# Asia confronts the impossible trinity

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# Asia confronts the impossible trinity

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**Abstract**

In this paper, we examine capital account openness and exchange rate flexibility in 11 Asian countries. Asia has made slow progress on *de jure* capital account openness, but has made much more progress on *de facto* capital account openness. While there is a slow pace of increase in exchange rate flexibility, most Asian countries continue to have largely inflexible exchange rates. This combination – of moving forward with *de facto* capital account integration without bringing in exchange rate flexibility – has lead to procyclicality of monetary policy when capital flows are procyclical. The paper emphasises the case for a consistent monetary policy framework.

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# Contents

# 1 Introduction

A core idea in modern macroeconomics is the 'impossible trinity', the notion that a country can have only two of an open capital account, a fixed exchange rate and autonomy of monetary policy. By and large, industrial countries have chosen consistent frameworks in the light of the impossible trinity. Most countries have an open capital account, floating exchange rate and an autonomous monetary policy, other than the countries of Eurozone which have an open capital account, a fixed exchange rate, and no autonomous monetary policy.

In Asia, there are a few polar examples like Hong Kong, which has a fixed exchange rate, an open capital account, and no monetary policy autonomy. But most Asian countries have not chosen a well specified monetary policy framework. Most countries have opted for a combination of certain capital controls and exchange rate inflexibility. This raises interesting questions in understanding Asia, and in thinking about the evolution of policy in the future. It emphasises the need for a consistent monetary policy framework.

In this paper, we focus on the 11 major Asian countries: India, China, Hong Kong, Taiwan, Singapore, Malaysia, Thailand, Indonesia, Philippines, Vietnam, and Korea. This is a highly heterogeneous group. It ranges from city-states like Singapore to giants like China. It ranges from poor countries like India to rich countries like Taiwan or Korea. We term these countries the Asia-11.

We examine where Asia-11 stand with respect to the three corners of the impossible trinity: capital controls, exchange rate regime and monetary policy autonomy. We obtain summary statistics about the countries, and also focus on numerical values for three countries – India, China and Korea.

In this paper, we focus on the *de facto* rather than the *de jure*.

*De jure* capital controls, the *de jure* exchange rate regime, the *de jure* monetary policy framework,often differ from the *de facto* regimes. etc. However, at the same time, countries often fail to do as they say. For the purposes of this paper, we focus on *de facto* conditions for capital account openness and the exchange rate regime, and its consequences for monetary policy as measured by the short-term interest rate expressed in real terms.

We find that while Asia has experienced some *de jure* capital account liberalisation, in most countries restrictions on capital flows are still in place. However, this has not impeded a substantial extent and a continuing pace of capital account integration at a *de facto* level, assisted by a growing sophistication of the financial system.

Alongside this, Asia is characterised by substantial exchange rate inflexibility. While exchange rate flexibility has increased after 2000, it remains low by world standards. The most flexible exchange rate – that of Korea – lags floating exchange rates.

Counter-cyclical policy is one of the strategies through which monetary policy achieves objectives of stabilising inflation and output. We focus on this objective of monetary policy in the context of the inconsistencies arising from the impossible trinity. Today most of Asia is in an environment with growing *de facto* capital account integration while having substantial *de facto* exchange rate inflexibility. The extent that capital flows are procyclical, the currency trading of central banks will convert the procyclicality of capital flows into procyclicality of monetary policy. China and India are interesting test cases of these phenomena, given a limited extent of *de facto* capital account opening and relatively weak financial systems. Yet, even with these two countries, we argue that monetary policy has been fairly procyclical.

We also argue that there is a potential for difficulties, with countries which have moved towards substantial *de facto* integration while continuing to have limited exchange rate flexibility. This

is particularly a concern with Malaysia and Taiwan, which combine (a) sophisticated financial systems, which erode the effectiveness of capital controls, (b) substantial *de facto* openness and (c) rigidity of the exchange rate. As difficulties in pursuing an counter cyclical monetary policy increase when countries with pegged exchange rates witness procyclical capital flows, the paper makes a case for a consistent monetary policy framework.

# 2 Capital controls

## 2.1 *De jure* controls: the Chinn-Ito database

We start with a description of the *de jure* capital controls in place in Asian economies compared to the rest of the world.Chinn and Ito (2008) have constructed a database about the *de jure* capital controls prevalent in a country, based on a principal components analysis of the information supplied by countries to the IMF's AREAR database. This yields a score for each country for each year. The values range from -1.81 for completely closed countries to +2.53 for completely open countries.

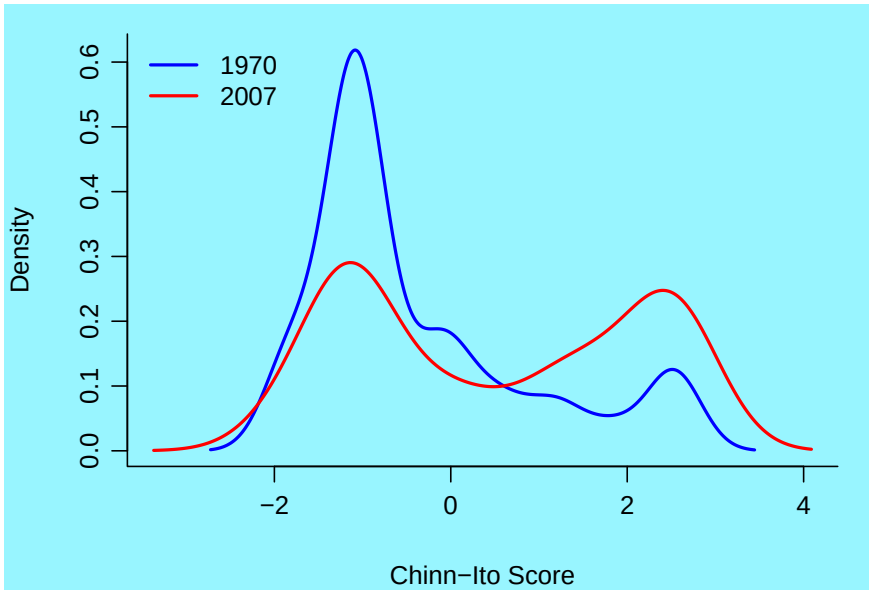
As an example, France, which was one of the last industrial countries to open up, went from a value of -1.27 in 1970 to a value of 2.53 in 1995. In another example, Israel shifted from a value of -1.13 in 1997 to 2.53 in 2004.

While this database is often used for an analysis of *de jure* capital controls, it important to point out that it does not capture easing of capital controls adequately since it contintues to give the same score unless all restrictions are removed. Further, the index rose significantly for most industrial countries in recent years, as they introduced prudential measures related to anti-money laundering, anti-terrorist financing, and the like. Therefore, the definition has changed [1].

[1] We are grateful to Shinji Takagi for pointing this out.

**Figure 1** Density of the Chinn-Ito measure across all countries: comparing 1970 vs. 2007

This graph shows the kernel density estimator of the cross-sectional distribution of the Chinn-Ito measure of *de jure* capital account openness. The blue line shows conditions in 1970 and the red line shows conditions in 2007. Both distributions are bimodal, with a clump of countries which are mostly open and a clump of countries which are mostly closed. There has been a strong shift of probability mass from the left hump (mostly closed) to the right hump (mostly open). This graph gives us a frame of reference for interpreting information from the Chinn-Ito database about Asia.



This database shows that over the years, a substantial scale of capital account decontrol has taken place worldwide. Figure 1 shows the kernel density plot of the Chinn-Ito measure across all countries. In both years, the density is bimodal, with a cluster of countries with largely open capital accounts and a cluster of countries with largely closed capital accounts. This graphically conveys the shift of many countries away from being mostly closed to being mostly open. The 1970 distribution has a sharp bump around a score of -1. This bump has sharply come down by 2007. Now there is a roughly even number of countries which have high openness when compared with the countries which have low openness.

