DO EAST ASIAN COUNTRIES CONSTITUTE AN OPTIMUM CURRENCY AREA?

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1. Introduction

Imagine a world in which there were no national borderlines. Then the imaginary monetary borderlines that would divide the world into optimum currency areas needed not be the same as the actual borderlines that divide the real world into many separate nations each with its own currency. It would be a great coincidence, even impossible, that they are the same. In his famous 1961 paper, Mundell emphasizes that flexible exchange rates may be efficient, but only between one optimum currency area and another. He says, "Today, if the case for flexible exchange rates is a strong one, it is, in logic, a case for flexible exchange rates based on *regional* currencies, not on national currencies. The optimum currency area is the region." The next sensible step is to ask—what is optimum currency area (hereafter, I will call it OCA)? Krugman and Obstfeld (2000) define OCA as "groups of regions with economies closely linked by trade in goods and services and by factor mobility (pp.629)." Mundell (1961) argues that an OCA is a group of countries, in which labor mobility is relatively high with in the group but low between the group itself and other nonmember countries. If, for example, a negative asymmetric demand shock hits one of the members of an OCA, then labor will move from this country to other members, restoring employment to its original level. With high labor mobility, labor will move between members so as to equalize wages. The need for exchange rate adjustments and monetary expansion is thus less extreme. Hence migration is a channel through which adjustment to asymmetric shocks can take place. And flexible exchange rates between the members are no longer necessary in order to restore internal instability.

Besides labor mobility, another important criterion for an OCA is volume of intra-regional trade among members. If two countries trade a lot with each other, Heckscher-Ohlin model tells us that we tend to observe some degree, if not complete, of factor price equalization. Let us consider two countries, call them country A and country B, and two goods, Autos and Beer. Assume that production of autos is capital-intensive and production of beer is labor-intensive. Further assume that country A is relatively well endowed with capital while country B is relatively well endowed with labor. According to Heckscher-Ohlin model, country A will export autos to and import beer from country B and vice versa. Suppose a genius doctor in country B discovers that drinking beer causes heart disease. This discovery will likely reduce demand for beer in country B, causing the price of beer in country B to fall. Stolper-Samuelson theorem says that a fall in the price of beer will unambiguously cause real wage to fall, hurting labor both in country B and country A (because of factor price equalization). If this happens in practice, the governments in both countries may want to use similar monetary policy to offset the fall in real wages. In this way, intra-regional trade acts as a shocks transmitter, and the need for each country to retain its monetary independence is smaller, and so is the cost of giving it up. It is also possible that two countries are affected by similar pattern of shocks even if they do not trade a lot with each other. This can happen if both countries trade intensively with the same third-party trade partner. For example, Thailand and Malaysia both trade largely with the United States. If the U.S. economy slips into a recession, then the U.S. will import less from both Thailand and Malaysia, hurting both Thai and Malaysian economies in the same way. In this case, it is trade with the third party that acts as a shock transmitter to Thailand and Malaysia.

When a monetary union is formed, a number of currencies will be reduced. This will enhance the role of money as a unit of account. Exchange rates variability and transaction costs of exchanging one currency into another will also be lower. However, the benefits of forming a monetary union are not without costs. These costs come from the loss of monetary independence. For example, the inability to use monetary policy and exchange rates adjustment as a stabilization policy. Mundell (1961) stresses that the costs of adopting a single currency depends crucially on how easily an economic shock in one country is transmitted to other countries in the same region. If, for example, a supply shock strikes one member of the union, and if correlations of shocks are high among the members, all members will be affected in the same way. A symmetrical set of policy mix can, then, be used to offset the shocks for all members, thereby eliminating the need for policy autonomy. Of courses, there are other criteria than those mentioned in this paper. They are, for example, price and wage flexibility, real exchange rate variability, fiscal integration, and international currency substitution. However, in this paper, I choose to look at correlations of shocks. The reason is that it is the easiest criterion to quantify. It would be much more difficult to quantify, for instance, a country's degree of price and wage flexibility or openness. Furthermore, it is generally accepted that the degree of integration and openness are the two most important and most basic criteria of OCA. And for countries to have high degree of integration and openness, they must trade intensively with each other. From our discussion above, high volume of intra-regional trade tends to act as a shock transmitter. Hence, it is natural to first ask whether a group of countries in question have high degree of shock correlations. Then we can deduce that perhaps it is because they have high degree of integration of openness that we observe high degree of shock correlations and that they may satisfy OCA criteria after all. I also want to note that there are some economists who do not agree with this approach, and I have to admit that this approach is not without flaw. Willett (1999) argues:

> Thus, for example, according to standard stabilization analysis countries that were out of phase cyclically would make good partners, helping to dampen each other's cycles. Thus temporary asymmetrical shocks would enhance the attractiveness of a currency union (p.13).

