HONG KONG INSTITUTE FOR MONETARY RESEARCH

A NEW APPROACH TO THE ESTIMATION OF EQUILIBRIUM REAL EXCHANGE RATES AMONG EAST-ASIAN ECONOMIES

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HKIMR Working Paper No.13/2016

July 2016

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

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Abstract

In view of the debate on exchange rate stabilization in Asia, this paper introduces a new and original approach to the determination of equilibrium real exchange rates (ERER) across ASEAN+3. Existing literature usually computes a country's ERER as the real exchange rate that brings the balance of payments of that country in to equilibrium with respect to the rest of the world, following a partial equilibrium approach. For a set of countries belonging to a highly integrated area, separately computing ERERs for each country may lead to mutual inconsistencies. The methodology in this paper achieves a simultaneous determination of the ERERs of all countries in the region, so that the trade balance of each of them is consistently in equilibrium with respect to the rest of the region. Numerical simulations conducted for ASEAN+3 show that such a methodology produces consistent results and may therefore be a useful way of evaluating exchange rate deviations from equilibrium within the area. The method is applied to assess ERER deviations of single currencies of ASEAN+3 vis-à-vis the Chinese yuan and the Japanese yen. The results provide a helpful insight into the relative suitability of these two currencies to play a benchmark role in an exchange rate system for the whole region.

Keywords: regional monetary integration, exchange rate regime, trade balance, ASEAN+3

JEL Classifications: F31, F33, F42, F45

* I gratefully acknowledge helpful comments and suggestions from Hongyi Chen, Matthew S. Yiu, and other seminar participants at the Hong Kong Institute for Monetary Research, from William R. Cline, and from an anonymous referee. The views expressed in this paper are my own, and do not necessarily reflect those of the Bank of Italy and the Eurosystem.

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. During the crisis, the countries of the region felt shockingly helpless in the face of international speculation and bank runs, while international support and assistance proved to be 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 foster market stability and resilience. In 2009, a reinforcement of the system of bilateral currency swaps into reserve pooling turned CMI into the 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 the debate about how to enhance monetary cooperation at a regional level a pivotal role is played by the choice of the exchange rate regime. The issue is made more relevant by, among other factors, 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, total intra-ASEAN trade amounted to 609 billion US dollars, or around one quarter of total ASEAN trade (table 1). Quite significantly, adding in China, Korea, and Japan, more than doubles intra-area (ASEAN+3) trade to 1335 billion dollars (table 2). According to official

[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.

data, intra-ASEAN trade increased at a faster pace, with annual growth rate averaging 10.5%, 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 against 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 like the Exchange Rate Mechanism (ERM) in Europe between 1979 and 1999.[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 of moving 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) propose 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 calculation of AMU and AMU Dis indicators are 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

[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).

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 +/− 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 period of 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 real exchange rate (ERER) is an indispensable prerequisite when building a common basket of currencies if speculative attacks triggered by the

[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).

perception that exchange rate levels are unsustainable are to be prevented.

In the light of the above the present paper sets out to provide a new and original methodology for calculating ERERs within a highly integrated economic space such as East- Asia.

This methodology is based on the realistic assumption that within an economically integrated area, the level of every country's ERERs should be determined simultaneously, within a framework where all trade balances across the area are mutually consistent. An example may help to clarify this proposition. Suppose that, starting from a situation of equilibrium, where all trade balances and the real exchange rates are in equilibrium, an exogenous shock causes Philippine's imports from Vietnam to sharply increase. As a consequence, the two countries' trade balances will shift to deficit and surplus, respectively, so that their ERERs will change. If the two countries' real exchange rates adjust accordingly this will nonetheless affect other trade partners' trade balances, thus affecting their ERERs. A new set of trade balances will therefore follow, which will ultimately require recalculation of ERER's. This process of recursive adjustment might prove endless. Only general equilibrium simultaneous calculation of consistent ERERs within the region can overcome the problems arising from a country-by-country partial equilibrium computation of ERER.

Based on the above line of reasoning this paper analyzes bilateral import and export flows within the ASEAN+3 area. These amount to 13 x 12 = 156 bidirectional flows. The simultaneous adjustment of the 13 trade balances in the intra-regional overall trade matrix will provide a whole set of 13 ERERs.

This methodological approach is used to illustrate, through numerical simulations, the size of the deviations of each ASEAN+3 currency from the value that is compatible with overall equilibrium of each member's trade balance. It can therefore provide a relevant policy tool to analyze the feasibility of a stricter monetary integration within a region such as ASEAN+3, and to determine the best candidate, among major currencies, to provide a monetary benchmark or anchor for the area.

2. Determining ERERs in the ASEAN+3 region

For the sake of generalization we assume an n-country model of mutually trading economies. This 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 rows represent bilateral imports m_{ij} of country *i* from country *j*, and diagonal elements m_{ii} are set equal to zero by definition. If we define x_{ij} as the exports of country *i* from country *j*, then $x_{ij} = m_{ji}$ applies 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 the real trade balance TB is:

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

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

[10] For $x_{ij} = m_{ji}$ to be true, exports and imports must be defined according to the same accounting standard. For convenience this paper uses imports, under the f.o.b. convention, as these are usually considered to be more reliable than export data.

