies marked with labels emerge.

TABLE XXIV gives a list of economies that are highly positively correlated with Asia as a whole and will also obtain positive inflation gains from adopting the common currency created by Asia as a whole.

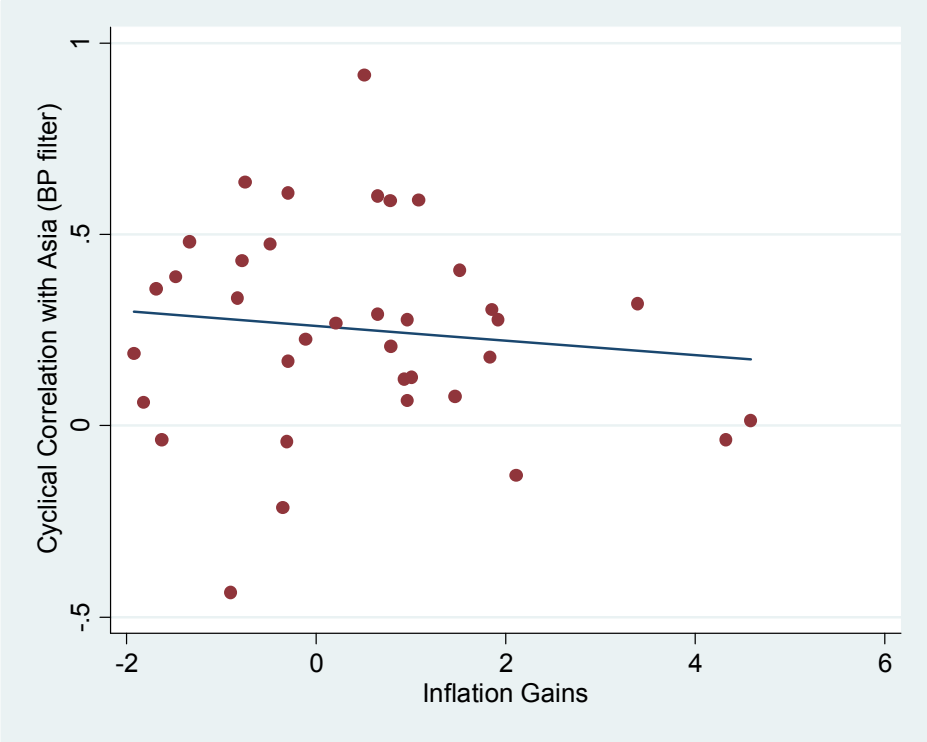


Figure 15. Gains vs. losses of 36 economies if adopting an Asian common currency (1979-2012)