But to verify this claim, one has to distinguish between temporary and permanent shocks, which, again, is very difficult to quantify in practice. Therefore, in this paper, I will not distinguish between temporary and permanent disturbances. It remains for future researchers to do so.

Based on the correlations of shocks criterion, it is interesting to ask whether monetary union is possible in practice. Besides the European Monetary Union (which is still questionable whether it is an optimum currency area), are there any other regions that may be qualified as optimum currency areas? The objective of my study is to identify whether a group of East Asian, including South East Asian, countries constitutes an optimum currency area. The main motivation comes from the break down of the monetary system in Asia since the financial crisis in 1997. It is clear from the crisis that fixing a currency to U.S. dollar is doomed to massive speculative attack and eventual failure of the peg. This is because each of the countries hard hit by the crisis is a small open economy with a small foreign reserve. When speculative attacks strike, it is very difficult for them to defend the peg because the funds in speculators' hands (especially hedge funds) are several times larger than their national foreign reserves. They are usually left with two choices—to abandon the peg or to defend the peg at all costs even if it means national bankruptcy. Thailand, South Korea, Philippines, and Indonesia all choose to float their currencies with Malaysia being the only one choosing to use capital control. Although floating exchange regime is one way to avoid speculative attack, but it introduces so much exchange rate variability. For example, Thai baht many times depreciates by 15 to 20 percent within a few weeks. Furthermore, the so-called "domino effect", in which Asian countries hit by the crisis all have high negative real GDP growth and fall into deep depression one after another just like domino, seems to suggest that economic shocks may be highly positively correlated among these countries. Therefore, forming a monetary union may be an alternative to floating exchange regime that should not be overlooked.

In Bayoumi and Eichengreen' 1994 paper, they study several countries in Europe, Asia, and America (North and South) based on the framework of Mundell and try to determine if there are any optimum currency areas among the countries of these three continents. They begin with the simple aggregate supply-aggregate demand in price-output space model and argue that positive demand shock will raise both price and output in the short run but only price in the long run, while positive supply shock will raise output and lower price both in short run and long run. They run vector autoregression on real GDP growth and inflation and identify supply and demand shocks. Next they calculate correlation matrix for supply and demand shocks. Furthermore, they also calculate the relative sizes of disturbances (the larger the size of disturbances, the more disruptive their effects will be, and hence the greater the opportunity cost of giving up monetary independence) and the speed of adjustment. As a benchmark, they do the same calculations for the United States, dividing it into seven sub-regions, New England, Mideast, Great Lakes, Southeast, Plains, Far West, and West. The correlations of disturbances for Asian countries turn out to be fairly close to those between the seven sub regions in the U.S. The average size of disturbances is lager in Asia than in the U.S. However, the speed of adjustment is higher in Asia. Assuming that the United States is itself an optimum currency area (this is a reasonable assumption since it would be inefficient and costly if these seven sub regions were to have their own currencies floating against each other) and using it as a bench mark, Bayoumi and Eichengreen (1994) conclude that Asia can be grouped into two optimum currency areas, the Northern Asian bloc (Japan, Korea, and Taiwan) and the Southeast Asian bloc (Hong Kong, Indonesia, Malaysia, Singapore, and Thailand). Interestingly enough, their results also seem to suggest that these two Asian blocs are even better qualified than the Northern European bloc (Austria, Belgium, Denmark, France, Germany, the Netherlands, and Switzerland).

It is also important to point out that it may be tempted just to consider real GDP growth and inflation shocks. Naturally, one may think that if two countries have high correlations of real GDP growth and inflation shocks, then they may use similar set of policy mix when there is shock (either real GDP growth or inflation) and hence the opportunity cost of giving up policy autonomy is smaller. However, this view is not entirely correct. According to the simple aggregate demand-aggregate supply in price-output space model, an inflation or real GDP growth shock may result from demand shock, supply shock, or a combination of the two. In other words, both real GDP growth and inflation shocks are composites of and dependent on the underlying supply and demand shocks. It is crucial to decompose real GDP growth and inflation shocks into supply and demand shocks because, in practice, if we observe a positive inflation shock, we can never be sure whether it is because of negative (adverse) supply shock, positive demand shock, or a combination of both. For example, suppose we observe an unanticipated rise in inflation, it may be because of a worldwide rise in oil price or an economic boom that causes this positive inflation shock. And if we do not know the cause, how can a government prescribe a correct set of policy mix? Therefore, knowing correlations of real GDP growth and inflation shocks across countries is not enough for us to determine whether it is possible for countries to give up monetary independence and policy autonomy because countries may have high degree of these correlations and yet employ different sets of policy. We need to know correlations of supply and demand shocks.

