Preliminary

Building a New Framework for Analyzing Effects of Japanese Shocks on Asia

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Abstract: This paper is a first step toward building a new macroeconomic model that is usable for analyzing the effects of shocks that originate in Japan on Asian economies. The new framework borrows its central ingredients from the literature of the "new open economy macroeconomics", that is characterized by explicit dynamic optimization, short-run nominal rigidity, and imperfect substitution between products. The last feature of this approach enables us to analyze how the trade structure between countries influences international transmission of shocks. This paper builds a three-country model, where the three countries are Asia, Japan, and US, which reflects trade and production patterns between them. Thus, the model is expected to yield more realistic predictions about how policy and productivity shocks in Japan affect Asian economies, both in the short and the long runs.

1 Introduction

This paper is a first step toward building a new macroeconomic model that is usable for analyzing the effects of shocks that originate in Japan on Asian economies. How shocks to the Japanese economy, such as productivity slowdown and monetary expansion, affect Asian economies is of great interest to policy makers both in Japan and in the rest of Asia. Heuristically, it seems plausible that the transmission mechanism has undergone some changes due to shifts in trade structure between Japan and Asia in the past twenty years or so. However, standard macroeconomic models, typically with the representative agent and homogeneous goods, are not suitable for investigating such possibility. Fortunately, recent progress in the literature of "new open macroeconomics" has made it possible to incorporate richer trade structure into the analysis of not only long run but also short run effects of changes in policies and productivity. This paper develops a three country model with three types of products, called "high-tech tradables", "low-tech tradables", and "non-tradables" (each of which consists of many varieties), which reflects realistic trade structure between Asia, Japan, and the US.

The literature of the "new open economy macroeconomics" is characterized by explicit dynamic optimization, short-run nominal rigidity, and imperfect substitution between products. The last feature of this approach enables us to analyze how the trade structure between countries influences international transmission of shocks. This kind of model can be applied to many important international policy issues. For example, some economists have argued that the depreciation of the Japanese yen since 1995[1] was partly responsible for triggering the Asian currency crisis in 1997. According to those views, the yen depreciation made East Asian products much less competitive in the

[1] In April 1995, the yen was at the historically highest level of 1\$=83.67¥. Since then, the yen depreciated rapidly, to 1\$=101.85¥ in December. The yen continued to depreciate, and reached the level of 1\$=125.51¥ in April 1997, just before the beginning of the Asian currency crisis. In August 1998, it hit the lowest value since

global market, and put pressures on Asian countries to devalue their own currencies. The theoretical framework offered in this paper is suitable for analyzing quantitative importance of such effects.

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.

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. The 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.

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mid 1990 at 1\$=144.67¥. (All the numbers are monthly averages.)

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.

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.[2] 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.

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[2] 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.

3 The Model

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

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

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:

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

(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

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

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,

$$\frac{P^{jk}_{NFLj,t}}{P^j_t} = \frac{\theta \cdot \kappa^{jk}}{\theta - 1} C^{jk}_{NFLt} \cdot Y^{jk}_{NFLt} \qquad \text{(for all } t \text{ and } j\text{)} \qquad (3\text{-}10)$$

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:

$$M^j_t - M^j_{t-1} + T^j_t = 0 \qquad \text{(for all } t \text{ and } j\text{)}, \qquad (3\text{-}11)$$

where M^j_t and T^j_t 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^{jk}_{FLt} and T^{jk}_{FLt}, and those for the myopic group as M^{jk}_{NFLt} and T^{jk}_{NFLt}, we can write

$$M^j_t = \sum_k \pi^{jk}_{FL} M^{jk}_{FLt} + \sum_k \pi^{jk}_{NFL} M^{jk}_{NFLt} \qquad (3\text{-}12)$$

and
$$T^j_t = \sum_k \pi^{jk}_{FL} T^{jk}_{FLt} + \sum_k \pi^{jk}_{NFL} T^{jk}_{NFLt} . \qquad (3\text{-}13)$$

3-5 Equilibrium conditions (resource constraint)

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

$$E^j_t (B^j_{t+1} - B^j_t) = SR^j_t + i_t E^j_t B^j_t - P^j_t C^j_t \qquad \text{(for all } t \text{ and } j\text{)}, \qquad (3\text{-}14)$$

where B^j_t, SR^j_t, and C^j_t are aggregate bond holding, sales revenue, and consumption, respectively. That is,

$$B^j_t = \sum_k \pi^{jk}_{FL} B^{jk}_{FLt} , \qquad (3\text{-}15)$$

$$SR^j_t = \sum_k \pi^{jk}_{FL} SR^{jk}_{FLt} + \sum_k \pi^{jk}_{NFL} SR^{jk}_{NFLt} \qquad (3\text{-}16)$$

(where SR^{jk}_{FLt} and SR^{jk}_{NFLt} 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. Those are summarized in the mathematical appendix 1 (to be added later).

