CHOICE OF EXCHANGE RATE REGIME: CURRENCY BOARD (HONG KONG) OR MONITORING BAND (SINGAPORE)?

RAMKISHEN S. RAJAN* and REZA SIREGAR**
University of Adelaide

Following the East Asian crisis, a number of observers have advocated that small and open economies in Asia adopt an irrevocably fixed regime. Such a hard peg, it is argued, signals greater commitment to rule out arbitrary exchange rate adjustments as well as the authorities' willingness to subordinate domestic policy objectives such as output and employment growth to the maintenance of the pegged exchange rate. But is this a reasonable position to adopt? In order to answer this question, we consider and contrast the experiences of Hong Kong and Singapore. While both of these economies share a number of broad similarities, the former operates a US dollar-linked currency board arrangement and the latter maintains an adjustable peg in the form of a monitoring band arrangement with the central parity based on an undisclosed trade-weighted currency basket.

I. Introduction

The wave of financial crises in developing economies in East Asia and elsewhere over the past decade has brought to fore a number of theoretical issues and puzzles, many of which have important implications for economic policy. Uppermost among these is the perennial issue of the appropriate exchange rate regime for small and open economies. The seeming frequency with which 'soft' or 'adjustable' pegs have been broken has led to a growing conviction that developing economies must adopt corner solutions to exchange rates arrangements. In other words, it is increasingly argued that the only viable exchange rate option for such economies is flexibility, on the one hand, or firm fixing, on the other.

There is a large and growing body of literature which shows that countries with flexible regimes have experienced 'excessive' volatility over the last few decades, with consequent negative impacts on trade, investment and growth (Bird and Rajan, 2001).[1] Even in the absence of a negative effect on *the level* of investment, insofar as flexible regimes have commonly been associated with currency misalignments, a flexible regime could have an adverse influence on the *composition* of investment as decisions may be based on disequilibrium prices. Correspondingly, the irrevocably fixed corner has gained widespread appeal. A currency can be made irrevocably or credibly fixed in one of three ways:

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* Correspondence: School of Economics, University of Adelaide, Australia. Email: ramkishen.rajan@adelaide.edu.au.

** School of Economics, University of Adelaide, Australia. Email: reza.siregar@adelaide.edu.au.

[1] Siregar and Rajan (2002) examine the impact of currency volatility on Indonesia's external trade sector.

maintaining a Currency Board Arrangement (CBA), effectively abandoning the domestic currency for a new currency (monetary union), or using domestically the currency of another country.

While Eichengreen (1999) has concluded that a single, regional currency zone may be the most attractive choice for small and open economies in the long run, such an option is politically, if not economically, nonviable in East Asia anytime in the near future (Rajan, 2000). What are the other alternatives? In principle, countries could unilaterally abandon the domestic currency altogether by using domestically the currency of another country. Nonetheless, the relatively low levels of *de facto* dollarisation in East Asia, on the one hand, and the economically significant role played by Japan and the yen in the region, on the other, implies that dollarisation (let alone eurorisation or yenisation) is not a practicable policy option. In addition, no matter what the cost-benefit calculus, political compulsions may preclude the adoption of such a policy in East Asia (national moneys often being seen as a symbol of national sovereignty).

For proponents of the corners hypothesis this seems to leave a CBA as the sole alternative. Such a hard peg is supposed to be 'transparent and verifiable' (Frankel *et al.*, 2000). It is understood to signal greater commitment to rule out arbitrary exchange rate adjustments (i.e. the 'escape clause' cannot be invoked) along with the authorities' willingness to subordinate domestic policy objectives such as output and employment growth to the maintenance of the pegged exchange rate. But is this a reasonable position to adopt? Would East Asian economies be well advised to heed this policy recommendation?

In order to shed further light on these questions we consider the experiences of Hong Kong and Singapore between 1983 and 2000. The choice of these two economies is dictated by the fact that both of them are small and open ones with broadly similar economic structures with a heavy dependence on the services sector (Table I). They are both important regional financial centres with strong trade and investment linkages with the rest of East Asia. This in turn exposes them to somewhat comparable external shocks such as the contagious fallout from the East Asian financial crisis of 1997–98.[2] Importantly, both Hong Kong and Singapore have boasted the soundest macroeconomic and financial 'fundamentals' in the region and possess fairly high degrees of internal flexibility (Rajan, Sen and Siregar, 2002). These broad commonalties notwithstanding, Singapore has operated a soft peg based on a trade weighted currency basket while the Hong Kong dollar is rigidly pegged to the US dollar via a CBA. With these two economies, we appear to have a rare opportunity to undertake as close to a controlled laboratory experiment as one could hope for in real world international macroeconomics.

The remainder of this paper is organised as follows. The next section offers a broad-brush review of the exchange rate policies and macroeconomic performances of Hong Kong and Singapore as well as highlights trends in real and nominal effective exchange rates and export competitiveness in the two economies. Section III briefly discusses the concept of the Natural Equilibrium Real Exchange Rate (NATREX) developed by Stein (1994, 1996), focusing specifically on its operationalisation. Section IV goes on to estimate the equilibrium real exchange rate (i.e. NATREX) for both currencies, an issue that is of paramount importance to

[2] Of course, there are at least two notable differences between these two cities. One, while Hong Kong is heavily dependent on Mainland China, Singapore is relatively more reliant on, and therefore exposed to, its Southeast Asian neighbours, Malaysia in particular (Rajan, Sen and Siregar, 2002). Two, the services sector is a relatively much larger share of GDP in Hong Kong than in Singapore, the latter still possessing a fairly strong manufacturing base (consisting of disk drives, semiconductors and related electronics industries as well as budding ones like biotechnology).

Table I Share of key sectors in GDP (in per cent), GDP *per capita* and population

	1985		*1990*		*1995*		*1998*	
Sectors	*HK*	*SG*	*HK*	*SG*	*HK*	*SG*	*HK*	*SG*
Manufacturing	20.69	24.63	16.88	29.30	7.87	24.12	6.20	23.12
Construction	4.67	12.34	5.19	5.45	5.08	7.46	6.10	9.44
Trade, Hotel & Restaurants	21.33	17.19	24.16	17.36	25.11	19.98	24.00	18.85
Transport & Communication	7.59	13.04	9.09	13.49	9.49	12.26	9.30	11.17
Finance	15.00	24.88	19.42	24.95	23.02	30.25	25.60	30.18
Total Share of GDP	69.28	92.08	74.74	90.55	70.57	94.07	71.2	92.76
GDP *per capita* (in US$)	6391	7126	13110	13556	22618	28019	24889	26694
Population (in millions)	5.45	2.48	5.70	2.71	6.16	2.99	6.69	3.16

Notes:
HK: Hong Kong; and SG: Singapore.
Source:
ICSEAD (2000).

export-oriented economies. In particular, we attempt to ascertain whether there is any clear evidence of structural misalignment in the two currencies. We also endeavour to answer the more general question as to whether Hong Kong's rules-based CBA has 'outperformed' the more flexible and discretionary intermediate regime pursued by Singapore over the last two decades, and in particular, during the 1997–98 East Asia financial crisis. The final section concludes the paper with an extended discussion of the cost-benefit calculus of the exchange rate arrangements of the two economies and draws out some policy options.

