Preliminary

Basket Pegs for East Asia?
A New Open Macroeconomics Perspective

June 12, 2005

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Abstract: This paper analyzes how the choice of currency regimes in East Asia affects the transmission of the effects of policies from Japan to East Asia. Using a three country model that consists of East Asia, Japan, and the US, which is in the tradition of the "new open macroeconomics" literature, the paper investigates this issue using numerical simulations. In particular, assuming that East Asia adopts a basket peg regime, the paper studies under what value of the currency weight attached to the Japanese yen the East Asian trade balance is least affected by Japanese policies.

1 Introduction

In recent years, many economists have proposed that East Asian countries should adopt basket peg regimes with more weights attached to currencies other than US dollars (see Williamson (1996), for example). Behind this argument is the empirical finding that those countries are now adopting *de facto* dollar pegs (see Fukuda and Cong (2001), for example) and, at the same time, they are trading heavily with countries other than the US, such as Japan. For example, according to Fukuda and Cong (2001), in 1999, the US's share in Thailand's trade was 32.12 percent, while that of Japan was 34.54 percent. Based on this kind of facts, it is argued that, through stabilizing their currencies to a basket of currencies weighted by trade shares, East Asian countries could hope to stabilize their trade balances against changes in macroeconomic policies of their trade partners. Ito, Ogawa and Sasaki (1998) provide extensive theoretical and empirical studies on this matter[1]. Trade shares, however, may not be the only important factor that determines the optimal weights, even if the sole objective of adopting basket pegs is to stabilize trade balance. It is worth noting that, although Japan takes up a sizable share in East Asia's trade volumes, when it comes to the currencies used for transaction, the US dollar still dominates the Japanese yen, even in trade between East Asia and Japan. It seems likely that this fact would change the calculation of the true optimal basket weights between the US dollar and the Japanese yen for East Asia. We need a framework that enables us to compute the optimal basket weights (in the sense of trade balance stabilization[2]), taking into account explicitly the fact that the US

[1] Ogawa and Ito (2000) characterize the situation in which governments, which take currency regimes of each other as given, falls into an inferior Nash equilibrium in which all currencies are pegged to a single currency.

[2] It is worth noting that trade balance stabilization may not be the sole criterion for choosing an exchange rate regime. Yoshino, Kaji and Suzuki (2004) consider various alternative objectives for the exchange rate policy and show that, depending on the objective, the optimal basket weights can be different. Sasaki (2001) studies the relationship between the basket weights and capital flows. In this paper, it is taken as given that the objective for the exchange rate policy is trade balance stabilization. As a practical matter, many developing countries have limited foreign reserves, and thus have to worry about taming fluctuations in trade balance.

dollar is the dominant currency used for invoicing in international trade.

This paper achieves this objective by building a new open macroeconomic model in which invoice currencies play important roles. It builds on a developed by Shioji (2004), which is a three country model in the tradition of New Open Macroeconomics[3]. The three countries, called East Asia, Japan and the US, produce three types of goods: one type of nontradable goods and two types of tradable goods. One type of the tradable goods is characterized by a high elasticity of substitution between different brands within the same type (and thus a more fierce price competition), and the other is characterized by a low elasticity. Compared to the three country model of Corsetti et. al. (2000), in which the three countries are assumed to produce different types of goods, this model can incorporate much more realistic features of international trade. In the model, it is assumed that short run nominal rigidity occurs to prices quoted in the units of currencies used for invoicing. This will be called *invoice currency pricing*[4]. This case will be contrasted with the case of *producer currency pricing* (meaning that prices are rigid in the units of the producer country's currency), which is a more typical assumption made in the theoretical literature (see, for example, Obstfeld and Rogoff (1995)). I shall also consider the case of *local currency pricing* in which prices are rigid in the short run in the units of the currency of the buyer (as in Devereux and Engel (1998) and Betts and Devereux (2000)). I study how the choice of optimal basket weights changes under different assumptions about the pricing behaviors.

The rest of the report is organized as follows. Section 2 provides an overview of the related literature. Section 3 describes the basic theoretical framework. Section 4 presents the model. Section 5 presents the results of numerical simulations. Section 6 concludes.

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[3] Otani (2001, written in Japanese) offers a good survey on this literature, with a special emphasis on the issue of pricing.

[4] Sasaki (2000, Chapter 3) provides some evidence consistent with this assumption. In this paper, the choice of invoicing currency itself is taken as exogenous. Oi, Otani and Shirota (2004) develop a theory in which currencies used for invoicing are determined endogenously. Also, Ohno and Fukuda (2004) develop a model in which pricing in dollars emerges as a consequence of coordination failure.

2 Overview of the model

The model considered in this paper builds on the framework of Corsetti et al. (2000). Their model in turn is based on a multi country equilibrium model of Obstfeld and Rogoff (1995 and 1996). In the Obstfeld-Rogoff model, each country produces one type of goods (which consists of many varieties). In each country, there are consumers who live for infinite number of periods. They decide today's consumption and labor supply so as to maximize their life-time utility, taking into account the intertemporal budget constraint. Unlike the international real business cycle models (see, for example, Backus, Kehoe and Kydland (1992), this model is characterized by *nominal rigidity*: Nominal prices are assumed to be set in advance, and stays unchanged during one period. This means that a pure monetary expansion could have real effects and could change the utility level of the locals and foreigners.

Corsetti et. al. (2000) develop a three country version of the Obstfeld-Rogoff model. In their model, each country is specialized in the production of just one type of products (each of which consists of many varieties) and those goods are traded internationally. Consumers live for infinite periods and maximize their life time utility. They do not face any borrowing constraint. Their preferences are assumed to be "symmetric" across countries, in the sense that consumers in any country spend the same fraction of their expenditure on goods produced in a particular country. Firms are monopolistically competitive and set nominal prices one period in advance.