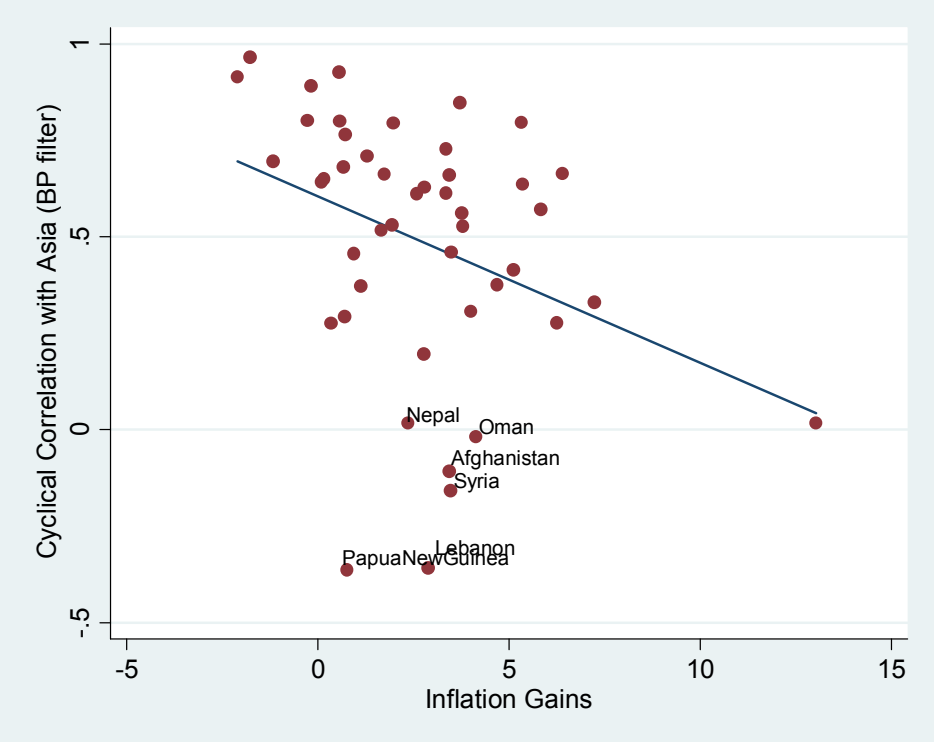


Figure 16. Gains vs. losses of 46 economies if adopting an Asian common currency (1995-2012)

TABLE XXIV

CANDIDATES OF THE POTENTIAL ASIA OCA(1995-2012)

i	$\bar{\pi}_i - \bar{\pi}_{Asia}$	$\rho_{i,Asia}^{HP6.25}$
Armenia	3.348	0.5246
Bahrain	1.972	0.2817
Bhutan	1.126	0.2996
Brunei	5.118	0.4936
China	3.349	0.649
Georgia	2.589	0.7333
Indonesia	3.792	0.5737
Kazakhstan	5.835	0.4927
Kuwait	5.355	0.5616
Laos	1.654	0.6174
Mongolia	3.760	0.4822
Myanmar	1.281	0.2091
Qatar	6.261	0.2522
Russian	5.319	0.6011
Saudi Arabia	4.694	0.5165
Sri Lanka	1.935	0.547
Timor-Leste	3.476	0.457
Turkey	2.780	0.753
United Arab Emirates	3.714	0.7544
Vietnam	3.427	0.7075

7.2 Multilateral Adoption for South Eastern Asia

This section focuses on the macroeconomic gains and losses for eleven South Eastern Asian economies[10] forming a potential monetary union, over two periods, 1979-2012 and 1998-2012. I set the year of 1997 as a starting point because the devastating impact of the Asian Financial Crisis staring in 1997 was a major trigger for the shift in policy focus towards economic stability and regional cooperation. Further intensive monetary integration has been taken into account after 1997 more than before. TABLE XXV provides average annual inflation rate and inflation volatility for each member country as well as the SE-Asia as a whole; the columns of ($\bar{\pi}_i - \bar{\pi}_{SEAsia}$) report differences in inflation bias between different countries and the whole area. TABLE XXVI shows business cycle correlations with SE-Asia, employing the four different de-trending methods. Combining the information from these two tables, I find that: (1) Average annual inflation rate changes in different ways over time. For example, Indonesia, Myanmar, and Malaysia, went through an increased inflation rate from the entire period to the more recent period; while Singapore, Cambodia, and the Philippines, had it decreased. (2) Inflation bias has varied across countries, which implies that member countries would obtain different weight of gains from joining a potential SE-Asian monetary union. For example, Brunei ($\bar{\pi}_i - \bar{\pi}_{SEAsia} = 3.535$), Indonesia ($\bar{\pi}_i - \bar{\pi}_{SEAsia} = 3.174$), Laos ($\bar{\pi}_i - \bar{\pi}_{SEAsia} = 1.086$), Vietnam ($\bar{\pi}_i - \bar{\pi}_{SEAsia} = 1.022$) and Timor-Leste ($\bar{\pi}_i - \bar{\pi}_{SEAsia} = 1.651$) have the most to gain since their inflation bias has been most pronounced, while the rest of countries have less to gain due to low or even negative values. (3) Looking at the results for the period after the financial crisis of 1998-2012, it emerges that for almost all countries, the business cycles have been more positively synchronized with SE-Asia as a whole than before. Some of them have a near perfect

[10] These South Eastern Economies are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, and Timor-Leste.