II. Exchange Rate Arrangements in the Twin Cities

II.1 *The Hong Kong's CBA*

Hong Kong adopted the CBA in October 17, 1983. The Hong Kong dollar has since been fixed at the nominal rate of 1 US dollar to 7.75 Hong Kong dollars. A one per cent bandwidth regulates the fluctuation of the nominal rate of Hong Kong dollar vis-à-vis the US dollar. During the initial period of the CBA, the Hong Kong Monetary Authority (HKMA) passively followed the automatic adjustment mechanism of the CBA. However, between 1988 and 1998, Hong Kong has been characterised as having moved from a 'rule-bound regime' to a 'regime in which active discretionary interventions were pursued'. This is so as the HKMA introduced several key monetary instruments which allowed the policy makers to engage in more discretionary intervention in the money and foreign exchange markets (Kwan *et al.*, 1999).

During the height of the East Asian financial crisis the Hong Kong Special Administrative Region (SAR) government reaffirmed its commitment to the linked exchange rate system and an adherence to the discipline of the CBAs. Tsang (1998) cited three reasons for the firm stand on the CBA. First, a floating exchange rate regime for a financial centre like Hong Kong was thought to have carried considerable instability and uncertainty, particularly at a time when the territory was going through a very politically sensitive transition period. Second, being a small open economy, doubts were expressed as to whether a floating regime would actually allow for much monetary 'autonomy' (see Hausmann *et al.*, (2000) for an elaboration of this point in general). Third, Hong Kong's high level of internal flexibility to absorb external shocks appeared to make it a particularly good candidate for a hard peg.

II.2 *Singapore's monitoring band*[3]

While the Singapore exchange regime has maintained a basic element of the CBA in the sense that the currency in circulation is 100 per cent backed by international assets for currency issuing, this is primarily done to maintain public confidence in the currency. The Monetary Authority of Singapore (MAS) has, since 1975, managed the Singapore dollar against an undisclosed basket of currencies of Singapore's main trading partners and competitors. The central parity is determined on the basis of countries that are the main sources of imported inflation and competition in export markets. Estimates of derived weights suggest that the US dollar had a weight of about 0.6, the remainder being divided between the yen and other currencies (Table II). Neither the central parity nor the bandwidth is completely fixed, being periodically reviewed so as to ensure that they are 'consistent with economics fundamentals and market conditions'.

The MAS seems effectively to have adopted a 'monitoring band' as opposed to a more conventional 'crawling band', in which there is an obligation to defend the edges of the band. The obligation in the case of a monitoring band is 'instead to avoid intervening within the band' (notwithstanding intermittent interventions) to 'smooth out exchange rate fluctuations as opposed to trying to defend the currency' (Williamson, 1998). To illustrate the degree of flexibility of the Singapore exchange rate policy, we note that the MAS allowed the Singapore dollar to depreciate by about 20 per cent during the height of the East Asian crisis; while more recently, it is believed to have intervened heavily in the market to prop up the Singapore dollar during the bearishness against regional currencies following sharp falls in the NASDAQ (*The Straits Times*, May 12, 2000).[4] Admittedly, some may interpret this sort of monitoring band as being little different from a dirty floating regime. However, unlike a floating regime, under a monitoring band, the threat of possible intervention by the monetary authority may suffice to reduce speculative attacks. The point of a monitoring band (or a crawling band with soft edges) is that if the authority decides that market pressures are 'overwhelming' it can choose to allow the rate to take the strain even if this involves the rate straying outside the band (Williamson, 1998).

II.3 *Comparative macroeconomic performance, 1984 to 1998*

Table III summarises some key macroeconomic indicators in Hong Kong and Singapore for the period between 1984 and 1998. As can be seen, while both economies have had comparably low unemployment rates, Singapore has, since the 1990s, consistently outperformed Hong Kong, both in terms of having experienced faster economic growth rates and lower rates of inflation. The differences in economic performances were particularly stark in the midst of the regional financial crisis. Open unemployment inevitably rose in both economies in 1998. However, while Hong Kong's GDP fell by 5 per cent (as opposed to an average expansion of over 5 per cent growth in the 1990s), Singapore was one of the few economies in East Asia to have staved off outright contraction that year (though the 1 per cent growth was sharply down from an average growth of almost 9 per cent in the late 1980s and mid 1990s) (see Rajan, Sen and Siregar, 2002 for details).

[3] See Lu and Yu (1999) for a discussion of the historical background, evolution and institutional arrangements supporting Singapore's managed exchange rate regime.
[4] Even more recently, the downward movement of the Japanese yen from 105 yen per US$ in December 1999 to a three year low of 133 yen by mid January 2002, was matched by a sliding trajectory of the Singapore dollar from S$ 1.7 per US$ to S$ 1.84 by January 2002.

Table II Derived currency weight of crisis-hit Southeast Asian economies, 1979–1995

	Frankel and Wei (1994)[a]		*Kwan (1995)*[b]	
Currency	*US dollar*	*Yen*	*US dollar*	*Yen*
Indonesian rupiah	0.95	0.16	0.99	0.00
Malaysian ringgit	0.78	0.07	0.84	0.04
Philippine Peso	1.07	−0.01	1.15	−0.24
Thai baht	0.91	0.05	0.82	0.11
Singapore dollar	0.75	0.13	0.64	0.11
Region-wide	0.93	0.07	0.95	0.00

Note:
[a] based on weekly movements for the period January 1992 to May 1992.
[b] based on weekly movements for the period January 1991 to May 1995.

Table III Selected key macroeconomic indicators

	Unemployment (per cent)[a]		*GDP Growth (per cent)*		*Inflation (per cent)*[b]	
Year	*HK*	*SG*	*HK*	*SG*	*HK*	*SG*
1984–1990	2.24	3.61	6.90	7.0	8.20	2.20
1991–1997	2.26	2.58	5.27	8.81	6.80	2.80
1997	2.48	2.45	5.15	8.80	5.80	1.40
1998	4.80	3.20	−5.00	0.50	2.40	0.50

Notes:
[a] Open Unemployment.
[b] Annual Changes of GDP Deflator.
HK: Hong Kong; and SG: Singapore.
Source:
ICSEAD (2000).