From [2] it is also:

$$TB = M^T - M \tag{4}$$

We now assume that the bilateral imports flow of country *i* from country *j* is a log-linear function of the GDP of country *i* and of 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)):

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

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

The relative price of country *i* vis-á-vis country *j* can be expressed in terms of a third currency, say the US dollar. Hence:

$$\frac{p_i}{p_j} = \frac{p_i^d}{e_i^\$} / \frac{p_j^d}{e_j^\$} \tag{6}$$

where p_i^d and p_j^d are domestic prices of countries *i* and *j* in terms of national currency, and $e_i^\$$ and $e_j^\$$ represent the price of one US dollar in terms of country *i*'s and country *j*'s national currencies respectively. It follows that:

$$\frac{p_i}{p_j} = \frac{p_i^d}{e_i^j p_j^d} \tag{7}$$

where the right hand of [7] is the real exchange rate of country *i* vis-à-vis country *j* , and $e_i^j = \dfrac{e_j^\$}{e_i^\$}$

is the cross rate obtained by the US dollar exchange rate of the currencies of country *i* and country *j*.

In matrix form the bilateral import functions [5] can be expressed by the system:

$$M = A + B \circ y1' + \Gamma \circ (p1' - 1p') \quad [8]$$

Where M is the $n \times n$ matrix of the logarithms of bilateral imports, A is the $n \times n$ 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 $n \times 1$ (column) vectors of logarithms of income and prices in the *n* countries. 1 is a $n \times 1$(column) all-one vector. 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 $(p1' - 1p')$ is equivalent to:

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

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

$$K = -K^T \qquad [10]$$

Following the definition [4] for the trade balance and using [8] we can represent the overall set of $n(n-1)$ bilateral trade balances as follows:

$$TB = (A^T - A) + [(B \circ y1')^T - B \circ y1'] + [(\Gamma \circ K)^T - \Gamma \circ K] \qquad [11]$$

Using condition [10] the last-right hand term of [12] can be re-written as: $(\Gamma^T + \Gamma) \circ K^T$

Hence we get:

$$TB = (A^T - A) + [(B \circ y1')^T - B \circ y1'] + [(\Gamma + \hat{\Gamma})1' \circ p] \qquad [12]$$

where:

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

and:

$$\hat{\Gamma} = \begin{bmatrix} \sum_{j \neq i}^{n} \gamma_{j1} & -\gamma_{21} & -\gamma_{31} & \cdots & -\gamma_{n1} \\ -\gamma_{12} & \sum_{j \neq i}^{n} \gamma_{j2} & -\gamma_{32} & \cdots & -\gamma_{n2} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ -\gamma_{1n} & -\gamma_{2n} & -\gamma_{3n} & \cdots & \sum_{j \neq i}^{n} \gamma_{jn} \end{bmatrix} \qquad [14]$$

The system [12] of n equations will now be used to determine the vector of n ERERs that is consistent with the simultaneous achievement of trade balance equilibrium in each of the n countries considered.

To achieve this we first define:

$$TB_i = \ln x_i - \ln m_i \tag{14}$$

Equation [14] represents country *i*'s trade balance as the ratio between its exports and imports.

Differentiating [14] yields:

$$\Delta TB_i = \frac{\Delta x_i}{x_i} - \frac{\Delta m_i}{m_i} \tag{15}$$

Since:

$$\frac{\Delta x_i}{x_i} = \sum_{j \neq i} \frac{x_{ij}}{x_i} \frac{\Delta x_{ij}}{x_{ij}} \tag{16}$$

and:

$$\frac{\Delta m_i}{m_i} = \sum_{j \neq i} \frac{m_{ij}}{m_i} \frac{\Delta m_{ij}}{m_{ij}} \tag{17}$$

we get:

$$\Delta TB_i = \sum_{j \neq i} \frac{x_{ij}}{x_i} \frac{\Delta x_{ij}}{x_{ij}} - \sum_{j \neq i} \frac{m_{ij}}{m_i} \frac{\Delta m_{ij}}{m_{ij}} \tag{18}$$

Hence, using the import equation [5] and using $x_{ij} = m_{ji}$ we get:

$$\Delta TB_i = \sum_{j \neq i}^{n} [\frac{x_{ij}}{x_i}(\beta_{ji}\frac{\Delta y_j}{y_j}) - \frac{m_{ij}}{m_i}(\beta_{ij}\frac{\Delta y_i}{y_i})] - \sum_{j \neq i}^{n}(\frac{x_{ij}}{x_i}\gamma_{ij} + \frac{m_{ij}}{m_j}\tilde{\gamma}_{ij})\frac{\Delta p_i}{p_i} \qquad [19]$$

Expression [19] can be inverted as follows:

$$\frac{\Delta p_i}{p_i} = -\{\Delta TB_i - \sum_{j \neq i}^{n} [\frac{x_{ij}}{x_i}(\beta_{ji}\frac{\Delta y_j}{y_j}) - \frac{m_{ij}}{m_i}(\beta_{ij}\frac{\Delta y_i}{y_i})]\} / \sum_{j \neq i}^{n}(\frac{x_{ij}}{x_i}\gamma_{ij} + \frac{m_{ij}}{m_j}\tilde{\gamma}_{ij}) \qquad [20]$$