The Chinn-Ito database has information for all the Asia-11 countries other than Taiwan. Since Taiwan largely has capital account convertibility, our information about Asia-11 drawn from this database is somewhat biased in the downward direction. Figure 2 shows the time-series of the average value of the Chinn-Ito measure for Asia-11 ex Taiwan, and compares these against the average value for the world. At the starting point and the endpoint, the *de jure* controls in Asia-11 were similar to the world average, However, there was an intermediate period where decontrol for Asia-11 had advanced more than the world average. While countries promoted long term capital flows like FDI, some of them put restrictions on short term flows. One example is India which imposed restrictions on short term debt.

Table 1 shows numerical values for India, China, Korea and the Asian average. China and India were at the value of -1.13 all through. Korea had moved forward to liberalisation, with a value of -0.09 in 1995. In the Asian crisis, Korea dropped back to -1.13 from 1996 till 2000. From 2001 onwards, Korea got back to liberalising the capital account, achieving a value of 0.18 in 2007. At the same time, Korea greatly lags the capital account openness of other OECD countries.

The average openness of the Asia-11 had risen sharply from -

**Figure 2** Evolution of the average Chinn-Ito measure for the Asia-11

The average value of the Chinn-Ito measure across countries is shown for each year computed. The black line shows the average for the whole world, and the grey line shows the average for Asia.
This suggests that in recent years, average *de jure* controls in Asia are similar to the world average. This reverses the relationship which prevailed in previous decades, where Asia was (on average) more open than the world average.

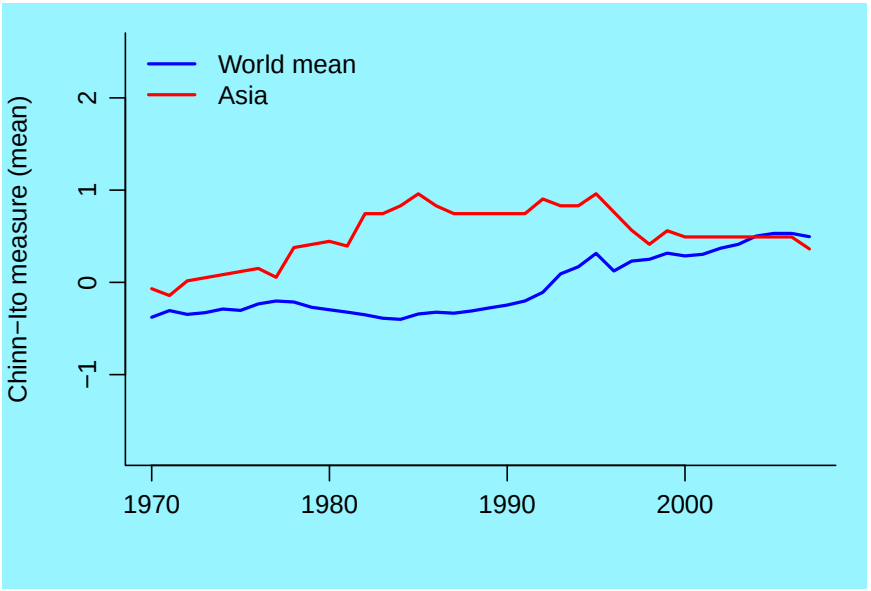


**Table 1** Evolution of the Chinn-Ito measure

This table focuses on India, China and Korea, and shows the evolution of the Chinn-Ito measure of these three countries as compared with the Asian mean.
Both India and China have a value of -1.13 throughout, which corresponds to the 'mostly closed' mode of the density graph seen in Figure 1. In Korea's case, *de jure* capital controls have changed several times. In the aftermath of the Asian Crisis, Korea was also at -1.13 till 2000. From there, Korea has engaged in considerable *de jure* capital account liberalisation, going up to a value of 0.18 in 2007.
The average for Asia-11 shows a peak value of 0.96 in 1985 and in 1995. Compared with that, Asia is more closed in 2007, with a value of 0.36 (which is still more open than India, China and Korea).

| Year | India | China | Korea | Asia-11 mean |
|---|---|---|---|---|
| 1970 | -1.13 | -1.13 | -1.13 | -0.07 |
| 1975 | -1.13 | -1.13 | -1.13 | 0.12 |
| 1980 | -1.13 | -1.13 | -0.09 | 0.45 |
| 1985 | -1.13 | -1.13 | -1.13 | 0.96 |
| 1990 | -1.13 | -1.81 | -0.09 | 0.74 |
| 1995 | -1.13 | -1.13 | -0.09 | 0.96 |
| 1996 | -1.13 | -1.13 | -1.13 | 0.76 |
| 1997 | -1.13 | -1.13 | -1.13 | 0.56 |
| 1998 | -1.13 | -1.13 | -1.13 | 0.41 |
| 1999 | -1.13 | -1.13 | -1.13 | 0.56 |
| 2000 | -1.13 | -1.13 | -1.13 | 0.49 |
| 2001 | -1.13 | -1.13 | -0.09 | 0.49 |
| 2002 | -1.13 | -1.13 | -0.09 | 0.49 |
| 2003 | -1.13 | -1.13 | -0.09 | 0.49 |
| 2004 | -1.13 | -1.13 | -0.09 | 0.49 |
| 2005 | -1.13 | -1.13 | -0.09 | 0.49 |
| 2006 | -1.13 | -1.13 | -0.09 | 0.49 |
| 2007 | -1.13 | -1.13 | 0.18 | 0.36 |
| Change 2000-2007 | 0 | 0 | +1.31 | -0.13 |

0.07 in 1970 (where it was ahead of China and India in 2007) to 0.96 in 1985. After the Asian crisis, *de jure* controls resurfaced; the average score dropped to 0.41 in 1998. The pre-crisis value of 0.96 has not been restored until 2007. However, becasue of the change in definition, because of factors such as money laundering, as well as the inability of the measure to capture easing in controls that do not mean a complete removal of restrictions, some of the progress made by Asian countries in de jure openness in recent years is likely not being picked up by the the Chinn-Ito measure.

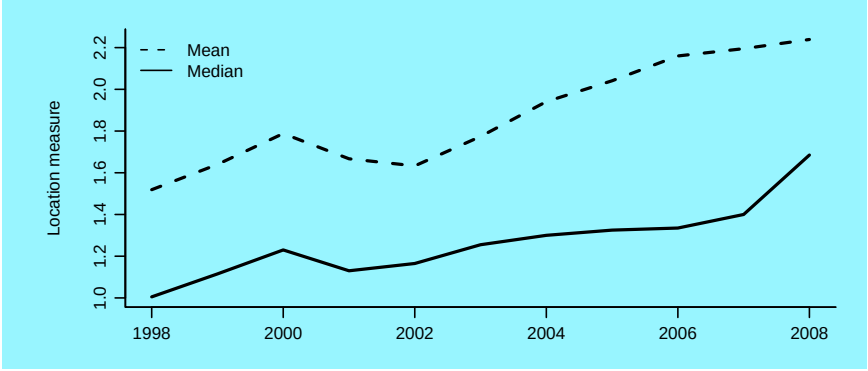
## 2.2 *De facto* capital account openness

### 2.2.1 Evidence from gross flows to GDP

The familiar trade/GDP ratio is defined as the sum of imports and exports, expressed as percent of GDP. This measures trade openness. A simple extension of this idea is the ratio of gross cross border financial flows on the BOP to GDP. This measures financial integration. The ability of the central bank to influence the exchange rate depends on the volume of cross border flows occurring on foreign exchange markets. Even when transactions net out over the year, on a daily basis import payments, export earnings and financial flows influence the exchange rate. In addition, while gross flows comprise both current account and capital account transactions, bigger current account transactions can imply greater capital account openness owing to the cross-border transfers of capital through possible trade misinvoicing. Patnaik *et al.* (2009) shows that greater trade misinvoicing occurs when the current account is bigger and acts as a mechanism to circumvent capital controls. As an example of the unexpected *de facto* capital account integration which comes about once multinational corporations play a substantial role in the economy, see Patnaik and Shah (2009 (forthcoming). Another literature that is linked to these ideas emphasises the

**Figure 3** Average value of gross flows to GDP for Asia-11

This graph focuses on gross flows to GDP – expressed as a ratio – as a measure of gloablisation. A value of 1 corresponds to gross flows in a year which are 100% of GDP in a year.
At each year, two location estimators (the mean and the median) of the values for Asia-11 countries are reported. Both show a considerable pace of integration into the world economy.




two-way links between openness on the current account and the capital account (Aizenman, 2003; Aizenman and Noy, 2004). We therefore look at gross flows on both the trade and capital account as a measure of globalisation of an economy.This takes both trade and financial integration into account.

