Transaction Costs and Welfare Effects of Currency Unions

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This paper analyzes the economic integration effects of forming a regional currency bloc by focusing on the efficiency gains that come from using a common currency. Particularly, this paper analyzes welfare effects of a currency union using the new open economy macroeconomics framework. A common currency boosts intra-regional trade, but decreases inter-regional trade. Accordingly, a currency block increases output and income of participating countries, but decreases those of non-member countries. In this context, regional monetary integration in East Asia will make East Asian countries in the currency union better off at the expense of non-participating countries.

Keywords: Currency Union, Transaction costs, East Asian monetary integration, New open economy macroeconomics

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I. Introduction

The Asian financial crisis of 1997 has shown how vulnerable fixed exchange rate regimes such as the adjustable peg are to increasing international capital mobility. Various policy options have been put forth to prevent its recurrence. In particular, the proposal

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to create a common currency in East Asia, similar to that adopted by the EU has drawn much attention. Many studies based on the optimum currency area theory suggest that a regional currency bloc is feasible in East Asia (Eichengreen and Bayoumi 1996).[1]

A currency union is the strongest form of monetary cooperation and forces participating countries to give up their monetary autonomy. Is such an extreme form of cooperation really beneficial to the participating countries? Until recently, the debate has been centered on the credibility of monetary authorities. The proposal for dollarization is a good example. If an anchor currency is adopted as a medium of exchange and as a means for store of value, the domestic currency will not depreciate nor will there be a speculative attack. Moreover, the domestic inflation rate of a "dollarized" country will converge into that of the anchor currency country. Because many Latin American countries are economically linked to the United States, dollarization may be a sensible alternative for these countries in order to stabilize their inflation rates. It may be questionable, however, whether such an argument for monetary unification would hold true for developing countries in other regions.

Emphasizing the real effects of a currency union has only recently emerged as a serious line of research. Frankel and Rose (2000) for example, show that currency unions promote trade, which then stimulates output. Using a gravity model, they found that intra-union trade triples while there is no evidence of trade-diversion. They also found that every one percent increase in trade raises per capita income by one third of a percent over twenty years. Rose and Engel (2000) confirm that members of currency unions are more integrated than countries with their own currencies, but less integrated than regions within a country. In the case of a fixed exchange rate regime, empirical evidence is still needed to prove that it reduces the costs of transaction and exchange risk (Baxter and Stockman 1989; and Aristotelous (2001)). If this is the case, the currency union seems to offer additional benefits by enhancing the quality of money as a unit of account, as a medium of exchange, and as a store of value.

[1]Most East Asian countries adopted flexible exchange rate regimes after the crisis. But, McKinnon (2000) insists that these countries have recently returned to the de facto dollar peg.

Despite the heightened interest at the policy level, few theoretical underpinnings have been proposed in the academic literature to support the case for regional monetary integration. Moreover, a naive examination of trade linkages of countries participating in a currency union may exaggerate benefits of a currency union. In order to analyze economic integration effects of forming a regional currency bloc, we need an analytical model that captures the salient features of using a common currency.

This paper aims to clarify welfare effects of a currency union on participating and non-participating countries by focusing on the efficiency gains from regional monetary integration. In particular, we introduce transaction costs for shipping goods between countries, which comes from the use of separate currencies. A fraction of any good shipped between countries evaporates in transit so that the law of one price or purchasing power parity does not hold (Samuelson 1971). It is assumed that a currency union will substantially reduce transaction costs within the area. The transaction costs for trade with non-participating countries remain the same.

The major finding of this paper is that those participating in a regional currency union will be better off, partially at the expense of non-participating countries. There are two contrasting effects of a regional bloc on international trade: the substitution effect and the income effect. Lowering of the intra-regional transaction costs will boost intra-regional trade and increase output. It is shown that the income effect on the third country is not large enough to offset the substitution effect. Accordingly East Asian minetary integration based on a common currency, *e.g.*, the Asian currency unit (ACU), will increase intra-regional trade among Japan and developing East Asian countries and decrease inter-regional trade with a third country, such as the U.S.

The structure of this paper is as follows. Section II presents the model with a special emphasis on transaction cost on trade in a three-country setting. Section III analyzes the welfare effects of an increase in transaction costs as well as how the formation of a regional currency union affects member and non-member countries. Section IV presents a numerical example to illustrate welfare effects of forming East Asian currency union. Finally, Section V concludes the paper.

II. The Model

The model is a standard three-country model developed by Corsetti *et al.* (2000). The world comprises two regions: East Asia and America. There are two countries in East Asia (country A and country B), while there is only one (country C) in America. The market structure is characterized by monopolistic competition. There are three types of goods and each country specializes in the production of one type. For each type of good there exists a continuum of individual monopolistic producers, indexed by x. The world is populated by households that consume all three types of goods, but each produces only one type of good. East Asia's share of the world population is γ^*, and country A's share of East Asia is γ^A. Thus, country A consists of consumer-producers on the interval $[0, \gamma^A \gamma^*)$, whereas country B's consumer-producers are located on $(\gamma^A \gamma^*, \gamma^*]$. Consumer-producers on the interval $(\gamma^*, 1]$ live in country C.

We define a real consumption index C for each country j as follows:

$$\begin{aligned} C^j(x) &= [\gamma^{*1/\rho} C^j_{*}{}^{\rho-1/\rho} + (1-\gamma^*)^{1/\rho} C^j_C{}^{\rho-1/\rho}]^{\rho/\rho-1} \\ &= [\gamma^{*1/\rho}\{(\gamma^A)^{1/\Psi} C^j_A{}^{\Psi-1/\Psi} + (1-\gamma^A)^{1/\Psi} C^j_B{}^{\Psi-1/\Psi}\}^{(\Psi/\Psi-1)(\rho-1/\rho)} \\ &\quad + (1-\gamma^*)^{1/\rho} C^j_C{}^{\rho-1/\rho}]^{\rho/\rho-1} \end{aligned} \tag{1}$$

ρ denotes the elasticity of substitution between the types of goods produced in America (country C) and in East Asia (*). Likewise, Ψ is the elasticity of substitution between goods produced in the same region. For each country's products, the elasticity of substitutability is assumed to be θ. Thus, the consumption of country j's goods produced in each country is determined as follows:

$$C^j_A(x) = [(\gamma^A \gamma^*)^{-1/\theta} \int_0^{\gamma^A \gamma^*} C^j_A(z,x)^{\theta-1/\theta} dz]^{\theta/\theta-1} \tag{2.1}$$

$$C^j_B(x) = [((1-\gamma^A)\gamma^*)^{-1/\theta} \int_{\gamma^A \gamma^*}^{\gamma^*} C^j_B(z,x)^{\theta-1/\theta} dz]^{\theta/\theta-1} \tag{2.2}$$

$$C^j_C(x) = [(1-\gamma^*)^{-1/\theta} \int_{\gamma^*}^{1} C^j_C(z,x)^{\theta-1/\theta} dz]^{\theta/\theta-1} \tag{2.3}$$

We also assume that the two countries in East Asia produce goods that are closer substitutes relative to the goods produced in *C*. Similarly, the elasticity of substitution among the goods produced in East Asia is more substitutable as opposed to goods produced in different countries: $\rho \leq \Psi \leq \theta$.