In this paper, I will first find correlation matrices for both supply and demand shocks for eight East Asian countries (Thailand, Malaysia, Singapore, Philippines, Japan, Korea, Indonesia, and Hong Kong) just like what Bayoumi and Eichengreen (1994) do in their paper based on the procedure proposed by Blanchard and Quah (1989). However, I will use data from different sample period (1970-1999 as oppose to 1969-1989 in Bayoumi and Eichengreen (1994)). The data used here comes from the IMF's international financial statistics. For all countries, growth rate is the percent change in real GDP and inflation is the percent change in consumer price index. The only exception is Hong Kong whose data on CPI are not available until 1990. So I have to use GDP deflator instead. In addition to finding correlations of supply and demand shocks like Bayoumi and Eichengreen (1994), this paper will also test the stability of these correlations. Correlations of shocks may be high among East Asian countries, but it does not mean that these correlations will continue to be high in the future. For example, high correlations of shocks may lead one to conclude that East Asian countries should adopt a common currency. But if these correlations somehow become significantly lower afterwards, does this imply that East Asian countries should no longer adopt one currency? Surely, one should not base forecasting power of an economics model entirely on past data. But, unfortunately, future data do not exist either. The best we can do is to test the stability of these correlations.

To do this, I will separate the data into three periods, before 1991, between 1991 and 1997, and after 1997. The reason is that in 1991 most East Asian counties liberalize their capital accounts, allowing capital to move in and out freely. And in 1997, Asian countries struck by the currency crisis (Thailand, Malaysia, South Korea, Indonesia, and Philippines) switch from fixed to floating exchange rate regime. Separating the data into three different time spans will allow us to see whether correlations of supply and demand shocks among East Asian countries have undergone any significant changes caused by the two major economic events. Perhaps we might find relatively high correlations of disturbances over the whole time span, but after separating the data, we might find that disturbances of correlations are very high prior to 1997 but have significantly declined or reversed since then. If this happens, we may not want to conclude that East Asian countries should form a monetary union even though correlations of shocks are high over the entire time span.

2. Methodology

2.1 Specifying a Statistical Model

First begin with a statistical model, vector autoregression, which I assume to describe the data reasonably well. The vector autoregressive equation can be written as:

$$X_t = B_1X_{t-1} + B_2X_{t-2} + \ldots + B_nX_{t-n} + e_t \qquad (1)$$

$$= [I - B(L)]^{-1}e_t \qquad (2)$$

$$= [I + D(L) + D(L)^2 + \ldots]\, e_t \qquad (3)$$

$$= e_t + D_1e_{t-1} + D_2\, e_{t-2} + \ldots \qquad (4)$$

where X_t is a 2x1 vector comprising of y_t (real GDP) and p_t (CPI) which are both in log-difference form ($\log y_t - \log y_{t-1}$), B_n is a 2x2 matrix of parameters, e_t is a 2x1 vector of residuals comprising of e_t^y and e_t^p, and L is a lag operator. The optimal lag length is identified by using Akaike Information Criteria and Schwarz Criteria.

2.2 Identifying Supply and Demand Shocks

Following the procedure proposed by Blanchard and Quah (1989), the next step is to define real GDP growth and inflation shocks in term of supply and demand shocks. Note again that it is crucial to decompose real GDP growth and inflation shocks because they are combinations of supply and demand shocks:

$$e_t = C^*\varepsilon_t \qquad (5)$$

where C is a 2x2 matrix of some constants, and ε_t is a 2x1 vector comprising of ε_t^s and ε_t^d which are supply shock and demand shock respectively. In order for matrix C to be uniquely defined, I impose four restrictions. The first two are normalizations of covariance matrix of ε_t^s and ε_t^d. This means variances of both ε_t^s and ε_t^d are equal to one. The third restriction is that ε_t^s and ε_t^d are orthogonal, meaning their covariance is zero. These three restrictions imply that the covariance matrix of ε_t^s and ε_t^d is an identity matrix.

