APEA- Asia-Pacific Economic Association
"Taiwan 2015"
National Taiwan University, Taiwan
July 8-10, 2015

Preliminary Draft
Not to be quoted

A New Approach to the Estimation of Equilibrium Exchange Rates among East-Asian Economies

Juan Carlos Martinez Oliva
Bank of Italy

Summary

Following the debate on exchange rate stabilization within the ASEAN+3, this paper presents a new approach to the determination of real equilibrium exchange rates in the region based on a general equilibrium approach. Based on the real bilateral export and import flows across the region, this methodological approach computes simultaneously all real exchange rates of single member countries. Numerical simulations are conducted for illustration, based on trade and price data and on several alternative assumptions on bilateral price elasticities. While the methodology can further benefit from empirical estimation of bilateral elasticities, it may already provide helpful elements for an assessment of the relevance of intra-regional trade imbalances, and of the associated deviations of real exchange rates from their equilibrium values.

1. Introduction

The severe economic trouble caused by the East Asian currency crisis of 1997-98 fueled widespread interest towards regional monetary cooperation and integration across East-Asia. In those circumstances the countries of the region felt shockingly helpless in front of international speculation, panic crises, and bank runs, while in the event international support and assistance proved to be quite inadequate. Not surprisingly, in the aftermath of the crisis Asian countries' response was almost unanimously pointed in the direction of creating some system of collective defense and mutual assistance. As a result, the ASEAN+3 established in 2000 the Chiang Mai Initiative (CMI), a network of bilateral and multilateral swap arrangements meant to cope with a currency crisis in member countries.[1] In 2003 the ASEAN+3 launched the Asian Bond Markets Initiative (ABMI), meant to reduce currency mismatches and fostering market stability and resilience. In 2009, a reinforcement of the system of bilateral currency swaps into reserve pooling turned CMI into Chiang Mai Initiative Multilateralization (CMIM). The strengthening of monetary cooperation among ASEAN+3 member countries emphasized the role of surveillance as a warning tool meant to prevent future currency crises.

In a debate on how to enhance monetary cooperation at the regional level a pivotal role is played by the choice of the exchange rate regime. The issue is made more relevant, among other factors, by the growing trend of trade integration in the region, which creates a further incentive for national authorities to stabilize the exchange rates across the area.

Indeed, since the early 1990's East Asia's intraregional trade and investment has grown considerably. In 2013, the total intra-ASEAN trade amounted to 609 billion US dollars, or around one quarter of total ASEAN trade (table 1). Quite significantly, China, Korea, and Japan, more than double the intra-area (ASEAN+3) trade, to 1335 billion dollars (table 2). According to official data, intra-ASEAN trade increased at a faster pace, with annual growth rate averaging 10.5%,

---

[1] ASEAN+3 is the forum which coordinates cooperation between the Association of Southeast Asian Nations (ASEAN) and the three East Asian nations of China, Japan, and South Korea. ASEAN is a political and economic organization of ten countries located in Southeast Asia. It was established on 8 August 1967 by Indonesia, Malaysia, the Philippines, Singapore and Thailand. Since then, membership has expanded to include Brunei, Burma (Myanmar), Cambodia, Laos, and Vietnam.

as compared to either overall ASEAN trade (by 9.2%) or extra-ASEAN trade (by 8.9%) during the period 1993-2013[2].

Among possible choices, the establishment of a single currency regime, along the lines of the European Monetary Union, can be viewed, for many reasons, as the hardest to materialize over the medium-term[3]. However, a set of alternative ways to stabilize regional exchange rates is available, not involving the political and technical complexities of irrevocably embracing a single currency regime. For example, countries can adopt the choice to stabilize their currencies vis-à-vis a reference currency such as the US dollar, the Japanese yen, the Chinese yuan, or a common basket of key currencies; or they can establish a full regional exchange-rate system likewise in the experience of the Exchange Rate Mechanism (ERM) in Europe[4].

Following technical proposals by the Asian Development Bank (ADB) and by academic experts to foster exchange rate stability in East-Asian region, the ASEAN+3 countries agreed in 2006 to explore the possibility to move in the direction of an Asian currency unit (ACU).[5]

Borrowing from the experience of the European Monetary System (EMS) established in 1979, Ogawa and Shimizu (2005) have propose both an Asian Monetary Unit (AMU), a mechanism based on a basket of ASEAN+3 currencies, and AMU deviation indicators (AMU Dis) meant to provide a measure of each currency's benchmark rate departure from AMU. The AMU and the AMU Dis calculations turn particularly helpful in providing both a surveillance indicator under the Chiang Mai initiative, and a reference for coordinating exchange rate policies among member countries.

The analogy between Asia and Europe is particularly appropriate in this respect. Following the breakdown of the Bretton Woods system in 1971, a group of European countries agreed to limit their currencies' fluctuations within a band of +/- 2.25 per cent (the European "currency snake" of 1972). In March 1979, the "snake" was replaced by the European Monetary System (EMS), and the European Currency Unit (ECU) was established, where member countries agreed to keep their foreign exchange rates within agreed bands with a narrow band of +/− 2.25 per cent and a wider band of

[2] See www.asean.org. The share of intra-ASEAN trade in overall ASEAN trade has been on an increasing trend starting from 19.2% in 1993 to 22% in 2000 and 24.2% in 2013, and accounted for 25% of the region's total GDP in 2013.
[3] For a survey of potential obstacles to the achievement of a fully-fledged monetary union in East Asia see Kawai(2009).
[4] A thorough survey of the debate is found in Park and Wyplosz (2010), chapter 2.
[5] See Mori et alii (2002), Ogawa (2006), Ogawa and Shimizu (2005, 2006, and 2011).

+/− 6 per cent. An interesting innovation in the Exchange Rate Mechanism (ERM) underlying the EMS was the use of a divergence indicator, a feature designed to introduce symmetry in the system's functioning. In fact, the responsibility of adjustment, to be pursued by intra-marginal interventions, would fall on the currencies deviating from the other partners, no matter whether they were the stronger or the weaker ones[6].

In Ogawa and Shimizu's methodology, the AMU Deviation Indicators measure the departure of each member currency in terms of the AMU. A benchmark period is chosen, namely 2000-2001 - which correspond to the lowest trade imbalances among member countries, between member countries and Japan, and between member countries and the rest of the world - where the exchange rate of the AMU vis-à-vis the US dollar and the euro is set to unity. The members' exchange rate levels in the benchmark period are defined as the benchmark rates.[7]

Past and present experiences in exchange rate stabilization within a multi-country region, confirm that when establishing a computational strategy aimed at a defining a policy rule for participating currencies, the determination of an appropriate common reference value is a crucial step for the mechanism to be successful. In particular, for the reference values of member currencies to be credible, they must be set as close as possible to their equilibrium level.[8]

In this vein, the calculation of equilibrium exchange rates is an indispensable prerequisite when building a common basket of currencies if speculative attacks triggered by the perception that exchange rate levels are unsustainable are to be prevented.

It is in the light of the above that the present paper sets out to offer a new methodology for calculating equilibrium exchange rates within an integrated economic space such as East- Asia.

---

[6] To be more precise, the ERM was based on a 'parity grid' system, i.e. a system of par values among ERM currencies. The par values in the parity grid were calculated for each of the EMS currencies in terms of the ECU, and named ECU central rates. The entire parity grid could be derived from the ECU central rates set by the European Commission.

[7] See Ogawa and Shimizu (2006). AMU and AMU Deviation Indicators are regularly updated in the website of the Research Institute of Economy, Trade, and Industry (RIETI). (http://www.rieti.go.jp/users/amu/en/detail.html).

[8] The intellectual elaboration of this economic concept descends from the debate surrounding the new international monetary order created at Bretton Woods 70 years ago The concept of equilibrium exchange rate was then defined by Ragnar Nurkse as follows: "The only satisfactory way of defining the equilibrium rate of exchange is to define it as that rate which, over a certain period of time, keeps the balance of payments in equilibrium.". Nurkse (1945).