The price deflator denotes the consumption-based price index. Country *j*'s price index, which corresponds to P^j, is as follows:

$$\begin{aligned} P^j &= [\gamma^* {P^j_*}^{1-\rho} + (1-\gamma^*){P^j_C}^{1-\rho}]^{1/1-\rho} \\ &= [\gamma^* \{\gamma^A {P^j_A}^{1-\Psi} + (1-\gamma^A)P^j_B)^{1-\Psi}\}^{(1/1-\Psi)(1-\rho)} + (1-\gamma^*){P^j_C}^{1-\rho}]^{1/1-\rho} \end{aligned} \tag{3}$$

The price index for country *j*'s consumption of each type of good (*A*,*B*,*C*) is as follows, where $P^j_k(z)$ is the price in country *j* of the good produced by household *z* in country *k*:

$$P^j_A = [(\gamma^A \gamma^*)^{-1} \int_0^{\gamma^A \gamma^*} P^j_A(z)^{1-\theta} dz]^{1/1-\theta} \tag{4.1}$$

$$P^j_B = [((1-\gamma^A)\gamma^*)^{-1} \int_{\gamma^A \gamma^*}^{\gamma^*} P^j_B(z)^{1-\theta} dz]^{1/1-\theta} \tag{4.2}$$

$$P^j_C = [(1-\gamma^*)^{-1} \int_{\gamma^*}^{1} P^j_C(z)^{1-\theta} dz]^{1/1-\theta} \tag{4.1}$$

The price of each commodity is set by its respective monopolistic producer. A home country's consumer price is the same as its producer price. Meanwhile, foreign consumers pay more because of the transaction costs involved with using different currencies. We assume that the transaction cost is proportional to the export price as seen in the "iceberg" model (Krugman 1980).[2]

Let E^j equal the exchange rate of country *j*'s currency against country *C*'s currency ($E^c = 1$). The transaction cost for trade between country *i* and *j* (actually exports from *i* to *j*) is denoted by τ^{BA}, which is assumed to be greater than zero. Therefore, consumer prices of foreign goods are determined as follows:

$$P^B_A(z) = (1+\tau^{BA})P^A_A(z)E^B/E^A,\ P^C_A(z) = (1+\tau^{CA})P^A_A(z)/E^A \text{ for } z \in [0, \gamma_A \gamma_B] \tag{5.1}$$

[2]Alesina and Barro (2000) adopt the similar approach by assuming that "the shipping of an intermediate good across country borders entails transaction costs, which can reflect trade barriers and difference in language and currency."

$$P_B^A(z)=(1+\tau^{AB})P_B^B(z)E^A/E^B,\ P_B^C(z)=(1+\tau^{CB})P_B^B(z)/E^B \text{ for } z\in(\gamma_A\ \gamma_B,\ \gamma^*] \quad (5.2)$$

$$P_C^A(z)=(1+\tau^{AC})P_C^C(z)E^A,\ P_C^B(z)=(1+\tau^{BC})P_C^C(z)E^B \text{ for } z\in(\gamma^*,1] \quad (5.3)$$

What will happen if a currency bloc is formed between country A and B? We assume that the transaction cost for trade between country A and B becomes zero ($\tau^{BA}=\tau^{AB}=0$) while the transaction cost for trade between these two countries and country C remains the same. For simplicity, we assume that the transaction costs for trade between country A and C, and trade between country B and C are the same ($\tau^{AC}=\tau^{CA}=\tau^{BC}=\tau^{CB}>0$). Figure 1 shows the effects of a currency union in East Asia on transaction costs. This scenario is similar to the case of forming a customs union. As in the latter case, the welfare changes in the three countries depend on the relative size of trade creation and trade diversion effects.[3]

We can examine the effects of a currency union by linearizing the model around a steady state (Obstfeld and Rogoff 1995). However, in applying this procedure to our model, we come across the difficulty that the law of one price does not hold in a steady state due to transaction costs. In order to cope with this problem, we assume that there is common money in the initial state so that there are no transaction costs. We then consider two separate cases in order to introduce transaction costs into the model.

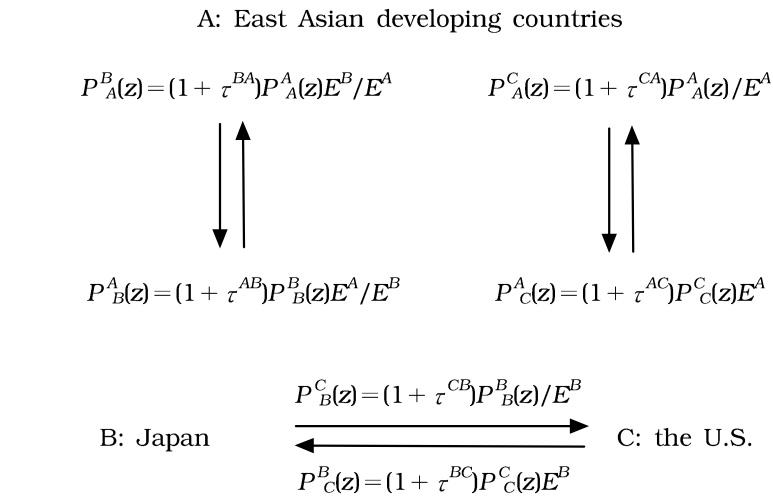
First, the case of a generalized flexible exchange rate regime assumes that all three countries have their own currencies. The transaction costs for international trade uniformly increase in all three countries: $\Delta\tau^{AC}=\Delta\tau^{CA}=\Delta\tau^{BC}=\Delta\tau^{CB}=\Delta\tau^{AB}=\Delta\tau^{BA}>0$.

Second, the case of an East Asian currency union assumes that country A and country B in East Asia form a currency union. In this case, the transaction costs for intra-regional trade in East Asia are zero but for inter-regional trade between East Asia and America the transaction costs are greater than zero: $\Delta\tau^{AC}=\Delta\tau^{CA}=\Delta\tau^{BC}=\Delta\tau^{CB}>0$, $\Delta\tau^{AB}=\Delta\tau^{BA}=0$.