II.4 *Trends in effective exchange rates and export competitiveness*

Figures 1 and 2 indicate close comovements in the real effective exchange rate (REER) and nominal effective exchange rate (NEER) series for both economies. As can be seen, Hong Kong has, on average, experienced a stronger appreciation of its REER than its NEER. In contrast, the appreciation of Singapore's NEER outpaced that of its REER.[5] Based on these trends, one might have expected Hong Kong's export performance to lag behind that of Singapore's. In fact, overall merchandise export performance remained strong in both economies, growing at an average annual rate of 10.5 per cent for Hong Kong and 11.4 per cent for Singapore since early 1980s (Figures 3 and 4). When we decompose the overall exports into its two components of domestic exports and re-exports, a contrasting trend emerges. Most of Hong Kong's exports were attributed to re-exports, particularly since 1990. Domestic exports stagnated between the period of 1990 and 1995 and have declined since 1996. In the case of Singapore, both domestic exports and re-exports contributed to the impressive performance of overall exports.

In summary, the relatively more rapid rise in Hong Kong's REER compared to its NEER may have had some implications for the performance of the economy's domestic exports. The rapid

[5] An increasing trend in the REER and NEER implies an appreciation of the domestic currency. A stronger appreciation of the REER than the NEER implies that the domestic price level is rising faster than the prices of the major trading partners.

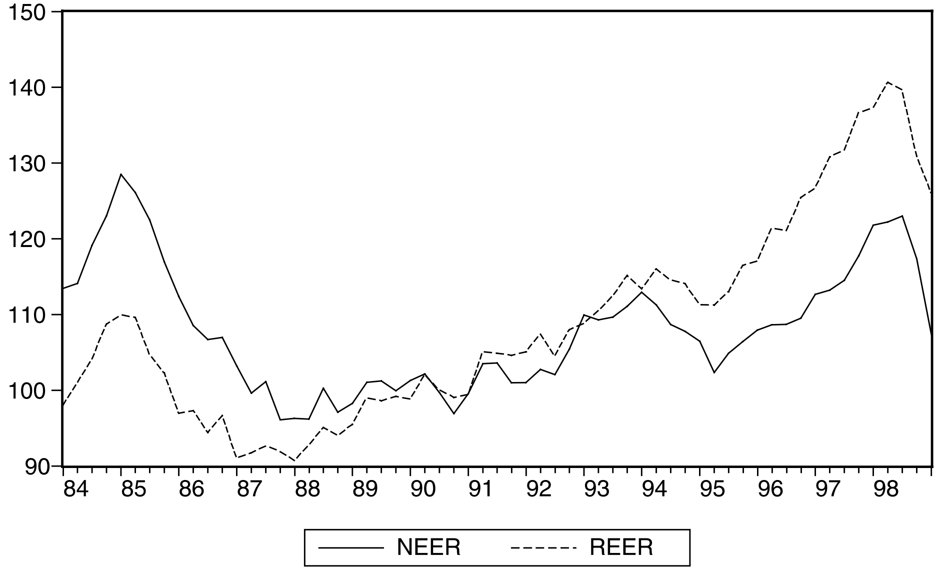

Figure 1. Hong Kong Dollar's Nominal Effective Exchange Rate (NEER) and Real Effective Exchange Rate (REER). *Note*: A rise in the index implies an appreciation of the Hong Kong dollar against the country's major trading partners' currencies. *Source*: IFS, IMF (various years) and J. P. Morgan exchange rate index series (1990 = 100)

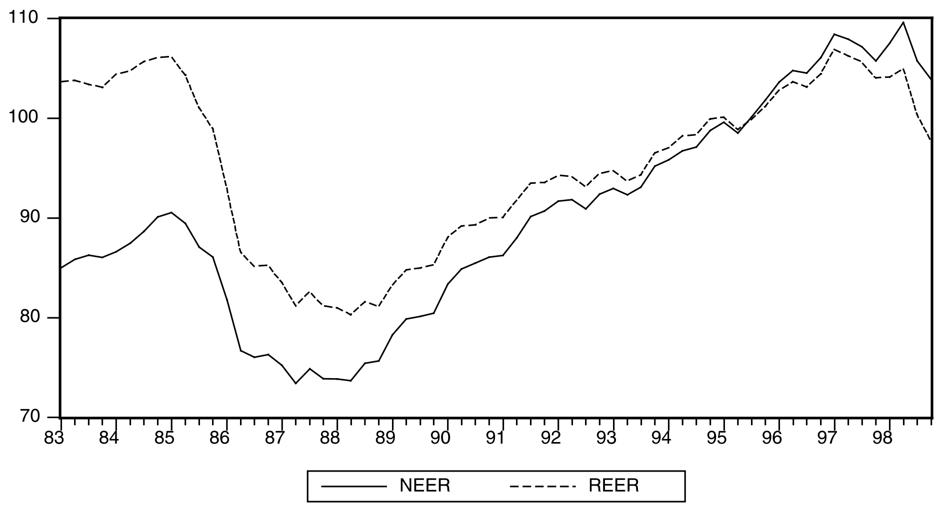

Figure 2. Singapore Dollar's Nominal Effective Exchange Rate (NEER) and Real Effective Exchange Rate (REER). *Note*: A rise in the index implies an appreciation of the Singapore dollar against the country's major trading partners' currencies. *Source*: IFS, IMF (various years) and J. P. Morgan exchange rate index series. (1995: Q1 = 100)

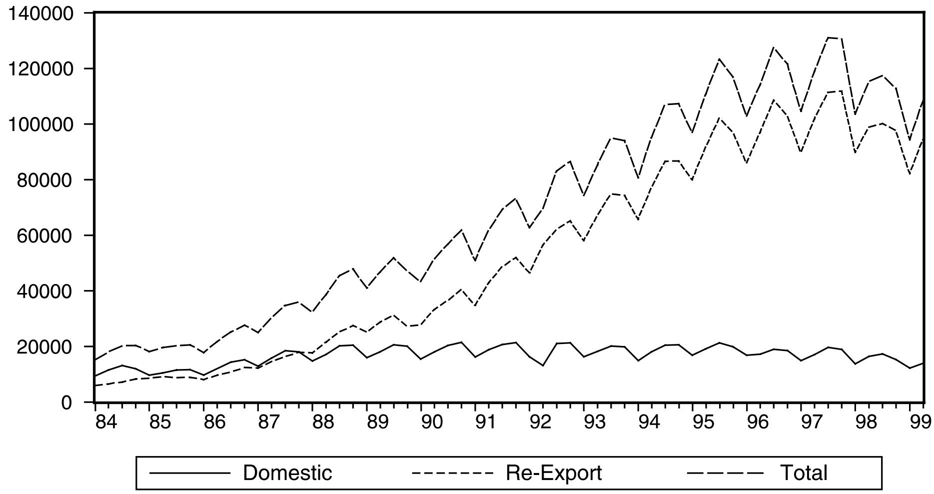

Figure 3. Exports of Hong Kong (in millions of Hong Kong dollars). *Source*: IFS, IMF (various years)