This research effort moves from the idea that for trade balances to be in equilibrium within a supposedly closed trade area, the levels of each member's equilibrium exchange rates are to be determined simultaneously because every single bilateral trade flow interacts with all the others. An example can help clarifying such proposition. Suppose that, moving from equilibrium Philippine's imports from Vietnam record a sudden boost, thus bringing the trade balances of both countries in deficit and in surplus, respectively. This will require setting equilibrium exchange rates for both countries' currencies to new levels, compatible with a new equilibrium. As a result, bilateral trade of each of the two countries with the rest of the region's partners will be affected, requiring a general adjustment of all equilibrium levels until the new general equilibrium levels is re-established.

Moving along such line of reasoning this paper analyzes bilateral import and export flows within the ASEAN+3 area. Corresponding to 13 x 12 = 156 bidirectional flows. The simultaneous adjustment of all the trade balances in the intra-regional overall trade pattern provides a full set of real equilibrium exchange rates.

This methodological approach is then used to illustrate, through tentative calculations, the size of deviations of each ASEAN+3 currency, in real terms, from those values which may be deemed compatible with trade equilibrium within the area.

2. Determining FEERs in the ASEAN+3 region

This section addresses the problem of determining the equilibrium real exchange rates of ASEAN+3 countries.

For the sake of generalization it is assumed an n-country model of integrated economies. Trade among the n economies creates a network of $n(n-1)$ bilateral real trade flows (exports and imports)[9]. Such a situation can be conveniently represented with the help of a square matrix M, where the rows represent bilateral imports m_{ij} of country *i* from country *j*, and the diagonal elements m_{ii} are set equal to zero by definition. Conversely the columns of M represent bilateral exports, with $x_{ij} = m_{ji}$ by definition.[10]

$$M = \begin{bmatrix} 0 & m_{12} & m_{13} & \dots & m_{1n} \\ m_{21} & 0 & m_{23} & \dots & m_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ m_{n1} & m_{n2} & m_{n3} & \dots & 0 \end{bmatrix} \quad [1]$$

From $x_{ij} = m_{ji}$ it follows that:

$$X = M^T \quad [2]$$

i.e. that the matrix of bilateral exports X is the transpose of the matrix of the bilateral imports M.

Since trade balance TB is:

$$TB = X - M \quad [3]$$

From [2] it is also:

$$TB = M^T - M \quad [4]$$

We now assume that the bilateral imports of country *i* from country *j* are a log-linear

[9] On the use of real trade balance as a more reliable policy indicator see Moore (1983).

[10] For the position $x_{ij} = m_{ji}$ to be true exports and imports must be defined according to the same accounting standard, namely the f.o.b. convention.

function of the GDP of country *i* and the ratio between domestic (*i*) and foreign (*j*) prices, expressed in the same currency, as in conventional literature (see Houthakker and Magee (1969), Kahn and Ross (1975), Goldstein, Kahn, and Officer (1980)):

$$\ln m_{ij} = \alpha_{ij} + \beta_{ij} \ln y_i + \gamma_{ij} \ln p_i / p_j \qquad [5]$$

where α is an intercept term, β is the (positive) income elasticity of imports, γ is the (negative) price elasticity of imports.

It is worth noting that if we define the domestic price of country *i* and country *j* in terms of a third currency, say the US dollar, and we define as $e_i^{\$}$ the price of one US dollar in terms of country *i*'s national currency, and as $e_j^{\$}$ the price of one US dollar in terms of country *j*'s national currency, the third term on the right-hand of [5] can be written as:

$$\frac{p_i}{p_j} = \frac{p_i^d}{e_i^{\$}} / \frac{p_j^d}{e_j^{\$}} \qquad [6]$$

where p_i^d and p_j^d are domestic prices of countries *i* and *j* in terms of national currency.

which can be written also as:

$$\frac{p_i}{p_j} = \frac{p_i^d}{e_i^j p_j^d} \qquad [7]$$

where $e_i^j = \frac{e_j^{\$}}{e_i^{\$}}$ is the cross rate obtained by the US dollar exchange rate of the currencies of country *i* and country *j*; it corresponds to the price of one unit of country *j*'s currency in terms of country *i*'s currency.

It can be checked that expression [7] corresponds to the real exchange rate of country *i* vis-à-vis country *j*. An increase in country *i*'s (or a reduction in country *j*'s) domestic price, or a revaluation of its exchange rate in terms of country *j*'s currency will bring about an increase in its real exchange rate, and therefore a loss of competiveness of the nationally produced goods.

In matrix form the bilateral imports function can be written as:

$$M = A + B \circ (Y \times w) + \Gamma \circ (P \times w - (P \times w)^T \qquad [8]$$

Where M is the $n \times n$ matrix of the logarithms of bilateral imports, M is the matrix of bilateral intercept coefficients, B is the $n \times n$ matrix of bilateral income elasticities, and Γ is the $n \times n$ matrix of bilateral price elasticities. Y and P are $n \times 1$ matrices of logarithms of income and prices in the *n* countries. w is a $1 \times n$ matrix where all elements are equal to unity. The symbol $\circ$ is the Hadamard product (Shur product or entrywise product) operator.

This is a convenient linear-algebra representation of the whole system of the $n(n-1)$ bilateral import equations of the n-country trade system so far described. For example, the term $(P \times w - (P \times w)^T$ is equivalent to:

$$\begin{bmatrix} 0 & \ln\frac{p_1}{p_2} & \ln\frac{p_1}{p_3} & \dots & \ln\frac{p_1}{p_n} \\ \ln\frac{p_2}{p_1} & 0 & \ln\frac{p_2}{p_3} & \dots & \ln\frac{p_1}{p_n} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ \ln\frac{p_n}{p_1} & \ln\frac{p_n}{p_2} & \ln\frac{p_n}{p_3} & \dots & 0 \end{bmatrix} \quad [9]$$

The above matrix is skew-symmetric (or anti-symmetric), i.e. a square matrix whose transpose is also its negative; this means that it satisfies the condition:

$$A = -A^T \quad [10]$$

The trade balance is therefore:

$$TB = X - M = M^T - M \quad [11]$$

Using [8] into [11] we can represent the overall set of $n(n-1)$ bilateral trade balances as follows:

$$TB = (A^T - A) + \{[B \circ (Y \times w)]^T - B \circ (Y \times w)\} + \{[\Gamma \circ (P \times w - (P \times w)^T)]^T - \Gamma \circ (P \times w - (P \times w)^T)\} \quad [12]$$

If we set

$$P \times w - (P \times w)^T = K \quad [13]$$

And, from property [9], we set $K = -K^T$ the right-hand term in [12] can be re-written as follows:

$$(\Gamma^T + \Gamma) \circ K^T \qquad [14]$$

We therefore get:

$$TB * w = (A^T - A) * w + \{[B \circ (Y \times w)]^T - B \circ (Y \times w)\} * w - [(\widehat{\Gamma} + \hat{\Gamma}) * w \circ P] \qquad [15]$$

where:

$$\widehat{\Gamma} = \begin{bmatrix} \sum_{j \neq i}^{n} \gamma_{1j} & -\gamma_{12} & -\gamma_{13} & \cdots & -\gamma_{1n} \\ -\gamma_{21} & \sum_{j \neq i}^{n} \gamma_{2j} & -\gamma_{23} & \cdots & -\gamma_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ -\gamma_{n1} & -\gamma_{n2} & -\gamma_{n3} & \cdots & \sum_{j \neq i}^{n} \gamma_{nj} \end{bmatrix} \qquad [16]$$

and:

$$\hat{\Gamma} = \begin{bmatrix} \sum_{j \neq i}^{n} \gamma_{ij} & -\gamma_{21} & -\gamma_{31} & \cdots & -\gamma_{n1} \\ -\gamma_{12} & \sum_{j \neq i}^{n} \gamma_{2j} & -\gamma_{32} & \cdots & -\gamma_{n2} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ -\gamma_{1n} & -\gamma_{2n} & -\gamma_{3n} & \cdots & \sum_{j \neq i}^{n} \gamma_{nj} \end{bmatrix} \qquad [17]$$

The system [15] of n equations can be used to determine the vector of n real exchange rates which are compatible with the simultaneous achievement of bilateral current account equilibrium on each of the n countries under consideration.

System [15] highlights the main feature of the strategy here adopted, which allows the determination of the set of exchange rates which are consistent with simultaneous trade balance equilibrium of all the chosen set of countries.