The effects of a currency union in East Asia on transaction costs are summarized in figure 1. We may figure out the effect of a currency union indirectly by comparing the above two cases. The

[3]In the case of a customs union, we need to consider tariff revenues. Fender and Yip (2000) analyze the effect of tariffs in the framework of a two-country model.

1. Before forming a currency union (Equations 5.1-5.3)



2. After forming a currency union ($\tau^{BA}=\tau^{AB}=0$ in Equations 5.1-5.3)

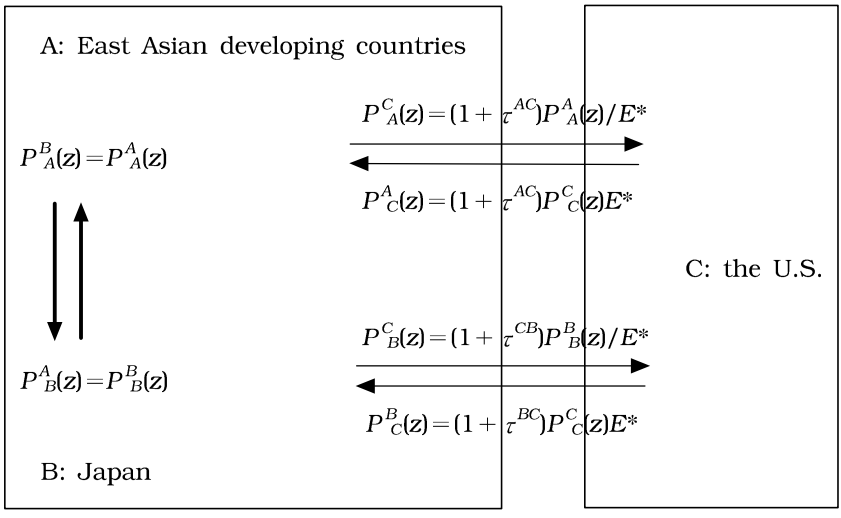


FIGURE 1

THE EFFECTS OF THE EAST ASIAN CURRENCY UNION ON TRANSACTION COSTS

initial steady state of the model assumes that there are no transaction costs ($\tau=0$). Therefore, the setup of the model is straightforward. All households in the world have identical preferences over a consumption index, real money balances (M/P), and labor efforts ($j=A,B,C$).

$$U^j_t(x)=Et\sum_{s=0}^{\infty}\beta^s(\ln C^j_{t+s}-\kappa/2\ Y^j_{t+s}(x)^2+\chi\ln(M^j_{t+s}(x)/P^j_{t+s}) \tag{6}$$

Given the constant-elasticity of substitution of a consumption index, world demand for each type of good for country j is determined as follows:

$$\begin{aligned}Y^A(z)=&[P^A_A(z)/P^A_A]^{-\theta}[P^A_A/P^A_*]^{-\psi}[P^A_*/P^A]^{-\rho}\ \gamma^A\gamma^*C^A\\&+[P^B_A(z)/P^B_A]^{-\theta}[P^B_A/P^B_*]^{-\psi}[P^B_*/P^B]^{-\rho}(1-\gamma^A)\gamma^*C^B\\&+[P^C_A(z)/P^C_A]^{-\theta}[P^C_A/P^C_*]^{-\psi}[P^C/P^C_*]^{-\rho}(1-\gamma^*)C^C\end{aligned} \tag{7-1}$$

$$\begin{aligned}Y^B(z)=&[P^A_B(z)/P^A_B]^{-\theta}[P^A_B/P^A_*]^{-\psi}[P^A_*/P^A]^{-\rho}\ \gamma^A\gamma^*C^A\\&+[P^B_B(z)/P^B_B]^{-\theta}[P^B_B/P^B_*]^{-\psi}[P^B_*/P^B]^{-\rho}(1-\gamma^A)\gamma^*C^B\\&+[P^C_B(z)/P^C_B]^{-\theta}[P^C_B/P^C_*]^{-\psi}[P^C_*/P^C]^{-\rho}(1-\gamma^*)C^C\end{aligned} \tag{7-2}$$

$$\begin{aligned}Y^C(z)=&[P^A_C(z)/P^A_C]^{-\theta}[P^A_C/P^A]^{-\rho}\ \gamma^A\gamma^*C^A\\&+[P^B_C(z)/P^B_C]^{-\theta}[P^B_C/P^B]^{-\rho}(1-\gamma^A)\gamma^*C^B\\&+[P^C_C(z)/P^C_C]^{-\theta}[P^C_C/P^C]^{-\rho}(1-\gamma^*)C^C\end{aligned} \tag{7-3}$$

where C^j denotes the per capita consumption for country j. World consumption is the weighted average of each country's consumption level:

$$C^W=\gamma^A\gamma^*C^A+(1-\gamma^A)\gamma^*C^B+(1-\gamma^*)C^C \tag{8}$$

Now, let us consider individual household budget constraints. We assume that the only internationally traded asset is a risk free real bond denominated in country C's currency. The period budget constraint for a representative, individual x, of country j in real terms are as follows:

$$E^j_t S^j_{t+1}(x)/P^j_t + M^j_t(x)/P^j_t + C^j_t(x) = (1+i_t)E^j_t S^j_t(x)/P^j_t + M^j_{t-1}(x)/P^j_t + R^j_t(x)/P^j_t - T^j_t(x)/P^j_t \quad (9)$$

where S, i and T denote bonds, nominal interest rates, and tax revenues, respectively. R^j is the sales revenue of country j. Each country's production condition is the same $(P^j_k(z)/E^k = P^j_j(z)/E^j)$ so that R^j is determined as follows:

$$R^j(z) = P^j_j(z)Y^j(z) \quad (10)$$

The maximization of the utility of the representative household under budget constraints with respect to S^j_{t+1}, M^j_t and $Y^j_t(x)$ should satisfy the following first-order conditions:

$$C^j_{t+1}(x)/C^j_t(x) = \beta(1+i_{t+1})(P^j_t/E^j_t)/(P^j_{t+1}/E^j_{t+1}) \quad (11)$$

$$M^j_t(x)/P^j_t = \chi\, C^j_t(x)\frac{(1+i_{t+1})/E^j_t}{(1+i_{t+1})E^j_{t+1} - E^j_t} \quad (12)$$

$$P^j_{j,t}(x)/P^j_t = \frac{\theta\kappa}{\theta - 1} C^j_t(x)Y^j_t(x) \quad (13)$$