Shioji (2001) develops a modified version of this model and analyzes the welfare effect of a Japanese monetary expansion on Asia. He finds that the overall welfare effect was *positive*. Shioji (2002) generalizes this model significantly by incorporating home bias in consumer preference and a fraction of agents that are myopic (that is, they simply maximize their periodic utility each period). He finds that the welfare implication of the previous paper is weakened but remains qualitatively similar.

The assumption that each country specializes in production of just one type of product, however, may not be particularly realistic. Some type of goods produced by one country may be better substitutes for certain type of goods produced by another country than another type of goods produced by that country. For example, towels exported from China to Japan are probably better substitutes for Japanese towels than, say, Japanese TV games. To better reflect the reality of the trade structure, this paper abandons the "one country, one type of goods" specification. Instead, the model in this paper has three types of goods that are produced in all three countries. They are called "high-tech tradables", "low-tech tradables", and "non-tradables". Countries differ in the relative shares of each of those three types of products in overall production, consumption, exports, and imports[5].

The model inherits the important features of the model of Shioji (2002):

(1) It allows for a possible asymmetry in preferences across countries. For example, utility might be characterized by "home bias": spending shares may be higher for domestically produced goods than foreign goods.

(2) It also incorporates "myopic" (not forward looking) consumers who do not borrow or save.[6] The fraction of those myopic agents is treated as a parameter in the model. Models with only forward looking consumers tend to predict unrealistically strong responses of current accounts in response to various shocks. Introduction of myopic consumers makes current account less responsive to shocks and is therefore appears to be more realistic.

3 The Model

The world consists of three countries, US (denoted by *U*), Japan (denoted by *J*), and

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[5] After I finished writing the first draft of Shioji (2005), which uses the same theoretical framework explained above, I found Teo (2005) on the web. Like this paper, Teo asks how the choice of invoice currency affects the optimal basket weights. Unlike this paper, however, Teo assumes that all the nominal prices are pegged in the units of the US dollar, rather than using the actual shares of currencies used for transaction, as is done in this paper. More importantly, Teo's model is a straightforward extension of Corsetti et. al. (2000) in which different countries are assumed to produce different types of products. I believe that my way of modeling, in which different countries produce the same (though differentiated) two types of products and nontradable goods play an important role, can capture more realistic features of production and trade between the economies.

[6] It might be more realistic to model them as consumers who face borrowing constraints. However, it is more difficult to incorporate such agents, as their behavior is asymmetric depending on "which side of the borrowing constraint" they are in each period.

East Asia (“Asia” for short from now on, denoted by *A*). Each country is inhabited by a continuum of households. The numbers of households in US, Japan, and Asia are all constant, and are denoted by γ_U, γ_J, and γ_A, respectively. Time is discrete and households live for infinite periods of time. There is free flow of goods and bonds between the countries.

3-1 Type of Goods

Goods are classified into three “types”, called “high-tech tradables” (denoted by subscript *H*), “low-tech tradables” (*L*), and “non-tradables” (*N*). Those three are imperfect substitutes. As the names suggest, *H* goods and *L* goods are traded internationally while *N* goods are consumed locally. Each of the three countries produces all three types of goods. Each type of goods consists of many “brands”, that are imperfect substitutes between each other. Each household specializes in production of just one brand of goods, over which it has a monopoly right to produce. This means that the number of brands produced is always equal to the number of households.

There is no investment and all the goods are final consumer goods. We make an assumption on the utility function so that all the households decide to consume all brands of goods available to them, that is, all brands of tradable goods as well as all non-tradable goods produced in the country they live in.

3-2 Households

In each period, each household obtains utility from consuming a bundle of consumer goods. It derives disutility from working to produce its own brand of consumer goods. It also derives utility from holding real money balance. The one-period utility of the household *x*, that produces type *k* goods (*k*=*H*, *L*, or *N*) in country *j* in period *t* is assumed to take the following form:

$$u_t^{jk}(x) = \ln C_t^{jk}(x) - \frac{\kappa^{jk}}{2}\left(Y_t^{jk}(x)\right)^2 + \chi \cdot \ln\left(\frac{M_t^{jk}(x)}{P_t^j}\right) \qquad (3\text{-}1)$$

The first part represents utility from consumption. The variable $C_t^{jk}(x)$ is a bundle of consumer goods (or the “composite consumption index”) consumed by this household in period *t*. The exact definition of this index will be specified later. The second part represents the disutility of work. The variable $Y_t^{jk}(x)$ is the amount of output produced by this household in period *t*, using labor as the sole input. The parameter κ (which is assumed to be positive) describes how work effort is related to output: when its value is high, it means that productivity is low (more work effort is needed to produce the same amount of output). The third part corresponds to the utility from money holding, where $M_t^{jk}(x)$ is the amount of cash held by this household, denoted in the unit of the local currency, while P_t^j is the average price level of country *j*, to be specified exactly later. The parameter χ is assumed to be positive. The periodic budget constraint takes the following form:

$$\frac{E_t^j B_{t+1}^{jk}(x)}{P_t^j} + \frac{M_t^{jk}(x)}{P_t^j} + C_t^{jk}(x) = (1+i_t)\frac{E_t^j B_t^{jk}(x)}{P_t^j} + \frac{M_{t-1}^{jk}(x)}{P_t^j} + \frac{SR_t^{jk}(x)}{P_t^j} - \frac{T_t^{jk}(x)}{P_t^j} \quad (3\text{-}2)$$