In order to better display the properties of the method employed we define:

$$TB_i = \ln x_i - \ln m_i \qquad [18]$$

[18] represents country *i*'s trade balance as the ratio, rather than the difference, between its exports and imports. The implication is that a balanced trade account will be equal to one. Differentiating [18] yields:

$$\Delta TB_i = \frac{\Delta x_i}{x_i} - \frac{\Delta m_i}{m_i} \qquad [19]$$

If we transform the equivalence:

$$\Delta x_i = \sum_{j \neq i} \Delta x_{ij} \qquad [20]$$

into:

$$\frac{\Delta x_i}{x_i} = \sum_{j \neq i} \frac{x_{ij}}{x_i} \frac{\Delta x_{ij}}{x_{ij}} \qquad [21]$$

and the equivalence:

$$\Delta m_i = \sum_{j \neq i} \Delta m_{ij} \qquad [22]$$

into:

$$\frac{\Delta m_i}{m_i} = \sum_{j \neq i} \frac{m_{ij}}{m_i} \frac{\Delta m_{ij}}{m_{ij}} \qquad [23]$$

By using [21] and [23] into [18] we get:

$$\Delta TB_i = \sum_{j \neq i} \frac{x_{ij}}{x_i} \frac{\Delta x_{ij}}{x_{ij}} - \sum_{j \neq i} \frac{m_{ij}}{m_i} \frac{\Delta m_{ij}}{m_{ij}} \qquad [24]$$

Hence, using the import equation [4] and since $x_{ij} = m_{ji}$ we get the expression

$$\Delta TB_i = \sum_{j \neq i}^{n} [\frac{x_{ij}}{x_i}(\beta_{ji} \frac{\Delta y_j}{y_j}) - \frac{m_{ij}}{m_i}(\beta_{ij} \frac{\Delta y_i}{y_i})] - \sum_{j \neq i}^{n} (\frac{x_{ij}}{x_i} \widehat{\gamma}_{ij} + \frac{m_{ij}}{m_j} \tilde{\gamma}_{ij}) \frac{\Delta p_i}{p_i} \qquad [25]$$

Expression [25] can be inverted as follows:

$$\frac{\Delta p_i}{p_i} = -\{\Delta TB_i - \sum_{j\neq i}^{n}[\frac{x_{ij}}{x_i}(\beta_{ji}\frac{\Delta y_j}{y_j}) - \frac{m_{ij}}{m_i}(\beta_{ij}\frac{\Delta y_i}{y_i})]\} / \sum_{j\neq i}^{n}(\frac{x_{ij}}{x_i}\widehat{\gamma}_{ij} + \frac{m_{ij}}{m_j}\tilde{\gamma}_{ij}) \qquad [26]$$

It is worth observing the main features of the equilibrium stationary state, where $\frac{\Delta y_i}{y_i} = \frac{\Delta x_i}{x_i} = \frac{\Delta m_i}{m_i} = 0$, (which implies that $\Delta TB_i = 0$).

We start from [24]:

$$\sum_{j\neq i}\frac{x_{ij}}{x_i}\frac{\Delta x_{ij}}{x_{ij}} = \sum_{j\neq i}\frac{m_{ij}}{m_i}\frac{\Delta m_{ij}}{m_{ij}} \qquad [27]$$

If we differentiate [5] and replace it in [27], since $x_{ij} = m_{ji}$ we obtain the following two expressions:

$$\frac{\Delta m_{ij}}{m_{ij}} = \gamma_{ij}(\frac{\Delta p_i}{p_i} - \frac{\Delta p_j}{p_j}) \qquad [28]$$

$$\frac{\Delta x_{ij}}{x_{ij}} = \gamma_{ji}(\frac{\Delta p_j}{p_j} - \frac{\Delta p_i}{p_i}) \qquad [29]$$

Imposing for simplicity the traditional neo-classical assumption on price elasticity $\gamma_{ij} = -1$ we get:

$$\sum_{j\neq i}\frac{x_{ij}}{x_i}(\frac{\Delta p_i}{p_i} - \frac{\Delta p_j}{p_j}) = \sum_{j\neq i}\frac{m_{ij}}{m_i}(\frac{\Delta p_j}{p_j} - \frac{\Delta p_i}{p_i}) \qquad [30]$$

that is (using the property that $\sum_{j\neq i}\frac{x_{ij}}{x_i} = 1$ and $\sum_{j\neq i}\frac{m_{ij}}{m_i} = 1$)

$$(n-1)\frac{\Delta p_i}{p_i} - \sum_{j\neq i}\frac{x_{ij}}{x_i}\frac{\Delta p_j}{p_j} = -(n-1)\frac{\Delta p_i}{p_i} + \sum_{j\neq i}\frac{m_{ij}}{m_i}\frac{\Delta p_j}{p_j} \qquad [31]$$

And finally:

$$\frac{\Delta p_i}{p_i} - \sum_{j \neq i} \frac{1}{2} (\frac{x_{ij}}{x_i} + \frac{m_{ij}}{m_i}) \frac{\Delta p_j}{p_j} / (n-1) = 0 \qquad [32]$$

Expression [32] represents the percentage change of real effective exchange rate, which is equal to 0 in equilibrium. Quite interestingly, [32] expresses the concept that for the real effective exchange rate to be in equilibrium, the domestic price change must match the weighted average of all trade partners' changes. If a system of n equations like [32] is simultaneously resolved the vector of all $\frac{\Delta p_i}{p_i}$ identifies the simultaneous equilibrium where for each country *i* it is $\Delta TB_i = 0$.

Having clarified the meaning of $\frac{\Delta p_i}{p_i}$ to the purposes of this paper's investigation, we will now pursue the calculation of the real exchange rate adjustment which is consistent with balanced (real) trade balances in all ASEAN+3 countries vis-à-vis their partners, that is to remove trade imbalances within ASEAN+3 area.

We start by defining:

$$TB_i = \ln x_i - \ln m_i \qquad [33]$$

By differentiating we obtain:

$$\Delta TB_i = \frac{\Delta x_i}{x_i} - \frac{\Delta m_i}{m_i} \qquad [34]$$

Equation [33] expresses the relationship between trade balance adjustment and the dynamics of exports and/or imports. For any required amount of trade balance adjustment a combination of export and import growth will be required. In the following we will derive the rule that connects trade balance adjustment with a set time pattern of growth of exports and imports.

A country's exports and imports at time t, x_t and m_t, can be defined as follows, in the discreet time:

$$x_t = x_0 (1+r)^t \qquad [35]$$

and:

$$m_t = m_0 (1+s)^t \qquad [36]$$

Where r and s are the average rates of growth between period 0 and period t for exports and for imports, respectively.

If we impose that TB_t is equal to zero at time t (wich is equivalent to $X_t = M_t$), we get the following:

$$x_0(1+r)^t = m_0(1+s)^t \quad [37]$$

Which is equivalent to:

$$\frac{x_0}{m_0} = \frac{(1+s)^t}{(1+r)^t} \quad [38]$$

If we then apply logarithms we get:

$$\ln(\frac{x_0}{m_0}) = \ln(1+s)^t - \ln(1+r)^t \quad [39]$$

Hence, using the property $\ln(1+n) \simeq n$ we obtain the following condition:

$$\frac{1}{t}\ln(\frac{x_0}{m_0}) = s - r \quad [40]$$

Condition [40] is crucial, in that it expresses the differential between the real growth rate of exports and imports consistent with the achievement of real trade balance equilibrium in t periods.
If we replace [40] for TB_i in equation [26] we get, for $t = 1$:

$$\frac{\Delta p_i}{p_i} = -\{s_i - r_i - \sum_{j\neq i}^{n}[\frac{x_{ij}}{x_i}(\beta_{ji}\frac{\Delta y_j}{y_j}) - \frac{m_{ij}}{m_i}(\beta_{ij}\frac{\Delta y_i}{y_i})]\} / \sum_{j\neq i}^{n}(\frac{x_{ij}}{x_i}\widehat{\gamma}_{ij} + \frac{m_{ij}}{m_j}\tilde{\gamma}_{ij}) \quad [41]$$

Expression [41] represents the relationship between US dollar-denominated domestic prices (defined as in [6]) and real trade balance. It can be used to simultaneously determine the percentage change of US dollar-denominated domestic prices of each country *i* which is necessary to achieve from the values consistent with an overall real trade balance equilibrium within the area.

