

Monetary Operations by Hong Kong's Currency Board

Stefan Gerlach*

Hong Kong Institute for Monetary Research
University of Basel
Centre for Economic Policy Research

Abstract

Currency boards are typically seen as demonstrating the advantages of rule-bound monetary policies with automatic responses to exchange market imbalances. We study the monetary operations conducted by Hong Kong's currency board, using daily data between September 1998 and December 2001. Since this regime is one-sided in that there is a commitment to sell, but not to buy, US dollars at a given rate, we estimate logit equations for dollar purchases. We show that these have shifted over time and that while the variables are statistically highly significant, the predictive power is low.

JEL Numbers: E42, E58

Key words: currency board, Hong Kong, logit estimation

*HKMA, 55/F Two International Finance Centre, 8 Finance Street, Hong Kong, tel. (852) 2878-8800, Fax (852) 2878-2280, email: stefan_gerlach@hkma.gov.hk. This is a revised version of an earlier paper entitled "*Hong Kong's Currency Board: Modelling the Discretion on the Strong Side.*" I am grateful to the editor, an anonymous referee, Ignazio Angeloni, Priscilla Chiu, Hans Genberg, Petra Gerlach-Kristen, Kitty Lai, Tony Latter, Robert McCauley, Frank Smets and seminar participants at the ECB, the Graduate Institute of International Studies in Geneva, Hong Kong Baptist University and the HKIMR for helpful comments. Raphael Lam provided excellent assistance with the data. The views expressed in this paper are solely my own.

1. Introduction

Despite the fact that there is much agreement among academic economists and monetary policy makers about the main strengths of a Currency Board arrangement, its transparency and the automaticity of monetary operations, little is in fact known about the day-to-day management of monetary policy under this framework.¹ For instance, there is apparently no literature that discusses how frequently the Convertibility Undertaking, the commitment by the authorities to engage in foreign exchange transactions at a given rate which is the linchpin of all such arrangements, is invoked by market forces. Do monetary operations take place several times a day, several times a week, or several times a year? How large and persistent are deviations of the market exchange rate from the announced parity and, if any, deviations of short-term interbank rates in domestic currency from interest rates in the key currency? Can domestic interbank rates be below rates in the key currency? If so, are these deviations temporary and pertain only to the shortest of interbank rates, or can they be more protracted and affect longer rates in, say, the six- to twelve-month maturity spectrum? Finally, is there any element of discretion, however small, in such an arrangement?

The paper has two main purposes. The first of these is to review what we can learn about the day-to-day behaviour of exchange rates and interest rates in a Currency Board regime. Since Hong Kong operates one of the oldest and arguably most successful Currency Boards, it is a natural object for such a study. “The Link” was introduced in 1983, following a speculative run on the currency which was partially related to concerns about the return of the colony to Mainland China in 1997, and has remained unchanged since then. Moreover, while many modern-day Currency Boards can be found in very small economies that are, or have been, undergoing a transition to a market economy (including Bosnia-Herzegovina, Bulgaria, Estonia, Latvia and Lithuania), Hong Kong is a rare example of a medium-sized economy that has employed this regime.² Finally, Hong Kong is an international financial centre with free and open capital markets. The fact that the Link has remained unchanged for more than twenty years in an environment in which there is ample leeway for market forces to exploit any perceived shortcomings of the framework suggests that it does indeed function with the automaticity that is the hallmark of textbook Currency Board regimes.

¹ By contrast, there is a considerable literature on the general aspects of currency boards (e.g., Baliño and Enoch (1997), Enoch and Gulde (1997) and Ghosh et al. (1998) and the references therein).

² World Bank (2001) indicates that Hong Kong’s PPP-adjusted gross national income in 1999 was 152 billion USD, that is, greater than that of a number of countries, including Chile, Denmark, Finland, Hungary, Israel, New Zealand, and Venezuela.

The second purpose of the paper arises from the fact that Hong Kong's Currency Board is one-sided. Thus, while the Hong Kong Monetary Authority (HKMA) stands ready to sell US dollars (USD) at the fixed rate of 7.8 Hong Kong dollar (HKD) per USD upon demand, there is no undertaking to purchase USD at a fixed rate. Instead, the HKMA purchases USD in response to offers from banks on the basis of liquidity conditions in the interbank market.³ The absence of a formal undertaking to buy USD at a given exchange rate raises the question of what beliefs market participants may have regarding the likelihood of HKMA purchases of USD and whether it is possible to predict when they will occur. The econometric analysis below aims at exploring these two questions.