TABLE XXV INFLATION PERFORMANCE FOR SOUTH-EASTERN ASIA

	1979-2012			1998-2012		
i	$\bar{\pi}$	$\sqrt{Var(\pi)}$	$\bar{\pi}_i - \bar{\pi}_{SEAsia}$	$\bar{\pi}$	$\sqrt{Var(\pi)}$	$\bar{\pi}_i - \bar{\pi}_{SEAsia}$
South Eastern Asia	**3.316**	**8.486**	**-**	**4.256**	**10.634**	**-**
Brunei	6.692	20.258	3.376	7.791	16.220	3.535
Cambodia	3.189	6.496	-0.127	1.850	5.729	-2.406
Indonesia	4.378	15.692	1.062	7.430	20.078	3.174
Laos	4.764	8.682	1.448	5.342	11.649	1.086
Malaysia	2.549	7.871	-0.767	3.507	9.894	-0.749
Myanmar	1.671	12.867	-1.645	4.095	18.132	-0.161
Philippines	3.505	8.425	0.189	2.872	10.120	-1.384
Singapore	3.948	6.098	0.632	2.125	6.780	-2.131
Thailand	3.003	7.505	-0.313	3.527	8.760	-0.729
Vietnam	5.153	18.105	1.837	5.278	6.933	1.022
Timor-Leste				5.907	7.328	1.651

[a] $\bar{\pi}$ is the average of percentage change of GDP deflator of economy i.

[b] GDP deflator is nominal GDP (at current price in USD) divided by real GDP (at constant price in USD).

TABLE XXVI
BUSINESS CYCLE SYNCHRONIZATION WITH SOUTH-EASTERN ASIA

	1979-2012				1998-2012			
i	DIFF	HP100	HP6.25	BK	DIFF	HP100	HP6.25	BK
Brunei	0.1579	0.3303	0.2176	0.4134*	0.3862	0.1553	0.4789	0.217
Cambodia	0.0928	0.0515	0.1149	0.1506	0.4513	0.6901*	0.6565*	0.7856*
Indonesia	0.8717*	0.9293*	0.8737*	0.9008*	0.9136*	0.4948	0.5054	0.795*
Laos	0.1552	0.2148	0.2185	0.1642	0.6618*	0.2402	0.322	0.5341*
Malaysia	0.9147*	0.9257*	0.9399*	0.9381*	0.9377*	0.8011*	0.8842*	0.9234*
Myanmar	-0.0464	0.0202	0.148	0.1242	0.6794*	0.4829	0.3676	0.8704*
Philippines	0.4951*	0.5462*	0.5859*	0.5553*	0.8938*	0.9567*	0.9507*	0.9333*
Singapore	0.7833*	0.8098*	0.7466*	0.7532*	0.779*	0.8861*	0.9175*	0.9147*
Thailand	0.8131*	0.8719*	0.8797*	0.8712*	0.9101*	0.6809*	0.8396*	0.869*
Vietnam	0.1108	0.2159	0.1779	0.3705*	0.5235*	0.7644*	0.6544*	0.9128*
Timor-Leste					0.2783	0.7131*	0.4573	0.5285*

* Critical value of correlation coefficient are respectively 0.338 (n=34) and 0.514(n=15), at 95% significant level.

synchronization with SE-Asia, such as Malaysia (0.8842), Philippines (0.9507), Singapore (0.9175), and Thailand (0.8396), followed by Cambodia, Indonesia, Vietnam, and Timor-Leste, with HP λ=6.25. This suggests that these countries have little to lose from the adoption of a common currency.