It is worth highlighting that this method provides a simultaneous general equilibrium set of price values. This means that any change in a single trade balance will simultaneously affect all exchange rates of other partner countries.

Given the definition [7], by subtracting any $\frac{\Delta p_j}{p_j}$ from $\frac{\Delta p_i}{p_i}$ we will get the real exchange rate of country *i* vis-à-vis country *j.*

[42]

3. Numerical simulations

The source of trade data is the International Monetary Fund Direction of Trade statistical database. Bilateral export flows data were used to build ASEAN+3 yearly exports matrices made of 13 rows x 13 columns from 2000 to 2013. (at the time when these simulations were carried out the fourth quarter of 2014 was not available yet). Import matrices were derived by transposing export matrices, thereby achieving f.o.b./f.o.b. consistency. Real GDP data, and export and import unit values indexes were derived from World Bank World Development Indicators. There are no data available for deflating bilateral trade flows, so a geometric average was used, between the export unit value index of the exporting country and the import unit value index of the importing partner.

Long-run bilateral income elasticities were assumed to be all equal to 1, and bilateral price elasticity are assumed to be all equal to -1, as implied by the conventional neoclassical economic trade theory. Matrices B and Γ were computed accordingly.

A note of caution is in order. The system of 156 bilateral trade flows is aggregated in 13 equations in order to determine 13 real effective exchange rates. Since the system is a closed one, with the sum of all trade balances equal to zero, once 12 equations are solved, the 13-th is determined by Walras' law, thus making one equation redundant. Consequently the system of 12 equations and 13 unknowns is underdetermined, unless one unknown is set at a preset constant value. However, having defined the trade balance TB in non-linear form as in [18] conveniently removes the redundancy problem, thus allowing to simultaneously computing the whole vector of prices.

Table 3 represents the percentage deviation from equilibrium values of domestic price index denominated in US dollars of all 13 countries of ASEAN+3 in the period 2000-2013 as calculated from [41]. Positive values $\frac{\Delta p_i}{p_i}$ associate to real deficits of trade balance, and represent the size of the deviation of price from equilibrium . Prices which are higher from their equilibrium level (which is a weighted average of all partners' domestic prices, corrected for demand effects) will be reflected in lower exports and higher imports, and therefore in a trade deficit. *Mutatis mutandis*, similar considerations hold for negative values of $\frac{\Delta p_i}{p_i}$.

In Table 3, 4 out of 13 countries (Brunei Darussalam, Japan, Korea, and Singapore) display almost permanent deviations of internal prices, which fall under the equilibrium value; they associate with trade surpluses vis-à-vis the other ASEAN+3 partners (see chart 1).

All the other countries, on the trade deficit side, feature domestic prices higher than equilibrium. Among them Cambodia, Vietnam and Philippines display the largest

deviations.
All in all, the size of overall deviations (positive or negative) appears relatively moderate, ranging from -4.7 to 5.9 throughout the whole period considered. Since the calculations are based on *a priori* values for demand and price elasticies, a set of different assumptions has been computed, in particular, to evaluate the sensitivity of the exercise to alternative values of γ_{ij}. In table 4, γ_{ij} terms have been randomly generated, within an interval of -2.2 – 0, with a mean value of -1 and a variance of 0.5. The results display an overall reduction of the size of deviations, which is reflected in a smaller the range of +4.4 to -3.7.

In table 5 larger γ_{ij} values have been imposed (equal to 1.5), resulting in smaller deviations of $\frac{\Delta p_i}{p_i}$ values. The explanation for this is intuitively simple: with larger price elasticities smaller price changes will produce the same given trade balance disequilibria than larger price changes with smaller price elasticities.

This is confirmed by table 6, where calculations are based on price elasticities γ_{ij} equal to 0.5. Percentage deviations of prices from their equilibrium levels are now far larger than in the basic case, ranging from a maximum value of 11.9 to a minimum value of -9.1.

In previous section 2 it had been suggested that expression [7] represents the real exchange rate between country i and country j. Expression $\frac{\Delta p_i}{p_i} - \frac{\Delta p_j}{p_j}$ therefore represents the percentage deviation of the real exchange rate from its equilibrium value in the simultaneous equilibrium.
Choosing a common value $\frac{\Delta p_j}{p_j}$ for all the countries involved in the exercise is equivalent at setting the currency of country j as the reference currency for the region, or, equivalently as the goal for ASEAN+3 members' exchange-rate stabilization policies. Measuring the deviation of every single currency real exchange rate from the reference currency provides a helpful measure of the trade and currency unbalances in the region.

For the sake of illustration, the currencies of the two major economies of the group, the Chinese yuan and the Japanese yen have been adopted in the exercise, under the already described alternative assumptions on the size of γ_{ij}.
In computational terms, choosing Chinese yuan or Japanese yen as a j reference currency is equivalent to calculate the values of:

$$\frac{\Delta p_i}{p_i} - \frac{\Delta p_{China}}{p_{China}} \qquad [43]$$

or:

$$\frac{\Delta p_i}{p_i} - \frac{\Delta p_{Japan}}{p_{Japan}} \quad [44]$$

For every $i \neq j$ ASEAN+3 currency.

As it can be seen in tables from 7 to 12, the size of deviations of real exchange rates from their equilibrium values is larger if the Japanese yen is adopted as a reference currency rather than the Chinese yuan. The reason is to be attributed to the systematic deviation of Japanese domestic prices expressed in US dollars from its equilibrium values, as computed in accordance to the procedure described in section 2.

The above result is attenuated or reinforced if price elasticities are larger or smaller respectively.

3. Conclusion

Extracting policy content from a numerical exercise which is meant to be as tentative and preliminary, is beyond the purposes of this paper. This paper has presented a new approach to the determination of real equilibrium exchange rate based on a general equilibrium approach where all exchange rates of the member countries of an integrated regional entity are determined simultaneously.

As the methodological illustration of section 2 clearly shows, bilateral trade elasticities may play a central role in the implementation of the method for policy purposes. For example, numerical simulations on the impact of the weaker yen on other Asian economies have suggested that yen depreciation in the period between 2012 and 2013 has exerted asymmetric effects on Asian partner economies (namely China and South Korea) depending on the degree of complementarity among Japanese traded goods and those produced by trade partners[11]. Clearly this peculiarity would translate into different bilateral elasticities between Japan on the one hand, and China or South Korea on the other, with obvious implications for the determination of the equilibrium exchange rates of the countries involved. Further effort should be therefore dedicated to the econometric estimation of bilateral elasticities across the region, in order to better catch the effects of national peculiarities and asymmetries.

Lastly, a special emphasis should be placed on the risks involved by a situation of permanent trade imbalances within an integrated area such as ASEAN+3. The case of the European Union may be telling in this respect[12].

.

[11] RIETI (2013).
[12] Hughes-Hallett and Martinez Oliva (2015).

References

Clark, P.B. and R. MacDonald (1998), “Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs”, IMF Working Paper, WP/98/67, May.

Cline W.R. (2008), “Estimating Consistent Fundamental Equilibrium Exchange Rates”, Peterson Institute for International Economics, Working Paper Series 08-6.

De Grauwe, P (2012), “In Search of Symmetry on the Eurozone”, CEPS Policy Brief n. 268, May.

Goldstein, M., Kahn M. S. and L.H. Officer (1980), “Prices of Tradable and Nontradable Goods in the Demand for Total Imports”, *The Review of Economics and Statistics*, 62, 2, May.

Houthakker, H. S. and S. P. Magee (1969), “Income and Price Elasticities in World Trade”, *The Review of Economics and Statistics*, 51, 2, May.

Hughes-Hallett A. and J.C. Martinez Oliva (2015), “The Importance of Trade and Capital Imbalances in the European Debt Crisis”, *Journal of Policy Modeling*, 2015, vol. 37, issue 2, pages 229-252.

Jeong, S.E. and J. Mazier (2001), “Equilibrium Exchange Rates of Eight East Asian Currencies: A Fundamental Equilibrium Exchange Rate (FEER) Approach” University of Paris-Nord (CEPN).