Figure 3 shows the evolution of the time-series of this measure of globalisation for the Asia-11, excluding Vietnam where data was not available. The median openness went up from roughly 100% of GDP in 1998 to roughly 160% of GDP in 2008. The average shows bigger values, because it is pushed up by very large values seen for small highly open countries like Singapore and Hong Kong.

Table 2 looks closer at individual countries. Both China and India had a slow pace of change until roughly 2000, after which the rate of change of integration went up. In India's case, from 2000 to 2008, there was a rise of 56 percentage points of GDP.

**Table 2** Gross flows to GDP for India, China and Korea

This table reports values for India, China and Korea, and the Asia-11 mean, for gross flows to GDP, a measure of global integration. A value of 1 corresponds to gross flows in a year which are 100% of GDP in a year. This shows a rise of 56 percentage points from 2000 to 2008 for India; a rise of 30 percentage points for China; a rise of 69 percentage points for Korea and a rise of 45 percentage points for the average country.

| Year | India | China | Korea | Mean for Asia-11 |
|---|---|---|---|---|
| 1998 | 0.44 | 0.48 | 0.85 | 1.52 |
| 1999 | 0.47 | 0.49 | 0.85 | 1.64 |
| 2000 | 0.56 | 0.58 | 1.00 | 1.79 |
| 2001 | 0.50 | 0.54 | 0.92 | 1.67 |
| 2002 | 0.53 | 0.56 | 0.76 | 1.63 |
| 2003 | 0.60 | 0.66 | 0.87 | 1.77 |
| 2004 | 0.68 | 0.75 | 0.89 | 1.94 |
| 2005 | 0.82 | 0.84 | 0.94 | 2.04 |
| 2006 | 1.00 | 0.89 | 1.01 | 2.16 |
| 2007 | 1.19 | 0.88 | 1.15 | 2.19 |
| 2008 | 1.12 | 0.88 | 1.69 | 2.24 |
| Change 2000-2008 | +0.56 | +0.30 | +0.69 | +0.45 |

Similar values were observed with China (30 percentage points of GDP), Korea (69 percentage points of GDP) and the Asia-11 average (45 percentage points of GDP).

This evidence suggests that while Asia might be a reluctant liberaliser when it comes to *de jure* controls, there has been a rapid pace of integrating into the world economy, *de facto*.

### 2.2.2 Financial sector development

The extent to which capital controls are effective has a lot to do with domestic financial sector development. When the financial system is sophisticated, over time, the effectiveness of capital controls tends to be eroded. Hence, when thinking about the effectiveness of *de jure* capital controls, it is important to look at the capability of the domestic financial system.

In order to achieve this, we turn to Dorrucci *et al.* (2009), who have developed a database offering panel data about financial sector development in 26 emerging economies. This covers all the Asia-11 countries of interest in this paper, other than Vietnam. The values of this index range from 0 (undeveloped domestic financial system) to 1 (highly capable domestic financial system). We focus on their 'narrow' measure owing to adequacy of frequency of updation.

Figure 4 shows the time-series of the mean and median of the score for the 10 countries of Asia where Dorrucci *et al.* (2009) have information. In both cases, we see significant sophistication of the financial system having built up prior to the Asian crisis, followed by a period of decline. From 2000 onwards, both measures of location show an upward trend.

Table 3 shows numerical values for this measure in India, China, Korea compared with the Asia-11 mean. The highest value for the Asia-11 mean was 0.55 in 1995. In the aftermath of the Asian crisis, this dropped to a low of 0.45 in 2000. After this, Asia-

**Figure 4** Average value of Dorrucci *et. al.* measure of financial sector development of the Asia-11

Dorrucci *et al.* (2009) report a measure of financial sector development across many countries for many years. This figure reports two location estimators (the mean and the median) for the Asia-11 countries over the years.
There was a striking decline in financial sector capability in the aftermath of the Asian crisis. From 2000 onwards, improvements are visible.

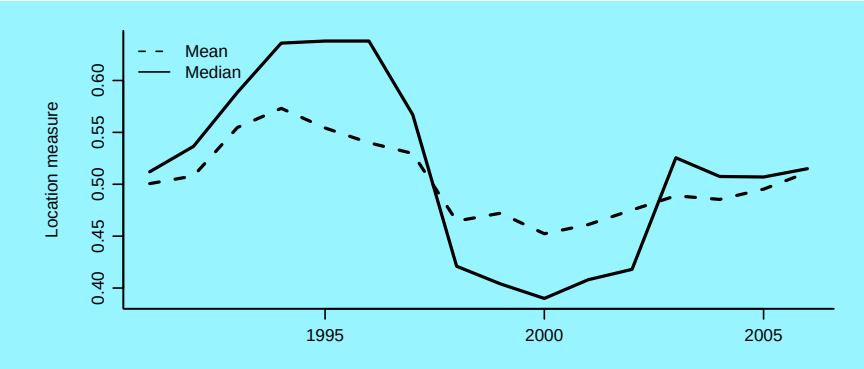


**Table 3** Measure of financial system capability

Dorrucci *et al.* (2009) report a measure of financial sector development across many countries for many years. This table reports values for India, China, Korea and the Asia-11 mean.
In absolute terms, even advanced Asia (i.e. Korea) has values like 0.6 and considerably lags the best values seen in OECD countries like the UK. India and China considerably lag the Asian mean. In all cases, there is a positive but modest pace of change over the 2000-2006 period.

| Year | India | China | Korea | Asia-11 Mean |
|---|---|---|---|---|
| 1991 | 0.28 | | 0.65 | 0.50 |
| 1995 | 0.34 | 0.47 | 0.64 | 0.55 |
| 1996 | 0.34 | 0.45 | 0.65 | 0.54 |
| 1997 | 0.34 | 0.41 | 0.62 | 0.53 |
| 1998 | 0.33 | 0.42 | 0.57 | 0.46 |
| 1999 | 0.34 | 0.40 | 0.61 | 0.47 |
| 2000 | 0.34 | 0.38 | 0.57 | 0.45 |
| 2001 | 0.32 | 0.41 | 0.63 | 0.46 |
| 2002 | 0.32 | 0.42 | 0.62 | 0.48 |
| 2003 | 0.32 | 0.44 | 0.62 | 0.49 |
| 2004 | 0.35 | 0.43 | 0.58 | 0.49 |
| 2005 | 0.36 | 0.43 | 0.58 | 0.50 |
| 2006 | 0.39 | 0.43 | 0.60 | 0.51 |
| Change 2000-2006 | +0.05 | +0.05 | +0.03 | +0.06 |

11 has got back into financial sector development, achieving an average value of 0.51 in 2006.

This evidence suggests that *de jure* controls are likely to have been more effective in the period from 1998 to 2004, where the average score of financial system capability was at low values, when compared with the environment before or after this period.

### 2.2.3 Evidence from the Lane & Milesi-Ferretti database

The second methodology for measurement of *de facto* integration into the world economy is based on the database from Lane & Milesi-Ferretti (Lane and Milesi-Ferretti, 2007). This measures the *stock* of foreign assets and liabilities in the country, by cumulating up the flows on the BOP. This is a valuable database in that it measures the outcomes of a system of capital controls as seen on the BOP. At the same time, it does not measure capital flows that take place through mechanisms such as trade misinvoicing, which involve evasion of capital controls and are not recorded on the BOP.

This database shows that over the years, a substantial scale of capital account *de facto* decontrol has taken place worldwide. Figure 5 shows the kernel density plot of the Lane-Milesi Ferreti measure across all countries. Unlike in Figure 1, the density of *de facto* openness is not bimodal. This graphically conveys that all economies have moved significantly from closed capital accounts to varied levels of open capital accounts. Further, there is no congregation of countries at one level of openness, suggesting that there is no broad understanding of the "appropriate" level of openness. Countries that have *de facto* opened up have continued to open up in a rapid pace.