In summary, focusing on shorter period and HP ($\lambda = 6.25$) results, most economies in sample are highly positively correlated with SE-Asia as a whole, yet five of them have positive inflation bias with the union and they are Brunei, Indonesia, Laos, Vietnam, and Timor-Leste. Hence, these economies are the most promising candidates of joining SE-Asia common currency area. On the contrary, the remaining rest six economies have little gains as well as little losses from the adoption and they are Cambodia, Malaysia, Myanmar, Philippines, Singapore, and Thailand.

8. CONCLUTION

This study examines the macroeconomic losses and gains of various types of monetary in Asia, including adopting the Chinese yuan as a common currency for 47 Asian economies. I obtain data from two main sources, *Penn World Table 8.0* and the *UN National Accounts*. Using data from 1979 to 2011, I find that inflation bias and business cycle synchronization with China vary substantially across countries. The estimated losses and gains from the adoption are often positively related, a relationship that appears to have strengthened over time. However, a net gain comparison is feasible for individual countries; In particular, by dividing sample economies into two groups East Asia and Other Asia, the empirical results suggest that Cambodia, Indonesia, Laos, Mongolia, Myanmar, Philippines, and Vietnam are countries that will gain more and lose less from adopting the yuan than the others, so they are the most promising candidates. I also investigate gains and losses for these Asian countries of adopting the yen or the U.S. Dollar. I find that the U.S. Dollar is a better choice for Bangladesh, India, Cambodia, Iraq, Israel, Mongolia, Pakistan, Philippines, United Arab Emirates, and Armenia than the yuan, while the yen is not considered as a promising common currency because of the Japanese deflation during the recent period.

This study also investigates the connection between business-cycle correlation and trade flows among countries. The real GDP data are taken from the *UN National Accounts* and bilateral trade data is obtained from the International Monetary Fund's *Direction of Trade Statistics*. The evidence shows that increasing trade intensity with China has led to a greater synchronization of business cycles between China and 43 Asian economies during 1982-2011. Most Asian economies have grown dramatically closer trade ties with China than with Japan or the U.S. over the period, which resulted in higher cyclical correlation with China. This finding strengthens the

net benefits of forming a Yuan Optimum Currency Area in Asia region since the destabilizing costs of joining a currency union diminish when the members are more business-cycle synchronized. The economies that traded most intensively with China over the past decade are Hong Kong, Japan, Laos, Macao, Mongolia, Myanmar, Oman, Kyrgyzstan, Malaysia, Singapore, and Vietnam.

Lastly, this study addresses the prospects of two forms of multilateral adoptions in Asia by measuring macroeconomic gains and losses of the potential formations for Asia as a whole and South-Eastern Asia as a whole, with two periods data, 1979-2012 and 1995-2012. Again, the results show that great (little) gains often coexist with great (little) losses. It does not appear promising Optimum Currency Area for Asia as a whole, neither for South-eastern as a whole. Four economies, Indonesia, Laos, Vietnam and Timor-Leste are promising candidates of joining South-Eastern Optimum Currency Area.

In conclusion, it appears that we cannot identify very strong yuanization candidates in Asia, though several countries can be shown to be better candidates than the others. Besides, considering China's current stage of development, forming a yuan OCAin Asia might be restricted by some fundamental institutional constraints, i.e., China's capital account is still controlled in many aspects, financial markets are not fully liberalized, and macroeconomic stability has not been achieved, etc. As a result, compared with the euro and dollarization, my empirical study implies that the issue of yuanization is not an immediate one. In addition to China's incomplete development, Asia economies might not have pressing desire to adopt Chinese yuan as common currency in the near future.