The paper is structured as follows. In Section 2 we provide a short overview of the history of Hong Kong's Currency Board. We review the behaviour of the market exchange rate between the HKD and the USD, relative to the Convertibility Undertaking at 7.80 HKD/USD. Moreover, we consider the frequency and size of the market operations, and study the evolution over time of spreads between HKD and USD short-term interbank rates and the movements of banks' clearing balances (the Aggregate Balance) with the HKMA. Since, as is explained in the historical overview, the Currency Board arrangements were considerably refined following the massive speculative attack that took place in the early fall of 1998, we use daily data for the period September 3, 1998, to December 25, 2001 for the analysis. The main finding is that, judging by almost any (informal) standard, the Currency Board has operated increasingly smoothly over time. While this no doubt is partially due to a calmer external environment, it suggests that the credibility of the regime has been increased by the fact that it overcame several speculative attacks during the Asian crisis and as a result of the technical enhancements that were introduced following this episode.

In Section 3 of the paper we turn to the fact that this Currency Board is asymmetric and allows for a very limited degree of tactical discretion in the sense that there is no formal commitment to buy USD at a given rate. To investigate the systematic element of the HKMA's operations, we estimate logit models for USD purchases. The empirical analysis suggests three conclusions. The first is that financial market variables contain information about the likelihood of dollar purchases. The stronger the exchange rate, the smaller the

³ While the reasons for why this arrangement was adopted have not been announced, central bank practice elsewhere provides two strong rationales. First, the introduction of a two-sided Convertibility Undertaking would have a detrimental effect on activity in the HKD foreign exchange market, and indirectly for Hong Kong's status as an international financial centre, as banks would prefer to trade with the HKMA at the fixed rate rather than with each other. Second, by introducing certainty about the rate at which speculators can unwind positions in USD, it would increase the likelihood of speculative attacks.

Aggregate Balance, and the higher HKD interest rates are relative to USD rates, the more likely is a purchase of USD. Second, there is evidence that the relative importance of the different variables has changed during the sample period. Third, despite the fact that USD purchases are forecastable, the level of predictability is limited. This is most likely due to the fact that daily data obscure important market developments that may occur within the day, and to the fact that there have been few cases of USD purchases, which suggests that the information content of the data is inherently low. Section 4 concludes.

2. Preliminaries

2.1 Hong Kong's currency board

After having adopted a floating exchange rate in the early 1970s, Hong Kong reintroduced a fixed exchange rate in October 1983, when the HKD was pegged to the USD at 7.8 HKD/USD.⁴ The main impetus behind the introduction of the linked exchange rate system was the sharp depreciation of the currency in 1982-1983. Between June 1982 and June 1983, the HKD fell from 5.9 per USD to 7.2, or by 18%, largely due to weak economic fundamentals. During the summer, however, things turned for the worse and the exchange rate continued to experience a sharp depreciation. In this case, however, the depreciation was largely due to concerns arising from China's announcement that it intended to regain sovereignty over Hong Kong in 1997. The exchange rate fell further to 7.89 HKD/USD by September 16. The most dramatic phase of the depreciation occurred on September 23-24, when the exchange fell by 10% in a single day's trading to 9.6 HKD/USD but stabilised subsequently. On October 17, 1983, the two note-issuing banks, the Hongkong and Shanghai Banking Corporation and the Standard Chartered Bank, were required to back the note issue by depositing an equivalent amount in US dollars, using a conversion rate of 7.8 HKD/USD, with the Currency Board, the government's Exchange Fund. Moreover, the Exchange Fund started to conduct operations in the foreign exchange markets with the intent to stabilise the rate.⁵ Together these two changes reintroduced the Currency Board system to Hong Kong.

Following the return to a fixed exchange rate system, the HKD experienced in the 1980s several episodes with strong pressures for a revaluation. However, nominal exchange rate stability was maintained. After the onset of the Asian financial crisis in the summer of 1997,

⁴ Jao and King (1990) contains a series of essays on aspects of the monetary history of Hong Kong. Chiu (2001) provides an overview of Hong Kong's recent experience with a Currency Board. This section draws on Jao (1990).