The nominal bonds are then set equal to zero:

$$\gamma^A \gamma^* S^A_t + (1-\gamma^A)\gamma^* S^B_t + (1-\gamma^*)S^C_t = 0 \quad (14)$$

To close the model, we focus on a symmetric steady state, assuming that all initial bond holdings are zero:

$$S^A = S^B = S^C = 0 \quad (15)$$

We analyze how the welfare of a representative agent is affected by transaction costs. We cannot solve the model in closed form in general. It is however possible to solve it by taking log-linear approximation around the symmetric steady state. We use the small letter to denote the rate of change around the initial steady state, and the upper bars for the steady state values:[4]

$$x=(X-\bar{X}_0)/\bar{X}_0 \tag{16}$$

In order to analyze dynamics under sticky prices, the economy is assumed to be initially at the symmetric steady state with no cross-country claims and no government spending. At time t unexpected shocks occur, and the adjustment of the economy goes in two stages. In the short run, at period t, prices cannot adjust because they were set before the shocks occurred and cannot be adjusted instantaneously. In the long run, from period $t+1$ on, the economy reaches the new steady state.

From equation (6), the overall welfare changes are determined by the weighted sum of short-run and long-run changes in consumption and output. We abstract from the direct impact of real balances, because they are in the utility function merely to generate a money demand.[5]

$$dU=\left(c+\frac{1-\beta}{\beta}\bar{c}\right)-\frac{\theta-1}{\theta}\left(y+\frac{1-\beta}{\beta}\bar{y}\right) \tag{16}$$

III. Effects of Forming a Regional Currency Union

In order to analyze the effects of a regional currency union, we must first analyze how the transaction costs affect the international linkages. Let us assume that there are no transaction costs and the law of one price holds initially. Then, we introduce the transaction costs to consider how they affect the equilibrium in the short run as well as in the long run.[6]

The transaction costs for trade between country i and j (actually exports from i to j) are denoted by τ, which is assumed to be greater than zero. An increase in the transaction costs ($\Delta\tau$)

[4]The only exception to this convention is the case of bond holding. Because the initial bond holding are zero, we scale them by the initial consumption.

[5]Even if we want to include the direct effect, the value of χ the value is so small to make the direct effect of real balances negligible compared to the impact of output and consumption.

[6]The solution of our model is explained in details in the Appendix.

decreases foreign demand for domestically produced goods. Thus, world output and consumption decrease both in the short-run and in the long run as follows, where the subscript g denotes the case of no regional currency union:

$$\bar{y}^W_g = \bar{c}^W_g = -\gamma^*\{1-\gamma^* + \gamma^*\gamma^A(1-\gamma^A)\}\Delta\tau \tag{18}$$

$$y^W_g = c^W_g = -2\beta\{\gamma^*(1-\gamma^*) + (\gamma^*)^2\gamma^A(1-\gamma^A)\}\Delta\tau \tag{19}$$

From equation (17), we can derive explicitly the welfare changes of each country. If each country is economically identical and domestic and foreign degrees of substitutability are the same, each country will be worse off:

$$\begin{aligned} dU^W_g = dU^A_g = dU^B_g = dU^C_g \\ = -\frac{1}{\theta}[2\beta\{\gamma^*(1-\gamma^*) + (\gamma^*)^2\gamma^A(1-\gamma^A)\} \\ + \frac{\beta}{1-\beta}\gamma^*(1-\gamma^*)\{1-\gamma^A(1-\gamma^A)\}\Delta\tau \end{aligned} \tag{20}$$

As will be shown later in the numerical illustration, economic size and degree of substitutability between domestic and foreign goods make the welfare changes for each country different. Generally speaking, a larger country is less affected by an increase in transaction costs. Meanwhile, the rise in the degree of domestic substitution makes the welfare effects of transaction costs smaller.

Now, we introduce a regional currency union in East Asia comprised of country A and country B. The formation of a regional currency union results in two significant changes to our model. First, the imposition of a single currency reduces transaction costs for bilateral trade between these two countries to zero. Second, the introduction of a single currency fixes the bilateral exchange rate between currency A and currency B ($e^A - e^B = 0$). We assume that a decrease in transaction costs are the only source of shocks affiliated with forming a regional currency union.[7]

Let us consider what happens if transaction costs for trade

between East Asia and America increases permanently, while transaction costs for trade within East Asia remains at zero. As expected, both world output and consumption decrease in the short run and in the long run, where the subscript l denotes the case of forming a regional currency union.

$$\bar{y}^W_l = \bar{c}^W_l = -\gamma^*(1-\gamma^*)\Delta\tau \tag{21-1}$$

$$y^W_l = c^W_l = -2\gamma^*(1-\gamma^*)\Delta\tau \tag{21-2}$$

Under the East Asian currency union, transaction costs increase only for inter-regional trade. Therefore, the negative effect on world output and consumption is much smaller (see equations (16) and (17)). For the symmetric case in which each country is identical in terms of economic size and degree of substitutability ($\rho = \Psi = \theta$), the changes in welfare of each country is determined as follows:

$$dU^W_l = dU^A_l = dU^B_l = dU^C_l$$

$$= -\frac{1}{\theta}[2\beta\gamma^*(1-\gamma^*) + \frac{\beta}{1-\beta}\gamma^*(1-\gamma^*)]\Delta\tau \tag{22}$$

In the general case of asymmetric sizes and asymmetric degrees of substitutability of goods in consumption, it is uncertain whether country A and country B would be better off from the increase in transaction costs associated with trade between the currency union countries and country C. As the economic size of a currency union in East Asia becomes smaller, the chance of being worse off will increase.[8]

$$dU^A_l = dU^B_l = -\frac{1}{\theta}[2\beta\gamma^*(1-\gamma^*) + \frac{\beta}{1-\beta}\gamma^*(1-\gamma^*)]\Delta\tau + (1-\gamma^*)\pi_{DIF}\Delta\tau \tag{23.1}$$

[7]We assume that East Asian countries adopt a common currency different from the US dollar to emphasize asymmetric effects of a regional currency union on intraregional and interregional trade.