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: nominal prices quoted by the producers are stuck at the previous levels in their own country. Prices in foreign markets might still change in response to fluctuations in the foreign exchange rates. Here, it is assumed that the nominal exchange rate pass-through is not necessarily complete: foreign prices may not fully reflect changes in the exchange rate between the seller's and the buyer's country. On the other hand, those prices may also be influenced by fluctuations in the exchange rate between the buyer's country and the third country: for example, when prices of exports from Japan to Asia are quoted in US dollars, it is conceivable that their prices measured in the units of the Asian currency might change when the US-Asia exchange rate changes.

In any case, as a consequence of the short run price rigidity, the world economy deviates from the long run equilibrium. It is assumed that, in the short run, output is 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[3].

Sectoral allocation of workers

In the "base-line case", total population of a country is allocated to each sector so as to mimic actual sectoral allocation of labor in each country *in recent years*. In the past decades, East Asia has become one of the most prominent areas for IT production. In Table 1, this is reflected in the *size* of "high tech tradables" employment in Asia, which

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3 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.

is comparable to that of Japan and the US (though smaller in terms of population *shares*). In the other case, called the "historical case", I consider Asia *before the historical structural change*. Back then, East Asia was predominantly agrarian and very little high-tech industries were present. To study how this transformation of Asia has changed international policy transmission channel, I set the share of households allocated to the high-tech sector to just 0.01% in this case. The difference in the shares between the two cases is allocated to the low-tech sector (think of agriculture).

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[4]. 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 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.

Utility Weights

The values of the expenditure share parameters, ω's, are chosen to equal actual spending shares of Asia, Japan, and US, summarized in the upper panel of Table 5[5][6]. Note that countries tend to spend disproportionately large shares of their expenditure allocated to tradable goods on domestically produced tradables (home bias). This paper's flexible specification of preference makes it possible to incorporate such features into the model. An important exception to this general tendency of home bias

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4 Labor productivity is estimated from combining information in *World Development Indicators 2002 CD-ROM* with that in Key Indicators and INDSTAT.

5 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.

6 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%.

is Asia's expenditure on "high-tech tradables". It purchases only a small fraction of high tech goods produced domestically, and buys far more high tech goods from abroad. This aspect of the data is replicated in the model by setting the utility weight of Asian consumers on domestically produced high tech goods very low.

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

Choice of this important parameter will be discussed in detail in the next section.

Exchange rate regimes

It is assumed that all three countries are under flexible exchange rate regimes. In future revision, I plan to study the case in which Asia fixes its exchange rate against the US.

Rate of nominal exchange rate pass-through

It is difficult to determine the extent of exchange rate pass through empirically. In this exercise, I assume that those rates are determined by the shares of currencies used in trade between each pair of two economies. Those shares, estimated from data provided in the web site of the Ministry of Finance of Japan, are presented in Table 3. 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 are assumed to 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. Those pass through rates are assumed to be equal between "high-tech tradables" and "low-tech tradables".

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 (%) <Base-line case> <Historical case>	 2.6, 49.8, 47.2 0.01, 52.39, 47.2	 6.6, 18.6, 74.8 Same as above	 4.2, 12.4, 83.4 Same as above
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:	See section 5.

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

Value shares of currencies used for transaction

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. First, in Table 6, I compare actual productivity (relative to Asia and relative to non-tradables sector) with the productivity predicted by the model. It can be seen that the model follows the actual patterns fairly closely.

Table 6: Relative productivity, actual and steady state

ACTUAL	Asia	Japan	US
GDP per capita (Asia=1)	1	12.8	12.2
H relative to N	2.90	1.24	1.29
L relative to N	0.38	0.78	1.06

MODEL	Asia	Japan	US
GDP per capita (Asia=1)	1	13.6	11.5
H relative to N	2.70	1.11	1.20
L relative to N	0.38	0.75	1.09

Next, 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.