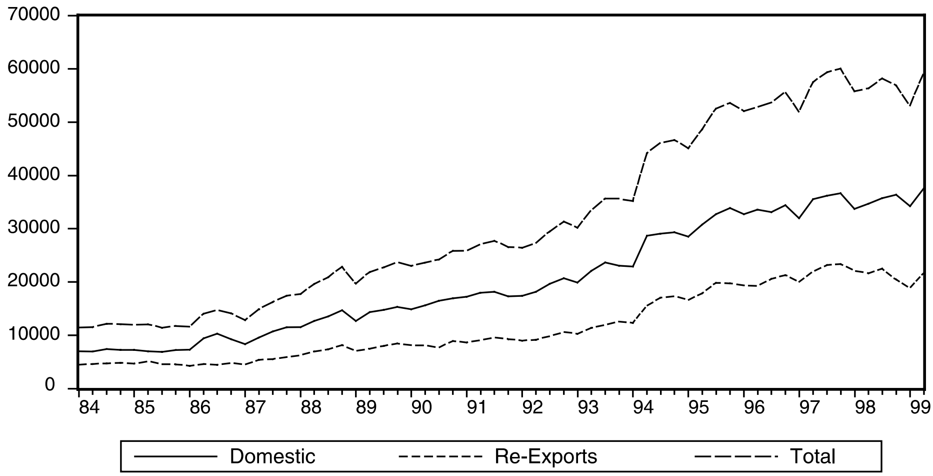

Figure 4. Exports of Singapore (in millions of Singapore dollars). *Source*: IFS, IMF for various years

rise in Hong Kong's REER, driven by the relatively higher domestic inflation rate than its trading partners' rates, could have been one of the factors contributing to the seeming loss of Hong Kong's export competitiveness, particularly since the early 1990s. As for Singapore, a more moderate rise in its REER ensured that the country's domestic exports remained fairly buoyant.

III. The NATREX Model

III.1 *Overview*

While the preceding discussion of trends in effective exchange rates is indicative, in order to evaluate the performance of the two exchange rate regimes more systematically, it is important to determine the consistency of the observed REERs of the two currencies against the underlying macroeconomic fundamentals of their respective economies. As noted by Edwards (2000)

> Exchange rate overvaluation is very costly, and has been at the heart of most recent currency crises. Defining effective methodologies to determine the presence of overvaluation is essential (p. 2).[6]

In other words, we need to ascertain some sort of 'equilibrium benchmark' such that any deviations from that equilibrium rate can be construed as at least indicative evidence of the currency's misalignment. To this end, we draw on the concept of a Natural Equilibrium Real Exchange Rate (NATREX) model developed by Jerome Stein (1994, 1996). The NATREX model does not require that the observed REER and the equilibrium real exchange rate be stationary. In fact, the NATREX will vary through time depending on the changes in the fundamentals. It is a moving equilibrium exchange rate, a marked contrast to the underlying hypothesis of the simplistic PPP model, for instance. The NATREX is the rate that is determined by the prevailing real economic fundamentals in the economy. As Stein and Paladino (1998) have emphasised, the NATREX model is based upon the attempt of micro agents, who make independent saving, investment, import and export decisions, to optimize when they know that there is significant uncertainty. The NATREX model is positive not normative—it is precisely the real exchange rate associated with both internal and external balance (pp. 1688–89 and 1712).

III.2 *Single equation estimation*

The general working model of the NATREX we rely on is the following single-equation econometric model

$$natrex_t = f(z_t) \tag{1}$$

where: z_t is a vector of economic fundamentals. What is important for the empirical application of the model is to find the appropriate set of fundamental variables included in vector (z). For most applications of the NATREX the vector (z) includes the *terms of trade variable* (*tot*), *productivity variable* (*prd*), *world real interest rate* (r^*) and *real government spending* (g).[7] This set of variables captures the open economy properties of Singapore and Hong Kong which rely heavily on international trade (*tot*) and cross-border capital flows (r^*) as well as domestic factors that are important to domestic economic performance such as high productivity (*prd*) and government expenditure (g).[8] This set of variables is also consistent with other equilibrium-based models which may otherwise lack the theoretical foundations of NATREX (Edwards, 2000 and Edwards and Savastano, 1999).

Because the *NATREX* is not observable, we estimate the following two sets of equations[9]

$$reer_t^{HK} = \alpha_0 + \alpha_1 g_t^{HK} + \alpha_2 r_t^* + \alpha_3 prd_t^{HK} + \alpha_4 tot_t^{HK} + \varepsilon_{1t} \tag{2}$$

[6] Also see Edwards and Savastano (1999).
[7] Small letters represent natural logs.
[8] Government spending may also be interpreted as a proxy for the rate of social time preference.
[9] Such single equation econometric models are commonly used in the literature on the determination of equilibrium real exchange rates (Edwards, 2000 and Edwards and Savastano, 1999).

$$reer_t^S = \beta_0 + \beta_1 g_t^S + \beta_2 r_t^* + \beta_3 prd_t^S + \beta_4 tot_t^S + \beta_5 pol_t^S + \varepsilon_{2t} \quad (3)$$

where: reer is a natural log of observable REER.

Table IV briefly describes each variable. A dummy variable (*pol*) is also introduced for Singapore to capture the country's policy shift from a steady nominal depreciation managed floating to a gradual nominal appreciation policy in early 1986 as briefly discussed in the previous section (Figure 2). We construct the equilibrium effective exchange rate for each economy's currency using the coefficient estimates obtained from regressing the above two equations.

III.3 *Coefficient estimates: what theory tells us*

It is important to briefly highlight the prior signs of the coefficients that should be expected based on theory.