The fourth and last restriction is a bit more troublesome. It is based on the aggregate demand-aggregate supply model in price-output space.

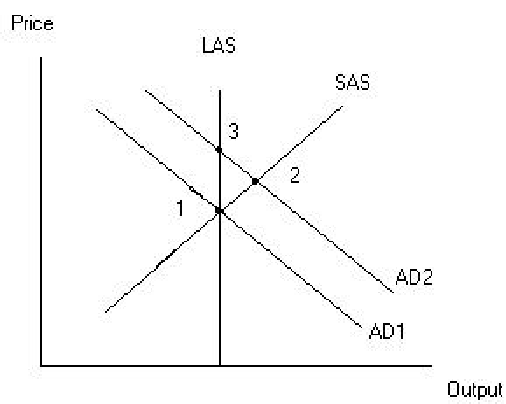

Figure 1

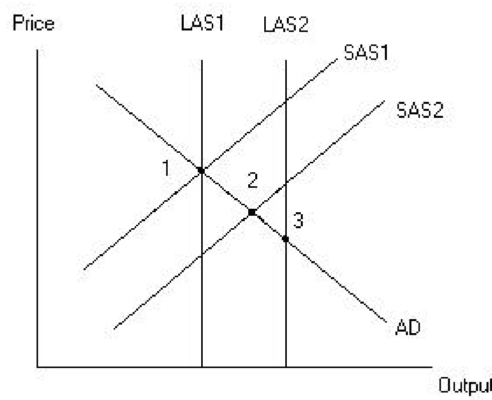

Figure 2

Figure 1 shows that when there is a positive demand shock, the economy will move from point 1 to point 2 with both price level and output increasing. But since the long-run aggregate supply curve is vertical, the economy will eventually move to point 3 to restore equilibrium. Similarly, a negative demand shock will cause both output and price level to decline in the short run, but only price level will decline in the long run. So, in the long run, a demand shock (positive and negative) has no effect on output. On the other hand, Figure 2 shows that when there is a positive supply shock, the economy will first move from point 1 to point 2 with output increasing but with price level decreasing. Overtime, the short-run aggregate supply curve SAS2 will become more vertical. Finally, SAS2 becomes the long-run aggregate supply curve LAS2. The economy moves to point 3 to restore long-run equilibrium with even higher output and lower price level.

Thus a supply shock (positive and negative) has effect on output and price level both in the long run and the short run.

The fourth restriction comes into play when we write equation (1) in a different form. Using the lag operator L, it can be rewritten as:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \ldots \qquad (6)$$

$$= \Sigma\, L_i A_i \varepsilon_t \quad ;\text{for i from 0 to } \infty \qquad (7)$$

$$\begin{bmatrix} y_t \\ p_t \end{bmatrix} = \sum_{i=0}^{\infty} L_i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \varepsilon_t^d \\ \varepsilon_t^s \end{bmatrix} \qquad (8)$$

Since demand shock must cause no change in output in the long run, this implies:

$$\sum_{i=0}^{\infty} a_{11i} = 0 \qquad (9)$$

In term of vector autoregression, equation (9) can also be written as:

$$\sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & \cdot \\ \cdot & \cdot \end{bmatrix} \qquad (10)$$

where 2x2 matrix $\Sigma\, D_i$ is equivalent to a 2x2 matrix $[I – B(L)]^{-1}$ of equation (2). In order to calculate for $[I – B(L)]^{-1}$, notice that in the long run at steady state, equation 1 becomes:

$$X_t = B_1X_t + B_2X_t + \ldots + B_nX_t + e_t \qquad (11)$$

$$(I - B_1 - B_2 - \ldots - B_n)X_t = e_t \qquad (12)$$

$$X_t = (I - B_1 - B_2 - \ldots - B_n)^{-1}\, e_t \qquad (13)$$

Since $B_1, B_2, \ldots, B_n$ are parameters obtained from running a vector autoregressive equation (1) with an optimal lag length, matrix $\Sigma\, D_i$ can now be calculated. Thus the fourth restriction is:

$$d_{11i} * c_{11} + d_{12i} * c_{21} = 0 \qquad (14)$$

Note that we only care about the multiplication of the first row of matrix D and the first column of matrik C. Next define Σ_e to be a 2x2 covariace matrix of e_t^y and e_t^p and Σ_ε to be a 2x2 covariance matrix of ε_t^s and ε_t^d which is, as a result of restrictions 1 to 3, just a 2x2 identity matrix. Then from $e_t = C^*\varepsilon_t$, we know that e_t is just a linear combination of ε_t. We can thus derive:

$$\Sigma_e = C\Sigma_\varepsilon C^T \qquad (15)$$

where C^T is a transpose of matrix C. After some matrix multiplications, we obtain the following equations:

$$c_{11}^2 + c_{12}^2 = \text{Var } e_t^y \qquad (16)$$

$$c_{11} * c_{21} + c_{12} * c_{22} = \text{Cov}(e_t^y, e_t^p) \qquad (17)$$

$$c_{21}^2 + c_{22}^2 = \text{Var } e_t^p \qquad (18)$$

With equations (14), (16), (17), and (18), we have four equations in 4 unknowns. Thus matrix C can be determined uniquely. Note that equation (5) can also be rewritten as:

$$C^{-1}e_t = \varepsilon_t \qquad (19)$$

where C^{-1} is a inverse of matrix C. Finally, we can calculate for ε_t^s and ε_t^d directly from equation (19).

2.3 Testing Stability

I next set up a linear regression equation in order to test stability of correlations of supply and demand shocks. Let us begin with equations:

$$\varepsilon_{i,t}^s = \alpha_1 + \alpha_2 D_t^1 + \alpha_3 D_t^2 + \omega_1\varepsilon_{j,t}^s + \omega_2(D_t^1\varepsilon_{j,t}^s) + \omega_3(D_t^2\varepsilon_{j,t}^s) + \eta_t^1 \qquad (20)$$

$$\varepsilon_{i,t}^d = \alpha_4 + \alpha_5 D_t^1 + \alpha_6 D_t^2 + \omega_4\varepsilon_{j,t}^d + \omega_5(D_t^1\varepsilon_{j,t}^d) + \omega_6(D_t^2\varepsilon_{j,t}^d) + \eta_t^2 \qquad (21)$$

where $\varepsilon_{i,t}^s$ and $\varepsilon_{i,t}^d$ are supply and demand shocks of country i respectively, $\varepsilon_{j,t}^s$ and $\varepsilon_{j,t}^d$ are supply and demand shocks of country j, and D_t^1 and D_t^2 are dummy variables. For period before 1991, let $D_t^1 = D_t^2 = 0$. For period between 1991and 1997, let $D_t^1 = 1$ and $D_t^2 = 0$. And for period after 1997, let $D_t^1 = 0$ and $D_t^2 = 1$. The purpose of running equation (20) and (21) is to test whether the parameters ω_2, ω_3, ω_5, and ω_6 are insignificant. The null hypothesis of no structural change implies that all ω_2, ω_3, ω_5, and ω_6 are equal to zero. Since the slope parameter is just covariance of supply (demand) shock in country i and supply (demand) shock in country j divided by variance of supply (demand) shock in country j, and since we have already assumed that variances of supply and demand shocks are equal to one for all countries, if, for example, ω_2 is positive and significant, we can unambiguously conclude that correlation of supply shocks between country i and country j has increased significantly due to a major economic event in 1991. Equations (20) and (21) are, then, run for all pairs of countries. Of course, we can also calculate correlation of supply shocks for a pair of countries for each period and determine whether the correlation has changed significantly from one period to the next (by Chow Test). In this way we can see whether correlations of shocks have become more or less correlated as a result of the two major economic events. But the problem is that the sample size for the period between 1997 and 1999 is very small (only three years). Thus we have no choice but to use linear regression with dummy variables.

3. Estimation Results

3.1 Choosing a Statistical Model

After running equation (1) for a few lag values, it turns out that the optimal lag length is 1 for all countries. In deciding which lag length is the best, I use Akaike Information Criterion and Schwarz Criterion, which are the two popular criteria for testing goodness of fit of a vector autoregressive model.

Table 1

Country	Lag1 Akaike Info. Criteria	Lag1 Schwarz Criteria	Lag2 Akaike Info. Criteria	Lag2 Schwarz Criteria
Hong Kong	11.77	12.05	12.01	12.49
Indonesia	13.43	13.71	13.65	14.13
Japan	9.26	9.54	9.24	9.72
Korea	12.74	13.03	12.94	13.42
Malaysia	10.67	10.95	10.90	11.38
Philippines	12.23	12.51	12.36	12.84
Singapore	10.69	10.98	10.54	11.02
Thailand	11.74	12.02	11.93	12.41

From Table 1 and, both Akaike information criteria and Schwarz criteria are lowest using lag 1 for all countries (lag 3 and higher are not shown because their Akaike information criteria and Schwarz criteria are even larger than those of lag 1 and 2) except Japan and Singapore. Japan and Singapore have lower Akaike information criteria using lag 2 but lower Schwarz criteria using lag 1. Nevertheless, it is obvious that the optimal lag length is 1.