APPENDICES

APPENDIX A

XXVII SELECTED THEORETICAL LITERATURE REVIEW ON OCA

Author(year)	Variables	Findings
Mundell (1961)	Factor mobility	The world can be divided into regions within each of which there is factor mobility and between which there is factor immobility; the regions have fixed exchange rate or hold a common currency within the boarders and flexible exchange rate with the rest of the world.
McKinnon (1963); Rose(2000); Frankel and Rose (2002); Glick and Rose (2002)	Openness	The more open the economy is, the more arguments there are for having a fixed exchange rate
Kenen (1969)	Product Diversification	Economies that are sufficiently diversified could tolerate small losses of abandonment of their national exchange rates and gains from a single currency.
Frankel (1999)	Endogeneity	A country is more likely to satisfy the OCA criteria ex post than ex ante due to increased business cycle correlation.
Calvo and Reinhart (2002)	Effectiveness of monetary policy	If the monetary policy is not effective, the loss of monetary independence is not high.
Edwards (1997) and Collins (1996)	Political factors	The governments have the incentive to tie their own hands by adopting a fixed exchange rate regime or joining in a currency union.
Alesina and Barro (2002)	Country size; Their distances; Bilateral trade; Correlation between shocks	A country that has more to gain from giving up its own currency is: (1) a small open economy; (2) trading heavily with the larger "anchor" partner; (3) with a high inflation history; (4) highly cyclical correlated with the "anchor"
Alesina and Stella(2010)	Country size: Inflation rates: Covariance of shocks: Trade gains	The financial crisis of 2008/09 has shaken some of the foundations of monetary policy and its institutions. Independent Central Banks targeting inflation were the solution.

XXVIII SELECTED EMPIRICAL LITERATURE REVIEW ON OCA

Author(year)	Sample	Methodology	Findings
Bayoumi and Eichengreen (1994)	9 East Asian countries and 2 Pacific countries; Annual data 1972-1989	SVAR approach by Blanchard and Quah (1989)	Two groups of countries are likely to form OCAs: (1) Japan, South Korea and Taiwan and (2) Hong Kong, Indonesia, Malaysia and Singapore. Supply shocks are symmetrical among these two groups; Demand shocks are highly symmetrical for the second group.
Bayoumi and Eichengreen (1999)	9 East Asian countries and 2 Pacific countries; Annual data 1972-1989	SVAR approach by Blanchard and Quah (1989)	Asia compares well with Europe in terms of the magnitude of disturbance. Demand disturbance were about twice as large in Europe as in Asia. Thailand is added into the second group. Again, supply shocks are symmetrical among these two groups and demand shocks are highly symmetrical for the second group.
Bayoumi and Eichengreen (1999)	Japan and its 19 leading trading partners. (10 Asian and Pacific economies, 7 European countries and 2 North American countries - the US and Canada); annual data 1976-1995	OCA index	Very small and open economies would find it most appealing to peg to other East Asian countries. The OCA index of the following countries pairs approaches Western European levels: Singapore-Malaysia, Singapore-Thailand, Singapore-Hong Kong, Singapore-Taiwan and Hong Kong-Taiwan. These pairs are promising of have a common external peg.
Alesina, Barro and Tenreyro (2002)	A panel of worldwide countries; annual data 1970-1990	Alesina and Barro (2002); Three anchor economies: United States, euro zone and Japan	Africa is more associated with euro zone; North America is highly associated with the United States; Latin America trades more with US while more associated with the euro zone; few countries are associated with Japan. There seems to be a fairly clear dollar area and euro area, but not a yen area.
Karras(2002)	19 American countries; annual data 1950 to 1990	The 'New Keynesian' monetary policy model of Clarida et al.(1999)	The estimated losses and gains vary substantially across countries and they are often positively correlated. Countries have a lot to gain from adopting also have a lot to lose, vice versa.
Karras(2005)	18 Asian and Pacific economies; annual data 1960-2001	The 'New Keynesian' monetary policy model of Clarida et al.(1999)	The estimated losses and gains vary substantially across countries and they are often positively correlated. Countries have a lot to gain from adopting also have a lot to lose, vice versa.
Karras(2007)	13 Middle Eastern countries; annual data 1980-2005	The 'New Keynesian' monetary policy model of Clarida et al.(1999)	The estimated losses and gains vary substantially across countries and they are often positively correlated. Many Middle Eastern countries have achieved remarkable convergence both in business-cycle synchronization and inflation outcomes.
Bacha (2008)	14 East Asian and Pacific	SVAR approach by Blanchard	The following paired countries show an absence of