World Real Interest Rate (r^*): International interest rate arbitrage implies that when the return on foreign currency dominated assets (r^*) exceeds that on local currency dominated

Table IV Variable descriptions

Variable	*Description*
	Singapore
$reer_{SG}$	Real effective exchange rate of Singapore dollar against 23 trading partners. The sources is (http://www.jpmorgan.com).
tot_{SG}	Terms of Trade is calculated as direct price of export/direct price of import. The source is the IFS, IMF (various years).
g_{SG}	Real government expenditure is derived by adjusting nominal government expenditure by the country's GDP deflator. The source is Monthly Digest of Statistics, Singapore Department of Statistics (various years).
$prod_{SG}$	Total factor productivity index is represented by GDP (gross domestic product) *per capita*. All information are obtained from Monthly Digest of Statistics, Singapore Department of Statistics (various years).
pol_{SG}	Policy dummy to capture the shift to a managed appreciation. The variable equals to zero from quarter 1, 1983 to quarter 2, 1986. Otherwise, it is equal to one.
	Hong Kong
$reer_{HK}$	Real effective exchange rate of Singapore dollar against 23 trading partners. The sources is (http://www.jpmorgan.com).
tot_{HK}	Terms of Trade is calculated as direct price of export/direct price of import. The source is the Monthly Statistical Bulletin, Hong Kong Monetary Authority (various years).
g_{HK}	Real government expenditure is derived by adjusting nominal government expenditure by the country's GDP deflator the Monthly Statistical Bulletin, Hong Kong Monetary Authority (various years).
$prod_{HK}$	Total factor productivity index is represented by GDP (gross domestic product) *per capita* data-series. All information are obtained from the Monthly Statistical Bulletin, Hong Kong Monetary Authority (various years).
	Variables that are used in both the Singapore and Hong Kong models
r^*	World real interest rate. To derive the series, we subtracted the three month annualised US consumer price index inflation from the three-month US dollar LIBOR rate. The source is IFS, IMF (various years).
t	Time trend (see Montiel 1997).
crisis	Dummy variable for the East Asian crisis. It equals to 1 from quarter 2, 1997 to quarter 3, 2000, and equals to zero otherwise.

assets (r), investors shift their portfolios away from local assets to foreign ones. Eventually, the rise in the world real interest rate will lead to a decline in the steady state capital intensity and a rise in the steady state debt. In the long run, the rise in the world real interest rate will depreciate the real exchange rate, i.e. $\alpha_2 < 0$, $\beta_2 < 0$.

Productivity (*prd*): An increase in productivity should stimulate investment and therefore improve the economy's balance of payments position. This will be the 'medium term effect'. In the long run, capital accumulation will increase the economy's overall productive capacity. In turn, the real exchange rate is expected to appreciate, i.e. $\alpha_3 > 0$ and $\beta_3 > 0$.[10]

Terms of Trade (*tot*): An improvement in the terms of trade will cause international capital to flow into the tradables sector, causing a rise in investment in the domestic economy. As discussed above, this should appreciate the real exchange rate, $\alpha_4 > 0$, $\beta_4 > 0$.

Government Expenditure (g): Following Obstfeld and Rogoff (1996), we assume that government expenditure is disproportionately devoted to nontradables. As g rises, the relative demand for nontradables also goes up, triggering an increase in the relative price of nontradables, i.e. $\alpha_1 > 0, \beta_1 > 0$.

IV. Empirical Analysis

Our analysis is based on quarterly movements of the two currencies between 1984 and 2000. We exclude the turbulent transition year of 1983 in Hong Kong when the CBA was first established, having replaced a floating regime. As noted, the observation period encompasses the East Asian financial crisis of 1997–98.

We conduct three sets of sequential tests. The first is the Unit Root test. If the variables are all found to be integrated of order 1 or I(1), we apply the Johansen Cointegration test to check for existence of cointegration relationship(s) among all variables given in Equations 2 and 3. Having estimated the *NATREX*, we conduct another Unit Root test to evaluate the stability of misalignment rates of the two currencies, particularly for the post 1990 period.

IV.1 *Statistical preliminaries*

Unit Root test: In order to determine the order of integration of each variable, we use the Augmented Dickey Fuller Unit Root test with all variables in log form. The Akaike Criteria test determines the appropriate number of lag periods for the ADF. Table V reports the results. The ADF test statistics indicate that all relevant variables are I(1).

However, given the potential presence of structural breaks in many time series variables, the low power of ADF test may not be sufficiently sensitive to differentiate a stationary series from one that is non-stationary. In order to evaluate the unit root property more structurally, we apply the next set of tests introduced by Banerjee, Lumsdaine and Stock (1992) – henceforth BLS – who provide a more in-depth investigation of the possibility that aggregate economic time series can be characterised as being stationary around 'a single or multiple structural breaks'. BLS do so by extending the Dickey-Fuller t test by constructing the time series of rollingly computed estimators and their t statistics. Following BLS we compute the smallest (minimal) and the largest (maximal) Dickey-Fuller t test statistics from the rolling test, both of which are compared to their respective critical values (Table VI). Both the

[10] The may also be a reflection of the Balassa-Samuelson hypothesis.

Table V ADF Unit – root test (all variables are in log)

Variable	*Singapore*	*Hong Kong*
reer	at level: −2.678	at level: −2.564
	AIC(4)*: −8.028 (trend and intercept)	AIC(2)*: −7.136 (trend and intercept)
	at first diff : −1.998	at first diff : −3.358
	AIC(3)*: −8.004 (no intercept, no trend)	AIC(4)*: −7.212 (no intercept, no trend)
tot	at level: −2.539	at level: −2.696
	AIC(2)*: −7.195 (trend and intercept)	AIC(5)*: −6.363 (intercept)
	at first diff : −6.518	at first diff : −8.658
	AIC(2)*: −7.155 (no intercept, no trend)	AIC (5)*: −6.522(no intercept, no trend)
G	at level: −2.058	at level: −2.160
	AIC(4)*: −5.984 (intercept and trend)	AIC (4)*: −4.505(no intercept, no trend)
	at first diff : −4.923	at first diff : −4.082
	AIC(3)*: −5.973 (intercept only)	AIC (3)*: −4.511 (intercept)
	at level: −2.003	at level: −2.003
*r**	AIC (3)*: −4.454 (intercept only)	AIC (3)*: −4.454 (intercept only)
	at first diff : −4.010	at first diff : −4.010
	AIC(3)*: −4.449 (no intercept, no trend)	AIC(3)*: −4.449 (no intercept, no trend)
prod	at level: −2.621	at level: −2.286
	AIC(4)*: −9.063 (trend and intercept)	AIC(2): −7.751 (intercept)
	at first diff : −4.106	at first diff: −2.786
	AIC(3)*: −9.017 (intercept only)	AIC(2): −7.791 (no intercept, no trend)

* AIC: Akaike Information Criterion.
(): represents number of lags included. All variables are found to be an I(1) variable at 5 per cent significant level.