3.2 Correlations of Supply and Demand Shocks

Using lag 1, I have calculated correlations of supply and demand shocks for all pairs of countries as discussed in the methodology. They are shown in the following tables:

Table 2: Correlations of Demand Shocks (1970-1999)

	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand
Hong Kong	1.000							
Indonesia	0.095	1.000						
Japan	-0.025	0.506	1.000					
Korea	0.078	0.147	0.392	1.000				
Malaysia	0.021	0.696	0.501	0.411	1.000			
Philippines	0.513	0.335	0.521	0.431	0.455	1.000		
Singapore	0.177	0.580	0.437	0.491	0.797	0.519	1.000	
Thailand	0.100	0.607	0.579	0.484	0.752	0.543	0.797	1.000

Table 3: Correlations of Supply Shocks (1970-1999)

	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand
Hong Kong	1.000							
Indonesia	0.594	1.000						
Japan	0.396	0.379	1.000					
Korea	0.455	0.683	0.399	1.000				
Malaysia	0.517	0.774	0.401	0.688	1.000			
Philippines	0.388	0.366	0.161	0.276	0.302	1.000		
Singapore	0.467	0.395	0.392	0.322	0.659	0.324	1.000	
Thailand	0.417	0.652	0.376	0.822	0.663	0.376	0.471	1.000

Note that highlighted numbers are those above 0.4. From Table 2, the correlations of demand shock are fairly high across East Asian countries with Hong Kong as the only exception. The reason probably is that the nature of Hong Kong's economy is very unique among all Asian economies. It specializes in financial activities and services, making it more difficult for demand shock to be transmitted via intra-regional trade. However, if we consider correlations of supply shock in Table 3, all countries, including Hong Kong, are highly correlated. Most correlation coefficients are above 0.3. This is not surprising because these countries are all oil-importers (except Indonesia) and trade mainly with the U.S. When oil price rises, they will all be similarly affected by adverse supply shock. And if, for example, U.S. dollar appreciates against their currencies, their aggregate demands will be affected in the same manner via export and import. But how do we know how high the correlation is considered high enough to form a monetary union? The following two tables present correlations of supply and demand shocks between the seven sub-regions in the U.S. calculated from data on real and nominal state product from 1963 to 1986. The reason I choose the U.S. as a benchmark because the U.S. itself, in some sense, is an optimum currency area. If these seven sub-regions were to use their own currencies floating against each other, the opportunity costs would be very high for the U.S. to do so.

Table 4: Correlations of Demand Shocks (1963-1986)

	New England	Mideast	Great Lakes	Southeast	Plains	Far West	West
New England	1.00						
Mideast	0.79	1.00					
Great Lakes	0.66	0.60	1.00				
Southeast	0.63	0.51	0.79	1.00			
Plains	0.51	0.50	0.70	0.69	1.00		
Far West	0.59	0.33	0.64	0.43	0.30	1.00	
West	0.26	0.28	0.03	-0.27	-0.23	0.30	1.00

Table 5: Correlations of Supply Shocks (1963-1986)

	New England	Mideast	Great Lakes	Southeast	Plains	Far West	West
New England	1.00						
Mideast	0.86	1.00					
Great Lakes	0.77	0.81	1.00				
Southeast	0.34	0.30	0.46	1.00			
Plains	0.44	0.67	0.66	0.49	1.00		
Far West	0.62	0.52	0.65	0.43	0.32	1.00	
West	0.07	-0.18	-0.11	-0.33	-0.66	0.26	1.00

Source: Bayoumi and Eichengreen, 1994

Note however that the data used to calculate correlations of supply and demand shocks for the U.S.'s seven sub-regions come from different sample period than those used for East Asia. The purpose of presenting correlations of shocks among the U.S.'s seven sub-regions is to use them as a benchmark for the sake of comparison. When compared to correlations of demand and supply shocks among the U.S.'s seven sub-regions, the eight Asian countries are too far off. Bayoumi and Eichengreen (1994) even suggest that the number 0.5 be used as a critical level of correlation for forming a currency union. Judging in this way, the eight Asian countries have a high potential to form a monetary union.