In the above, E_t^j is the exchange rate of country *j* (*j*=*U*, *J*, or *A*) in period *t*. We shall take the US dollar as the numeraire so that E_t^U =1. The other exchange rates are defined as the value of a US dollar in the units of local currency, so an *increase* in this variable means a *depreciation* of the local currency against the US dollars. $B_{t+1}^{jk}(x)$ is the amount of bond held by this household at the end of period *t*, measured in US dollars. The nominal interest rate that accrues to holding this bond between periods *t*-1 and *t* is denoted by i_t, and this is also measured in the US dollars. The assumption of free financial capital mobility implies that this value will always be the same across the countries. $SR_t^{jk}(x)$ is the revenue from sales of the goods produced by this household, defined in the units of the local currency. In a flexible price equilibrium (long run), law of one price holds, and the sales revenue is equal to the price of this brand of goods charged by this monopolistically competitive household (which will be denoted by $P_t^{jk}(x)$), times the quantity of the goods sold world-wide ($SR_t^{jk}(x) = P_t^{jk}(x) \cdot Y_t^{jk}(x)$). In a fixed price equilibrium (short run), the domestic price is fixed, while sales prices abroad vary depending on the pass-through rate between the seller's country and the buyer's country. Finally, $T_t^{jk}(x)$ is lump sum tax imposed by the government, also defined in the units of the local currency.

Also, note that, as a producer, each household faces a downward sloping demand curve, as different brands of goods are assumed to be imperfect substitutes. Later, we shall specify exactly how those varieties of goods enter into each household's utility. For the moment, it suffices to know that, in a flexible price equilibrium (long run), each household faces the demand curve of the following kind:

$$Y_t^{jk}(x) = P_t^{jk}(x)^{-\theta_x} \cdot Z_t^{jk}, \tag{3-3}$$

where θ_x is a sector-specific constant larger than one, whose role in the utility function will be spelled out later. And Z_t^{jk} is some variable that is beyond the control of each household.

I assume that there are two types of households, forward looking households and myopic ones. Forward looking ones maximize the following life time utility:

$$U_t^{jk}(x) = E_t \sum_{s=0}^{\infty} \beta^s u_{t+s}^{jk}(x), \tag{3-4}$$

(where β is the subjective discount factor) subject to the periodic budget constraint and a non-Ponzi game condition. Myopic ones simply maximize $u_t^{jk}(x)$, period by period. This maximization is also subject to the same periodic budget constraint, though it should be noted that they will optimally choose not to hold any bond at the end of each period, namely $B_t^{jk}(x)=0$ for all *t*, *j*, and *k*. I will denote the set of forward looking households as *FL* and that of myopic households as *NFL* (for *not* forward looking). The population shares of each type are fixed in each country. I denote the number of forward looking households that produce type *k* goods in country *j* by π_{FL}^{jk} and that of non forward looking ones with similar characteristics as π_{NFL}^{jk}.

3-3 Equilibrium conditions (forward looking households)

Here, I will discuss equilibrium conditions that have to be satisfied for forward looking households as a whole. For example, define the average consumption of forward looking households producing type *k* goods in country *j* in period *t* as the integral of $C_t^{jk}(x)$ over all *x* that belongs to the forward looking group in the country. Denote such a variable as C_{FLt}^{jk}. Define Y_{FLt}^{jk}, M_{FLt}^{jk}, and B_{FLt}^{jk}, in analogous ways for output, money holdings, and bond holdings, respectively. Then, by the assumption of symmetry within the forward looking group, we obtain

$$C_{FLt}^{jk} = C_t^{jk}(x), \quad Y_{FLt}^{jk} = Y_t^{jk}(x), \quad M_{FLt}^{jk} = M_t^{jk}(x), \quad B_{FLt}^{jk} = B_t^{jk}(x), \qquad (3\text{-}5)$$

for all $x \in FL$, *j*, *k* and *t*.

In equilibrium, the following three conditions that are derived from individual forward looking household's optimization conditions have to be satisfied at the aggregate level. First, the following Euler equation has to be satisfied:

$$\frac{C_{FLt+1}^{jk}}{C_{FLt}^{jk}} = \beta(1 + i_{t+1}) \frac{P_t^j / E_t^j}{P_{t+1}^j / E_{t+1}^j} \qquad \text{(for all } t, j, \text{ and } k). \qquad (3\text{-}6)$$

Second, the following "money demand" relationship has to be satisfied:

$$\frac{M_{FLt}^{jk}}{P_t^j} = \chi C_{FLt}^{jk} \frac{(1 + i_{t+1}) E_{t+1}^j}{(1 + i_{t+1}) E_{t+1}^j - E_t^j} \qquad \text{(for all } t, j, \text{ and } k). \qquad (3\text{-}7)$$

The previous two conditions have to be satisfied at all times. When prices are flexible, the following optimality condition for the consumption-leisure choice will have to be met as well:

$$\frac{P_{FLj,t}^{jk}}{P_t^j} = \frac{\theta \cdot \kappa^{jk}}{\theta - 1} C_{FLt}^{jk} \cdot Y_{FLt}^{jk} \qquad \text{(for all } t, j, \text{ and } k), \qquad (3\text{-}8)$$

where P_{FLjt}^{jk} is the average price index for the type *k* goods produced and sold in country *j* by forward looking agents in country *j* (which will be equal to individual price $P_t^{jk}(x)$ for $x \in FL$, by symmetry).