Table VI Rolling Unit-root test (all variables are in log)

	Singapore		*Hong Kong*	
Variable	*Maximum*	*Minimum*	*Maximum*	*Minimum*
Tot	−1.020	−3.900	−0.133	−1.770
G	0.217	−4.080	0.11	−1.56
prod	0.837	−0.410	0.210	−0.210
*r**	−0.850	−4.820	−0.850	−4.820
reer	2.030	−1.145	−0.080	−1.390

minimum and maximum Dickey-Fuller t test statistics of the BLS rolling test are significantly larger than each respective critical value. These test results confirm the findings of the ADF tests that the null hypothesis of nonstationarity at the 5 per cent critical value cannot be rejected for all the key variables.[11]

Johansen Maximum Likelihood-Cointegration test: Given that all variables are I(1), we next conduct the Johansen cointegration tests on both the single equation models (Equations 2 and 3). Since the observation set spans the post-1997 financial crisis period we will also include a crisis dummy (*crisis*) in the regressions. In addition, due to a possible presence of

[11] The BLS rolling unit root test results at the first difference for all variables are found to be significantly smaller than their respective 5 per cent critical values. Hence, all variables are found to be I(1), confirming the ADF test-results. The crisis and policy dummy variables for Singapore (pol) were excluded in this test.

Table VII Johansen test results for Hong Kong sample period: Q1:1984–Q3:2000 (lags = 3 (based on Akaike Info Criteria))

Eigen value	*Trace statistics*	*1 per cent critical value*	*Hypothesised no. of CE(s)*
0.7528	154.82	96.58	None[a]
0.3042	66.77	70.05	At most 1
0.2994	43.92	48.45	At most 2
0.2250	21.52	30.45	At most 3
0.0829	5.45	16.26	At most 4

[a] Likelihood-Ratio indicates 1 cointegrating equation at 1 per cent significance level.

The Nomalised Cointegrating Coefficients:

Reer = $-10.42 + 0.045g - 0.060r^{*} + 0.329prd + 2.465tot - 0.004t$

(0.041)	(0.016)	(0.157)	(0.194)	(0.002)	(standard errors)
(1.205)	(14.06)	(4.391)	(161.45)	(4.00)	(Chi-squares)

Chi-square critical values: at 1 per cent = 6.6349; at 5 per cent = 3.8415; and at 10 per cent = 2.7055.

Table VIII Cointegration test for Singapore Sample period: Q1:1983–Q2:2000 (lags = 1 (based on Akaike Info Criteria))

Eigen value	*Trace statistics*	*1 per cent critical value*	*Hypothesised no. of CE(s)*
0.5559	137.27	133.57	None[a]
0.4011	80.44	103.18	At most 1
0.2267	44.55	76.07	At most 2
0.1732	26.55	54.46	At most 3
0.1265	13.24	35.65	At most 4
0.0491	3.78	20.04	At most 5

[a] Likelihood-Ratio indicates 1 cointegrating equation at 1 per cent significance level.

The Nomalised Cointegrating Coefficients:

Reer = $-16.24 + 0.042g - 0.040r^{*} + 2.490prd + 0.434tot - 0.112pol - 0.023t$

(0.053)	(0.020)	(0.338)	(0.215)	(0.036)	(0.004)	(standard errors)
(0.628)	(4.00)	(54.29)	(4.07)	(9.679)	(33.06)	(Chi-squares)

Chi-square critical values: at 1 per cent = 6.6349; at 5 per cent = 3.8415; and at 10 per cent = 2.7055.

deterministic time trend in long run macroeconomic variables such as exchange rate, following Enders (1995), Montiel (1997) and others, we also include a time trend in our cointegration regression equations.

The trace statistics (likelihood-ratio) indicate that there is one cointegrating relationship (significant at the 1 per cent level) in each of the single equation models (Table VII and VIII). All fundamental variables for both Hong Kong and Singapore have theoretically consistent coefficient estimates. We find that in both, the coefficient estimates for real government expenditure variable is the only insignificant variable at the 10 per cent of Chi-square critical value. We excluded the crisis dummy variable from the regressions as the estimated coefficients are statistically insignificant. Furthermore, the inclusion of the dummy variable only worsens the overall results of the cointegration tests. We retain the time trend (t) as the coefficient estimates are significant in both cases.[12] Based on the Chi-square statistics, among

[12] The explanatory variables remain significant even if we drop the deterministic time trend (t) from the regressions. But given that it is significant and that its inclusion improves the overall results, we retained the time trend in the cointegration tests. Thus, the explanatory variables introduced by NATREX model explain the stochastic component of the REER series.

the statistically significant explanatory variables, the productivity rate variable is the most significant in the case of Singapore, while the terms of trade has the highest Chi-square in the case of Hong Kong.

IV.2 *Tests for misalignment and stability*

We next construct the *NATREX* series by using the estimated coefficients. Figures 5 and 6 plot the fundamentally derived equilibrium exchange rates for the two currencies (NATREX)

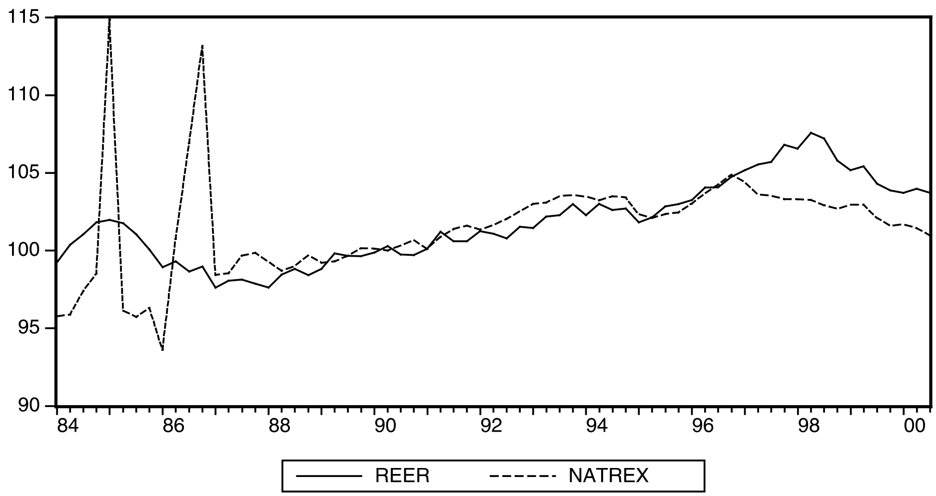

Figure 5. NATREX and REER for Hong Kong (1990 = 100)