To better understand the meaning of [20] we impose overall trade balance equilibrium $\Delta TB_i = 0$, which implies that $\frac{\Delta y_i}{y_i} = \frac{\Delta x_i}{x_i} = \frac{\Delta m_i}{m_i} = 0$, so that [18] becomes:

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

If we differentiate [5] and replace it in [21], since $x_{ij} = m_{ji}$ we obtain the two following expressions:

$$\frac{\Delta m_{ij}}{m_{ij}} = \gamma_{ij}(\frac{\Delta p_i}{p_i} - \frac{\Delta p_j}{p_j}) \qquad [22]$$

$$\frac{\Delta x_{ij}}{x_{ij}} = \gamma_{ji}(\frac{\Delta p_j}{p_j} - \frac{\Delta p_i}{p_i}) \qquad [23]$$

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

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

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

$$(n-1)\frac{\Delta p_i}{p_i}-\sum_{j\neq i}\frac{x_{ij}}{x_i}\frac{\Delta p_j}{p_j}=-(n-1)\frac{\Delta p_i}{p_i}+\sum_{j\neq i}\frac{m_{ij}}{m_i}\frac{\Delta p_j}{p_j} \quad [25]$$

And finally:

$$\frac{\Delta p_i}{p_i}=\sum_{j\neq i}\frac{1}{2}(\frac{x_{ij}}{x_i}+\frac{m_{ij}}{m_i})\frac{\Delta p_j}{p_j}/(n-1) \quad [26]$$

According to [26] for the real trade balance to be in equilibrium, the domestic price changes must match the changes of a trade-weighted average of all trade partners' prices.

Coming back to [20], to make the calculation tractable some assumptions must be made on ΔTB_i

.

To start with, exports x_t and imports m_t at time t are defined as follows:

$$x_t = x_0(1+r)^t \quad [27]$$

and:

$$m_t = m_0(1+s)^t \quad [28]$$

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 (which is equivalent to $X_t = M_t$), we get:

$$x_0(1+r)^t = m_0(1+s)^t \quad [29]$$

Hence:

$$\frac{x_0}{m_0}=\frac{(1+s)^t}{(1+r)^t} \quad [30]$$

Applying logarithms we get:

$$\ln(\frac{x_0}{m_0}) = \ln(1+s)^t - \ln(1+r)^t \qquad [31]$$

Using the property $\ln(1+n) \approx n$ we obtain the following condition:

$$\frac{1}{t}\ln(\frac{x_0}{m_0}) = s - r \qquad [32]$$

Condition [32] crucially expresses the differential between the real growth rate of exports and imports that is consistent with the achievement of real trade balance equilibrium in t periods.

If we replace [32] for ΔTB_i in [20] we get, for $t=1$:

$$\frac{\Delta p_i}{p_i} = -\{s_i - r_i - \sum_{j\neq i}^{n}[\frac{x_{ij}}{x_i}(\beta_{ji}\frac{\Delta y_j}{y_j}) - \frac{m_{ij}}{m_i}(\beta_{ij}\frac{\Delta y_i}{y_i})]\} / \sum_{j\neq i}^{n}(\frac{x_{ij}}{x_i}\gamma_{ij} + \frac{m_{ij}}{m_j}\tilde{\gamma}_{ij}) \qquad [33]$$

Expression [33] represents the relationship between US dollar-denominated domestic prices (defined as in [6]) and real trade account balance for the i-th of n countries. It allows us to numerically compute the set of values of $\frac{\Delta p_i}{p_i}$, i.e. the percentage change of US dollar-denominated domestic prices in each i-th country, that is consistent with the country's real trade balance equilibrium.

After obtaining the full set of $\frac{\Delta p_i}{p_i}$, and using the definition [7], the deviation from ERER of the real exchange rate of currency *i* vis-à-vis currency *j* can be easily computed by subtracting $\frac{\Delta p_j}{p_j}$ from $\frac{\Delta p_i}{p_i}$.

3. Numerical simulations

The calculation of consistent and simultaneous ERERs for East-Asian economies follows two steps.

The first step computes the values of $\frac{\Delta p_i}{p_i}$ as in system [33]. The set of all $\frac{\Delta p_i}{p_i}$ expresses the size of domestic price adjustment that is needed in every country to achieve real trade balance equilibrium in every country simultaneously[11].

The second step uses equation [7] to obtain the percentage deviation from the ERER of any currency vis-á-vis any other currency in the set. The implications of this exercise are illustrated using the Chinese yuan and the Japanese yen as reference currencies.

Computer calculations have been performed by using Speakeasy, a numerical computing interactive environment also featuring a powerful interpreted programming language [12].

The source of trade data is the International Monetary Fund Direction of Trade statistical database. Bilateral export flows data are used to build ASEAN+3 yearly exports matrices made of 13 rows x 13 columns from 2000 to 2013. (at the time data for the fourth quarter of 2014 were not available). 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 are derived from World Bank's 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 are assumed to be all equal to 1, and bilateral price elasticity are assumed to be all equal to -1, as implied by conventional neoclassical trade theory. Alternative

[11] In section 2 it has been shown that in equilibrium $\frac{\Delta p_i}{p_i}$ is equivalent to a trade-weighted average of the prices of all the partners/competitors in the area.