Kahn, M. S. and K.Z. Ross (1975), “Cyclical and Secular Income Elasticities of the Demand for Imports”, *The Review of Economics and Statistics*, 57, 3, August.

Kawai, M. (2014), “Asian Monetary Integration: A Japanese Perspective”, Asian Development Bank Institute, ADBI Working Paper Series No. 475, April.

Kawai M. (2009), “The Role of an Asian Currency Unit for Asian Monetary Integration”, Asian Development Bank Institute, 9 September (mimeo).

Moore G.H. (1983), “Will the "Real" Trade Balance Please Stand up?”, Journal of International Business Studies, 14, 1, Spring – Summer.

Mori J., M. Kinukawa, H. Nukaya, and M. Hashimoto (2002), “Integration of East Asian Economics and a Step by Step Approach Towards a Currency Basket Regime”, IIMA Research Report 2.

Murray, T. and P.J. Ginman (1976), “An Empirical Examination of the Traditional Aggregate Import Demand Model”, *The Review of Economics and Statistics*, 58, 1, May.

Nurkse R. (1945), “Conditions of International Monetary Equilibrium*”, Princeton Essays in International Finance,* N. 4, Spring.

Ogawa E. (2006), “AMU and AMU Deviation Indicators”, Tokio, Research Institute of Economy, Trade, and Industry (RIETI).

Ogawa E. and J. Shimizu (2011), “Asian Monetary Unit and Monetary Cooperation in Asia”, Asian Development Bank Institute, ADBI Working Paper Series No. 275, April.

Ogawa E. and J. Shimizu (2006), “AMU Deviation Indicator for Coordinated Exchange Rate Policies in East Asia and its Relation with Effective Exchange Rates”, RIETI Discussion Paper 06-E-002. January.

Ogawa E. and J. Shimizu (2005), “A Deviation Measurement for Coordinated Exchange Rate Policies in East Asia”, RIETI Discussion Paper Series 05-E-017. May.

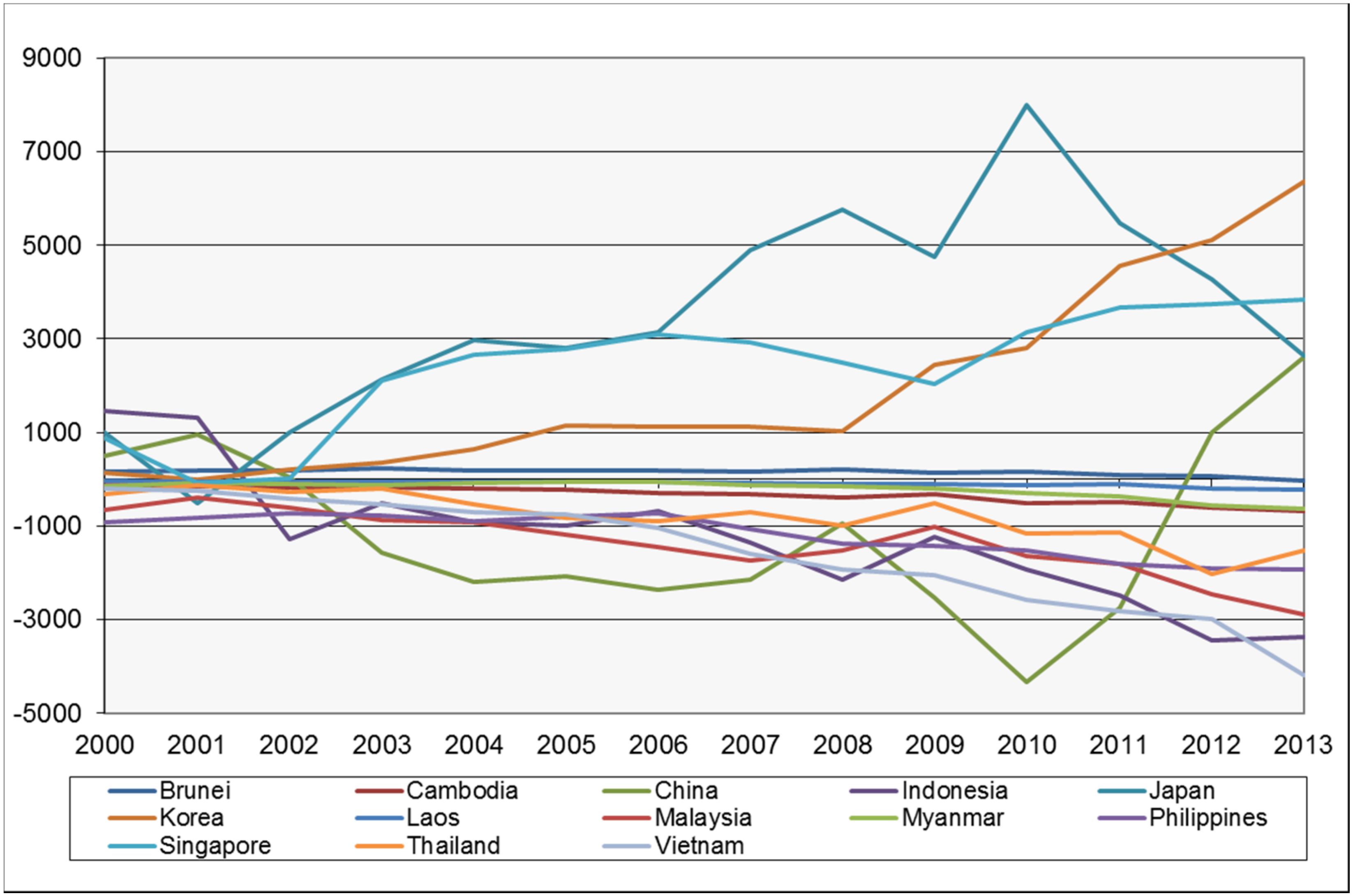
Park, Y.C. and C.Y. Song (2011), “Prospects for Monetary Cooperation in East Asia”, Asian Development Bank Institute, ADBI Working Paper Series No. 314, October.

Park, Y. C. and C. Wyplosz (2010), “Monetary and Financial Integration in East Asia. The Relevance of European Experience”, Oxford University Press, Oxford.

RIETI (2013), “Impact of the Weaker Yen on Asian Economies: With a focus on comparing China and South Korea”, www.rietigo.jap/en/china

CHARTS AND TABLES

Figure 1: Trade Balances in real terms of ASEAN+3 countries



Source, IMF DOT statistics and author's calculations

Table 1: Intra- and extra-ASEAN trade, 2013

Million US dollars and percentages

Country	Intra-ASEAN exports		Extra-ASEAN exports		Total exports	Intra-ASEAN imports		Extra-ASEAN imports		Total imports	Intra-ASEAN trade		Extra-ASEAN trade		Total trade
	Value	Share to total exports	Value	Share to total exports		Value	Share to total imports	Value	Share to total imports		Value	Share to total trade	Value	Share to total trade	
Brunei Darussalam	2.644,33	23,10	8.801,09	76,90	11.445,42	1.843,62	51,04	1.768,15	48,96	3.611,78	4.487,95	29,81	10.569,24	70,19	15.057,19
Cambodia	1.300,86	14,22	7.847,32	85,78	9.148,18	2.818,25	30,71	6.357,72	69,29	9.175,97	4.119,11	22,48	14.205,04	77,52	18.324,15
Indonesia	40.630,76	22,26	141.921,04	77,74	182.551,80	54.030,99	28,95	132.597,68	71,05	186.628,67	94.661,75	25,64	274.518,72	74,36	369.180,47
Lao PDR	1.234,33	47,61	1.358,48	52,39	2.592,81	2.494,96	75,79	797,08	24,21	3.292,05	3.729,29	63,37	2.155,57	36,63	5.884,86
Malaysia	63.981,57	28,02	164.349,73	71,98	228.331,30	55.050,65	26,74	150.846,78	73,26	205.897,42	119.032,22	27,41	315.196,51	72,59	434.228,73
Myanmar	5.624,94	49,18	5.811,38	50,82	11.436,33	4.244,01	35,34	7.765,11	64,66	12.009,12	9.868,95	42,09	13.576,49	57,91	23.445,45
Philippines	8.614,87	15,96	45.363,40	84,04	53.978,27	14.171,35	21,76	50.959,27	78,24	65.130,62	22.786,22	19,13	96.322,67	80,87	119.108,89
Singapore	128.787,01	31,39	281.462,69	68,61	410.249,70	77.885,29	20,88	295.130,47	79,12	373.015,77	206.672,30	26,39	576.593,17	73,61	783.265,47
Thailand	59.320,50	25,93	169.409,72	74,07	228.730,22	44.348,14	17,77	205.168,99	82,23	249.517,12	103.668,64	21,68	374.578,71	78,32	478.247,35
Viet Nam	18.178,91	13,70	114.485,19	86,30	132.664,10	21.352,95	16,16	110.756,92	83,84	132.109,87	39.531,86	14,93	225.242,11	85,07	264.773,97
ASEAN	330.318,07	20,62	1.271.399,52	79,38	1.601.717,59	278.240,23	22,43	962.148,17	77,57	1.240.388,39	608.558,30	24,23	1.902.958,23	75,77	2.511.516,53