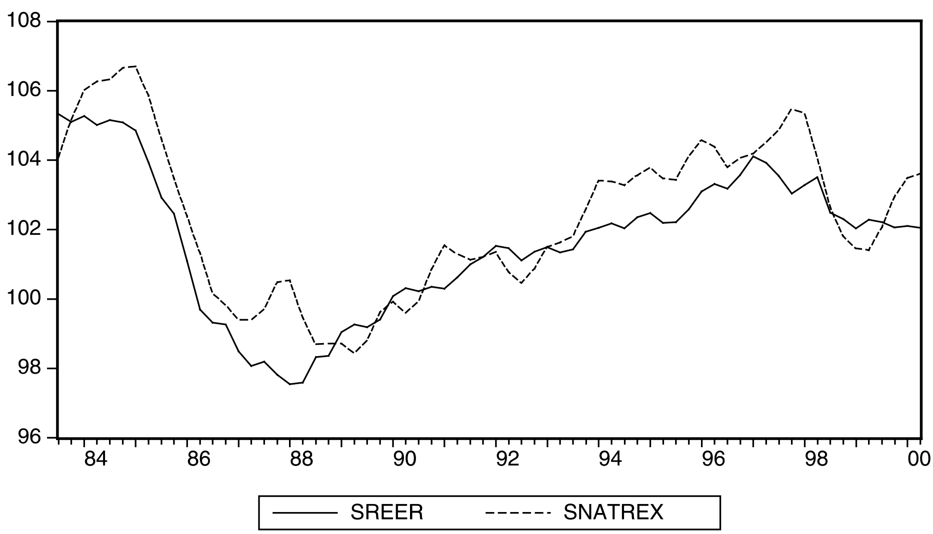

Figure 6. NATREX and REER for Singapore (1990 = 100)

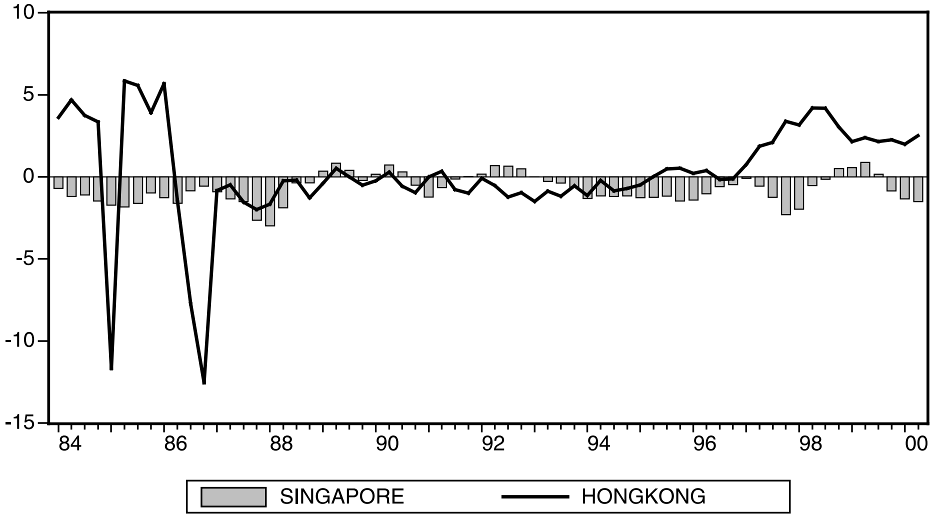

Figure 7. Misalignment ((REER – NATREX)/NATREX) for Singapore and Hong Kong (in per cent)

Table IX Quarterly rate of over-and under-valuation (in per cent)

	Mean	*Maximum*	*Minimum*	*Standard Deviation*
Hong Kong				
1990:1–1997:1	−0.38	0.75	−1.49	0.61
1998:1–2000:2	2.79	4.19	1.98	0.82
Singapore				
1990:1–1997:1	−0.49	0.72	−1.47	0.70
1998:1–2000:2	−0.43	0.87	−1.96	0.97

against observed REERs. As stated earlier, a positive (negative) difference between the REER and NATREX implies an overvaluation (undervaluation) of the Hong Kong and the Singapore dollar. Several interesting observations warrant highlighting.

The Hong Kong dollar experienced a persistent undervaluation between 1991 and mid 1995 and was mildly overvalued until mid 1996 (Figure 5 and Figure 7). In contrast, the Singapore's REER was undervalued between mid 1993 to mid 1996 before returning to its equilibrium or NATREX rate in late 1996 and early 1997. Overall, neither currency appears to have experienced severe misalignments prior to mid 1997 (recall the outbreak of the financial crisis began in June-July 1997 with the devaluation of the Thai baht).[13] Table IX further reveals that between Q1: 1990 and Q1: 1997 the overall performance of the REERs of both currencies has been highly comparable. On average, they both experienced a mild rate of undervaluation. Both the maximal and minimal rate of misalignments are identical, the only difference being that Singapore had a moderately higher standard deviation, implying relatively more volatility in the extent of currency misalignment.

[13] For details of the Thai crisis, see Rajan (2001).

Table X ADF Unit-root test for (REER NATREX)

Country	*ADF*	*Phillips–Perron* (*PP*)
Singapore:	At level: ADF test–statistics: −3.5067 Critical Value: At 5 per cent: −2.9320 At 10 per cent: −2.6039 # of lags = 1; Only intercept included	At level: PP test–statistics: −1.9088 Critical Value: At 5 per cent: −1.9488 At 10 per cent: −1.6199 # of lag truncation = 2 No trend and No intercept
Hong Kong:	At level: ADF test–statistics: −2.0643 Critical Value: At 5 per cent: −3.5162 At 10 per cent: −3.1882 # of lags = 1; Both trend and intercept included	At level: PP test–statistics: −2.2036 Critical Value: At 5 per cent: −3.5162 At 10 per cent: −3.1882 # of lag truncation = 3 Both trend and intercept included
Period: – Hong Kong: Q1: 1990 to Q3: 2000 – Singapore: Q1: 1990 to Q2: 2000		

However, a contrasting trend emerges during the post-1997 financial crisis. Our test results indicate that Singapore has been far more successful in weathering the speculative attacks and the effects of the contagious fallout during the 1997–98 crisis. On average, its post-crisis REER was undervalued, though at basically the same rate as during the pre-crisis period. As expected, we find the currency was more volatile during the crisis period, with the standard deviation having risen, albeit at a relatively small increment from 0.7 per cent during the pre-crisis period to about 1.0 per cent during the first three years of the crisis period. In contrast, Hong Kong's REER became overvalued during the post-crisis period at a quarterly average rate of around 2.8 per cent, a substantial increase from an average undervaluation of 0.4 per cent per quarter during the pre-crisis period.