[8] $\pi_{DIF} = \pi_{36} > 0$ (see equation A.30 in the Appendix).

$$dU_l^C = -\frac{1}{\theta}[2\beta\gamma^*(1-\gamma^*) + \frac{\beta}{1-\beta}\gamma^*(1-\gamma^*)]\Delta\tau - \gamma^*\pi_{DIF}\Delta\tau \qquad (23.2)$$

Now, we are ready to derive the net welfare effect of a currency union in East Asia:

$$dU^A = dU_g^A - dU_l^A \qquad (24.1)$$

$$dU^B = dU_g^B - dU_l^B \qquad (24.2)$$

$$dU^C = dU_g^C - dU_l^C \qquad (24.3)$$

IV. Numerical Illustration: East Asian Currency Union

Taking into account the complications associated with analytical solutions, we draw on a numerical illustration for discussion. As shown in Table 1, we calculated the effect of a unit shock to transaction costs on welfare levels. We considered four separate cases that differ in their assumptions of economic size and degree of substitutability. The economic size for the symmetric case is 1/3 for each country, assuming that each country has the same population.

As for the case of asymmetric economic size, we used the actual economic sizes of a group of East Asian developing countries, Japan and the U.S. measured by the average nominal GDP in U.S. dollars from 1991-5. Therefore, the ratio of East Asia (γ^*) is 0.45, and the ratio of Country A in East Asia ((A) is 0.25 in the asymmetric case.[9] As for the degree of inter-regional substitutability, we look at two sets of parameters: a symmetric case of $\rho = \Psi = \theta = 6.0$ and an asymmetric case of $\rho = 2.0$, $\Psi = 4.0$, $\theta = 6.0$ (Tille 2001).[10] The inter-temporal discount factor (β) is set to 0.96, corresponding to $i = 0.04$.

[9]The size of a country is defined as the average GDP during 1991-5, denominated in the U.S. dollar. As for Country A, the sum of seven Asian countries' GDP is used as a proxy: China (Mainland and Hong Kong), Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand.

[10]Tille (2001) refers to Backus *et al.* (1994) showing that the elasticity of substitution between goods produced in different countries is in the range of 1-2, and Rotemberg and Woodford (1992) suggesting that the elasticity between goods produced in the same country is about 6.

TABLE 1

WELFARE EFFECTS OF TRANSACTION COST SHOCKS

1. Symmetric Sizes and Symmetric Substitutability: $\gamma_A=0.5$, $\gamma^*=2/3$; $\rho=\Psi=\theta=2.0$				
Coefficient of a unit transaction cost shock	ΔU^A	ΔU^B	ΔU^C	ΔU^W
No currency union*	-4.32	-4.32	-4.32	-4.32
East Asian currency union**	2.74	2.74	-14.14	-2.88
Net welfare gain***	7.06	7.06	-9.82	1.44
2. Symmetric Sizes and Asymmetric Substitutability: $\gamma_A=0.5$, $\gamma^*=2/3$; $\rho=2.0$, $\Psi=4.0$, $\theta=6.0$				
Coefficient of a unit transaction cost shock	ΔU^A	ΔU^B	ΔU^C	ΔU^W
No currency union*	-1.44	-1.44	-1.44	-1.44
East Asian currency union**	4.65	4.65	-12.17	-0.96
Net welfare gain***	6.09	6.09	-10.73	0.48
3. Asymmetric Sizes and Symmetric Substitutability: $\gamma_A=0.25$, $\gamma^*=0.45$; $\rho=\Psi=\theta=2.0$				
Coefficient of a unit transaction cost shock	ΔU^A	ΔU^B	ΔU^C	ΔU^W
No currency union*	-11.09	-11.09	2.35	-3.70
East Asian currency union**	-5.62	-5.62	-1.22	-3.21
Net welfare gain***	5.47	5.47	-3.58	0.49
4. Asymmetric Sizes and Asymmetric Substitutability: $\gamma_A=0.25$, $\gamma^*=0.45$; $\rho=2.0$, $\Psi=4.0$, $\theta=6.0$				
Coefficient of a unit transaction cost shock	ΔU^A	ΔU^B	ΔU^C	ΔU^W
No currency union*	-8.62	-8.62	4.81	-1.23
East Asian currency union**	-3.59	-3.59	0.99	-1.06
Net welfare gain***	5.03	5.03	-3.82	0.16

Notes: * $\Delta\tau^{AB}=\Delta\tau^{BA}=\Delta\tau^{AC}=\Delta\tau^{CA}=\Delta\tau^{BC}=\Delta\tau^{CB}=\Delta\tau>0$

** $\Delta\tau^{AC}=\Delta\tau^{CA}=\Delta\tau^{BC}=\Delta\tau^{CB}=\Delta\tau>0$

*** $\Delta\tau^{AB}=\Delta\tau^{BA}=-\Delta\tau<0$

$\beta=0.96$

For each case, we consider two different scenarios: one with no currency union and another with a regional currency union between countries *A* and *B*. The difference between these two scenarios can be interpreted as the net welfare effect of forming a currency union in East Asia.

The exercise reported in Table 1 provides us with several interesting implications for introduction of a common currency such as the ACU. First of all, an increase in transaction costs decreases world welfare levels. However, the losses are not evenly distributed. If a country is large enough in economic size, it may gain from this shock in transaction costs (cases 3 and 4 if there is no currency union). Meanwhile, the increase in the inter-regional degree of substitutability lessens the welfare losses (and increases the welfare gains for country *C* in cases 3 and 4). The changes in intra-regional degree of substitutability does not matter in our exercise.

The East Asian currency union only benefits its member countries. Both country *A* and country *B* gain substantially from forming a currency union. On the other hand, the currency union will make the third country (country *C*) worse off. The detrimental effect on country C comes from a decrease in demand for its goods following a reduction in transaction costs for bilateral trade between country *A* and country *B*. The depreciation of country *C*'s currency does not offset this rise in the relative price. As a matter of fact, the increase in overall consumption in country *A* and country *B* has a positive income effect on country *C*'s products. However, the income effect is not strong enough to offset the substitution effects that result from the changes in terms of trade.

V. Conclusion

This paper has explicitly analyzed the welfare effects associated with forming a regional currency union. We have confirmed that a currency union will substantially decrease transaction costs between participants. The efficiency gain in international trade makes these countries better off. On the other hand, non-participating countries are negatively affected. Because of an increase in the relative price level, demand for goods produced in the nonparticipating country decreases. The increase in overall consumption levels in the countries belonging to a currency union

have a positive income effect on the third country, but this effect is not strong enough to offset the negative substitution effect.

Our analysis shows that East Asian monetary integration will make regional economies better off. However, it does not deny the costs of participating in a currency union, particularly in light of limited labor mobility and divergence in macroeconomic conditions in East Asia. The heated debate on the necessity of a monetary union between Canada and the U.S. implies that costs and benefits of a currency union depend on how decision-making and sovereignty in the union is shared by member countries. For example, the loss of "lender of last resort" and monetary autonomy are powerful arguments against unilateral monetary union in Canada (Buiter 1999). In this context, we need to emphasize that a supranational central bank that can properly cope with shocks to the area in a balanced way is a prerequisite for a credible currency union in East Asia.