⁵ While the authorities did not announce what precise exchange rate they intended to defend, over time they came to resist movements beyond 7.75 HKD/USD, that is, at a somewhat stronger exchange

the HKD was exposed to heavy speculation in late October that year. The precipitating event was the Taiwanese authorities' decision not to defend the new Taiwan dollar against speculative outflows, which led in turn to selling pressure on the HKD. In response, the HKMA purchased HKD, which caused short-term interest rates to rise very sharply, with the overnight rate briefly reaching 280%. Subsequently, market conditions normalised. While the exchange market remained turbulent in the first half of 1998, the Currency Board successfully withstood incidents of selling pressure in January and June.

The most dramatic episode of speculative outflows occurred in the autumn of 1998, when the currency was exposed to heavy selling pressure. One of the hallmarks of the Currency Board system is the automaticity of responses to currency outflows. In such instances, banks desiring to purchase USD from the Currency Board at the pre-specified rate trigger the Convertibility Undertaking. While this prevents the exchange rate from depreciating, it leads to a contraction of the Aggregate Balance and a fully predictable rise in short-term interbank rates. Since the rise of interest rates in turn depresses equity prices, intense pressures were brought to bear on the exchange rate by market participants who took short positions in the equity market and sold the currency. During the most active period of speculation that took place in late August, the Exchange Fund took the unprecedented step of purchasing equities for some 15 billion USD to impose losses on those taking short positions in the equity market. This calmed the equity and foreign exchange markets and more tranquil conditions were restored.

The severe attack on the linked exchange rate led the authorities to announce the so-called *seven technical measures* to improve the resilience of the Currency Board arrangement (HKMA 1998, 1999). The most critical element was the clear undertaking by the HKMA to licensed banks to convert HKD to USD at the fixed exchange rate of 7.75 HKD/USD, the intervention rate at that time. The authorities also announced that the Convertibility Undertaking would be changed to 7.8 HKD/USD, that is, the exchange rate that applied to the issuance and redemption of bank notes. On November 26, 1998, it was further announced that the change in the Convertibility Undertaking from 7.75 to 7.8 HKD/USD would be undertaken in gradual way, by 1 pip (or 0.0001 HKD) per day, starting on April 1, 1999, and ending on August 14, 2000.

rate than that applicable to the backing of bank notes. Thus, there was difference between the Convertibility Undertaking and the exchange rate objective.

A second change of importance was the adoption of measures on November 26, 1998, to reduce fluctuations in interest rates. These entailed the introduction of a discount window facility with the interest rate determined by the federal funds target rate plus 150 basis points or, if this was higher, a five-day moving average of overnight and one-month interbank rates in Hong Kong.⁶ Therefore, a sharp rise in interbank rates would only gradually be passed along to the discount window and thus to the banking system more broadly. Pressures in the foreign exchange markets would instead impact on the Aggregate Balance. This suggests that during the sample period the Aggregate Balance became more informative about pressures in the interbank market and thus about the likelihood that the HKMA would enter the market to inject liquidity.

A third feature of the changes was an increase in the level of transparency regarding the operations conducted by the HKMA. From the perspective of this paper, this is important because it made it easier for market participants to understand the sources of changes in interbank liquidity and to form expectations about the HKMA's participation in the market. This is likely to have promoted a smooth functioning of the interbank market.

2.2 *Some stylised facts*

As noted in the introduction, while a high level of transparency is a hallmark of a Currency Board regime, little is in fact known about how this regime operates on a day-to-day basis. Next we therefore review the behaviour of the HKD exchange rate and the spreads between interbank rates in HKD and USD.

Exchange rates and USD operations

Figure 1 displays the Convertibility Undertaking together with the market exchange rate and Figure 2 displays the distance between the two series (labelled DISTANCE in what follows) for the period September 1998 to December 2001. Moreover, it seems natural to divide the full data set into three sub-periods, the ends of which are indicated with vertical lines. The first these covers the period until the end of March, 1999, when the Convertibility Undertaking started to shift. The second ends in mid-August when the Convertibility Undertaking had reached the new level of 7.8 HKD/USD.

Figure 1 shows that in the first sub-period, the exchange appreciated quite often and for relatively long time periods above the 7.8 HKD/USD limit. Shorter periods of appreciation

⁶ The discount window was in fact introduced in September 1998, but the mechanism for determining the cost of borrowing, which plays a key role in reducing interest rate volatility, was not introduced

occurred in the beginning and middle of the second sub-period, and in the beginning of the third sub-period. However, the deviations of the market exchange rate from the Convertibility Undertaking were extremely limited, typically in the order of 0.02% and peaking at 0.13%. Figure 2 shows DISTANCE together with the dates and rates at which the HKMA purchased and sold USD. In interpreting the figure it should be noted that all data are taken at the end of the day, except the prices for the HKMA's purchases and sales, which are taken during the day. Thus, the fact that some USD purchases took place at rates much below the exchange rate quotation for the day may simply be an indication of intra-day exchange rate fluctuations. Moreover, it may be that such purchases by the HKMA sent a potent signal to the markets that the HKD had appreciated excessively, leading the exchange rate to depreciate towards the Convertibility Undertaking during the rest of the day.