[12] A long-lasting numerical package, Speakeasy was initially developed for internal use at the Physics Division of Argonne National Laboratory by the theoretical physicist Stanley Cohen.

values for bilateral price and income elasticities were used to test for sensitivity analysis.

Finally, it is worth recalling that determining 13 ERERs from 13 equations in a closed general equilibrium framework would meet Walras' law, because if the system is set linear the sum of all trade balances is equal to zero by definition. This would make one equation redundant and require setting one ERER at a preset constant value. However, since we have defined real trade balance TB in non-linear form (see [15]) the redundancy problem does not apply, and the simultaneous computation of the whole vector of $\frac{\Delta p_i}{p_i}$ is thus made possible.

Table 3 represents the percentage deviation from equilibrium values of the 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 $\frac{\Delta p_i}{p_i}$ are associated with real deficits in trade balances, and represent the size of the deviation of price from equilibrium. If prices are higher than their equilibrium level (which is a weighted average of all partners' domestic prices, corrected for demand effects) this 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 level; they pair 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. Cambodia, Vietnam and Philippines display the largest deviations.

All in all, the size of overall deviations (positive or negative) appears relatively modest, 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 elasticities, a set of different assumptions has been computed 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 show an overall reduction in the size of deviations, which is reflected in a smaller 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 the previous section, it was 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 reference value $\frac{\Delta p_j}{p_j}$ for all the countries involved in the exercise is equivalent to setting the currency of country j as the reference currency for the region, or, equivalently as the goal for a hypothetical ASEAN+3 members' coordinated exchange-rate policy. Measuring the deviation of every single real exchange rate from the reference currency provides a helpful measure of trade and currency inbalances in the region.

Last but not least, the currencies of the two major economies of the region, the Chinese yuan and the Japanese yen, have been used as reference currencies in the exercise under all the alternative assumptions on the size of γ_{ij} previously utilized.

In computational terms, choosing the Chinese yuan or Japanese yen as a j reference currency is equivalent to calculating the values of:

$$\frac{\Delta p_i}{p_i} - \frac{\Delta p_{China}}{p_{China}} \tag{34}$$

or:

$$\frac{\Delta p_i}{p_i} - \frac{\Delta p_{Japan}}{p_{Japan}} \tag{35}$$

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

As can be seen in tables 7 to 12, the size of the deviation of real exchange rates from their equilibrium values is larger if the Japanese yen is adopted as a reference currency instead of the Chinese yuan. This reflects the systematic deviation of Japanese domestic prices expressed in US dollars from their equilibrium values, computed in accordance with the procedure described in section 2. This is reflected in the large trade balance in real terms of Japan vis-à-vis the rest of ASEAN+3.

4. Conclusions

This paper has presented a new and original approach to the determination of equilibrium real exchange rates based on a general equilibrium approach, where all exchange rates of the member countries of an integrated regional entity are determined simultaneously.

Model simulations provide useful hints on the relative position of the ASEAN+3 currencies and on the size and sign of their deviation from their ERERs. Sensitivity analysis shows that when the bilateral trade elasticities are set within reasonable limits the results are robust and stable. Using this method in assessing the relative suitability of the Chinese yuan or Japanese yen as a benchmark currency in the ASEAN+3 can provide helpful insights which may justify further research effort in this area. Our tentative and preliminary results suggest that the Chinese yuan may be a better candidate than the Japanese yen as a benchmark currency for the ASEAN+3.

Since income and trade elasticities play a central role in the implementation of this method for policy purposes, estimating the actual bilateral elasticities across ASEAN+3 could be helpful. Literature on the impact of the weaker yen on Asian economies lends support to the idea that yen depreciation in the period between 2012 and 2013 had an asymmetric effect on China and South Korea, which was influenced by the degree of complementarity among Japanese traded goods and those produced by trading partners.[13] This empirical finding, and its implications for the bilateral elasticities between Japan, China, and South Korea, is relevant to the determination of ERERs among the three countries.

Lastly, it is worth recalling the policy relevance of early detection of countries that have real exchange rates that are systematically misaligned, and the associated risks of persistent trade imbalances within a highly integrated area such as ASEAN+3. The case of the European Union may be telling in this respect.[14]

[13] RIETI (2013).
[14] See 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.