Appendix: Welfare Effects of an Increase in Transaction Costs

We analyze how an increase in transaction costs affects welfare levels of representative agents of three-countries. As explained in the text, we assume that a new steady state is reached after one period. There are no transaction costs and the law of one price holds in the initial steady state.

The Long Run Effect

In the long run, the first-order conditions for money demand and markup in price determination (equations 12-13) hold:

$$\bar{m}^j - \bar{p}^j = \bar{c}^j \tag{A.1}$$

$$\bar{p}^j_j - \bar{p}^j = \bar{c}^j + \bar{y}^j \tag{A.2}$$

Having taken logarithmic transformation, a variable with an upper bar denotes the rate of change in the long run around the initial steady state. The demand for goods and output are determined as follows:

$$\bar{y}^A = -\Psi(\bar{p}_A^A - \bar{p}^A) + \bar{y}^* - \Psi\pi_1 \Delta\tau \tag{A.3.1}$$

$$\bar{y}^B = -\Psi(\bar{p}_B^B - \bar{p}^B) + \bar{y}^* - \Psi\pi_2 \Delta\tau \tag{A.3.2}$$

$$\bar{y}_*^* = -\rho(\bar{p}_{**} - \bar{p}^C) + \bar{c}^W - \rho\pi_3 \Delta\tau \tag{A.3.3}[11]$$

$$\bar{y}^C = -\rho(\bar{p}_C^C - \bar{p}^C) + \bar{c}^W - \rho\pi_4 \Delta\tau \tag{A.3.4}$$

$$\pi_1 = (1-\gamma^A)(1+\gamma^* - 2\gamma^*\gamma^A) > 0,$$
$$\pi_2 = \gamma^A(1-\gamma^* + 2\gamma^*\gamma^A) > 0,$$
$$\pi_3 = -\gamma^*(1-\gamma^*)\{1+(\gamma^A)^2 + (1-\gamma^A)^2\} < 0,$$
$$\pi_4 = (\gamma^*)^2\{1+(\gamma^A)^2 + (1-\gamma^A)^2\} > 0.$$

The nominal current account balance in per capita terms can be derived from individual household budget constraints (equation 9) as follows:

$$\bar{c}^j = \frac{1-\beta}{\beta}\bar{s}^j + \bar{p}_j^j - \bar{p}^j + \bar{y}^j \tag{A.4}$$

Because we assume that all bond holdings are zero in the initial state, the change in bond holdings of country j is denominated by the initial consumption value ($\bar{s}^j = S^j / Pc_0 C_0$). From equation 15, the sum of changes of all three countries should be zero:

$$\gamma^A\gamma^*\bar{s}^A + \gamma^B\gamma^*\bar{s}^B + \gamma^C\bar{s}^C = \gamma^*\bar{s}^* + \gamma^C\bar{s}^C = 0 \tag{A.5}$$

From the above long run equilibrium conditions, we can derive the long-run relations between America and East Asia.

$$(\bar{p}_*^* - \bar{p}_C^C) - (\bar{p}^* - \bar{p}^C) = (\bar{c}^* - \bar{c}^C) - (\bar{y}^* - \bar{y}^C) \tag{A.6}$$

$$(y^* - y^C) = -\rho(\bar{p}_*^C - \bar{p}_C^C) - \rho\pi_5 \Delta\tau \tag{A.7}$$

$$\bar{c}^* - \bar{c}^C = \frac{1-\beta}{\beta}\bar{s}^*/(1-\gamma^*) + (\bar{p}_*^* - \bar{p}_C^C) - (\bar{p}^* - \bar{p}^C) - (\bar{y}^* - \bar{y}^C) \tag{A.8}$$

[11] $\bar{y}^* = -\rho(\bar{p}_{**} - \bar{p}^C) + \bar{c}^W - \rho\pi_3 \Delta\tau = -\rho(\bar{p}_{**} - \bar{p}^*) + \bar{c}^W - \rho\pi_3' \Delta\tau$
$\pi_3' = \pi_3 + 1 - [(2\gamma^* - 1) + 2\gamma^A\gamma^*(\gamma^A - 1)]$

$$\pi_5 = \pi_3 - \pi_4 = -\gamma^*\{1 + (\gamma^A)^2 + (1-\gamma^A)^2\} < 0$$

Transaction costs affect the economy through output changes. As expected, purchasing power parity does not hold between the two regions:

$$\bar{p}_*^C + \bar{e}^* = \bar{p}_*^* + \pi_6 \Delta \tau \quad , \tag{A.9}$$

$$\bar{p}_*^C + \bar{e}^* = \bar{p}^* + \pi_7 \Delta \tau \quad , \tag{A.10}$$

$$\pi_6 = 1, \quad \pi_7 = -[(1-2\gamma^*) + 2\gamma^A \gamma^*(1-\gamma^A \quad .$$

Using the above equations, the long run relationships (equations (A.6)-(A.8)) can be rearranged as follows:

$$(\bar{p}_*^* - \bar{p}_C^C) - (\bar{e}^* - \pi_7 \Delta \tau) = (\bar{c}^* - \bar{c}^C) - (\bar{y}^* - \bar{y}^C) \tag{A.6}'$$

$$(\bar{y}^* - \bar{y}^C) = -\rho(\bar{p}_*^* - \bar{p}_C^C - \bar{e}^*) - \rho\pi_8 \Delta \tau \tag{A.7}'$$

$$\bar{c}^* - \bar{c}^C = \frac{1-\beta}{\beta}\bar{s}^*/(1-\gamma^*) + (\bar{p}_*^* - \bar{p}_C^C - \bar{e}^*) - (\bar{y}^* - \bar{y}^C) + \pi_7 \Delta \tau \tag{A.8}'$$

$$\pi_8 = \pi_5 + \pi_6 = -\gamma^*\{1 + (\gamma^A)^2 + (1-\gamma^A)^2 \quad .$$

The consumption differential is proportional to bond holdings while the output differential is inversely related to bond holdings.

$$\bar{p}_*^* - \bar{p}_C^C - \bar{e}^* = \frac{1}{2\rho} \frac{1-\beta}{\beta}\bar{s}^*/(1-\gamma^*) + \pi_9 \Delta \tau \tag{A.11}$$

$$\bar{y}^* - \bar{y}^C = -\frac{1}{2} \frac{1-\beta}{\beta}\bar{s}^*/(1-\gamma^*) - \rho\pi_{10} \Delta \tau \tag{A.12}$$

$$\bar{c}^* - \bar{c}^C = \frac{1+\rho}{2\rho} \frac{1-\beta}{\beta}\bar{s}^*/(1-\gamma^*) + \pi_{11} \Delta \tau \tag{A.13}$$

$$\pi_9 = -\pi_8$$
$$\pi_{10} = -(\pi_8 + \pi_9) = 0$$
$$\pi_{11} = \pi_9 + \pi_7 - \rho\pi_{10}$$