As is evident from the figure, when the market exchange rate started to appreciate from the Convertibility Undertaking, the HKMA frequently accepted offers from banks to purchase USD in the market, particularly during the period in which the Convertibility Undertaking was gradually shifted from 7.75 to 7.8 HKD/USD. The figure also shows that the Convertibility Undertaking was triggered by banks a number of times, particularly in the first part of the sample. More interestingly, the figure indicates that market operations have become increasingly rare. For instance, during the last subperiod, which contains almost 360 observations, the HKMA purchased/sold USD on 10/6 occasions, that is, about 3%/2% percent of the days. One interpretation of the rarity of purchases and sales is that, in a credible Currency Board regime, expectations that the regime will remain in force exert a strong stabilising force on the exchange rate.

The amount of USD purchased or sold is provided in Figure 3, which shows that the size of purchases and sales of USD tended to decline over the sample period. While operations the size of several hundred million USD occurred in the first part of the sample, the operations at the end of the sample were much less than 100 million USD.

Interest rates

Next we turn to the behaviour of the spread between overnight interbank rates which we use in the econometric analysis below. For comparison purposes we also plot the spread between one-year interbank rates. Since the HKD is tied to the USD, one would expect short-term rates in the two currencies to be virtually identical. Yet, as evidenced by Figure 4, this does

until November.

not appear to be the case.⁷ Several aspects of the behaviour of the spreads are of interest. First, the spread fluctuates sharply. At times, the difference between HKD and USD rates can be as large as 400-500 basis points. Of course, given the difficulty in arbitraging them, such divergences at the very short end are not surprising. The Currency Board appears to have become more credible over time as illustrated by the fact that the volatility of the overnight rate is much lower towards the end of the sample. Furthermore, while the spread between one-year rates was as large as 600 basis points in fall of 1998, it declined sharply over time. Third, there have been episodes in which HKD rates have been *below* USD rates by economically significant amounts for extended periods. For instance, between the summer of 2000 and the first quarter of 2001, one-year HKD interbank rates were below USD rates by as much as 40 basis points.

--- insert figures 1 - 5 ---

The Aggregate Balance

Finally, we consider the evolution over time of the Aggregate Balance (AGGBAL), measured in billion HKD, which is plotted in Figure 5.⁸ The figure indicates that over time the Aggregate Balance became much less volatile. In the latter half of the sample, it was moreover on average very small, typically in the order of a few hundred million HKD.

Summary

Overall, the figures presented above suggest that the Currency Board functioned much more calmly towards the end than in the beginning of the sample. Thus, deviations between the market exchange rate and the Convertibility Undertaking have become smaller and less persistent, market operations have become increasingly rare and those that have been conducted have been of smaller scale. Moreover, interest rate spreads have shrunk and become less volatile and the Aggregate Balance has become smaller and more stable. While these developments no doubt partially are due to a calmer external environment, they also suggest that the HKMA enjoyed increased credibility as a consequence of having successfully endured the Asian crisis and because of the technical improvements introduced in its aftermath.

⁷ It should be noted that there are 16 days for which there are no observations on the overnight spread (but observations on the other variables). Rather than dropping these dates from the econometric analysis below, we follow Greene (2000) and replace the missing observations by the average value of the overnight spread.

⁸ The measure of the Aggregate Balance used excludes discount window borrowing.

3. Empirical results

As noted in the introduction, Hong Kong's Currency Board is asymmetric in that while there is an explicit undertaking to sell USD at the rate 7.8 HKD/USD upon demand from banks, there is no similar undertaking to purchase USD at a pre-announced rate. Instead, such operations are conducted as necessary, given liquidity conditions in the interbank markets, in response to offers from banks. This raises the question whether it is possible to predict when such purchases will occur.