Source: www.asean.org - External Trade Statistics

Table 2: Asean Trade by Partner in 2013

Thousands US dollars

Trade partner country	Value of trade			Share to total		
	Exports from ASEAN	Imports by ASEAN	Total trade	Exports from ASEAN	Imports from ASEAN	Total trade
ASEAN	330.318.074,7	278.240.225,7	608.558.300,4	50,2	41,1	45,6
China	152.545.531,7	197.962.837,0	350.508.368,7	23,2	29,3	26,3
Japan	122.863.231,8	117.903.870,5	240.767.102,3	18,7	17,4	18,0
Korea, Republic of	52.822.992,7	82.139.580	134.962.572,8	8,0	12,1	10,1
Total	658.549.830,9	676.246.513,3	1.334.796.344,2	100,0	100,0	100,0

Source: www.asean.org - External Trade Statistics

Table 3 - standard price elasticities (gamma=-1.0)

YEAR	BRD	CAM	CHN	IND	JAP	KOR	LAO	MAL	MYN	PHL	SNG	THL	VTN
	Domestic price index denominated in US dollars (*) (percentage deviations from equilibrium values)												
2000	-3	5.4	-.8	-3.3	-1.3	-.2	3.1	1.1	3.5	2.5	1.4	.7	1
2001	-3.3	5.5	-1.4	-3	.7	0	3.6	.7	1.7	2.3	.1	.3	1.1
2002	-2.7	5.6	0	-2.8	-1.2	.3	3.7	1	1.6	1.8	0	.5	1.8
2003	-3.5	5.6	1.7	.9	-2.2	-.4	3.8	1.2	2.2	1.7	-2.6	.3	2
2004	-3	5.7	2	1.4	-2.6	-.7	4	1.1	1.4	1.7	-2.8	.8	2.1
2005	-3	5.6	1.7	1.4	-2.3	-1.1	3.3	1.4	.8	1.5	-2.7	1.1	2
2006	-3	5.7	1.8	.9	-2.4	-1	2.3	1.5	.7	1.4	-2.7	1.1	2.5
2007	-2.6	5.9	1.5	1.6	-3.4	-.9	2.8	1.7	1.6	1.9	-2.4	.8	3.2
2008	-2.8	6	.6	2.4	-3.8	-.8	3	1.4	1.5	2.4	-2	1	3.4
2009	-2	5	1.8	1.6	-3.5	-2	2.9	1.1	2	2.8	-1.8	.6	3.7
2010	-2.2	5.5	2.5	2	-4.7	-1.9	2.7	1.4	2.6	2.3	-2.3	1.1	3.8
2011	-1	5.1	1.5	2.3	-3.1	-2.8	2.2	1.5	2.6	2.8	-2.5	1	3.7
2012	-.8	5.1	-.5	3	-2.4	-3.1	2.9	1.9	3.4	2.7	-2.5	1.7	3.5
2013	.4	4.9	-1.3	2.9	-1.4	-3.6	2.9	2.1	3.1	2.6	-2.4	1.3	4.2

(*)Positive (negative) values indicate competitiveness loss (gain)

Table 4 - Random price elasticities (mean=-1; variance=0.5; interval=-2.2-0)

YEAR	BRD	CAM	CHN	IND	JAP	KOR	LAO	MAL	MYN	PHL	SNG	THL	VTN
	Domestic price index denominated in US dollars (*) (percentage deviations from equilibrium values)												
2000	-2.5	4.4	-.6	-2.7	-1.1	-.2	2.6	.9	2.9	2.1	1.1	.6	.8
2001	-1.2	1.9	-1	-1.7	.5	0	1.2	.5	.6	1.2	.1	.1	.5
2002	-1.7	3.3	0	-1.9	-.9	.2	2.2	.7	1	1.2	0	.4	1.1
2003	-2.3	3.6	1.3	.6	-1.6	-.3	2.4	.9	1.4	1.2	-1.9	.2	1.3
2004	-2.3	4.4	1.5	1.1	-2	-.5	3.1	.9	1.1	1.3	-2.2	.6	1.6
2005	-2.1	3.9	1.3	1	-1.7	-.8	2.3	1	.6	1.1	-2	.8	1.4
2006	-2.4	4.4	1.4	.7	-1.8	-.7	1.8	1.2	.5	1.1	-2.1	.8	2
2007	-2.3	5	1.1	1.3	-2.6	-.7	2.4	1.3	1.4	1.5	-1.9	.6	2.6
2008	-1.4	2.9	.4	1.5	-2.7	-.5	1.4	.9	.7	1.3	-1.3	.6	1.9
2009	-.5	1.1	1.2	.7	-2.2	-1.2	.6	.5	.5	1	-1	.3	1.3
2010	-2	5	2	1.7	-3.7	-1.5	2.5	1.2	2.4	2	-1.8	.9	3.4
2011	-.5	2.9	1.1	1.5	-2.2	-2	1.2	1	1.5	1.7	-1.7	.7	2.3
2012	-.4	2.9	-.4	1.9	-1.7	-2.1	1.6	1.2	2	1.6	-1.7	1.1	2.2
2013	.2	2.5	-.9	1.8	-1	-2.5	1.5	1.3	1.7	1.5	-1.6	.8	2.5

(*)Positive (negative) values indicate competitiveness loss (gain)

Table 5 - high price elasticities (gamma=-1.5)

Domestic price index denominated in US dollars (*) (percentage deviations from equilibrium values)

YEAR	BRD	CAM	CHN	IND	JAP	KOR	LAO	MAL	MYN	PHL	SNG	THL	VTN
2000	-2	3.6	-.5	-2.2	-.9	-.1	2.1	.8	2.4	1.7	.9	.5	.7
2001	-1	1.6	-.8	-1.4	.4	0	1	.4	.5	1	.1	.1	.4
2002	-1.4	2.8	0	-1.6	-.8	.2	1.9	.6	.8	1.1	0	.3	1
2003	-2	3.1	1.1	.5	-1.4	-.3	2.1	.8	1.2	1	-1.7	.2	1.1
2004	-2	3.8	1.3	.9	-1.8	-.5	2.7	.8	.9	1.2	-1.9	.5	1.4
2005	-1.9	3.4	1.1	.9	-1.5	-.7	2	.9	.5	1	-1.8	.7	1.3
2006	-2.1	3.9	1.2	.6	-1.6	-.7	1.6	1	.5	.9	-1.9	.7	1.7
2007	-2	4.5	1	1.2	-2.4	-.6	2.1	1.2	1.3	1.4	-1.7	.6	2.4
2008	-1.2	2.6	.4	1.3	-2.4	-.5	1.3	.8	.7	1.2	-1.2	.6	1.7
2009	-.4	1	1	.6	-2	-1.1	.6	.5	.4	.9	-.9	.3	1.2
2010	-1.8	4.5	1.7	1.5	-3.4	-1.3	2.2	1	2.1	1.8	-1.6	.8	3
2011	-.5	2.6	1	1.3	-2	-1.8	1.1	.9	1.3	1.5	-1.5	.6	2
2012	-.4	2.6	-.3	1.7	-1.5	-1.9	1.5	1.1	1.8	1.5	-1.5	1	1.9
2013	.2	2.3	-.8	1.6	-.9	-2.2	1.4	1.2	1.5	1.4	-1.5	.7	2.3