3-3 Equilibrium conditions (myopic households)

Denote average consumption, output, money holdings and the price charged by myopic agents in their own country as C_{NFLt}^{jk}, Y_{NFLt}^{jk}, M_{NFLt}^{jk} and $P_{NFLj,t}^{jk}$, respectively. Again, by the within-group symmetry, consumption etc. of individual household in this group is equal to these group averages. In their case, only the *intra*-temporal optimization conditions have to hold. First,

$$\frac{M_{NFLt}^{jk}}{P_t^j} = \chi C_{NFLt}^{jk} \qquad \text{(for all } t, j, \text{ and } k) \qquad (3\text{-}9)$$

has to always hold. Second, when prices are flexible,

$$\frac{P_{NFLj,t}^{jk}}{P_t^j} = \frac{\theta \cdot \kappa^{jk}}{\theta - 1} C_{NFLt}^{jk} \cdot Y_{NFLt}^{jk} \qquad \text{(for all } t \text{ and } j) \qquad (3\text{-}10)$$

also has to hold.

3-4 Equilibrium conditions (government)

Next, the government's budget constraint has to be satisfied in equilibrium. In this paper, it is assumed that the government's only role is to print money and to distribute it across households in a lump sum fashion. This implies:

$$M_t^j - M_{t-1}^j + T_t^j = 0 \qquad \text{(for all } t \text{ and } j\text{)}, \tag{3-11}$$

where M_t^j and T_t^j are money supply and transfer, respectively, in country *j* in period *t*. I assume that the government supplies the same amounts of money and transfers to households within the same category, i.e., those who produce the same type of goods and have the same utility function (forward looking or not forward looking). Then, writing such money supply and transfers per capita to the forward looking group as M_{FLt}^{jk} and T_{FLt}^{jk}, and those for the myopic group as M_{NFLt}^{jk} and T_{NFLt}^{jk}, we can write

$$M_t^j = \sum_k \pi_{FL}^{jk} M_{FLt}^{jk} + \sum_k \pi_{NFL}^{jk} M_{NFLt}^{jk} \tag{3-12}$$

and

$$T_t^j = \sum_k \pi_{FL}^{jk} T_{FLt}^{jk} + \sum_k \pi_{NFL}^{jk} T_{NFLt}^{jk} . \tag{3-13}$$

3-5 Equilibrium conditions (resource constraint)

The aggregate resource constraint for country *j* can be written as:

$$E_t^j (B_{t+1}^j - B_t^j) = SR_t^j + i_t E_t^j B_t^j - P_t^j C_t^j \qquad \text{(for all } t \text{ and } j\text{)}, \tag{3-14}$$

where B_t^j, SR_t^j, and C_t^j are aggregate bond holding, sales revenue, and consumption, respectively. That is,

$$B_t^j = \sum_k \pi_{FL}^{jk} B_{FLt}^{jk} , \tag{3-15}$$

$$SR_t^j = \sum_k \pi_{FL}^{jk} SR_{FLt}^{jk} + \sum_k \pi_{NFL}^{jk} SR_{NFLt}^{jk} \tag{3-16}$$

(where SR_{FLt}^{jk} and SR_{NFLt}^{jk} are sales revenue for forward-looking and myopic households, respectively), and $$C_t^j = \sum_k \pi_{FL}^{jk} C_{FLt}^{jk} + \sum_k \pi_{NFL}^{jk} C_{NFLt}^{jk} \,. \qquad (3\text{-}17)$$

The world wide net supply of bonds has to be equal to zero:

$$B_t^U + B_t^J + B_t^A = 0 \qquad \text{(for all } t\text{)}. \qquad (3\text{-}18)$$

The amount of output produced by each type of household has to equal the demand for the good. That is,

$$Y_t^j(x) = D_{U,t}^j(x) + D_{J,t}^j(x) + D_{A,t}^j(x) \qquad \text{(for } k=H \text{ or } L\text{, for all } x, t \text{ and } j\text{)}, \quad (3\text{-}19a)$$

for tradable goods,

and $$Y_t^j(x) = D_{j,t}^j(x) \qquad \text{(for all } x, t \text{ and } j\text{)}, \qquad (3\text{-}19b)$$

for non-tradable goods, where $D_{U,t}^j(x)$, $D_{J,t}^j(x)$, and $D_{A,t}^j(x)$ are demand for output produced by household x in country j that come from the US, Japan, and Asia, respectively. Those demands will be specified in detail later.

3-6 Composite consumption indices

Now I move on to specify contents of each consumption index. In this section, time subscript t is omitted for the sake of exposition. The overall consumption index, $C^{jk}(x)$, is assumed to take the following form:

$$C^{jk}(x) = \left[\omega_{HL}^{j\ 1/\rho} \left(C_{HL}^j(x) \right)^{(\rho-1)/\rho} + \omega_N^{j\ 1/\rho} \left(C_N^j(x) \right)^{(\rho-1)/\rho} \right]^{\rho/(\rho-1)}, \qquad (3\text{-}20)$$

where $C_{HL}^j(x)$ is itself a composite consumption index of H goods and L goods, and $C_N^j(x)$ is an index of non-tradable goods consumption. The parameter ρ is the elasticity of substitution between tradable goods as a whole and non-tradable goods, and ω's are the expenditure share parameters. The index $C_{HL}^j(x)$ is defined as

and $$C_{HL}^j(x) = \left[\omega_H^{j\ 1/\psi} \left(C_H^j(x) \right)^{(\psi-1)/\psi} + \omega_L^{j\ 1/\psi} \left(C_L^j(x) \right)^{(\psi-1)/\psi} \right]^{\psi/(\psi-1)}. \qquad (3\text{-}21)$$

The parameter ψ is the elasticity of substitution between high-tech tradable goods as and low-tech tradable goods.