3.3 Testing the Stability

The next step is to test the stability of these correlations. As mentioned before, it is also important to ask whether there correlations have undergone any significant structural changes. The following tables present the parameters ω_2, ω_3, ω_5, and ω_6 with their t-statistics in parenthesis:

Table 6: Estimated w_2 (1970-1999)

	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore
Hong Kong							
Indonesia	-3.14 (-1.09)						
Japan	-0.48 (-0.81)	-0.56 (-1.40)					
Korea	0.31 (0.24)	-0.06 (-0.05)	0.56 (0.46)				
Malaysia	-1.36 (-0.88)	-0.53 (-0.57)	-2.00 (-1.51)	-0.52 (-0.38)			
Philippines	-0.35 (-0.26)	-0.53 (-0.48)	1.59 (1.25)	0.39 (0.27)	-1.13 (-0.82)		
Singapore	1.29 (1.07)	-0.85 (-1.33)	-0.94 (-0.82)	-0.30 (-0.27)	-1.30 (-1.97)	-0.61 (-0.59)	
Thailand	-2.37 (-1.27)	-0.39 (-0.38)	0.70 (0.45)	0.29 (0.17)	-0.25 (-0.21)	-0.11 (-0.07)	-1.57 (-1.38)

Table 7: Estimated w_3 (1970-1999)

	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore
Hong Kong							
Indonesia	-0.71 (-1.48)						
Japan	52.87 (0.88)	-135.87 (-3.36)*					
Korea	1.06 (0.81)	-3.19 (-2.87)*	-0.38 (-0.31)				
Malaysia	-1.30 (-0.96)	2.35 (2.88)*	-0.58 (-0.50)	-1.46 (-1.22)			
Philippines	0.63 (0.53)	-3.66 (-3.73)*	-0.60 (-0.54)	0.74 (0.58)	-1.59 (-1.32)		
Singapore	1.81 (0.83)	-5.78 (-4.97)*	-0.46 (-0.22)	1.34 (0.67)	-2.55 (-2.13)*	1.19 (0.63)	
Thailand	1.90 (0.84)	-5.90 (-4.78)*	-0.60 (-0.32)	1.38 (0.68)	-2.52 (-1.70)	1.22 (0.64)	0.22 (0.16)

Table 8: Estimated w_5, (1970-1999)

	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore
Hong Kong							
Indonesia	-1.44 (-0.56)						
Japan	-0.60 (-1.06)	-0.01 (-0.03)					
Korea	-0.43 (-0.29)	0.27 (0.28)	0.18 (0.12)				
Malaysia	-1.08 (-0.49)	0.21 (0.15)	2.50 (1.09)	0.45 (0.26)			
Philippines	-0.28 (-0.39)	-0.05 (-0.10)	0.48 (0.63)	-0.05 (-0.10)	0.13 (0.23)		
Singapore	-0.27 (-0.31)	-0.09 (-0.15)	-0.32 (-0.36)	-0.02 (-0.03)	-0.20 (-0.37)	0.37 (0.37)	
Thailand	0.20 (0.19)	-0.10 (-0.15)	-2.06 (-2.31)*	-0.40 (-0.63)	-0.40 (-0.55)	-0.87 (-0.81)	-0.32 (-0.31)

Table 9: Estimated ω_6, (1970-1999)

	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore
Hong Kong							
Indonesia	-0.37 (-0.88)						
Japan	2.12 (1.09)	5.41 (4.17)*					
Korea	0.13 (0.26)	1.03 (3.10)*	-0.19 (-0.38)				
Malaysia	-0.21 (-0.51)	0.55 (2.07)	-0.28 (-0.66)	0.51 (1.61)			
Philippines	0.69 (0.84)	2.15 (3.96)*	0.35 (0.40)	1.94 (3.03)*	2.43 (3.83)*		
Singapore	0.75 (0.84)	2.51 (4.01)*	0.15 (0.16)	2.23 (3.12)*	2.38 (4.22)*	0.85 (0.82)	
Thailand	0.27 (0.49)	1.17 (3.23)*	-0.41 (-0.84)	0.42 (1.23)	1.00 (2.54)*	-0.05 (-0.08)	-0.04 (-0.08)