	countries; annual data 1970-2003	and Quah (1989)	common currency linkage: Malaysia-Singapore; Japan-Korea; Indonesia-Thailand; Australia-New Zealand. The reason may be geographic proximity.
Karras(2011)	11 euro members: annual data 1991-2009	Alesina and Stella(2010)	Euro membership has been typically accompanies by lower inflation, but also by higher business-cycle volatility. The macroeconomic losses and gains are often positively correlated. Cyclical synchronizations and volatilities appear strong negative relationship. The introduction of the euro didn't fundamentally change the relationship between cyclical correlation with the euro zone and business-cycle volatilities, but the degree of synchronization with the whole euro area.

APPENDIX B:

Frankel and Rose (1998) develop a theoretical model to derive testable relationship hypothesis between bilateral trade intensity and business cycle synchronization. They assume that the sector specific shock $\{\mu_{it}\}$ is distributed independently across both sector and time of each other, with sectorial variance σ_i^2. α_i is the weight of sector i in total output. Output shock $\{\nu_t\}$ are distributed independently to the sector-specific shocks and over time. Hence, the covariance between growth rates of countries y and y* is:

$$Cov(\Delta y_t, \Delta y_t^*) = Cov(\sum_i \alpha_i \mu_{i,t}, \sum_i \alpha_i^* \mu_{i,t}) + Cov(\nu_t, \nu_t^*) = \sum_i \alpha_i \alpha_i^* \sigma_i^2 + \sigma_{v,v^*} \quad (1)$$

Equation (1) has shown that the net impact of greater trade integration on BSC is theoretically ambiguous because it depends on the uncertain relative variance of aggregate shocks σ_{v,v^*} and industry-specific shocks ($\sum_i \alpha_i \alpha_i^* \sigma_i^2$):

i. If most trade is inter-industry, higher trade integration brings about deeper specialization, which develops a negative cross-industry correlation between α_i and α_i^*. Then variance of industry-specific shocks is larger than the variance of aggregate shocks, so that covariance falls accordingly and we expect closer trade integration to decrease cyclical correlation.

ii. If intra-industry accounts for most international trade, or demand shocks predominates, the covariance of the country-specific aggregate shocks σ_{v,v^*} may be affected by increased integration. For example, trading more may induce a more rapid spread of productivity shocks, raising the covariance. We would expect more synchronized business cycle since variance of aggregate shocks is larger than the variance of industry-specific shocks.

APPENDIX C

TABLE XXIX REGRESSION ANALYSIS WITH AR(1) (%TOTAL TRADE)

Dependent Variable: Cyclical Correlation with China

	DIFF b/se	HP100 b/se	HP6.25 b/se	BP b/se
With **Random effects**				
Bilateral Trade Intensity	0.0913** (0.0325)	0.1192** (0.0374)	0.0899** (0.0291)	0.1228*** (0.0300)
_cons	0.4425*** (0.1177)	0.6289*** (0.1354)	0.4679*** (0.1053)	0.5916*** (0.1089)
Wald chi2	7.88	10.18	9.54	16.75
Prob > chi2	0.0194	0.0062	0.0085	0.0002
$\hat{\rho}$_AR(1)	-0.0426	0.0637	0.0382	0.101
Modified Bhargava et al. Durbin–Watson statistic	**2.08**	**1.87**	**1.92**	**1.80**
With Country-specific Fixed Effects				
Bilateral Trade Intensity	0.0365 (0.0888)	0.1144 (0.0905)	0.2314*** (0.0811)	0.2530*** (0.0793)
_cons	0.375 (0.2477)	0.7675** (0.2449)	0.9466*** (0.2275)	1.0481*** (0.2033)
F-test	0.17	1.6	8.15	10.16
Prob > F	0.6839	0.215	0.0075	0.0032
$\hat{\rho}$_AR(1)	-0.0426	0.0637	0.0382	0.101
Modified Bhargava et al. Durbin–Watson statistic	**2.08**	**1.87**	**1.92**	**1.80**

[a] * p<0.05, ** p<0.01, *** p<0.001

[b] Standard errors are given in parenthesis.