Each of the above indices are themselves composite consumption indices. For example, in the case of high-tech tradable goods,

$$C_H^j(x) = \left[\omega_{H,U}^{j\ \ 1/\theta_H} \cdot C_{H,U}^j(x) + \omega_{H,J}^{j\ \ 1/\theta_H} \cdot C_{H,J}^j(x) + \omega_{H,A}^{j\ \ 1/\theta_H} \cdot C_{H,A}^j(x) \right]^{\theta_H/(\theta_H - 1)}$$

(3-22)

where θ_H is the elasticity of substitution between brands within type H goods, and $C_{H,i}^j(x)$ (i=U, J, or A) is an index of consumption of high-tech tradable goods produced in country i :

$$C_{H,i}^j(x) = \omega_{H,i}^{j\ \ -1/\theta_H} \cdot \sum_{z_{H,i}} \left(C_H^j(z_{H,i}, x) \right)^{(\theta_H - 1)/\theta_H} \qquad (3\text{-}23)$$

where summation inside the brackets is taken over all the high-tech tradable brands produced in country i.

Likewise, for low-tech tradable goods, we define:

$$C_L^j(x) = \left[\omega_{L,U}^{j\ \ 1/\theta_L} \cdot C_{L,U}^j(x) + \omega_{L,J}^{j\ \ 1/\theta_L} \cdot C_{L,J}^j(x) + \omega_{L,A}^{j\ \ 1/\theta_L} \cdot C_{L,A}^j(x) \right]^{\theta_L/(\theta_L - 1)},$$

(3-24)

and $$C_{L,i}^j(x) = \omega_{L,i}^{j\ \ -1/\theta_L} \cdot \sum_{z_{L,i}} \left(C_L^j(z_{L,i}, x) \right)^{(\theta_L - 1)/\theta_L} . \qquad (3\text{-}25)$$

For non-tradable goods,

$$C_N^j(x) = \left[\omega_N^{j\ -1/\theta_N} \cdot \sum_{z_N} \left(C_N^j(z_N, x) \right)^{(\theta_N - 1)/\theta_N} \right]^{\theta_N/(\theta_N - 1)} . \qquad (3\text{-}26)$$

3-7 Price indices and demand functions

The above definitions of consumption indices allow us to appropriately define composite price indices. Also, we can derive demand functions that each household faces as a producer of goods.

3-8 Long run vs. Short run equilibrium, and pricing regimes

In the long run, all the prices are assumed to be flexible and that all the markets clear. In such a case, the contemporaneous optimality conditions between consumption and leisure are satisfied for all the households: that is, equations (3-8) and (3-10) are satisfied. In the short run, prices are rigid in the sense that will be specified below, and output becomes demand-determined. As a consequence, equations (3-8) and (3-10) no longer hold.

In the short run, the nominal prices of domestically produced goods are assumed to be rigid (that is, the same as their values in the previous period) in the units of the domestic currency. As for the goods traded internationally, we consider four different types of pricing regimes.

- *Producer currency pricing* (*PCP*) In this case, the traded goods prices are rigid in the units of the currency of the country in which they are produced.
- *Local currency pricing* (*LCP*) Their prices are rigid in the units of the currency of the country in which they are sold.
- *US currency pricing* (*UCP*) Their prices are rigid in the units of the US dollar.
- *Invoice currency pricing* (*ICP*) The units of the currencies in which the goods prices are rigid are determined by the shares of the currencies used for invoicing. To give an example, take the case of an H good produced by forward looking households in Japan, that is exported to Japan. Let us denote its sale price in Japan (measured in the yen unit) by $Q_{FL,J,t}^{A,H}$, where $Q_{FL,J,t}^{A,H} = \left(E_t^J / E_t^A\right) P_{FL,J,t}^{A,H}$. Let the average shares of the Asian currency, the Japanese yen, and the US dollar in this type of transaction by s_A, s_J, and s_U, respectively ($s_A + s_J + s_U = 1$). Then,

$$\Delta \ln\left(Q_{FL,J,t}^{A,H}\right) = s_A \cdot \left(\Delta \ln\left(E_t^J\right) - \Delta \ln\left(E_t^A\right)\right) + s_U \cdot \Delta \ln\left(E_t^J\right)$$

where Δ denotes change from period t-1[7].

[7] It would be more realistic to assume that, for each transaction, single currency is used for invoicing, and that different transactions potentially involve different currencies. The above specification should be regarded as a simplification. Otani (2002) develops a model in which firms that set prices in the units of the producer's currency, and those that set prices in the units of the buyer's currency, coexist. Although a similar specification would be more realistic, it would increase the number of types of agents in the model to a level that is not manageable: there are three countries and three currencies here, as opposed to two in Otani's model. Also, goods are more heterogeneous in this paper's model.

4 Description of the Numerical Exercise

4-1 Dynamics of the Model

In the following analysis, it is assumed that the world economy starts from a flexible price equilibrium with constant money supply. It is also assumed that all households had zero foreign bonds or debt at the outset. All the countries are in the steady state in which all the variables remain constant over time. Then a permanent shock hits the Japanese economy. In the short run, there is price rigidity, as described in the previous section. As a consequence, the world economy deviates from the long run equilibrium. Output becomes demand determined. After one period, prices become fully flexible. The world economy arrives at a new flexible price equilibrium, which is likely to be different from the old one. In a case without myopic households ($\pi_j = 1$ for all *j*), the world economy will automatically jump to the new long run equilibrium immediately. This is the beauty of the approach of Corsetti, et.al. (2000): it converts an infinite period model into a virtual two period model, and researchers have to worry about only the “short run” (period 1) and the “long run” (period 2 onwards). This is not necessarily the case when myopic households are present. Due to the asymmetry in the demand for money (refer to equations (3-7) and (3-9)), money holdings at the end of period 1 by forward looking and myopic households do not necessarily coincide their new long run equilibrium levels. In such a case, there will be a transition to the new steady state and the analysis would be far more complicated. To avoid such complication, I introduce the following governmental re-distribution policy. I assume that, at the beginning of period 2, the government in each country re-distributes money through lump sum transfers so that the amounts of monetary wealth held by each type of households at the beginning of period 2 would be equal to their respective long run values. In this case, the world economy will jump to the new long run steady state immediately, just as in the model without myopic households. This assumption is admittedly artificial but it simplifies the analysis enormously without altering the essential aspects of the conclusions.