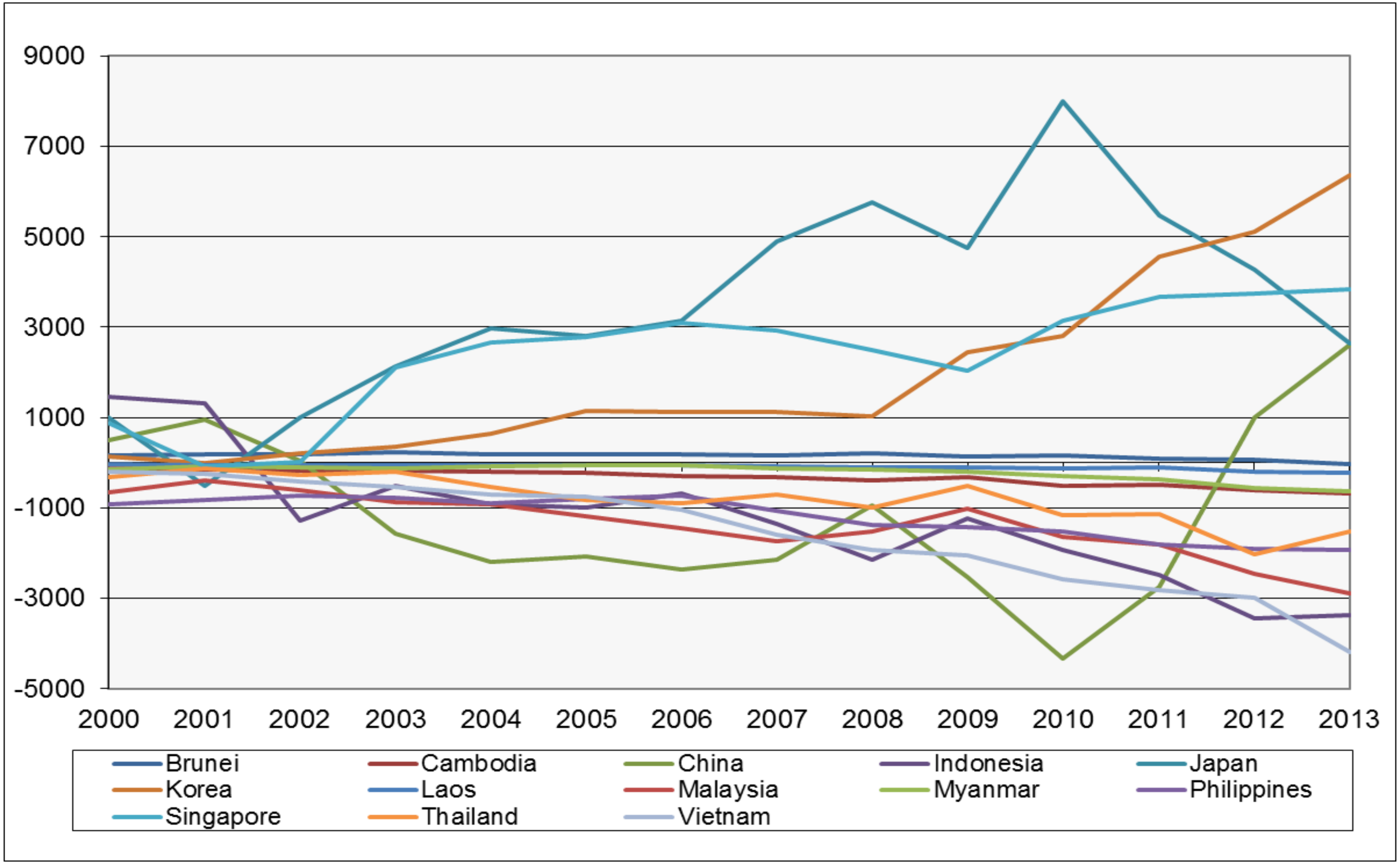
Park, Y.C. and C.Y. Song (2011), "Prospects for Monetary Cooperation in East Asia", Asian Development Bank Institute, ADBI Working Paper Series No. 314, October.

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)

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	-3.0	5.4	-0.8	-3.3	-1.3	-0.2	3.1	1.1	3.5	2.5	1.4	0.7	1.0
2001	-3.3	5.5	-1.4	-3.0	0.7	0.0	3.6	0.7	1.7	2.3	0.1	0.3	1.1
2002	-2.7	5.6	0.0	-2.8	-1.2	0.3	3.7	1.0	1.6	1.8	0.0	0.5	1.8
2003	-3.5	5.6	1.7	0.9	-2.2	-0.4	3.8	1.2	2.2	1.7	-2.6	0.3	2.0
2004	-3.0	5.7	2.0	1.4	-2.6	-0.7	4.0	1.1	1.4	1.7	-2.8	0.8	2.1
2005	-3.0	5.6	1.7	1.4	-2.3	-1.1	3.3	1.4	0.8	1.5	-2.7	1.1	2.0
2006	-3.0	5.7	1.8	0.9	-2.4	-1.0	2.3	1.5	0.7	1.4	-2.7	1.1	2.5
2007	-2.6	5.9	1.5	1.6	-3.4	-0.9	2.8	1.7	1.6	1.9	-2.4	0.8	3.2
2008	-2.8	6.0	0.6	2.4	-3.8	-0.8	3.0	1.4	1.5	2.4	-2.0	1.0	3.4
2009	-2.0	5.0	1.8	1.6	-3.5	-2.0	2.9	1.1	2.0	2.8	-1.8	0.6	3.7
2010	-2.2	5.5	2.5	2.0	-4.7	-1.9	2.7	1.4	2.6	2.3	-2.3	1.1	3.8
2011	-1.0	5.1	1.5	2.3	-3.1	-2.8	2.2	1.5	2.6	2.8	-2.5	1.0	3.7
2012	-.8	5.1	-0.5	3.0	-2.4	-3.1	2.9	1.9	3.4	2.7	-2.5	1.7	3.5
2013	0.4	4.9	-1.3	2.9	-1.4	-3.6	2.9	2.1	3.1	2.6	-2.4	1.3	4.2