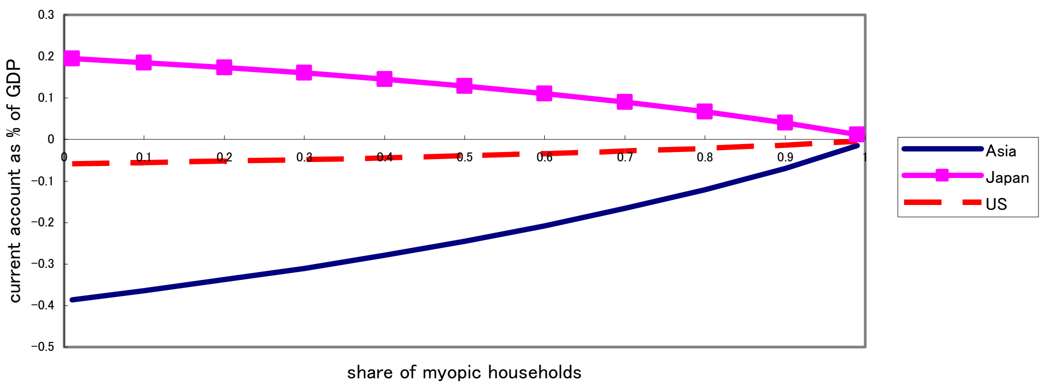
5 Main findings

5-1 Effects of Japanese Monetary Expansion in the base-line case

Before moving onto detailed analysis of the numerical results, I will investigate how the results are sensitive to different assumptions about the share of myopic households. Suppose that, in the base-line case, there was a once-and-for-all monetary expansion in Japan, which increases its money supply by one percent. Figure 1 plots short run responses of current accounts of the three countries, measured as percentages of the original levels of GDP of respective countries, under different assumptions on the population share of myopic households (the share is assumed to be equal across the sectors and across the countries). When the share is only 1%, Japanese current account increases by almost 0.2% (of GDP), while that of Asia declines by about 0.4%, and that of the US decreases by 0.06%. These reactions seem too large, considering that they are responses to just 1% increase in money. As the share of myopic households increases, these reactions become weaker. When the share reaches 99%, the response of Japanese current account is only 0.01%.

As we lack objective criteria to choose an appropriate value for this share, in what follows, I will simply set this value equal to an intermediate value of 0.5 for all the sectors and the countries.

Figure 1: Effects of Japan's Monetary Expansion on Current Accounts



5-2 Effects of Japanese Monetary Expansion in the base-line case (Continued)

Table 7 summarizes effects of a one percent increase in money supply in Japan on important variables in three countries, under the base-line case in which Asia is assumed to be reasonably high-tech. All the numbers are percentage changes (with the exception of the current account, which is denoted as a percentage of the original level of GDP).

Table 7 Effects of a one percent increase in money supply in Japan, Base-line case (Asia is high tech).

A. Short Run

	Asia	Japan	US
Exchange rate	-0.03	0.93	---
GDP in const. US $	-0.48	1.23	-0.08
Exports in const. US $			
Total	-1.51	1.21	-2.36
High-tech Goods	-0.28	0.62	-0.67
Low-tech Goods	-2.72	2.94	-3.66
Current Account	-0.25	0.13	-0.04

B. Long Run

	Asia	Japan	US
Exchange rate	0.03	0.93	---
GDP in const. US $	0.01	-0.01	0.00
Exports in const. US $			
Total	0.07	-0.15	0.13
High-tech Goods	0.02	-0.10	0.04
Low-tech Goods	0.13	-0.31	0.20
Current Account	0.03	-0.01	0.00

There is a strong yen depreciation right after the monetary expansion. This creates a big boom in exports, and output expands in Japan. Note that low-tech exports respond more strongly: this is because the within-type elasticity of substitution is assumed to be much higher for low-tech goods than for high-tech goods. Likewise, loss of exports in Asia comes more from the low-tech sector than the high-tech sector.

In the long run, as Japan can enjoy interest payments on its foreign bonds that it accumulates during the short run, households work for less hours and thus output and exports contract.

5-3 Effects of Japanese Monetary Expansion in the Historical Case

Table 8 summarizes effects of the same shock under the historical case in which Asia is assumed to be predominantly agrarian.

Table 8 Effects of a one percent increase in money supply in Japan, Historical case (Asia is low tech).