The effects of the policy change are analyzed by log-linearizing the equilibrium conditions around the steady state with zero bond holding. As it is difficult to obtain analytical results, I report results from numerical exercises in the next section.

4-2 Calibration

The model is calibrated to fit characteristics of data for the US, Japan, and Asia on production and spending patterns, such as relative sectoral productivity and sectoral shares in expenditure. Data for Asia is computed by aggregating values for Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, and Thailand (Taiwan is omitted due to missing data). In computing sectoral statistics from data, I interpret "high-tech tradables" sector as the machinery (including transport equipment) industry, "low-tech tradables" sector as agriculture, mining and manufacturing (other than machinery), and "non-tradables" sector as the rest. The actual numbers employed are summarized in Table 1-3.

Population

World population is normalized to equal 1, and each country's population is chosen to match its actual share (among the three economies) in the number of persons employed, as is shown in Table 1[8].

Sectoral allocation of workers

Total population of a country is allocated to each sector so as to mimic actual sectoral allocation of labor in each country as shown in Table 1.

Productivity

The productivity parameters in the last row of Table 1 are chosen to match observed GDP per worker as well as data on relative sectoral productivity[9]. Productivity in the "non-tradables" sector in Asia is normalized to be 1. Note that Asia's "high-tech tradables" sector is much more productive than the other two sectors, especially in comparison with the "low-tech tradables" sector. On the other hand, GDP per worker is

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[8] Total numbers and sectoral allocation of workers are estimated by combining information from the *Key Indicators* web site of the Asian Development Bank and the *INDSTAT3 2003 CD-ROM* (UNIDO). I use data from year 2000 whenever available.
[9] Labor productivity is estimated from combining information in *World Development Indicators 2002 CD-ROM* with that in Key Indicators and INDSTAT.

relatively similar across sectors in the US and Japan. This means that, in the model, Asia has a very strong comparative advantage in "high-tech tradables" sector.

Subjective Discount Factor and the Utility Weight on Money

As is shown in Table 2, I set the subjective discount factor at $\beta = 0.9$. The parameter for money in the utility, χ, is somewhat arbitrarily set at 1.

Elasticities

Assumptions on the elasticities of substitution are summarized in Table 2. High-tech goods tend to be highly differentiated, and thus the within-type elasticity tends to be low. This idea is reflected in the small value of θ_H. On the other hand, low-tech goods and non-tradable goods are assumed to be highly substitutable with the other goods of the same type.

Share of myopic households

Due to the lack of reliable estimate, I simply set this value to 0.5. Qualitative implications of the paper are insensitive to this choice. As for quantitative implications, a smaller share of myopic households would mean greater reactions of current accounts to a shock.

Exchange rate regimes

It is assumed that both Japan and the US are under flexible exchange rate regimes. Asia, on the other hand, employs a basket peg regime in which its nominal exchange rate is fixed against a weighted average of the Japanese yen and the US dollars. Later, implications of choosing different weights between the two currencies will be studied.

Invoice currencies

For the case of "invoice currency pricing (ICP)", it is necessary to obtain shares of the currencies used for invoicing for different types of trade. Table 3 shows estimates of the shares of Asian currencies, the Japanese yen, and the US dollars used for invoicing for trade classified by countries of origin and destination, computed from data provided in the web site of the Ministry of Finance of Japan. For example, the table shows that, in the total value of exports from Asia to Japan, 2% is mediated by Asian currencies, while the shares of the Japanese yen and the US dollars are 27% and 71%, respectively. In such a case, in the model, short run prices of goods exported from Asia to Japan would increase by 0.02 times the rate of depreciation of the Asian currency against the Japanese yen, plus 0.71 times the rate of depreciation of the US dollars against the Japanese yen. Due to the lack of data, those shares are assumed to be equal between "high-tech tradables" and "low-tech tradables".

Utility Weights

The values of the expenditure share parameters, ω's, are chosen to match the actual trade patterns between the three economies. The upper panels of Table 4 and 5 summarize the estimated trade structure between the three. Table 4 corresponds to the shares of goods and services produced by each economy that are purchased by different economies. Table 5 shows the shares of goods and services purchased by each economy that are produced by different economies[10] [11]. The expenditure share parameters are set to be equal to the actual spending shares summarized in the upper panel of Table 5. Note that countries tend to spend disproportionately large shares of their expenditure allocated to tradable goods on domestically produced tradables. This paper's flexible specification of preference makes it possible to incorporate such home bias into the model. An important exception to this general tendency is Asia's expenditure on "high-tech tradables". Asia purchases only a small fraction of high tech goods produced domestically, and buys far more high tech goods from abroad.

[10] Output shares and expenditure shares in Table 4 and Table 5 are computed from the three sources mentioned in the previous footnotes and the *COMTRADE* web site of the United Nations.

[11] In computing those shares, I ignore trade with the "rest of the world", such as EU and China. This has an inconvenient consequence that the importance of domestic consumption in the relative shares of spending is exaggerated. Another minor problem with this omission is that expenditure shares do not exactly add up to 100%, as can be seen in the upper panel of Table 5. In the calibration exercise, the share parameters are adjusted slightly so that they would always sum up to 100%.

Table 1: Parameter values for the calibration exercise (A)

Population and Productivity

(Sectoral variables are listed in the order of high-tech, low-tech, non-tradable.)