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

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

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	-2.5	4.4	-0.6	-2.7	-1.1	-0.2	2.6	0.9	2.9	2.1	1.1	0.6	0.8
2001	-1.2	1.9	-1.0	-1.7	0.5	0.0	1.2	0.5	0.6	1.2	0.1	0.1	0.5
2002	-1.7	3.3	0.0	-1.9	-0.9	0.2	2.2	0.7	1.0	1.2	0.0	0.4	1.1
2003	-2.3	3.6	1.3	0.6	-1.6	-0.3	2.4	0.9	1.4	1.2	-1.9	0.2	1.3
2004	-2.3	4.4	1.5	1.1	-2.0	-0.5	3.1	0.9	1.1	1.3	-2.2	0.6	1.6
2005	-2.1	3.9	1.3	1.0	-1.7	-0.8	2.3	1.0	0.6	1.1	-2.0	0.8	1.4
2006	-2.4	4.4	1.4	0.7	-1.8	-0.7	1.8	1.2	0.5	1.1	-2.1	0.8	2.0
2007	-2.3	5.0	1.1	1.3	-2.6	-0.7	2.4	1.3	1.4	1.5	-1.9	0.6	2.6
2008	-1.4	2.9	0.4	1.5	-2.7	-0.5	1.4	0.9	0.7	1.3	-1.3	0.6	1.9
2009	-0.5	1.1	1.2	0.7	-2.2	-1.2	0.6	0.5	0.5	1.0	-1.0	0.3	1.3
2010	-2.0	5.0	2.0	1.7	-3.7	-1.5	2.5	1.2	2.4	2.0	-1.8	0.9	3.4
2011	-0.5	2.9	1.1	1.5	-2.2	-2.0	1.2	1.0	1.5	1.7	-1.7	0.7	2.3
2012	-0.4	2.9	-0.4	1.9	-1.7	-2.1	1.6	1.2	2.0	1.6	-1.7	1.1	2.2
2013	0.2	2.5	-0.9	1.8	-1.0	-2.5	1.5	1.3	1.7	1.5	-1.6	0.8	2.5

Note: (*)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	-2.0	3.6	-0.5	-2.2	-0.9	-0.1	2.1	0.8	2.4	1.7	0.9	0.5	0.7
2001	-1.0	1.6	-0.8	-1.4	0.4	0.0	1.0	0.4	0.5	1.0	0.1	0.1	0.4
2002	-1.4	2.8	0.0	-1.6	-0.8	0.2	1.9	0.6	0.8	1.1	0.0	0.3	1.0
2003	-2.0	3.1	1.1	0.5	-1.4	-0.3	2.1	0.8	1.2	1.0	-1.7	0.2	1.1
2004	-2.0	3.8	1.3	0.9	-1.8	-0.5	2.7	0.8	0.9	1.2	-1.9	0.5	1.4
2005	-1.9	3.4	1.1	0.9	-1.5	-0.7	2.0	0.9	0.5	1.0	-1.8	0.7	1.3
2006	-2.1	3.9	1.2	0.6	-1.6	-0.7	1.6	1.0	0.5	0.9	-1.9	0.7	1.7
2007	-2.0	4.5	1.0	1.2	-2.4	-0.6	2.1	1.2	1.3	1.4	-1.7	0.6	2.4
2008	-1.2	2.6	0.4	1.3	-2.4	-0.5	1.3	0.8	0.7	1.2	-1.2	0.6	1.7
2009	-0.4	1.0	1.0	0.6	-2.0	-1.1	0.6	0.5	0.4	0.9	-0.9	0.3	1.2
2010	-1.8	4.5	1.7	1.5	-3.4	-1.3	2.2	1.0	2.1	1.8	-1.6	0.8	3.0
2011	-0.5	2.6	1.0	1.3	-2.0	-1.8	1.1	0.9	1.3	1.5	-1.5	0.6	2.0
2012	-0.4	2.6	-0.3	1.7	-1.5	-1.9	1.5	1.1	1.8	1.5	-1.5	1.0	1.9
2013	0.2	2.3	-0.8	1.6	-0.9	-2.2	1.4	1.2	1.5	1.4	-1.5	0.7	2.3

Note: (*)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	-0.4	6.2	2.2	6.9	4.9	2.7	1.3	2.0
2001	-6.3	10.9	-2.8	-5.8	1.4	0.0	7.2	1.4	3.4	4.5	0.3	0.5	2.1
2002	-5.2	11.1	-0.1	-5.4	-2.4	0.6	7.3	1.9	3.2	3.6	-0.1	1.1	3.5
2003	-6.6	11.2	3.3	1.7	-4.2	-0.8	7.5	2.4	4.3	3.4	-5.0	0.6	3.8
2004	-5.8	11.4	3.8	2.7	-5.0	-1.3	7.9	2.2	2.7	3.4	-5.4	1.5	4.0
2005	-5.7	11.1	3.3	2.7	-4.5	-2.1	6.5	2.6	1.6	3.0	-5.2	2.1	3.9
2006	-5.7	11.3	3.5	1.7	-4.6	-1.9	4.5	3.0	1.3	2.6	-5.3	2.1	4.9
2007	-5.0	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	3.0	4.7	-3.8	2.0	6.6
2009	-3.9	9.8	3.5	3.0	-6.7	-3.8	5.8	2.0	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	-6.0	-5.5	4.3	2.8	5.1	5.4	-4.9	2.0	7.2
2012	-1.5	10.2	-1.0	5.9	-4.6	-5.9	5.7	3.7	6.8	5.3	-4.7	3.3	6.8
2013	0.7	9.6	-2.5	5.7	-2.8	-7.0	5.6	4.1	6.1	5.1	-4.7	2.4	8.3