[c] Time fixed effects are included by dummies for the period 1982-1991, 1992-2001, and 2002-2011.

APPENDIX D

TABLE XXX REGRESSION ANALYSIS WITH AR(1) (%GDP)

Dependent Variable: Cyclical Correlation with China

	DIFF b/se	HP100 b/se	HP6.25 b/se	BP b/se
With **Random effects**				
Bilateral Trade Intensity	0.0927*** (0.0268)	0.1072*** (0.0305)	0.0926*** (0.0240)	0.1371*** (0.0266)
_cons	0.5571*** (0.1292)	0.7119*** (0.1470)	0.5956*** (0.1158)	0.8348*** (0.1286)
Wald chi2	11.97	12.39	14.84	26.61
Prob > chi2	0.0025	0.0020	0.0006	0.0000
$\hat{\rho}$_AR(1)	-0.0521	0.06	0.0319	0.1353
Modified Bhargava et al. Durbin–Watson statistic	**2.10**	**1.88**	**1.94**	**1.73**
With Country-specific Fixed Effects				
Bilateral Trade Intensity	0.0627 (0.0782)	0.1136 (0.0782)	0.2366** (0.0690)	0.3275*** (0.0703)
_cons	0.4993 (0.2957)	0.8814** (0.2925)	1.2336*** (0.2682)	1.6600*** (0.2353)
F-test	0.64	2.11	11.74	21.73
Prob > F	0.4285	0.1561	0.0017	0.0001
$\hat{\rho}$_AR(1)	-0.0521	0.06	0.0319	0.1353
Modified Bhargava et al. Durbin–Watson statistic	**2.10**	**1.88**	**1.94**	**1.73**

[a] * p<0.05, ** p<0.01, *** p<0.001

[b] Standard errors are given in parenthesis.

[c] Time fixed effects are included by dummies for the period 1982-1991, 1992-2001, and 2002-2011.

APPENDIX E:

TABLE XXXI ROBUSTNESS REGRESSION ANALYSIS

Dependent Variable: Cyclical Correlation with China

	With Random Effect				With Country Pair-Specific Fixed Effects			
	DIFF b/se	HP100 b/se	HP625 b/se	BP b/se	DIFF b/se	HP100 b/se	HP625 b/se	BP b/se
Trade Intensity by Total Trade (without logarithms, 3 sub-periods)	0.8282 (0.4583)	1.1655* (0.5326)	1.1035** (0.4062)	1.3213** (0.4145)	2.2377* (0.8299)	3.1471*** (0.8977)	2.6375*** (0.7278)	1.2778 (1.5083)
Trade Intensity by GDP (without logarithms, 3 sub-periods)	0.8945 (0.4664)	0.945 (0.533)	0.9196* (0.4238)	1.1614* (0.4649)	1.7037 (1.0499)	2.4847* (1.1445)	1.9807* (0.9609)	2.8202* (1.0824)
Trade Intensity by Total Trade (with lnratio, 2 sub-periods)	0.1278*** (0.0323)	0.1869** (0.0411)	0.0935** (0.0328)	0.0759* (0.0347)	0.1278*** (0.0323)	0.1869*** (0.0411)	0.0935** (0.0328)	0.0759* (0.0347)
Trade Intensity by GDP (with lnratio, 2 sub-periods)	0.1217*** (0.0261)	0.18*** (0.0326)	0.1042*** (0.0269)	0.0904** (0.0293)	0.2555*** (0.0401)	0.2569*** (0.0390)	0.2229*** (0.0430)	0.2179*** (0.0458)

* p<0.05, ** p<0.01, ***p<0.001

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