Figure 6 shows the time-series of the average value of Asia-11 by this measure. The last year for which this data is observed was 2004. The rapid changes of recent years are, hence, missed out. As with the information presented in Figure 3, the sample

**Figure 5** Density of the Lane-Milesi Ferreti measure across all countries: comparing 1970 vs. 2007

This graph shows the kernel density estimator of the cross-sectional distribution of the Lane-Milesi Ferreti measure of *de facto* capital account openness. The black line shows conditions in 1970 and the grey line shows conditions in 2007.
The distributions, unlike Chinn-Ito in Figure 1 are not bimodal, with most countries being largely closed in 1970 and all countries opening rapidly in 2007. There has been a strong shift of probability mass from the left hump (mostlyclosed) into a long tail of openness. This graph gives us the frame of reference for interpreting information from the Lane-Milesi Ferreti database about Asia.

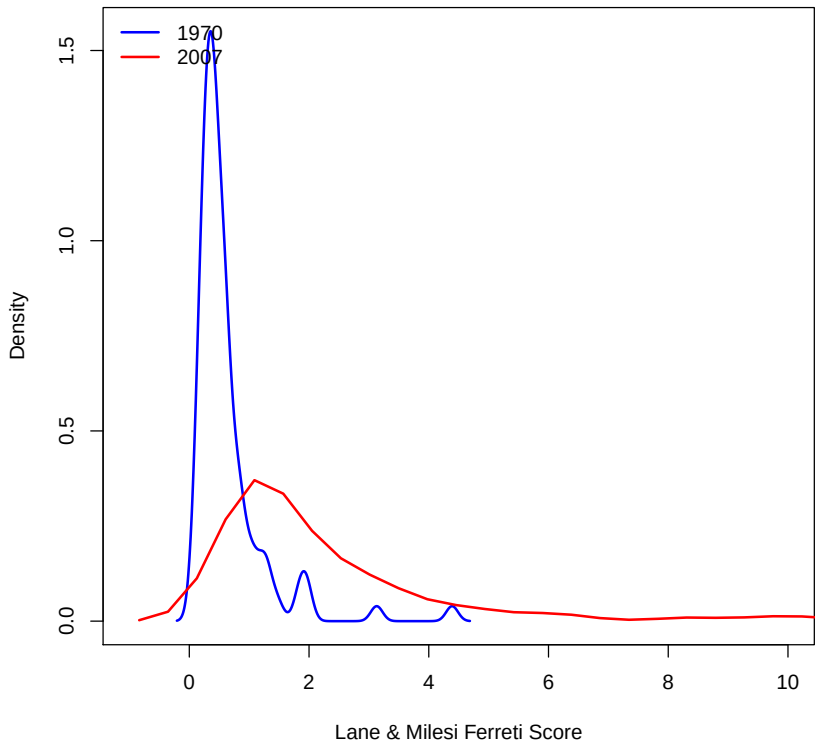


**Figure 6** Average value for Asia-11 of Lane & Milesi-Ferretti measure of *de facto* integration

Lane and Milesi-Ferretti (2007) have a database measuring the external assets and liabilities of countries, expressed as a ratio to GDP. The figure reports two location estimators (the mean and the median) for Asia-11 across time. While the mean value has risen sharply, the median has not. This suggests a small group of countries which are strongly integrating into the world economy while others are not.

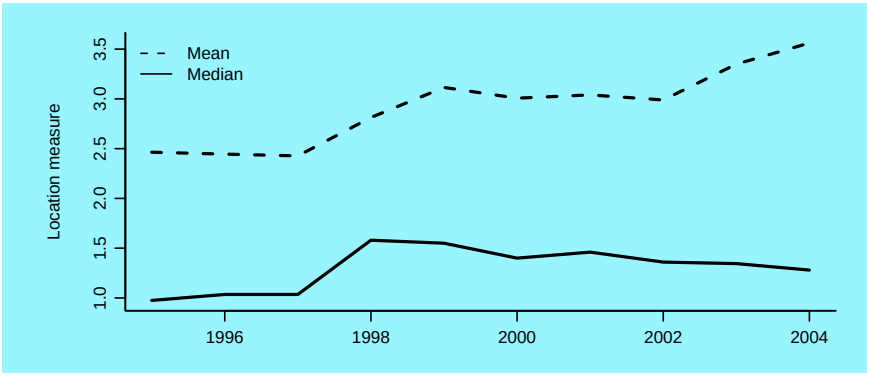


**Table 4** Lane & Milesi-Ferretti measure

Lane and Milesi-Ferretti (2007) have a database measuring the external assets and liabilities of countries, expressed as a ratio to GDP. While the Asia-11 mean shows a value in 2007 of 507% of GDP, this partly reflects the highly open small countries.
In the case of India, China and Korea, more modest values of 85%, 113% and 135% of GDP are seen in 2007. In all cases, the change from 2000 to 2007 is one of strong increases in international economic integration, with changes of 43%, 28%, 56% and 187% of GDP.

| Year | India | China | Korea | Asia-11 mean |
|---|---|---|---|---|
| 1997 | 0.39 | 0.72 | 0.57 | 2.62 |
| 1998 | 0.41 | 0.77 | 1.02 | 2.98 |
| 1999 | 0.41 | 0.82 | 0.97 | 3.33 |
| 2000 | 0.42 | 0.85 | 0.79 | 3.20 |
| 2001 | 0.44 | 0.88 | 0.90 | 3.23 |
| 2002 | 0.49 | 0.92 | 0.88 | 3.15 |
| 2003 | 0.55 | 0.99 | 0.97 | 3.53 |
| 2004 | 0.58 | 1.03 | 1.06 | 3.73 |
| 2005 | 0.57 | 0.93 | 1.09 | 3.74 |
| 2006 | 0.71 | 1.07 | 1.18 | 4.27 |
| 2007 | 0.85 | 1.13 | 1.35 | 5.07 |
| Change 2000-2007 | +0.43 | +0.28 | +0.56 | +1.87 |

mean is pushed upwards owing to the presence of a few small countries which are very open. The median is a better measure of location. The time-series of the median shows relatively little change after 2000.

Turning to specific countries, Table 4 shows a significant pace of *de facto* integration by India, China and Korea after 2000. The change in seven years was 43, 28 and 56 percentage points of GDP respectively.

# 3 Exchange rate regime

## 3.1 Methodology

In the last decade, the literature has revealed that the *de jure* exchange rate regime in operation in many countries that is announced by the central bank differs from the *de facto* regime in operation. This has motivated a small literature on data-driven methods for the classification of exchange rate regimes (Reinhart and Rogoff, 2004; Levy-Yeyati and Sturzenegger, 2003; Calvo and Reinhart, 2002a). This literature has attempted to create datasets identifying the exchange rate regime in operation for all countries in recent decades, using a variety of alternative algorithms. While these databases are useful for many applications, they have limited usefulness in measuring the fine structure of intermediate regimes. As an example, the Reinhart and Rogoff classification sees the Indian rupee as a single exchange rate regime from 1993 onwards. As the evidence ahead shows, there is a fine structure in the post-1993 period which yields fresh insights into the causes and consequences of the exchange rate regime and monetary policy framework.

A valuable tool for understanding the de facto exchange rate regime in operation is a linear regression model based on cross-currency exchange rates (with respect to a suitable numeraire). Used at least since Haldane and Hall (1991), this model was popularized by Frankel and Wei (1994) (and is hence also called Frankel-Wei model). Recent applications of this estimation strategy include Bénassy-Quéré *et al.* (2006), Shah *et al.* (2005) and Frankel and Wei (2007). In this approach, an independent currency, such as the Swiss Franc (CHF), is chosen as an arbitrary 'numeraire'. If estimation involving the Indian rupee (INR) is desired, the model estimated is:

$$d\log\left(\frac{\text{INR}}{\text{CHF}}\right) = \beta_1 + \beta_2 d\log\left(\frac{\text{USD}}{\text{CHF}}\right) + \beta_3 d\log\left(\frac{\text{JPY}}{\text{CHF}}\right) + \beta_4 d\log\left(\frac{\text{DEM}}{\text{CHF}}\right) + \epsilon$$

This regression picks up the extent to which the INR/CHF rate fluctuates in response to fluctuations in the USD/CHF rate. If there is pegging to the USD, then fluctuations in the JPY and DEM will be zero. If there is no pegging, then all the three betas will be different from 0. The $R^2$ of this regression is also of interest; values near 1 would suggest reduced exchange rate flexibility.