Note: (*)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	-0.5	0.6	3.9	1.9	4.3	3.3	2.2	1.5	1.8
2001	-0.3	3.5	-0.9	1.8	1.2	2.8	1.8	2.0	2.7	1.3	1.4	1.8
2002	-2.1	4.2	-2.4	-1.2	0.3	2.8	0.9	1.3	1.6	0.0	0.5	1.5
2003	-4.5	3.0	-0.8	-3.7	-2.0	1.5	-0.4	0.2	-0.1	-4.1	-1.3	0.1
2004	-5.0	3.7	-0.6	-4.6	-2.7	2.0	-0.9	-0.6	-0.3	-4.8	-1.2	0.1
2005	-4.4	3.4	-0.4	-4.0	-2.8	1.3	-0.4	-1.0	-0.2	-4.3	-0.7	0.2
2006	-4.9	4.1	-0.9	-4.2	-2.8	0.6	-0.2	-1.1	-0.4	-4.6	-0.7	0.8
2007	-4.5	5.2	0.3	-5.0	-2.4	1.7	0.3	0.4	0.5	-4.0	-0.7	2.0
2008	-2.4	3.2	1.4	-4.2	-1.3	1.3	0.6	0.4	1.2	-2.3	0.3	1.9
2009	-2.2	-0.1	-0.7	-4.5	-3.2	-0.7	-0.9	-1.0	-0.3	-2.9	-1.2	0.2
2010	-5.2	4.1	-0.4	-7.5	-4.6	0.7	-1.1	0.6	0.0	-5.0	-1.4	1.9
2011	-2.1	2.4	0.6	-4.3	-4.0	0.2	-0.1	0.6	0.9	-3.7	-0.5	1.6
2012	-0.1	4.4	3.1	-1.7	-2.3	2.7	2.2	3.1	2.7	-1.7	2.0	3.4
2013	1.5	4.7	3.6	-0.1	-2.1	3.2	3.0	3.5	3.3	-1.0	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 $; (11) THAILAND BAHT; (12) VIETNAM DONG.

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	0.5	-2.0	1.1	4.4	2.4	4.8	3.8	2.7	2.0	2.3
2001	-2.1	1.7	-1.8	-2.7	-0.6	1.0	0.0	0.2	0.9	-0.5	-0.4	0.0
2002	-0.9	5.4	1.2	-1.2	1.5	4.0	2.1	2.5	2.8	1.2	1.7	2.7
2003	-0.8	6.7	3.7	2.9	1.7	5.2	3.3	3.9	3.6	-0.4	2.4	3.8
2004	-0.4	8.3	4.6	4.0	1.9	6.6	3.7	4.0	4.3	-0.2	3.4	4.7
2005	-0.4	7.4	4.0	3.6	1.2	5.3	3.6	3.0	3.8	-0.3	3.3	4.2
2006	-0.7	8.3	4.2	3.3	1.4	4.8	4.0	3.1	3.8	-0.4	3.5	5.0
2007	0.5	10.2	5.0	5.3	2.6	6.7	5.3	5.4	5.5	1.0	4.3	7.0
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	0.3	4.5	4.2	4.9	5.2	0.6	3.8	5.9
2012	1.6	6.1	1.7	4.8	-0.6	4.4	3.9	4.8	4.4	0.0	3.7	5.1
2013	1.6	4.8	0.1	3.7	-2.0	3.3	3.1	3.6	3.4	-0.9	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 $; (11) THAILAND BAHT; (12) VIETNAM DONG.

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

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	-1.5	4.1	-1.7	-0.4	0.4	2.6	1.3	2.9	2.2	1.4	1.0	1.2
2001	-0.2	2.4	-0.6	1.2	0.8	1.8	1.2	1.3	1.8	0.9	0.9	1.2
2002	-1.4	2.8	-1.6	-0.8	0.2	1.9	0.6	0.8	1.1	0.0	0.3	1.0
2003	-3.1	2.0	-0.6	-2.5	-1.4	1.0	-0.3	0.1	-0.1	-2.8	-0.9	0.0
2004	-3.3	2.5	-0.4	-3.1	-1.8	1.4	-0.5	-0.4	-0.1	-3.2	-0.8	0.1
2005	-3	2.3	-0.2	-2.6	-1.8	0.9	-0.2	-0.6	-0.1	-2.9	-0.4	0.2
2006	-3.3	2.7	-0.6	-2.8	-1.9	0.4	-0.2	-0.7	-0.3	-3.1	-0.5	0.5
2007	-3.0	3.5	0.2	-3.4	-1.6	1.1	0.2	0.3	0.4	-2.7	-0.4	1.4
2008	-1.6	2.2	0.9	-2.8	-0.9	0.9	0.4	0.3	0.8	-1.6	0.2	1.3
2009	-1.4	0.0	-0.4	-3.0	-2.1	-0.4	-0.5	-0.6	-0.1	-1.9	-0.7	0.2
2010	-3.5	2.8	-0.2	-5.1	-3.0	0.5	-0.7	0.4	0.1	-3.3	-0.9	1.3
2011	-1.5	1.6	0.3	-3.0	-2.8	0.1	-0.1	0.3	0.5	-2.5	-0.4	1.0
2012	-0.1	2.9	2.0	-1.2	-1.6	1.8	1.4	2.1	1.8	-1.2	1.3	2.2
2013	1.0	3.1	2.4	-0.1	-1.4	2.2	2.0	2.3	2.2	-0.7	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 $; (11) THAILAND BAHT; (12) VIETNAM DONG.