Stability test: In order to further evaluate the overall performance of the two currencies, we apply the following standard criterion as a condition for judging the stability of exchange rate regime

$$reer_t - natrex_t = \varepsilon_t, \quad \text{such that } \varepsilon_t \text{ is I(0)} \tag{4}$$

That is, for the REER to be stable, its misalignment (captured by ε_t) from the equilibrium rate must be stationary. The ADF Unit Root test and the Phillips-Perron test are both applied to ε_t. We focus only on the period of 1990–2000.[14]

The results indicate that Hong Kong's REER has been non-stationary (Table X). Both the ADF-test statistics and the Phillips-Perron test statistics are well above the 5 per cent critical value. As for Singapore's REER, we find the ADF and the Phillips-Perron test statistics to be less than the 5 and 10 per cent critical values, respectively. Hence, the stability tests suggest that the misalignment of Singapore's REER was stable, while that of the Hong Kong dollar was not during the last decade. This seems to support our previous findings (Table IX). While the post-crisis misalignment rate of the Singapore's REER has remained at the same rate as the pre-crisis average, that of Hong Kong dollar experienced a sharp

[14] We did not apply the BLS-Unit Root test in view of the relatively small sample size.

u-turn from being undervalued during the pre-crisis to being overvalued during the post-crisis period.

V. Concluding Remarks

The foregoing empirical analysis indicates that Singapore's monitoring band-based exchange rate regime *a la* Williamson (1998), accompanied by a policy of crawling appreciation since 1981, has been relatively successful in insulating the Singapore economy from external shocks until mid 1997. This exchange rate-centred monetary policy has also ensured that Singapore's REER was maintained at a level that has been broadly consistent with the underlying macroeconomic fundamentals of the economy in the 1990s. In the spirit of the monitoring band arrangement, the Singapore dollar was temporarily floated during the midst of the 1997–98 crisis and particularly after the devaluation of the Taiwanese currency, which was an important export competitor. Against the backdrop of the spate of devaluations of the regional currencies, the Singapore dollar promptly depreciated and lost one fifth of its value. This expenditure-switching policy, which facilitated adjustment to the external shocks, was matched by severe and credible expenditure-reducing and cost-cutting ones (Rajan, Sen and Siregar, 2002), hence ensuring that domestic prices remained relatively stable. Consequently, the nominal depreciation was translated into an undervalued REER (where equilibrium is based on the NATREX model). The efficacy of the 'strong Singapore dollar policy' during periods of normalcy (i.e. secular appreciation of the Singapore dollar against major currencies) to keep inflationary tendencies under check, on the one hand, while allowing for exchange rate adjustments during periods of external shocks, on the other, has been further confirmed by empirical analysis by Yip and Wang (2001).

What about Hong Kong's experience? Starting from the late 1980s until 1991, its REER remained closely aligned to its equilibrium rate. Between 1990 and 1995, Hong Kong's average inflation rose to slightly over 9 per cent, running above that of the US and other major trading partners, including Singapore. In an attempt to control these inflationary pressures, the HKMA hiked up the key domestic interest rate independently of the US in May 1991. The positive interest rate spread offered in Hong Kong over mature markets in the US led to massive capital inflows until 1996–97. Insofar as the exchange rate was firmly fixed to the US dollar via a CBA, the large-scale capital inflows led to a sharp increase in domestic liquidity, much of which was absorbed into the property sector, which in turn fuelled an asset price bubble.[15] As discussed, a rise in the price of nontradables such as real estate, should appreciate the natural rate of real exchange rate (or NATREX). This is shown in Figures (5 and 7). The NATREX rate appreciated faster than the actual REER, creating further undervaluation of the Hong Kong dollar. Between 1991–1995, the Hong Kong dollar's REER was undervalued by an average of 0.5 per cent per quarter, almost double the average quarterly undervaluation rate during the previous two years (1989–1991).

The independent policy measure taken by the HKMA in 1991 was part of the 'more discretionary policy interventions' actively pursued since the late 1980s (Kwan *et al.*, 1999). Hong Kong's problems were exacerbated during the regional crisis as the currency's rigid peg to the US dollar led to an overvaluation of the Hong Kong dollar from the second quarter of 1997. During the first quarter of 1997, the real effective exchange rate was overvalued by less

[15] A surge of funds from Mainland China in the run up of the handover of Hong Kong to Chinese rule further intensified the financial bubble in Hong Kong.

than 1 per cent. However, the rate of overvaluation continued to rise and reached its peak at more than 4 per cent in the second and third quarters of 1998. This coincided with severe speculative attacks on the currency soon after the devaluation of the Taiwanese and Singapore currencies.

It is against this background that we conclude that the more flexible intermediate exchange rate regime in Singapore has ‘outperformed’ the Hong Kong’s CBA in general, and particularly in the last decade when a series of external shocks hit the region, impacting both the economies. This seems to support the analyses by Rajan (2002a) and Williamson (1998) who argue that, in a world of generalised floating among major currencies, the most feasible and desirable alternative for small and open economies in Asia in the relatively near and medium terms may be a genuine currency basket arrangement, so as to insulate the economy from crossrate variations.

A point that is insufficiently recognised is the Catch-22 that is inherent with a hard peg. On the one hand, an economy faced with sharp external shock may require some degree of discretion to mitigate the effects of these shocks, as the required internal adjustments, which are extremely costly, are not always forthcoming. Failure to undertake the necessary adjustments will lead to loss of price competitiveness in international markets and a build up of imbalances, making the CBA a severe liability to the economy, possibly encouraging markets to test the durability of the peg which only exacerbates the problems.[16] On the other hand, it is this very discretion that undermines the credibility and concomitant benefits of the hard peg.

As noted, Hong Kong had pursued such a discretionary policy in the 1990s, resulting in a sustained attack on the Hong Kong dollar in the midst of the crisis, agents understandably doubting the commitment of the HKMA to the CBA (Rajan, Sen and Siregar, 2002). Hong Kong has since de-emphasised discretion and returned to a rulebased regime since the crisis. Specifically, on September 6, 1998, the Hong Kong authorities announced a series of measures which fall into three broad categories (HKMA, 1998): (a) an explicit commitment by the HKMA to purchase Hong Kong dollars and government bonds from any licensed currency dealer (as opposed to just the large banks) at a fixed rate of HK$7.75 to the US dollar, thus making the commitment to the link more explicit; (b) revamping the mechanism for providing liquidity assistance; and (c) enhancing the transparency of the CBA. While this reversion to ‘auto pilot’ may help to shore up the credibility of the arrangement, there is the unending concern about the consequences of such rigidity when the next external shock hits and the entire adjustment must take place internally (Rajan, 2002b). Altering the exchange rate is one means of attempting to bring about the necessary economic adjustments. By acting as a safety valve, flexible exchange rates provide a less costly adjustment mechanism by which relative prices may be altered in response to such shocks as opposed to fixed rates which rely on gradual reductions in relative costs via deflation and productivity increases vis-à-vis trade partners to restore internal balance.

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[16] This appears to have been the case in Argentina (Rajan, 2002b).

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