In this part of the paper we report the results from estimated logit models for the decision to purchase USD. In the empirical work the dependent variable, BUY, is a dummy that takes the value of unity on the days on which the HKMA purchased USD and zero otherwise.⁹ The independent variables are the size of the Aggregate Balance (AGGBAL), the distance between the market exchange rate and Convertibility Undertaking (DISTANCE), the spread between overnight interest rates in HKD and USD (SPREAD) and the lagged SPREAD. In order to test whether a purchase of USD dollars yesterday raises the probability of a purchase today, we also use the lagged value of BUY in the analysis. To explore whether a sale of USD yesterday raises the likelihood of a purchase today, we define a dummy variable SELL that takes the value of unity on the days on which the HKMA sold USD and zero otherwise and use the lagged value of this variable in the analysis.

3.1 Descriptive statistics

As a first step, it is useful to review the data. For reasons discussed below, we allow for a one-day lag between the BUY dummy and the other variables: AGGBAL, DISTANCE, SPREAD, BUY and SELL.¹⁰ Table 1 provides descriptive statistics for these data. To get an impression of whether these variables may be useful for predicting purchases of USD the next day, we calculate their means on the day before days with and without USD purchases.¹¹

--- insert tables 1 and 2 about here ---

⁹ Logit models are discussed in any good introduction to econometrics, e.g., Greene (2000).

¹⁰ Thus, we use BUY(t), AGGBAL(t-1), DISTANCE(t-1), SPREAD(t-1), BUY(t-1) and SELL(t-1).

¹¹ To do so, we let $X = \text{AGGBAL}, \text{DISTANCE}, \text{SPREAD}, \text{BUY}$ and SELL , and regress $X(t-1)$ on $1 - \text{BUY}(t)$ and $\text{BUY}(t)$. The coefficient on $\text{BUY}(t)$ is then the conditional mean of X the day before days with dollar purchases. Similarly, the coefficient on $1 - \text{BUY}(t)$ is the conditional mean on the day before days without purchases.

The results in Table 2 suggest that on days preceding USD purchases, the Aggregate Balance is smaller, the market exchange rate is further way from 7.80 HKD/USD, and the spread between HIBOR and LIBOR interest rates is larger than on other days. We also see that the average value of BUY was higher on days before USD purchases, suggesting that HKMA purchased USD several days in a row. By contrast, the conditional mean of the SELL dummy does not differ appreciably, implying that purchases of USD don't follow immediately after sales of USD.

3.2 Specification and sample periods

Since, as noted above, we use end-of-day data, we lag the explanatory variables by one day to avoid problems arising from simultaneity. Thus, in the regression below we seek to determine if the values of the different variables at the end of the day $t-1$ are useful in predicting USD purchases of the Exchange Fund the following day.

Since the analysis above indicated that the institutional changes that have been introduced after the speculative attacks in 1998 are likely to have led to shifts in the predictive relationship, we consider three sample periods. The first of these contains 135 usable observations between September 3, 1998 and March 31, 1999, on six of which the HKMA purchased USD. This sample thus covers the period immediately after the speculative attack in August. Given the intense efforts to improve the functioning of the linked exchange rate regime and the introduction of a number of refinements, the parameters of the estimated logit regressions reported below may be shifting.

The second sample covers the period April 1, 1999, to August 11, 2000, that is, the period during which the Convertibility Undertaking was gradually changed from 7.75 HKD/USD to 7.8 HKD/USD. As evidenced by Figures 1 and 2, the period was associated with several episodes in which the HKD appreciated and the HKMA purchased USD. This interval contains 325 usable observations, 27 of which were associated with USD purchases.

The third sample covers the period August 14, 2000, to December 25, 2001, and consists of 321 usable daily observations in which USD were purchased on eight occasions. During this time span the exchange rate was typically very close to the Convertibility Undertaking. This suggests that the Currency Board mechanism functioned more smoothly after the technical improvements that were undertaken following the events of 1998.

Next we turn to the estimates.

3.3 *First sub-sample*

We first estimate logit models using the lagged level of AGGBAL, DISTANCE and SPREAD. Since some preliminary estimates showed that the twice-lagged SPREAD tended to be significant, we also included in the model. Finally, we included the lagged BUY and SELL dummies to see if purchases tended to be correlated over time, or if purchases tended to occur in response to recent USD sales. The results for the full model, shown in column 1 in Table 3, indicate that only the once- and twice-lagged interest rate spreads are significant at the 10% level in the first sub-sample. Since most variables are insignificant, we removed sequentially insignificant variables. This led to the specification in column 2. The restrictions imposed by this equation on the model in column 1 were tested by a Wald test, which yielded a p-value of 56.8%, indicating that the restrictions are not rejected by the data. The results suggest that the HKMA responded to tightness in interbank liquidity, as captured by spreads between overnight rates in the HIBOR and LIBOR markets. The fact that DISTANCE does not enter the model is perhaps more surprising. Overall, the model implies that the likelihood of banks offering to buy USD was higher if interbank rates had been for two days in a row.