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

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	-1.1	4.5	0.4	-1.3	0.8	3.0	1.7	3.3	2.6	1.8	1.4	1.6
2001	-1.4	1.2	-1.2	-1.8	-0.4	0.6	0.0	0.1	0.6	-0.3	-0.3	0.0
2002	-0.6	3.6	0.8	-0.8	1.0	2.7	1.4	1.6	1.9	0.8	1.1	1.8
2003	-0.6	4.5	2.5	1.9	1.1	3.5	2.2	2.6	2.4	-0.3	1.6	2.5
2004	-0.2	5.6	3.1	2.7	1.3	4.5	2.6	2.7	3.0	-0.1	2.3	3.2
2005	-0.4	4.9	2.6	2.4	0.8	3.5	2.4	2.0	2.5	-0.3	2.2	2.8
2006	-0.5	5.5	2.8	2.2	0.9	3.2	2.6	2.1	2.5	-0.3	2.3	3.3
2007	0.4	6.9	3.4	3.6	1.8	4.5	3.6	3.7	3.8	0.7	3.0	4.8
2008	1.2	5.0	2.8	3.7	1.9	3.7	3.2	3.1	3.6	1.2	3.0	4.1
2009	1.6	3.0	3.0	2.6	0.9	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	3.0	3.3	0.2	3.1	2.9	3.3	3.5	0.5	2.6	4.0
2012	1.1	4.1	1.2	3.2	-0.4	3.0	2.6	3.3	3.0	0.0	2.5	3.4
2013	1.1	3.2	0.1	2.5	-1.3	2.3	2.1	2.4	2.3	-0.6	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 $; (11) THAILAND BAHT; (12) VIETNAM DONG.

Table 11 – low price elasticities (gamma=-0.5)

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	-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	-0.5	7.2	-1.7	3.8	2.5	5.6	3.6	4.1	5.5	2.7	2.9	3.7
2002	-4.0	8.5	-4.6	-2.2	0.6	5.7	1.8	2.6	3.2	0.0	1.0	3.0
2003	-8.8	6	-1.7	-7.3	-4.0	3.0	-0.9	0.4	-0.2	-8.0	-2.6	0.1
2004	-9.6	7.6	-1.1	-8.8	-5.1	4.1	-1.6	-1.1	-0.4	-9.2	-2.3	0.2
2005	-8.6	6.9	-0.8	-7.7	-5.4	2.7	-0.7	-1.8	-0.4	-8.4	-1.3	0.4
2006	-9.4	8.2	-1.7	-8.1	-5.4	1.2	-0.5	-2.2	-.8	-8.8	-1.4	1.6
2007	-8.6	10.5	0.5	-9.6	-4.7	3.3	0.5	0.7	1.1	-7.7	-1.3	4.0
2008	-4.7	6.6	2.8	-8.0	-2.5	2.7	1.2	0.9	2.4	-4.5	0.6	3.9
2009	-4.4	-0.2	-1.2	-8.9	-6.2	-1.4	-1.7	-1.8	-0.4	-5.7	-2.3	0.5
2010	-10	8.3	-0.7	-14.5	-8.8	1.4	-2.0	1.2	0.1	-9.7	-2.6	3.7
2011	-4.2	4.8	1.1	-8.5	-7.9	0.4	-0.3	1.1	1.7	-7.3	-1.1	3.2
2012	-0.1	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	-0.2	-4.1	6.4	6.0	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 $; (11) THAILAND BAHT; (12) VIETNAM DONG.

Table 12 – low price elasticities (gamma=-0.5)

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	-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	-0.2	0.3	1.7	-1.1	-0.9	-0.1
2002	-1.8	10.7	2.2	-2.4	2.8	7.9	4.0	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	-0.7	4.7	7.4
2004	-0.8	16.4	8.8	7.7	3.7	12.9	7.2	7.7	8.4	-0.4	6.5	9.0
2005	-0.9	14.6	7.7	6.9	2.3	10.4	7.0	5.9	7.3	-0.7	6.4	8.1
2006	-1.3	16.3	8.1	6.4	2.7	9.3	7.6	5.9	7.3	-0.7	6.7	9.7
2007	1.0	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	8.0	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	0.6	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	0.0	7.3	10.1
2013	3.1	9.5	0.2	7.4	-3.9	6.6	6.2	7.0	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 $; (11) THAILAND BAHT; (12) VIETNAM DONG.