	Asia	Japan	US
Population	0.49	0.16	0.35
Population shares of sectors (%)	2.6, 49.8, 47.2	6.6, 18.6, 74.8	4.2, 12.4, 83.4
Sectoral Productivity (square root of $1/\kappa$)	2.90, 0.38, 1.00	12.06, 7.59, 9.69	11.41, 9.37, 8.82

Table 2: Parameter values for the calibration exercise (B)

Preference parameters

Preference parameters:	
Discount factor (β)	0.9
Utility weight on money (χ)	1
Elasticities:	
Between tradables and non-tradables (ρ)	2
Between high-tech and low-tech (ψ)	2
Within high-tech (θ_H)	3
Within low-tech (θ_L)	10
Within non-tradables (θ_N)	10
Share parameters (ω 's):	Set to equal actual expenditure shares that appear in the upper panel of Table 5.
Share of myopic households:	0.5

Table 3: Parameter values for the calibration exercise (C)

Value shares of currencies used for invoicing.

In the order of Asian, Japanese, and US currencies.

	To Asia	To Japan	To US
From Asia	-	2%, 27%, 71%	2%, 0%, 98%
From Japan	3%, 48%, 49%	-	0%, 16, 84%
From US	0%, 0%, 100%	0%, 17%, 83%	-

Table 4: Output shares,
by type of goods produced
and by country of destination

Data

ASIA		to ASIA	to JPN	to USA	total
	H	0.5%	2.7%	7.0%	10.2%
	L	16.7%	3.8%	5.4%	25.8%
	N	63.9%			63.9%
	sum	81.1%	6.5%	12.4%	100.0%
JPN		to ASIA	to JPN	to USA	total
	H	1.5%	4.8%	2.2%	8.4%
	L	0.9%	13.4%	0.7%	14.9%
	N		76.6%		76.6%
	sum	2.4%	94.8%	2.9%	100.0%
USA		to ASIA	to JPN	to USA	total
	H	0.8%	0.4%	4.1%	5.3%
	L	0.5%	0.5%	11.8%	12.9%
	N			81.8%	81.8%
	sum	1.3%	0.9%	97.7%	100.0%

Model Steady State

ASIA		to ASIA	to JPN	to USA	total
	H	0.4%	3.1%	6.2%	9.6%
	L	16.4%	5.4%	4.0%	25.8%
	N	64.6%			64.6%
	sum	81.4%	8.5%	10.2%	100.0%
JPN		to ASIA	to JPN	to USA	total
	H	1.4%	4.6%	1.6%	7.6%
	L	0.7%	13.5%	0.3%	14.5%
	N		77.8%		77.8%
	sum	2.1%	96.0%	2.0%	100.0%
USA		to ASIA	to JPN	to USA	total
	H	0.6%	0.4%	3.9%	4.9%
	L	0.5%	0.8%	11.9%	13.2%
	N			81.8%	81.8%
	sum	1.2%	1.1%	97.7%	100.0%

Table 5: Expenditure shares, by type of goods purchased and by country of origin

Data

ASIA		from Asia	from JPN	from USA	total
	H	0.5%	6.7%	4.9%	12.1%
	L	16.7%	3.9%	3.1%	23.7%
	N	63.9%			63.9%
	sum	81.1%	10.6%	8.0%	99.7%
JPN		from Asia	from JPN	from USA	total
	H	0.7%	4.8%	0.6%	6.0%
	L	1.0%	13.4%	0.8%	15.1%
	N		76.6%		76.6%
	sum	1.7%	94.8%	1.3%	97.8%
USA		from Asia	from JPN	from USA	total
	H	0.9%	1.1%	4.1%	6.1%
	L	0.7%	0.4%	11.8%	12.9%
	N			81.8%	81.8%
	sum	1.6%	1.5%	97.7%	100.8%

Model Steady State

ASIA		from Asia	from JPN	from USA	total
	H	0.4%	6.0%	5.2%	11.5%
	L	16.4%	3.1%	4.4%	24.0%
	N	64.6%			64.6%
	sum	81.4%	9.1%	9.6%	100.0%
JPN		from Asia	from JPN	from USA	total
	H	0.7%	4.6%	0.7%	6.0%
	L	1.2%	13.5%	1.4%	16.2%
	N		77.8%		77.8%
	sum	1.9%	96.0%	2.1%	100.0%
USA		from Asia	from JPN	from USA	total
	H	0.8%	0.9%	3.9%	5.6%
	L	0.5%	0.2%	11.9%	12.6%
	N			81.8%	81.8%
	sum	1.2%	1.1%	97.7%	100.0%

4-3 Steady State of the Model

I first derive values of various shares and ratios in the initial steady state with zero bond holding for the base-line case. By comparing those with actual statistics, we can study how closely the model replicates the actual patterns of production and spending. The lower panel of Table 4 reports the model's prediction for the sectoral composition of goods produced in each country as well as where those goods are sold to. Those values can be compared with the actual numbers presented in the upper panel of the same table. Also, the lower panel of Table 5 displays the predicted sectoral composition of expenditure on various types of goods as well as where the goods come from. Those numbers can be contrasted with the actual ones shown in the upper panel of the same table. In general, the model replicates the actual patterns very well.