A. Short Run

	Asia	Japan	US
Exchange rate	0.05	0.93	---
GDP in const. US $	-0.60	1.23	-0.07
Exports in const. US $			
Total	-2.54	1.01	-2.65
High-tech Goods	-0.30	0.55	-0.79
Low-tech Goods	-2.59	2.63	-4.14
Current Account	-0.31	0.13	-0.04

B. Long Run

	Asia	Japan	US
Exchange rate	0.04	0.93	---
GDP in const. US $	0.02	-0.01	0.00
Exports in const. US $			
Total	0.12	-0.15	0.14
High-tech Goods	0.02	-0.10	0.04
Low-tech Goods	0.13	-0.33	0.22
Current Account	0.03	-0.01	0.00

Note that, compared to the base-line case, Asian exports decline more strongly in response to a yen depreciation in the short run. This is because, in this case, Asia is more specialized in exporting low-tech goods, whose markets are more competitive (the within-type elasticity of substitution is higher). As a consequence, current account of Asia deteriorates more strongly and output declines more. Thus, comparing the two cases, it can be seen that the advance of high-tech, more differentiated sectors in Asia has contributed to partial insulation of shocks from Japan.

5-4 Effects of a Productivity Increase in Japan

Next, consider what happens when the overall productivity in Japan increases by 1% (that is, its κ declines by 0.5%). Table 9 reports the results for the base-line case, and Table 10 reports those for the historical case.

As is typically the case with this class of models, a permanent productivity increase causes a short run *reduction* in output in the country that experiences the productivity surge. As output is demand determined in the short run, better productivity does not stimulate production immediately. At the same time, Japanese households (forward looking ones) perceive that their permanent income has become higher, so they increase consumption and reduce work effort. This results in a temporary current account deficit in Japan, which is accompanied by an appreciation of the yen. This causes exports and output of the other two countries to rise in the short run.

Comparing the two tables, it can be seen that the short run expansion of Asian output and exports, as well as its improvement in current account, are all stronger under the historical case. Thus, again, we find that the recent rise of the high-tech sector in Asia has played the role of a partial shelter from shocks that originate in Japan.

Table 9 Effects of a one percent productivity increase in Japan

Base-line case (Asia is high tech).

A. Short Run

	Asia	Japan	US
Exchange rate	-0.008	-0.204	---
GDP in const. US $	0.127	-0.063	0.021
Exports in const. US $	0.432	-0.261	0.634
Current Account	0.065	-0.034	0.011

B. Long Run

	Asia	Japan	US
Exchange rate	-0.007	-0.205	---
GDP in const. US $	-0.004	0.252	-0.001
Exports in const. US $	-0.005	0.184	0.002
Current Account	-0.007	0.004	-0.001

Table 10 Effects of a one percent productivity increase in Japan

Historical case (Asia is low tech).

A. Short Run

	Asia	Japan	US
Exchange rate	-0.011	-0.206	---
GDP in const. US $	0.157	-0.061	0.019
Exports in const. US $	0.684	-0.219	0.719
Current Account	0.080	-0.033	0.010

B. Long Run

	Asia	Japan	US
Exchange rate	-0.010	-0.206	---
GDP in const. US $	-0.004	0.252	-0.001
Exports in const. US $	-0.001	0.181	0.018
Current Account	-0.009	0.004	-0.001

6 Conclusions

This paper has developed a new macroeconomic model for analyzing policy effects of Japan on Asian economies. The model is rich enough to incorporate various features of industrial (as well as trade) structure in Asia, Japan, and the US. In particular, it has been shown that the emerging high-tech sector in East Asia has altered the transmission mechanism of Japanese policy on Asia substantially.

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

References

Corsetti, Giancarlo, Paolo Pesenti, Nouriel Roubini and Cédric Tille (2000). "Competitive devaluations: toward a welfare-based approach." Journal of International Economics 51(1), pp. 217-241.

Obstfeld, Maurice and Kenneth Rogoff (1995). "Exchange rate dynamics redux." *Journal of Political Economy* 103, pp. 624-660.

Obstfeld, Maurice and Kenneth Rogoff (1996). *Foundations of international macroeconomics*. Cambridge, MA: MIT Press.

Shioji, Etsuro (2001). "Welfare implications of the 1995-1998 yen depreciation on Asia." EMEAP Study on Exchange Rate Regimes (http://www.emeap.org:8084/exchange/chap3.htm).

Shioji, Etsuro (2002). "Consumption Smoothing, Home Bias in Preferences, and Welfare Effects of a Yen Depreciation on Asia." Mimeo.