(*)Positive (negative) values indicate competitiveness loss (gain)

Table 6 - Low price elasticities (gamma=-0.5)

Domestic price index denominated in US dollars (*) (percentage deviations from equilibrium values)

YEAR	BRD	CAM	CHN	IND	JAP	KOR	LAO	MAL	MYN	PHL	SNG	THL	VTN
2000	-5.7	10.7	-1.5	-6.3	-2.6	-.4	6.2	2.2	6.9	4.9	2.7	1.3	2
2001	-6.3	10.9	-2.8	-5.8	1.4	0	7.2	1.4	3.4	4.5	.3	.5	2.1
2002	-5.2	11.1	-.1	-5.4	-2.4	.6	7.3	1.9	3.2	3.6	-.1	1.1	3.5
2003	-6.6	11.2	3.3	1.7	-4.2	-.8	7.5	2.4	4.3	3.4	-5	.6	3.8
2004	-5.8	11.4	3.8	2.7	-5	-1.3	7.9	2.2	2.7	3.4	-5.4	1.5	4
2005	-5.7	11.1	3.3	2.7	-4.5	-2.1	6.5	2.6	1.6	3	-5.2	2.1	3.9
2006	-5.7	11.3	3.5	1.7	-4.6	-1.9	4.5	3	1.3	2.6	-5.3	2.1	4.9
2007	-5	11.7	2.8	3.2	-6.5	-1.7	5.4	3.2	3.2	3.6	-4.6	1.5	6.2
2008	-5.3	11.9	1.2	4.7	-7.4	-1.5	5.8	2.7	3	4.7	-3.8	2	6.6
2009	-3.9	9.8	3.5	3	-6.7	-3.8	5.8	2	3.8	5.5	-3.4	1.2	7.3
2010	-4.2	10.9	4.8	3.8	-9.1	-3.6	5.2	2.7	5.1	4.5	-4.4	2.2	7.5
2011	-1.8	10.2	2.9	4.4	-6	-5.5	4.3	2.8	5.1	5.4	-4.9	2	7.2
2012	-1.5	10.2	-1	5.9	-4.6	-5.9	5.7	3.7	6.8	5.3	-4.7	3.3	6.8
2013	.7	9.6	-2.5	5.7	-2.8	-7	5.6	4.1	6.1	5.1	-4.7	2.4	8.3

(*)Positive (negative) values indicate competitiveness loss (gain)

Table 7 - standard price elasticities (gamma=-1.0)

Real exchange rate vis-à-vis the Chinese yuan
Percentage deviations from equilibrium values)

YEAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2000	-2.2	6.2	-2.5	-.5	.6	3.9	1.9	4.3	3.3	2.2	1.5	1.8
2001	-.3	3.5	-.9	1.8	1.2	2.8	1.8	2	2.7	1.3	1.4	1.8
2002	-2.1	4.2	-2.4	-1.2	.3	2.8	.9	1.3	1.6	0	.5	1.5
2003	-4.5	3	-.8	-3.7	-2	1.5	-.4	.2	-.1	-4.1	-1.3	.1
2004	-5	3.7	-.6	-4.6	-2.7	2	-.9	-.6	-.3	-4.8	-1.2	.1
2005	-4.4	3.4	-.4	-4	-2.8	1.3	-.4	-1	-.2	-4.3	-.7	.2
2006	-4.9	4.1	-.9	-4.2	-2.8	.6	-.2	-1.1	-.4	-4.6	-.7	.8
2007	-4.5	5.2	.3	-5	-2.4	1.7	.3	.4	.5	-4	-.7	2
2008	-2.4	3.2	1.4	-4.2	-1.3	1.3	.6	.4	1.2	-2.3	.3	1.9
2009	-2.2	-.1	-.7	-4.5	-3.2	-.7	-.9	-1	-.3	-2.9	-1.2	.2
2010	-5.2	4.1	-.4	-7.5	-4.6	.7	-1.1	.6	0	-5	-1.4	1.9
2011	-2.1	2.4	.6	-4.3	-4	.2	-.1	.6	.9	-3.7	-.5	1.6
2012	-.1	4.4	3.1	-1.7	-2.3	2.7	2.2	3.1	2.7	-1.7	2	3.4
2013	1.5	4.7	3.6	-.1	-2.1	3.2	3	3.5	3.3	-1	2.3	4.6

(*)Positive (negative) values indicate competitiveness loss (gain)
(1)BRUNEI $;(2)CAMBODIA RIEL;(3)INDONESIAN RUPIAH;(4)JAPANESE YEN;(5)KOREAN WON;
(6)LAOS KIP;(7) MALAYSIAN RINGGIT;(8)MYANMAR KYAT;(9)PHILIPPINES PESO;(10 SINGAPORE $

Table 8 - standard price elasticities (gamma=-1.0)

Real exchange rate vis-à-vis the Japanese yen
Percentage deviations from equilibrium values)

YEAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2000	-1.7	6.7	.5	-2	1.1	4.4	2.4	4.8	3.8	2.7	2	2.3
2001	-2.1	1.7	-1.8	-2.7	-.6	1	0	.2	.9	-.5	-.4	0
2002	-.9	5.4	1.2	-1.2	1.5	4	2.1	2.5	2.8	1.2	1.7	2.7
2003	-.8	6.7	3.7	2.9	1.7	5.2	3.3	3.9	3.6	-.4	2.4	3.8
2004	-.4	8.3	4.6	4	1.9	6.6	3.7	4	4.3	-.2	3.4	4.7
2005	-.4	7.4	4	3.6	1.2	5.3	3.6	3	3.8	-.3	3.3	4.2
2006	-.7	8.3	4.2	3.3	1.4	4.8	4	3.1	3.8	-.4	3.5	5
2007	.5	10.2	5	5.3	2.6	6.7	5.3	5.4	5.5	1	4.3	7
2008	1.8	7.4	4.2	5.6	2.9	5.5	4.8	4.6	5.4	1.9	4.5	6.1
2009	2.3	4.4	4.5	3.8	1.3	3.8	3.6	3.5	4.2	1.6	3.3	4.7
2010	2.3	11.6	7.5	7.1	2.9	8.2	6.4	8.1	7.5	2.5	6.1	9.4
2011	2.2	6.7	4.3	4.9	.3	4.5	4.2	4.9	5.2	.6	3.8	5.9
2012	1.6	6.1	1.7	4.8	-.6	4.4	3.9	4.8	4.4	0	3.7	5.1
2013	1.6	4.8	.1	3.7	-2	3.3	3.1	3.6	3.4	-.9	2.4	4.7

(*)Positive (negative) values indicate competitiveness loss (gain)
(1)BRUNEI $;(2)CAMBODIA RIEL;(3)CHINESE YUAN;(4)INDONESIAN RUPIAH;(5)KOREAN WON;
(6)LAOS KIP;(7) MALAYSIAN RINGGIT;(8)MYANMAR KYAT;(9)PHILIPPINES PESO;(10 SINGAPORE $

Table 9 - high price elasticities (gamma=-1.5)

YEAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Real exchange rate vis-à-vis the Chinese yuan Percentage deviations from equilibrium values)											
2000	-1.5	4.1	-1.7	-.4	.4	2.6	1.3	2.9	2.2	1.4	1	1.2
2001	-.2	2.4	-.6	1.2	.8	1.8	1.2	1.3	1.8	.9	.9	1.2
2002	-1.4	2.8	-1.6	-.8	.2	1.9	.6	.8	1.1	0	.3	1
2003	-3.1	2	-.6	-2.5	-1.4	1	-.3	.1	-.1	-2.8	-.9	0
2004	-3.3	2.5	-.4	-3.1	-1.8	1.4	-.5	-.4	-.1	-3.2	-.8	.1
2005	-3	2.3	-.2	-2.6	-1.8	.9	-.2	-.6	-.1	-2.9	-.4	.2
2006	-3.3	2.7	-.6	-2.8	-1.9	.4	-.2	-.7	-.3	-3.1	-.5	.5
2007	-3	3.5	.2	-3.4	-1.6	1.1	.2	.3	.4	-2.7	-.4	1.4
2008	-1.6	2.2	.9	-2.8	-.9	.9	.4	.3	.8	-1.6	.2	1.3
2009	-1.4	0	-.4	-3	-2.1	-.4	-.5	-.6	-.1	-1.9	-.7	.2
2010	-3.5	2.8	-.2	-5.1	-3	.5	-.7	.4	.1	-3.3	-.9	1.3
2011	-1.5	1.6	.3	-3	-2.8	.1	-.1	.3	.5	-2.5	-.4	1
2012	-.1	2.9	2	-1.2	-1.6	1.8	1.4	2.1	1.8	-1.2	1.3	2.2
2013	1	3.1	2.4	-.1	-1.4	2.2	2	2.3	2.2	-.7	1.5	3.1