5 Main findings

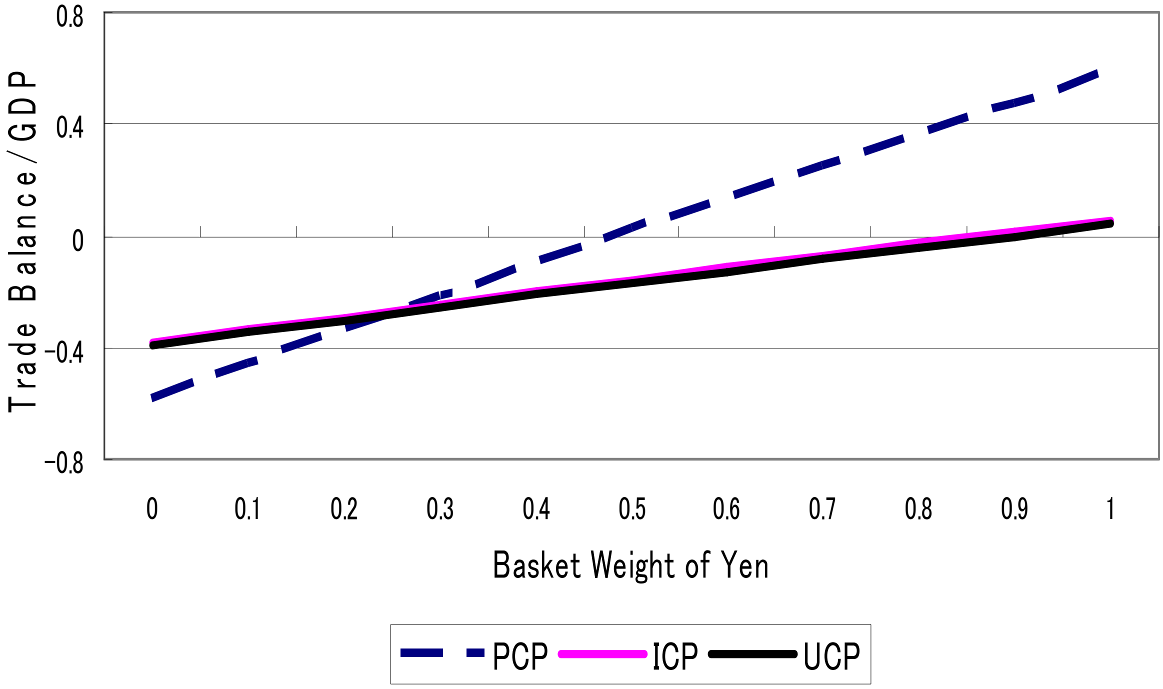
In this section I report the simulation results. I assume that there was a once-and-for-all one percent increase in Japan's money supply. The world economy deviates from the previous long run equilibrium with zero bond holdings, and, after one period, jumps to a new long run equilibrium. I study, under different pricing regimes and different weights of the Japanese yen and the US dollars in invoicing, how the Asian current account responds to the shock in the short run. I do not explicitly report long run consequences, but they can be inferred from the short run results. If Asia experiences a short run current account deficit, in the long run equilibrium, it has to produce a surplus whose amount is equal to the short run deficit times the long run interest rate (which is equal to the subjective discount rate) every period. The opposite is true when Asia enjoys a short run surplus.

Although I report only the case of a Japanese monetary expansion, the case of a US monetary expansion turned out to be an almost exact mirror image.

Figure 1 summarizes the results. The horizontal axis measures the weight of the Japanese yen in Asia's currency basket. The vertical axis measures the short run response of Asia's current account, as a ration to its own GDP, under each value of the yen's weight. Different lines correspond to different pricing regimes. First, the line denoted "PCP" corresponds to the case of producer currency pricing. In this case, Asian current account turns deficit when the basket weight of the yen is very low.

This effect, however, is lessened as Asia increases the yen's weight in its currency basket, and its current account becomes almost independent of this type of shock when the weight is around 50 percent. When the weight exceeds that value, Asia's current account turns surplus. Hence, Asia's current account is almost insulated from fluctuations in the yen-dollar exchange rate when the basket weights between the Japanese yen and the US dollars are fifty-fifty. Next, the case of "local currency pricing (LCP)" is not described in Figure 1, because the effects turned out to be negligible. As the sales prices for any type of tradable goods in any economy become independent of a current period shock under this regime, Japan's monetary policy cannot yield a sizable quantitative effect, irrespective of Asia's currency system. Next, the line denoted "ICP" corresponds to the invoice currency pricing regime, and "UCP" corresponds to the US currency pricing regime. Note that they are practically indistinguishable, reflecting the fact that the US dollar is the main currency for invoicing in international transactions in any direction. Hence, I will discuss the two cases together in the following. In those cases, when the basket weight of the Japanese yen is very small, Asia's current account turns deficit, just as in the producer currency pricing case. However, the effect is quantitatively weaker. As the basket weight of the yen is increased, the effect on Asia's current account is weakened, but only gradually. It is only when the basket weight of the yen is increased to about 80 percent that Asia's current account is stabilized. Hence, we conclude that, under the invoice (or the US) currency pricing regime, Asia has to adapt a basket weight for Japan that far exceeds its trade share. And this result shows that the pricing regime matters for the choice of the optimal basket weights, and can potentially be an important factor for the consideration of the exchange rate systems.

Figure 1: Response of East Asia's Trade Balance to a Japanese monetary expansion



6 Conclusions

This paper has utilized a new macroeconomic model to analyze the impact of different pricing regimes on the effects of the yen-dollar exchange rate fluctuations on Asian current account, with a special emphasis on the case of invoice currency pricing. The model is rich enough to incorporate various features of industrial (as well as trade) structure in Asia, Japan, and the US. It has been shown that, if invoice currency pricing holds, Asia has to assign a much larger weight to the Japanese yen in its currency basket, compared to the case of producer currency pricing which is assumed in the basic new open macroeconomics model of Obstfeld and Rogoff (1995).

In a future version of the paper, I will explore the possibility of incorporating intermediate goods and FDI into this analytical framework.

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