* indicates t-statistics that is significant at 95% confidence

For Table 6, 7, 8, and 9, countries in column are the regressands (the left-hand side of equations (20) and (21)), where as countries in row are the regressors (the right hand-side). For example, column 1 row 2 means Hong Kong is a regressand and Indonesia is a regressor. From Table 6 and Table 7, for demand shock, it is evident that no one country has undergone any significant structural change except Indonesia. Notice that the t-statistics of Indonesia's correlations of demand shock with other Asian countries for 1997 are all significant (except with Hong Kong) and that Indonesia's parameter ω_3's are all negative (except with Malaysia). This means the Asian financial crisis in 1997 really does affect Indonesia's correlations of demand shocks with other Asian in a way that Indonesia's demand shock has become less positively correlated (or even negatively if $\omega_3 > \omega_1$) with those of other Asian economies. The reason probably is politics. With the downfall of President Suharto along with economic melt down, many islands demanded independence from Indonesia. Many Islamic islanders slaughtered the Chinese, who used to control many big businesses in Indonesia, blaming them for having ruined the country. Even in Jakarta, the capital of Indonesia, there was a massacre of the Chinese. This political crisis following the economic crisis probably brought Indonesia's economic activities with other Asian countries to a halt, separating Indonesia from the rest of the region. Unlike a supply shock, which depends more on factors coming from outside the region (i.e. oil shock), demand shock is more likely to be generated from within the region (i.e. loss of consumer's confidence and a drop in private and foreign direct investments resulting from bad economic prospect or political instability). So when a demand shock hits one of the other East Asian countries, it is less likely that the shock will be transmitted to Indonesia via trade.

Now the interesting part is the stability of relationships of supply shock. From Table 8, there is no evidence of any significant structural change in 1991. But for 1997 financial crisis (Table 9), some countries' correlations of supply shock have undergone significant change (using 95% significance level). Especially for South East Asian countries (Thailand, Singapore, Malaysia, Indonesia, and Philippines) and South Korea, correlations of supply shocks across these countries have significantly increased. In other words, supply shocks all move more in the same direction for all countries (since ω_6's are all positive). This is not surprising because in 1997 most South East Asian countries and South Korea are hard hit by the currency crisis, suffering severe devaluation of their currencies. Their imports of many intermediate goods and raw materials, especially oil, necessary for their productions of goods and services are several times more expensive in term of their own currencies. They are thus similarly affected by adverse supply shock resulting from the currency crisis, which might explain why their supply shocks seem to move more in the same way after 1997. Given this new result, we can conclude that Indonesia probably should not yet be part of the monetary union because its demand shock seems to diverge significantly from the rest of other countries in the region. The remaining seven Asian countries' correlations of both supply and demand shocks remain positively correlated through 1991 and 1997 major economic events, and therefore, they satisfy the correlations of shocks criterion of OCA and can adopt a single regional currency with relatively small opportunity costs. The evidence is even more obvious for the South East Asian countries including South Korea. Therefore, with an exception of Indonesia, East Asian economies do have high potential in forming a monetary union.

4. Concluding Remark

This study suggests that East Asian countries can form a monetary union without incurring so much opportunity costs of losing monetary independence and policy autonomy. With an exception of Indonesia, East Asia may first want to form a monetary union and use a regional currency among a group of South East Asian countries including possibly South Korea. After this is achieved, the union may, then, be extended northwards to include Japan and Hong Kong. Nevertheless, it is still controversial as how accurate and reliable this approach (of looking at correlations of shocks) is. Shioji (2000) suggests that one should take out any monetary shocks when looking at correlations of shocks across countries. He argues that the U.S. has relatively high correlations of shocks between the seven sub-regions because these regions are already in a monetary union! If, for example, a demand disturbance resulting from a monetary shock (i.e. a fall in money supply) suddenly hits the U.S. economy, then all seven sub-regions will be affected in the same way only because they share the same monetary policy and the same central bank. Thus correlations of shocks will tend to be higher for countries in a monetary union. Shioji (2000) further argues that it is, therefore, important to distinguish between shocks coming from the IS side and the LM side, and only shocks coming from the IS side should be taken into account when finding correlations of shocks across countries. In fact, in his paper, Shioji (2000) finds that after adjusting for shocks coming from the LM side, correlations of real GDP growth and inflation shocks are lower among the U.S.'s sub-regions. Others argue that the OCA criteria themselves may be endogenous. Frankel and Rose (1998) propose that a country that does not meet OCA criteria might still be able to join a union. This is because after joining, this country might begin to trade more with other members of the union, increasing the degree of integration of this particular country with other members and thus automatically pushing it above the criteria. Also, there are other ways to look at the OCA problem, with correlations of shocks being one among many (prices and wages flexibility, etc.). It thus depends on how one judge which criterion to be the most important one to consider when asked whether so and so group of countries should establish a regional currency since it is not likely that we can quantify them all and look at them simultaneously.

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