To understand the de facto exchange rate regime in a given country in a given time period, researchers and practitioners can easily fit this regression model to a given data window, or use rolling data windows. However, such a strategy lacks a formal inferential framework for determining changes in the regimes. This has motivated an extension of the econometrics of structural change for the purpose of analysing structural change in the Frankel-Wei model (Zeileis *et al.*, 2008). This involves extending the familiar Perron-Bai methodology (Bai and Perron, 2003) for identifying the dates of structural change in an OLS regression. Through this, dates of structural change in the exchange rate regime are identified. We focus on the period after 1976, and utilise weekly changes in exchange rates for these estimations. Values shown in brackets are $t$ statistics.

For each country, a set of sub-periods are identified. In each subperiod, the regression $R^2$ serves as a summary statistic about exchange rate flexibility. Values near 1 convey tight pegs. Floating rates prove to have values of 0.4 to 0.5.

Using this classification scheme we are able to do the following:

- We are able to measure and quantify the fine structure of intermediate regimes, with a real-valued measure of exchange rate inflexibility, the regression $R^2$, which naturally suggests a real-valued measure of exchange flexibility, $1 - R^2$.
- Sharp dates are obtained, at which the exchange rate regime changed. We implement these methods using weekly per-

centage changes of exchange rates, which yields break dates to the resolution of the week. Through this, for each country, a time-series of exchange rate flexibility is obtained, of the value of the $R^2$ which prevailed at a point in time.

- The number of breaks and the placement of breaks is based on sound inference procedures.

## 3.2 Evidence on exchange rate flexibility of Asia-11

We apply this methodology to understanding the *de facto* exchange rate regime of each of the Asia-11 countries. Through this, for each country, a time-series of the currency flexibility is obtained. This leads to summary statistics about exchange rate flexibility in Asia at each point in time.

In India, the rupee began its life as a 'market determined exchange rate' in March 1993. However, this date is not identified as a structural break by the analysis of the data. A single subperiod of the exchange rate regime is found, from 1976 till 1998. In this period, the rupee was *de facto* pegged to the dollar, with a certain degree of exchange rate flexibility, with an $R^2$ of 0.84.

After the Asian crisis subsided, India embarked on a tight rupee-dollar peg. From 28 September 1998 till 19 March 2004, the USD coefficient went back to 1.01. The other coefficents were not economically significant. The $R^2$ rose to 0.97. In this period, the exchange rate regime in India was similar to that found in China after July 2005.

In the last period, India returned to significant exchange rate flexibility. Coefficients for non-dollar currencies have started achieving significant values. The $R^2$ dropped to 0.81. The change in the exchange rate regime which took place in March 2004 was both statistically significant and economically significant.

**Table 5** India's *de facto* exchange rate regime

The methodology of Zeileis *et al.* (2008) is applied to identifying dates of structural break in the exchange rate regression :

$$d\log\left(\frac{\text{INR}}{\text{CHF}}\right) = \beta_1 + \beta_2 d\log\left(\frac{\text{USD}}{\text{CHF}}\right) + \beta_3 d\log\left(\frac{\text{JPY}}{\text{CHF}}\right) + \beta_4 d\log\left(\frac{\text{DEM}}{\text{CHF}}\right) + \epsilon$$

In the Indian case, three distinct sub-periods are visible. While the first and second period clearly shows pegging to the US dollar, other currencies started mattering after March 2004. Exchange rate inflexibility is measured by the $R^2$ of these regressions. It shows a value of 0.81 in the third regime. The values in brackets are standard errors.

| Period | USD | EUR | GBP | JPY | $\sigma_e$ | $R^2$ |
|---|---|---|---|---|---|---|
| 9 Jan '76 - 21 Aug '98 | 1.15 | 0.00 | -0.15 | -0.02 | 0.73 | 0.84 |
| | (0.05) | (0.03) | (0.02) | (0.02) | | |
| 28 Sep '98 - 19 Mar '04 | 1.01 | 0.00 | -0.00 | -0.01 | 0.26 | 0.97 |
| | (0.01) | (0.01) | (0.02) | (0.01) | | |
| 26 Mar '04 - 29 May '09 | 1.24 | -0.35 | -0.15 | -0.05 | 0.77 | 0.81 |
| | (0.05) | (0.08) | (0.04) | (0.03) | | |

**Table 6** China's *de facto* exchange rate regime

The dating methodology of Zeileis *et al.* (2008) reveals a series of break dates for the Chinese exchange rate regime. However, across all these, for all practical purposes, the Chinese exchange rate regime remains a *de facto* peg to the US dollar, with near-zero exchange rate flexibility at all times. The values in brackets are standard errors.

| Period | USD | EUR | GBP | JPY | $\sigma_e$ | $R^2$ |
|---|---|---|---|---|---|---|
| 9 Jan '81 - 1 Nov '85 | 0.76 | 0.33 | -0.10 | -0.06 | 0.72 | 0.89 |
| | (0.13) | (0.06) | (0.04) | (0.05) | | |
| 8 Nov '85 - 5 Apr '91 | 1 | 0 | 0 | 0 | 0 | 1 |
| 12 Apr '91 - 19 May '95 | 0.97 | 0.04 | 0.02 | -0.01 | 0.29 | 0.97 |
| | (0.04) | (0.02) | (0.02) | (0.02) | | |
| 2 Jun '95 - 15 Jul '05 | 1 | 0 | 0 | 0 | 0 | 1 |
| 22 Jul '05 - 29 May '09 | 1.05 | -0.04 | 0.00 | -0.00 | 0.23 | 0.98 |
| | (0.015) | (0.025) | (0.013) | (0.012) | | |

Table 6 shows the results of this estimation strategy for the Chinese Renminbi. It finds that the first period runs from 9 Jan 1981 till 1 November 1985. This was a period with bigger currency flexibility by Chinese standards; the $R^2$ was 0.89. After that, China has always had a tight USD peg. There are relatively minor changes in the exchange rate regime, but it is primarily a simple USD peg with a USD coefficient of 1 and an $R^2 \approx 1$.

In some respects, these results agree with official statements and a simple visual examination of the exchange rate. The break date of 22 July 2005 that is derived from the econometrics is consistent with that announced by the authorities. In these respects, the results for China help us see that the econometric analysis is broadly on the right track.

At the same time, it is important that after 22 July 2005, no further structural change is announced. This contradicts a variety of official claims about the evolution of the exchange rate away from dollar pegging towards a basket peg, and towards greater exchange rate flexibility.

The econometrics suggests that remarkably little has changed about the actual exchange rate regime in operation when compared with the previous regime. The USD coefficient has dropped to 0.949. A statistically significant Euro coefficient has emerged, with a small value of 0.06 where the null hypothesis of 0 can be rejected. The residual standard deviation has more than doubled to 0.243. But the $R^2$ has dropped only slightly to 0.974. While there was more exchange rate flexibility in this period, the change in the exchange rate regime was extremely small.

Finally, in our third single-country example, Table 7 shows the evolution of the exchange rate regime in Korea. From 1981 till early 1995, Korea ran a *de facto* peg to the US dollar. In 1995, a big increase in currency flexibility came about and the $R^2$ dropped to 0.65. This is a regime with greater flexibility than what is found in India.

**Figure 7** The evolution of exchange rate inflexibility in Asia

For each of the Asia-11 countries, the dating methodology of Zeileis *et al.* (2008) is applied. This reveals the *de facto* exchange rate regime that is in operation at all points in time. The regression $R^2$ values across all countries are summarised in this graph. Two location estimators, the mean and the median, are reported. This yields a summary statement of how exchange rate flexibility in Asia has evolved through time.

This graph vividly shows the extreme exchange rate inflexibility in the decade preceding the Asian crisis, which is now understood to have been a key contributor to the crisis.