(*)Positive (negative) values indicate competitiveness loss (gain)
(1)BRUNEI $;(2)CAMBODIA RIEL;(3)INDONESIAN RUPIAH;(4)JAPANESE YEN;(5)KOREAN WON;
(6)LAOS KIP;(7) MALAYSIAN RINGGIT;(8)MYANMAR KYAT;(9)PHILIPPINES PESO;(10 SINGAPORE $

Table 10 - high price elasticities (gamma=-1.5)

YEAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Real exchange rate vis-à-vis the Japanese yen Percentage deviations from equilibrium values)											
2000	-1.1	4.5	.4	-1.3	.8	3	1.7	3.3	2.6	1.8	1.4	1.6
2001	-1.4	1.2	-1.2	-1.8	-.4	.6	0	.1	.6	-.3	-.3	0
2002	-.6	3.6	.8	-.8	1	2.7	1.4	1.6	1.9	.8	1.1	1.8
2003	-.6	4.5	2.5	1.9	1.1	3.5	2.2	2.6	2.4	-.3	1.6	2.5
2004	-.2	5.6	3.1	2.7	1.3	4.5	2.6	2.7	3	-.1	2.3	3.2
2005	-.4	4.9	2.6	2.4	.8	3.5	2.4	2	2.5	-.3	2.2	2.8
2006	-.5	5.5	2.8	2.2	.9	3.2	2.6	2.1	2.5	-.3	2.3	3.3
2007	.4	6.9	3.4	3.6	1.8	4.5	3.6	3.7	3.8	.7	3	4.8
2008	1.2	5	2.8	3.7	1.9	3.7	3.2	3.1	3.6	1.2	3	4.1
2009	1.6	3	3	2.6	.9	2.6	2.5	2.4	2.9	1.1	2.3	3.2
2010	1.6	7.9	5.1	4.9	2.1	5.6	4.4	5.5	5.2	1.8	4.2	6.4
2011	1.5	4.6	3	3.3	.2	3.1	2.9	3.3	3.5	.5	2.6	4
2012	1.1	4.1	1.2	3.2	-.4	3	2.6	3.3	3	0	2.5	3.4
2013	1.1	3.2	.1	2.5	-1.3	2.3	2.1	2.4	2.3	-.6	1.6	3.2

(*)Positive (negative) values indicate competitiveness loss (gain)
(1)BRUNEI $;(2)CAMBODIA RIEL;(3)CHINESE YUAN;(4)INDONESIAN RUPIAH;(5)KOREAN WON;
(6)LAOS KIP;(7) MALAYSIAN RINGGIT;(8)MYANMAR KYAT;(9)PHILIPPINES PESO;(10 SINGAPORE $

Table 11 - Low price elasticities (gamma=-0.5)

YEAR	Real exchange rate vis-à-vis the Chinese yuan Percentage deviations from equilibrium values) (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2000	-4.2	12.2	-4.8	-1.1	1.1	7.7	3.7	8.4	6.4	4.2	2.8	3.5
2001	-.5	7.2	-1.7	3.8	2.5	5.6	3.6	4.1	5.5	2.7	2.9	3.7
2002	-4	8.5	-4.6	-2.2	.6	5.7	1.8	2.6	3.2	0	1	3
2003	-8.8	6	-1.7	-7.3	-4	3	-.9	.4	-.2	-8	-2.6	.1
2004	-9.6	7.6	-1.1	-8.8	-5.1	4.1	-1.6	-1.1	-.4	-9.2	-2.3	.2
2005	-8.6	6.9	-.8	-7.7	-5.4	2.7	-.7	-1.8	-.4	-8.4	-1.3	.4
2006	-9.4	8.2	-1.7	-8.1	-5.4	1.2	-.5	-2.2	-.8	-8.8	-1.4	1.6
2007	-8.6	10.5	.5	-9.6	-4.7	3.3	.5	.7	1.1	-7.7	-1.3	4
2008	-4.7	6.6	2.8	-8	-2.5	2.7	1.2	.9	2.4	-4.5	.6	3.9
2009	-4.4	-.2	-1.2	-8.9	-6.2	-1.4	-1.7	-1.8	-.4	-5.7	-2.3	.5
2010	-10	8.3	-.7	-14.5	-8.8	1.4	-2	1.2	.1	-9.7	-2.6	3.7
2011	-4.2	4.8	1.1	-8.5	-7.9	.4	-.3	1.1	1.7	-7.3	-1.1	3.2
2012	-.1	8.7	6.1	-3.4	-4.5	5.4	4.3	6.2	5.4	-3.4	3.9	6.7
2013	2.9	9.3	7.2	-.2	-4.1	6.4	6	6.8	6.5	-1.8	4.5	9.2

(*)Positive (negative) values indicate competitiveness loss (gain)
(1)BRUNEI $;(2)CAMBODIA RIEL;(3)INDONESIAN RUPIAH;(4)JAPANESE YEN;(5)KOREAN WON;
(6)LAOS KIP;(7) MALAYSIAN RINGGIT;(8)MYANMAR KYAT;(9)PHILIPPINES PESO;(10 SINGAPORE $

Table 12 - Low price elasticities (gamma=-0.5)

YEAR	Real exchange rate vis-à-vis the Japanese yen Percentage deviations from equilibrium values) (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2000	-3.1	13.3	1.1	-3.7	2.2	8.8	4.8	9.5	7.5	5.3	3.9	4.6
2001	-4.3	3.4	-3.8	-5.5	-1.3	1.8	-.2	.3	1.7	-1.1	-.9	-.1
2002	-1.8	10.7	2.2	-2.4	2.8	7.9	4	4.8	5.4	2.2	3.2	5.2
2003	-1.5	13.3	7.3	5.6	3.3	10.3	6.4	7.7	7.1	-.7	4.7	7.4
2004	-.8	16.4	8.8	7.7	3.7	12.9	7.2	7.7	8.4	-.4	6.5	9
2005	-.9	14.6	7.7	6.9	2.3	10.4	7	5.9	7.3	-.7	6.4	8.1
2006	-1.3	16.3	8.1	6.4	2.7	9.3	7.6	5.9	7.3	-.7	6.7	9.7
2007	1	20.1	9.6	10.1	4.9	12.9	10.1	10.3	10.7	1.9	8.3	13.6
2008	3.3	14.6	8	10.8	5.5	10.7	9.2	8.9	10.4	3.5	8.6	11.9
2009	4.5	8.7	8.9	7.7	2.7	7.5	7.2	7.1	8.5	3.2	6.6	9.4
2010	4.5	22.8	14.5	13.8	5.7	15.9	12.5	15.7	14.6	4.8	11.9	18.2
2011	4.3	13.3	8.5	9.6	.6	8.9	8.2	9.6	10.2	1.2	7.4	11.7
2012	3.3	12.1	3.4	9.5	-1.1	8.8	7.7	9.6	8.8	0	7.3	10.1
2013	3.1	9.5	.2	7.4	-3.9	6.6	6.2	7	6.7	-1.6	4.7	9.4

(*)Positive (negative) values indicate competitiveness loss (gain)
(1)BRUNEI $;(2)CAMBODIA RIEL;(3)CHINESE YUAN;(4)INDONESIAN RUPIAH;(5)KOREAN WON;
(6)LAOS KIP;(7) MALAYSIAN RINGGIT;(8)MYANMAR KYAT;(9)PHILIPPINES PESO;(10 SINGAPORE $