The changes in world consumption and output are negatively affected by the increase in transaction costs:

$$\bar{y}^W = \bar{c}^W = -\pi_{12}\Delta\tau$$
$$\pi_{12} = \gamma^*(\pi_6 - \pi_7)/2 = \gamma^*[2(1-\gamma^*) + 2\gamma^A(1-\gamma^A)\gamma^*] \tag{A.14}$$

The differentials of the variables of country A and country B located in the East Asia are determined similarly:

$$\bar{p}_A^A - \bar{p}_B^B - (\bar{e}^A - \bar{e}^B) = \frac{1}{2\Psi}\,\frac{1-\beta}{\beta}(\bar{s}^A - \bar{s}^*)/(1-\gamma^*) + \pi_{13}\Delta\tau \tag{A.15}$$

$$\bar{y}^A - \bar{y}^B = -\frac{1}{2}\,\frac{1-\beta}{\beta}(\bar{s}^A - \bar{s}^*)/(1-\gamma^*) + \Psi\pi_{14}\Delta\tau \tag{A.16}$$

$$\bar{c}^A - \bar{c}^B = \frac{1+\Psi}{2\Psi}\,\frac{1-\beta}{\beta}(\bar{s}^A - \bar{s}^*)/(1-\gamma^*) + \pi_{15}\Delta\tau \tag{A.17}$$

$$\pi_{13} = -\Psi(\pi_1 - \pi_2) + \gamma^*(1 - 2\gamma^A)$$
$$\pi_{14} = (1 - 2\gamma^A) - (\pi_1 - \pi_2) - \pi_{13}$$
$$\pi_{15} = -\Psi(\pi_1 - \pi_2) - \Psi\pi_{14}$$

The Short-Run Effect

The short-run equilibrium is similar to the system that we defined for the long run. While the barred variables denote the long run (period 2 and beyond), variables without bars denote the short run ($\Delta i = i_{t+1} - i_t$.).

$$\bar{c}^j - c^j = \beta\Delta i + (p^j - e^j) - (\bar{p}^j - \bar{e}^j) \tag{A.18}$$

$$\bar{m}^j - p^j = c^j + \frac{\beta}{1-\beta}(e^j - \bar{e}^j - \beta\Delta i) \tag{A.19}$$

Equations (A.19) and (A.20) imply that the changes in the short run and the long run for both consumption and the exchange rate are the same:

$$c^j - c^k = \bar{c}^j - \bar{c}^k \tag{A.20.1}$$

$$e^j - e^k = \bar{e}^j - \bar{e}^k \tag{A.20.2}$$

The demand for goods and output are given as follows:

$$y^A = \Psi(1 - \gamma^A)(e^A - e^B) + y^* - \Psi \pi_{16} \Delta\tau \tag{A.21.1}$$

$$y^B = -\Psi \gamma^A (e^A - e^B) + y^* - \Psi \pi_{17} \Delta\tau \tag{A.21.2}$$

$$y^* = \rho(1 - \gamma^*)e^* + c^w - \rho \pi_{18} \Delta\tau \tag{A.21.3}$$

$$y^C = -\rho \gamma^A e^* + c^w - \rho \pi_{19} \Delta\tau \tag{A.21.4}$$

$$\pi_{16} = -(1 - \gamma^A) + \pi_1, \quad \pi_{17} = -\gamma^A + \pi_2$$
$$\pi_{18} = -(1 - \gamma^*) + \pi_3, \quad \pi_{19} = -\gamma^* + \pi_4$$

One further difference between the short run and the long run is that income does not have to be equal to expenditure in the period when a shock hits. Instead, a country may run a current account surplus or a deficit.

$$y^A - c^A = \bar{s}^A + (e^A - \gamma^* e^*) + \pi_{20} \Delta\tau \tag{A.22.1}$$

$$y^B - c^B = \bar{s}^B + (e^B - \gamma^* e^*) + \pi_{21} \Delta\tau \tag{A.22.2}$$

$$y^C - c^C = \bar{s}^C - \gamma^* e^* + \pi_{22} \Delta\tau \tag{A.22.3}$$

$$\pi_{20} = 1 - \gamma^A \gamma^*, \quad \pi_{21} = 1 - (1 - \gamma^A)\gamma^*, \quad \pi_{22} = \gamma^*$$

The short-run equilibrium values for differentials between East Asia (Country A and Country B as a whole) and America (Country C) are derived from the first order condition for money demand, output demand and the budget constraint:

$$\bar{m}^* - \bar{m}^C - e^* = \bar{c}^* - \bar{c}^C + \pi_{23} \Delta\tau \tag{A.23.1}$$

$$y^* - y^C = \rho e^* - \rho \pi_{24} \Delta\tau \tag{A.23.2}$$

$$\frac{1-\beta}{\beta}\,\bar{s}^*/(1-\gamma^*)+(\bar{c}^*-\bar{c}^C)=-e^*+(\bar{y}^*-\bar{y}^C)+\pi_{25}\Delta\tau \qquad \text{(A.23.3)}$$

$$\pi_{23}=1-2\gamma^*+2\gamma^A\gamma^*-2(\gamma^A)^2\gamma^*, \quad \pi_{24}=\pi_{18}-\pi_{19}$$
$$\pi_{25}=1-\gamma^*+2\gamma^*\gamma^A-(1-\gamma^A)\gamma^*$$