In the immediate aftermath of the crisis, there was greater flexibility for a brief period, but then 'fear of floating' resurfaced, as was pointed out by Calvo and Reinhart (2002b). However, this graph suggests that exchange rate inflexibility in Asia did not go all the way back to pre-crisis levels.

While Dooley *et al.* (2003) have emphasised the emergence of an Asian-led 'Bretton Woods II' regime, through the last decade, exchange rate inflexibility in Asia has declined at a slow pace.

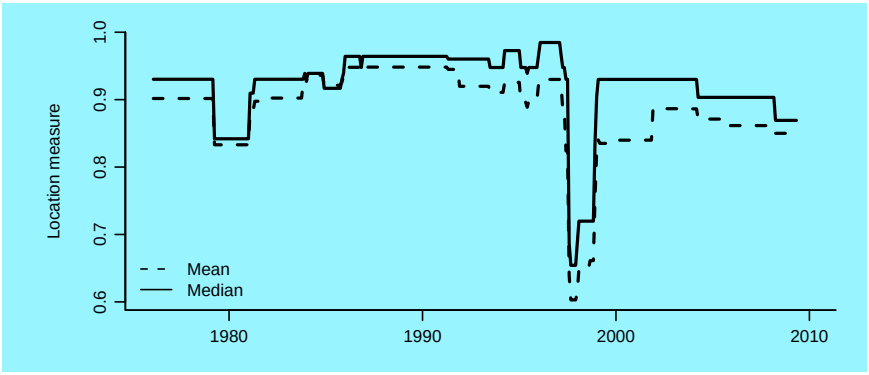


**Table 7** Korea's *de facto* exchange rate regime

The dating methodology of Zeileis *et al.* (2008), applied to Korea, reveals two periods. From 1981 till early 1995, the *de facto* exchange rate regime was a pure USD peg. After that, exchange rate flexibility has gone up considerably; the regression $R^2$ dropped to 0.65. The values in brackets are standard errors.

| Period | USD | EUR | GBP | JPY | $\sigma_e$ | $R^2$ |
|---|---|---|---|---|---|---|
| 24 Apr '81 - 20 Jan '95 | 0.97 | 0.03 | -0.00 | -0.00 | 0.25 | 0.98 |
| | (0.02) | (0.01) | (0.01) | (0.01) | | |
| 27 Jan '95 - 29 May '09 | 1.25 | -0.07 | -0.17 | -0.18 | 1.12 | 0.65 |
| | (0.04) | (0.03) | (0.04) | (0.03) | | |

Figure 7 shows the average and the median value of the $R^2$ of the exchange rate regression for the Asia-11 countries. At each time point, for each country, the exchange rate regime then in operation is identified, and the $R^2$ value from that sub-period is utilised.

The average $R^2$ started out at a high value of 0.9. There was a small increase in flexibility in 1980 and 1981. However, after that, there was a sustained period of exchange rate rigidity. From 1982 till 1997, the average $R^2$ was above 0.9. This inflexibility of the exchange rate, coupled with increasing *de facto* capital account openness, helped lead up to the Asian crisis, which involved firms and banks borrowing in foreign currency based on expectations of exchange rate rigidity.

During the Asian crisis, exchange rate flexibility increased. In 1998, the average $R^2$ dropped to 0.61. However, immediately after that, exchange rate rigidity went up. This empirical fact was brought to prominence by Calvo and Reinhart (2002b), who emphasised that after the Asian crisis, little had changed with exchange rate regimes in Asia. This perspective was further amplified by the 'Bretton Woods II' hypothesis, which tried to rationalise this exchange rate rigidity (Dooley *et al.*, 2003).

Our evidence offers a somewhat different perspective in two respects. First, while the exchange rate inflexibility of Asia-11 rose after the crisis subsided, it went back up to lower values when compared with what prevailed before the crisis. The mean $R^2$ was 0.93 in 1997. Post-crisis, this went back up to 0.88 over the 2002-2004 period.

The second interesting observation is that from 2002 onwards, the exchange rate flexibility of Asia-11 has been slowly rising. The mean $R^2$ dropped slightly from the value of 0.886 which reigned from 2002-2004 to 0.85 in 2009. This suggests that while Asia-11 continues to have considerable exchange rate inflexibility, there is some evidence of gradual movement towards greater flexibility. With an average value of 0.85 in 2009, the environment has changed when compared with the average value of 0.93 in 1997.

# 4 Policy analysis

Table 8 summarises where Asia stands in terms of the choice of the exchange rate regime and capital account openness. There are two important perspectives on this situation: the distinction between *de jure* and *de facto* capital account restrictions, and the extent to which monetary policy autonomy is ceded.

## 4.1 Asia and the impossible trinity

The 'impossible trinity' is the assertion that a country can only have two of three things: exchange rate setting, capital account openness and monetary policy autonomy. In the extreme, a country with a completely open capital account and a completely fixed exchange rate has no monetary policy autonomy.[2] In the

[2]In a recent paper, Aizenman *et al.* (2008) find empirical support for the impossible trinity.

**Table 8** Asia and the impossible trinity

This table summarises key results for the Asia-11. It shows the status of the Asia-11 countries in the most recent observed year.
The exchange rate inflexibility, observed for 2009, draws on the methodology of Section 3.1. The Chinn-Ito database is used for measurement of *de jure* capital controls prevalent in 2007. The Lane Milesi-Feretti measure is used for measurement of *de facto* capital account openness in 2007.

| Country | Exchange rate inflexibility (2009) | Capital account openness *De jure* (2007) | *De facto* (2007) |
|---|---|---|---|
| China | 0.98 | -1.13 | 1.13 |
| Hong Kong | 1.00 | 2.53 | 23.91 |
| India | 0.81 | -1.13 | 0.71 |
| Indonesia | 0.68 | 1.18 | 0.87 |
| Korea | 0.65 | 0.18 | 1.35 |
| Malaysia | 0.92 | -0.09 | 2.22 |
| Philippines | 0.78 | 0.14 | 1.32 |
| Singapore | 0.93 | 2.53 | 10.39 |
| Taiwan | 0.90 | N.A. | 3.37 |
| Thailand | 0.83 | -1.13 | 1.42 |
| Vietnam | 0.87 | -1.13 | 1.30 |
| Mean | 0.85 | 0.195 | 4.08 |
| Median | 0.87 | 0.025 | 1.58 |

typical Asian setting, increasing *de facto* openness has come about through a combination of *de jure* liberalisation coupled with domestic financial sector development, and the evasion of capital controls that become possible with a large current account. Under these conditions, exchange rate inflexibility can lead to distortions of monetary policy. Even though a country might try to regain monetary policy autonomy through financial repression, intensified implementation of capital controls, or sterilisation, the logic of the impossible trinity suggests that exchange rate pegging comes at the cost of autonomy in monetary policy.

Of particular importance in an emerging market setting is the procyclicality of capital flows. When times are good, business cycle conditions are buoyant, capital tends to come into the country. If exchange rate appreciation is prevented by the central bank, this requires buying dollars which ultimately leads to lowered domestic interest rates. Conversely, when times are hard in a business cycle downturn, capital tends to leave the country. When the central bank combats this by selling dollars, this ultimately leads to higher domestic interest rates. The procyclicality of capital flows interacts with exchange rate pegging to induce procyclicality of monetary policy. This is the specific sense, in an emerging market setting, in which monetary policy is distorted.

The status of Asia on the two policy choices of the impossible trinity is diverse with economies with high capital account openness and low or no exchange rate flexibility (Singapore, Hong Kong)and economies that have low capital account openness and inflexible exchange rates (China, India).

In terms of the direction of movement from 2000 to 2008, all the countries have moved towards greater *de facto* openness, other than Malaysia, the Philippines and Indonesia. Exchange rate flexibility went down for Indonesia, was unchanged for most countries, and went up for Malaysia, India and slightly for China.

In the impossible trinity framework a country could have a fixed exchange rate and give up independent monetary policy. This would be consistent with the framework. Open capital account with fixed exchange rate leads to loss of monetary policy autonomy, as has been experienced in Hong Kong. The currency board of Hong Kong is a consistent monetary policy framework, where domestic interest rates fluctuate as a side effect of the exchange rate peg.