Equations (A.23.1)-(A.23.3) combined with equation (A.11) for the long run consumption differential determine the exchange rate differential, the output differential and the consumption differential in the short-run:

$$\bar{s}^*/(1-\gamma^*)=\frac{2\beta(\rho-1)}{1+\beta+\rho(1-\beta)}(\bar{m}^*-\bar{m}^C)-\pi_{26}\Delta\tau \qquad \text{(A.24.1)}$$

$$(c^*-c^C)=\frac{(\rho-1)(1-\beta)(1+\rho)}{\rho(1+\beta+\rho(1-\beta))}(\bar{m}^*-\bar{m}^C)+\pi_{27}\Delta\tau \qquad \text{(A.24.2)}$$

$$e^*=\frac{1-\beta+\rho(1+\beta)}{\rho(1+\beta+\rho(1-\beta))}(\bar{m}^*-\bar{m}^C)+\pi_{28}\Delta\tau \qquad \text{(A.24.3)}$$

$$(y^*-y^C)=\frac{1-\beta+\rho(1+\beta)}{(1+\beta+\rho(1-\beta))}(\bar{m}^*-\bar{m}^C)+\rho\,\pi_{29}\Delta\tau \qquad \text{(A.24.4)}$$

$$\pi_{26}=\frac{2\beta\rho}{1+\beta+\rho(1-\beta)}\left\{\frac{1}{\rho}(\pi_{25}+\rho\,\pi_{24}-\pi_{23})+\pi_{23}+\pi_{11}\right\}$$

$$\pi_{27}=-\frac{(1+\rho)(1+\beta)}{2\rho\beta}\pi_{26}+\pi_{11}$$

$$\pi_{28}=(-\pi_{26}+\pi_{25}+\pi_{24}-\pi_{23})/\rho$$

$$\pi_{29}=\pi_{28}-\pi_{24}$$

World consumption and output are negatively affected by the transaction cost in the short run as well:

$$y^W = c^W = \bar{m}^W - \beta\pi_{30}\Delta\tau$$
$$\pi_{30} = 2\{\gamma^*(1-\gamma^*) + (\gamma^*)^2\gamma^A(1-\gamma^A)\} > 0 \tag{A.25}$$

The short run relationships for country A and country B can be derived in the same way, using the equilibrium conditions for the exchange rate differential, the consumption differential, and the output differential:

$$\bar{m}^A - \bar{m}^B - (e^A - e^B) = \bar{c}^* - \bar{c}^C + \pi_{23'}\Delta\tau \tag{A.26.1}$$

$$y^* - y^C = \rho(e^A - e^B) - \Psi - \pi_{24'}\Delta\tau \tag{A.26.2}$$

$$\frac{1-\beta}{\beta}\bar{b}^*/(1-\gamma^*) + (\bar{c}^* - \bar{c}^C) = -e^* + (\bar{y}^* - \bar{y}^C) - \pi_{25'}\Delta\tau \tag{A.26.3}$$

$$\pi_{23'} = \gamma^*(1-2\gamma^A), \quad \pi_{24'} = \gamma^*(1-2\gamma^A), \quad \pi_{25'} = -\gamma^*\gamma^A + \gamma^*(1-\gamma^A)$$

From the above equations, we can derive the direct effect of transaction cost on intra-regional differentials:

$$(\bar{s}^A - \bar{s}^*)/(1-\gamma^A) = \frac{2\beta(\Psi-1)}{1+\beta+\Psi(1-\beta)}(\bar{m}^A - \bar{m}^B) - \pi_{31}\Delta\tau \tag{A.27.1}$$

$$(c^A - c^B) = \frac{(\Psi-1)(1-\beta)(1+\Psi)}{\Psi(1+\beta+\Psi(1-\beta))}(\bar{m}^A - \bar{m}^B) + \pi_{32}\Delta\tau \tag{A.27.2}$$

$$(e^A - e^B) = \frac{1-\beta+\Psi(1+\beta)}{\Psi(1+\beta+\Psi(1-\beta))}(\bar{m}^A - \bar{m}^B) + \Psi\pi_{33}\Delta\tau \tag{A.27.3}$$

$$(y^A - y^B) = \frac{1-\beta+\Psi(1+\beta)}{1+\beta+\Psi(1-\beta)}(\bar{m}^A - \bar{m}^B) + \Psi\pi_{34}\Delta\tau \tag{A.27.4}$$

$$\pi_{31} = \frac{2\beta\Psi}{1+\beta+\Psi(1-\beta)}\left\{\frac{1}{\Psi}(\pi_{25'} + \Psi\pi_{25'} - \pi_{23'}) - \pi_{23'} - \pi_{15}\right\}$$

$$\pi_{32} = -\frac{(\Psi+1)(1-\beta)}{\Psi(1+\beta+\Psi(1-\beta))}\pi_{31} + \pi_{15}$$

$$\pi_{33} = \frac{1}{\Psi}\{-\pi_{31} + \pi_{25}' + \Psi\pi_{24}' - \pi_{23}'\}$$

$$\pi_{34} = \pi_{33} - (\pi_{16} - \pi_{17})$$

Welfare Changes

Overall welfare changes can be determined as follows:[12]

$$dU = (c + \frac{1-\beta}{\beta}\bar{c}) - \frac{\theta-1}{\theta}(y + \frac{1-\beta}{\beta}\bar{y}) \tag{A.28}$$

From the short-run and long-run equilibrium values, we can derive intra-regional and inter-regional differentials of welfare change ($u \equiv dU$):

$$u^W = \frac{1}{\theta}\bar{m}^W + \pi_{35}\Delta\tau \tag{A.29}$$

$$u^* - u^C = \frac{\rho-\theta}{\rho\theta}\left(\frac{1+\rho}{1+\beta+\rho(1-\beta)}\right)(\bar{m}^* - \bar{m}^C) + \pi_{36}\Delta\tau \tag{A.30}$$

$$u^A - u^B = \frac{\Psi-\theta}{\Psi\theta}\left(\frac{1+\Psi}{1+\beta+\Psi(1-\beta)}\right)(\bar{m}^A - \bar{m}^B) + \pi_{37}\Delta\tau \tag{A.31}$$

$$\pi_{35} = \frac{1}{\theta}\left(-\beta\pi_{30} - \frac{\beta}{1-\beta}\pi_{12}\right)$$

[12]In the symmetric equilibrium, $Y^2 = (\theta-1)/\theta k$.

$$\pi_{36}=\frac{\beta}{1-\beta}\pi_{27}-\frac{\theta-1}{\theta}(\rho\,\pi_{29}+\pi_{26}/2+\rho\frac{\beta}{1-\beta}\pi_{10})$$

$$\pi_{37}=\frac{\beta}{1-\beta}\pi_{32}-\frac{\theta-1}{\theta}(\Psi\,\pi_{34}+\pi_{31}/2+\Psi\frac{\beta}{1-\beta}\pi_{14})$$

Because we are interested in welfare effects of transaction costs, we may set the money stock changes equal to zero. Then, the welfare change of each country is determined as follows:

$$u^A=\pi_{35}+(1-\gamma^*)\,\pi_{36}+(1-\gamma_A)\,\pi_{37} \tag{A.32.1}$$

$$u^B=\pi_{35}+(1-\gamma^*)\,\pi_{36}-\gamma_A\,\pi_{37} \tag{A.32.2}$$

$$u^C=\pi_{35}-(1-\gamma^*)\,\pi_{36} \tag{A.32.3}$$

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