Floating exchange rate with open capital account is also well understood. Countries with floating exchange rates turn out to have an $R^2$ in the exchange rate regression of 0.4 to 0.5. These countries are able to achieve open capital accounts and monetary policy autonomy. The Asian country which is closest to that zone is Korea, and the country which has made the biggest movement towards that was India.

The interesting questions lie with those economies with low capital account openness and inflexible exchange rates. If a country had an inflexible exchange rate and a *de facto*closed capital account – with gross flows on the BOP of well below 40% of GDP – then it could obtain monetary policy autonomy. As an example, in the late 1980s, India appears to have enjoyed monetary policy autonomy, where exchange rate inflexibility was combined with gross flows to GDP of roughly 25%. In either 2000 or in 2008, none of the Asia-11 countries occupy that region of the graph.

The country closest to this arrangement in 2008 is China, which is attempting to have negligible exchange rate flexibility while having considerable capital account openness. It is hence of considerable importance to ask the question: *Has China been able to preserve monetary policy autonomy?*

Many authors have examined the details of Chinese monetary policy, with a focus on issues such as mechanisms of sterilisation, measurement of sterilisation coefficients, and the interplay between sterilisation and the banking system. In our treatment, we treat all these as intermediate factors that influence the end

outcome of monetary policy: the short-term interest rate of the economy. In order to understand the extent to which monetary policy has been pro-cyclical, it is not essential to examine these intermediate features. Instead, we re-express the short-term interest rate in China in real terms, and juxtapose it against business cycle conditions. This allows us to assess the extent to which interest rates were high in a business cycle expansion and vice versa, or whether such counter-cyclicality of monetary policy failed to arise.

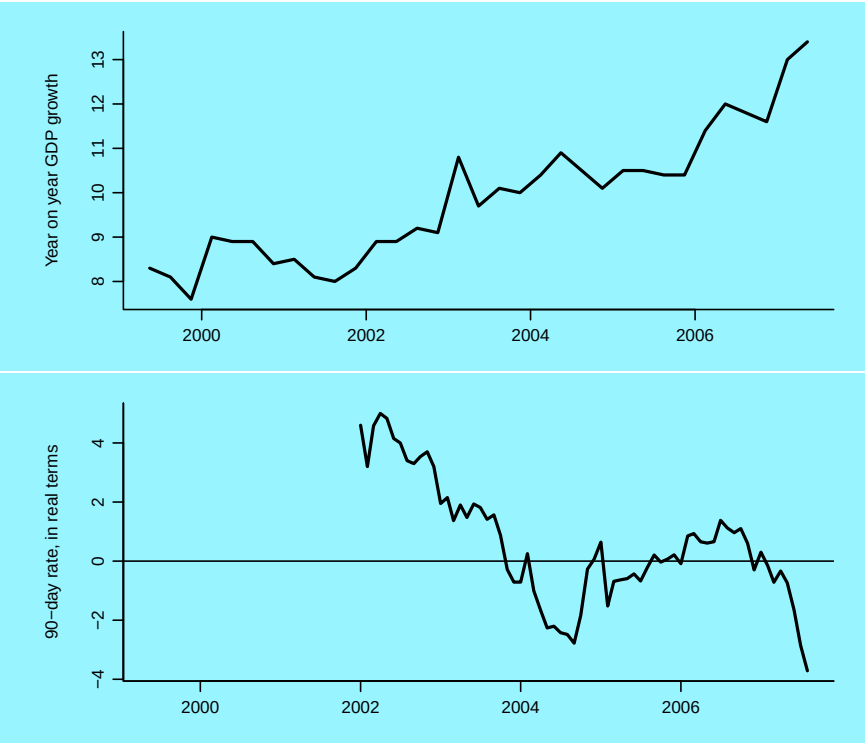
Figure 8 examines the extent to which monetary policy in China became procyclical in the recent business cycle expansion. In the figure, the time-series of quarterly GDP growth measures Chinese business cycle conditions. This shows an enormous boom in GDP growth from 2002 onwards till 2007. Juxtaposing this against the 90-day treasury bill rate (expressed in real terms), we see that from 2002 till early 2008, the real rate dropped by an enormous 800 basis points. This suggests that in good times, monetary policy was expansionary. This is consistent with the idea that exchange rate pegging converts the pro-cyclicality of capital flows into pro-cyclicality of monetary policy. The use of loose monetary policy at a time of an unprecedented business cycle expansion, in both countries, helped induce an acceleration of inflation and an asset price boom.

This 800 basis point decline in the real rate, in an unprecedented business cycle expansion, suggests that China was not able to avoid the impossible trinity through sterilised intervention or other techniques based on either capital controls or financial repression. While a wide variety of these measures were attempted, they did not avoid the ultimate outcome: the only way to obtain the pegged exchange rate was to have a very low interest rate in real terms.

A similar analysis can be conducted for India, with similar results. Even though India had more exchange rate flexibility than China, monetary policy was ultimately forced to yield negative

**Figure 8** Chinese monetary policy and the Chinese business cycle

The time-series of Chinese quarterly GDP growth is used as a measure of business cycle conditions. The short-term nominal rate of the economy is re-expressed in real terms using current inflation rates, to obtain the time-series of the real rate. The broad picture is one where the real rates attained low values in an unprecedented business cycle expansion.



real rates in the expansion and switch around to positive real rates in the downturn.[3] China and India are in the best position, in Asia, to try to preserve monetary policy autonomy despite having exchange rate inflexibility, given relatively modest values of *de facto* openness and a poorly developed domestic financial system. However, the evidence suggests that even in these two countries, exchange rate pegging resulted in procyclicality of monetary policy.

The constraints of the impossible trinity are likely to be even more acute in Malaysia, Taiwan, and Thailand, all of which have more *de facto* openness than China and India, better developed financial systems than China or India but have less exchange rate flexibility than India.

Among Asian Economies, Korea has made the most progress towards the mainstream configuration of industrial countries, where the capital account is open and the exchange rate floats. Korea has high capital account openness, and the most flexible exchange rate in Asia. It has made considerable progress on establishing the institutional capability of a central bank. However, the Korean exchange rate regime, with an $R^2$ of 0.65, lags the flexibility seen with floating rates where the $R^2$ attains values of 0.4 to 0.5

Financial sector development and *de facto* openness in the Philippines and Indonesia are low. Hence, in principle, these countries could possibly have chosen to have exchange rate pegging and try to not lose monetary policy autonomy. Among the Asia-11 countries, these are the two countries where it can most be attempted, where the monetary policy distortions associated with exchange rate inflexibility would be the lowest. Despite this, these countries have chosen to have considerable exchange rate flexibility.

[3]For a detailed analysis of the procyclicality of monetary policy in India, see Patnaik and Shah (2009); Bhattacharya *et al.* (2008); Patnaik (2007).

# 5 Choice of regime

The rationale for the choice of a tight peg in contrast to a more flexible rate can be many. First, the central bank may try to prevent depreciation in the context of high exchange rate pass through to keep inflation under control. Alternatively, if a large number of firms have large dollar borrowings, the problem of the 'original sin', the central bank may try to prevent large depreciations to protect the balance sheet of these companies. Under such conditions, the central bank may lean against the wind when there is downward pressure on the exchange rate and prevent depreciation by selling foreign exchange reserves.

Similary, in a different context central banks may prevent appreciation of the currency. Capital inflows to emerging economies since the early 2000s have put pressure on their exchange rates to appreciate. During this period some emerging economies, such as countries in Asia, have, been pursuing policies of export led growth(Rodrik, 2007). Allowing the exchange rate to appreciate can put at risk a country's policy of promoting export led growth through an undervalued exchange rate. The exchange rate regimes of most emerging markets in this period have been *de jure* managed floats. Thus, these countries intervene in foreign exchange markets to prevent appreciation of the exchange rate. Ramachandran and Srinivasan (2007); Pontines and Rajan (2008) find evidence to support the hypothesis that Asian countries have intevened in foreign exchange market to prevent currency appreciation. The rationale for doing so may lie in the large share of exports to GDP in many of these economies.

# 6 Conclusion

The main argument of this paper is that it is more important to avoid an inconsistent monetary policy framework than it is

to avoid capital account liberalisation. While Asia has avoided *de jure* capital account liberalisation, integration into the world economy has continued, *de facto*.

Asia-11 countries have moved forward on a program of domestic financial sector liberalisation. The average value of the Dorrucci *et al.* (2009) measure of domestic financial system capability went up from a low point of 0.45 in 2000 to 0.51 in 2006. The effectiveness of capital controls is diminished when the financial system is sophisticated, and growing current account integration gives economic agents the opportunity to engage in illegal transfers of capital. All countries increased *de facto* capital account openness from 2000 to 2008, other than Indonesia, Philippines and Malaysia.

Increasing *de facto* integration poses questions about the evolution of the exchange rate regime. Figure 7 shows that on average, Asian exchange rate regimes have moved towards greater flexibility when compared with the 'fear of floating' period which came immediately after the Asian crisis. At the same time, the *de facto* arrangement shows considerable exchange rate pegging. None of the Asia-11 countries is a floating exchange rate. The country with the most exchange rate flexibility – Korea – is not yet at a floating rate. From 2000 to 2008, Malaysia and India moved towards greater flexibility, and China moved towards slightly more flexibility. Apart from this, Asia-11 largely appears to be on a trajectory with increasing *de facto* openness and a lack of reform of the monetary policy regime.

The approach of deepening *de facto* capital account openness, coupled with exchange rate rigidity, has two consequences:

- Central banks seeking exchange rate rigidity could have to distort the policy rate in order to achieve exchange rate targets. To the extent that capital flows are procyclical, exchange rate pegging would generate procyclical monetary policy. A key observation of this paper lies in the extent of procyclicality of China and India, the countries

with lower financial system capability and lower *de facto* openness than most of Asia. If these countries are unable to avoid procyclical monetary policy when implementing exchange rate inflexibility, then these problems would be present in other Asian countries to a greater extent.

- Systemic crises could also arise. Asian countries continue to experience dogfights between speculators and central banks, problems with unhedged foreign currency borrowing by corporations, and other consequences of an inconsistent monetary policy regime. Bigger problems in the future cannot be ruled out, particularly in Malaysia and Taiwan where there is an awkward combination of (a) considerable *de facto* openness, (b) sophisticated domestic financial systems and (c) exchange rate inflexibility comparable to that of China.

From the viewpoint of systemic crises, the key source of problems lies in households, banks and corporations which count on exchange rate rigidity. When it is felt that exchange rate fluctuations will not take place, substantial exchange rate exposures build up. This leads to difficulties when large exchange rate movements take place. Hence, the first stages of reform should emphasise exchange rate flexibility and the development of currency derivatives markets. Exchange rate flexibility would give economic agents the incentive to do risk management, and currency derivatives markets would give them the ability to execute desired trades. Asia is, by and large, disregarding this wisdom on sequencing, by moving forward on *de facto* capital account openness before bringing in the currency flexibility.

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# A Appendix: Exchange rate regime analysis

In the main text of the paper, we have shown the results for three countries, namely India, China and Korea. Results for the remaining 8 countries are in this appendix.

## A.1 Hong Kong

| start | end | r2 | US | DUR | GBP | JPY | Variance |
|---|---|---|---|---|---|---|---|
| 1991-01-11 | 1995-01-20 | 1.00 | 1.02 | -0.02 | 0.00 | -0.01 | 0.01 |
| | | | 75.38 | -2.38 | 0.39 | -0.88 | |
| 1995-01-27 | 2000-12-15 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | 441.65 | 0.25 | 0.92 | 3.83 | |
| 2000-12-22 | 2003-09-19 | 1.00 | 1.00 | 0.00 | 0.00 | -0.00 | 0.00 |
| | | | 1822.53 | 0.96 | 0.10 | -0.10 | |
| 2003-09-26 | 2009-05-29 | 1.00 | 0.98 | 0.01 | 0.00 | 0.01 | 0.01 |
| | | | 218.94 | 1.33 | 0.01 | 2.54 | |

## A.2 Indonesia

| start | end | r2 | USD | DUR | GBP | JPY | Variance |
|---|---|---|---|---|---|---|---|
| 1991-11-15 | 1997-07-11 | 0.98 | 1.03 | 0.00 | -0.02 | -0.01 | 0.05 |
| | | | 35.03 | 0.15 | -1.65 | -1.23 | |
| 1997-07-18 | 2001-11-09 | 0.16 | 1.10 | -0.22 | 0.00 | -0.13 | 12.68 |
| | | | 4.40 | -2.12 | 0.01 | -0.87 | |
| 2001-11-16 | 2009-05-29 | 0.68 | 1.35 | -0.32 | -0.14 | -0.08 | 1.55 |
| | | | 22.72 | -2.79 | -2.33 | -1.57 | |

## A.3 Philippines

| start | end | r2 | USD | DUR | GBP | JPY | Variance |
|---|---|---|---|---|---|---|---|
| 1991-11-15 | 1995-12-29 | 0.65 | 0.86 | 0.07 | -0.02 | -0.03 | 1.49 |
| | | | 4.64 | 0.73 | -0.24 | -0.49 | |
| 1996-01-05 | 1997-07-04 | 1.00 | 1.01 | 0.01 | -0.01 | -0.01 | 0.00 |
| | | | 49.36 | 0.69 | -1.82 | -2.23 | |
| 1997-07-11 | 1998-11-20 | 0.30 | -1.14 | 0.83 | 0.27 | -0.45 | 4.63 |
| | | | -1.94 | 2.67 | 0.91 | -3.89 | |
| 1998-11-27 | 2009-05-29 | 0.78 | 1.12 | -0.01 | -0.08 | -0.02 | 0.69 |
| | | | 33.29 | -0.51 | -2.40 | -0.83 | |

## A.4 Singapore

| start | end | r2 | USD | DUR | GBP | JPY | Variance |
|---|---|---|---|---|---|---|---|
| 1991-01-11 | 1997-07-11 | 0.94 | 0.98 | -0.12 | 0.02 | 0.10 | 0.11 |
| | | | 23.26 | -5.58 | 1.09 | 6.47 | |
| 1997-07-18 | 1999-01-08 | 0.31 | 0.17 | -0.04 | 0.44 | 0.21 | 1.52 |
| | | | 0.98 | -1.15 | 2.33 | 3.07 | |
| 1999-01-15 | 2009-05-29 | 0.84 | 0.63 | 0.26 | 0.08 | 0.09 | 0.25 |
| | | | 31.39 | 6.80 | 3.83 | 5.92 | |

## A.5 Thailand

| start | end | r2 | USD | DUR | GBP | JPY | Variance |
|---|---|---|---|---|---|---|---|
| 1991-01-11 | 1997-05-16 | 0.99 | 1.02 | -0.09 | 0.01 | 0.07 | 0.02 |
| | | | 65.31 | -11.39 | 1.18 | 12.36 | |
| 1997-05-23 | 1998-09-25 | 0.06 | 0.73 | -0.42 | -0.01 | 0.21 | 4.82 |
| | | | 0.98 | -1.16 | -0.03 | 1.06 | |
| 1998-10-02 | 2009-05-29 | 0.67 | 0.71 | 0.10 | 0.08 | 0.12 | 0.81 |
| | | | 20.53 | 3.87 | 2.31 | 4.75 | |

## A.6 Taiwan

| start | end | r2 | USD | DUR | GBP | JPY | Variance |
|---|---|---|---|---|---|---|---|
| 1991-01-11 | 1997-07-25 | 0.93 | 1.02 | -0.07 | 0.03 | 0.05 | 0.17 |
| | | | 20.24 | -2.82 | 1.49 | 2.52 | |
| 1997-08-01 | 1998-10-30 | 0.35 | 0.90 | -0.26 | 0.20 | 0.23 | 1.32 |
| | | | 2.29 | -1.38 | 1.21 | 3.68 | |
| 1998-11-06 | 2009-05-29 | 0.86 | 0.77 | 0.02 | 0.11 | 0.06 | 0.29 |
| | | | 35.75 | 1.09 | 5.40 | 3.55 | |