--- insert table 3 about here ---

3.4 *Second sub-sample*

The full model estimated on the data from the second sub-sample, during which the objective for the exchange rate shifted from 7.75 HKD/USD to 7.80, is presented in column 3. Also in this case is the lagged overnight spread significant. In addition, DISTANCE is also highly significant, indicating that USD purchases were more likely to take place when the HKD was strong. This suggests that the HKMA wanted to maintain the market exchange rate close to the shifting objective. Moreover, AGGBAL was significant and negative, implying that tightness in interbank liquidity raised the probability that banks would offer to purchase USD.

Sequentially dropping insignificant variables and re-estimating the model yields the results in column 4, in which the two overnight spreads, AGGBAL and DISTANCE are significant. It is notable that the fit of the equation, as captured by the McFadden R-squared (or, equivalently, by the value of the log likelihood function), is not affected by the removal of the insignificant variables.

3.5 *Third sub-sample*

Next we estimate the model on the third sub-sample. Figure 2 shows that in this period the exchange rate deviated little from the Convertibility Undertaking and USD purchases occurred relatively rarely. With few occasions in which the exchange rate diverged from the Convertibility Undertaking, DISTANCE is not likely to be highly significant. In fact, the estimates of the general model in column 5 indicate that only the once- and twice-lagged SPREADs are significant, together with the lagged BUY and SELL dummies. Sequentially removing insignificant variables leads to the model in column 6, in which the two spreads, BUY and SELL enter.¹² Overall, this model suggests that tightness in the market for interbank liquidity raised the probability that the HKMA would purchase USD to relieve the tightness in the interbank market. Furthermore, the likelihood of USD purchases was linked to the pattern of past purchases and sales.

3.6 *Economic significance*

The analysis above indicates that the probability of USD purchases is statistically significantly related to a limited number of variables. This naturally raises the question of the economic significance of the relationship. This question is reviewed below. We first look at how well the different models predict whether the HKMA will or will not purchase USD on a given day.

Consider first Panel A in Table 4, which shows the predictive ability of the restricted equation for the first subsample, September 3, 1998, to March 31, 1999. In this sample of 135 observations, the HKMA purchased USD on six days. The results show that the model did not predict (in the sense that the estimated probability was less than 50%) a USD purchase on 127 of 129 days when no such purchase was made. Thus, the model appears to predict quite well when purchases will not be made. Turning to the more interesting question of how well the model predicts USD purchases, we see that it does so poorly. In particular, it predicted a dollar purchase on only two of the six days when such a purchase took place. This failure to predict purchases suggests that the model does not adequately fit the data. A possible explanation is that with purchases occurring only on six of 135 observations, there is inherently little information in the data. Moreover, reasons to purchase USD may arise during the course of the day, implying that the information content of end-of-day data is low. In addition, it may be that in the aftermath of the speculative attack in August 1998, which was

¹² Surprisingly, the lagged BUY and SELL both enter with a positive sign, implying that if the HKMA entered the foreign exchange market yesterday, it is more likely to purchase USD today, irrespectively of whether it sold or purchased USD yesterday. It is not clear what may explain this.

characterised by intense efforts to improve the functioning of the Currency Board, banks' willingness to offer USD for sale (and the HKMA's willingness to accept these offers) was evolving. If so, one would expect the explanatory power of the models to be higher in the subsequent sample periods.

--- insert table 4 about here ---

To see if that was the case, we turn to Panel B in Table 4, which contains the results for the second sample period, April 1, 1999, to August 11, 2000. The results indicate that the model correctly predicts no purchase on 292 of the 298 days (or about 98% of the cases) on which the HKMA did not buy USD. However, only on four of the 27 days when purchases took place did the model predict so. Overall, the findings are broadly similar to (or somewhat worse than) those for the first sample period.

Panel C gives the results for the third sub-sample period, August 14, 2000, to December 25, 2001. Again we find that the model predicted very well when purchases will not take place, that is, it forecasted no purchase on 312 of the 313 days when no purchase occurred. More importantly, the model does a marginally better at predicting USD purchases in this period in that it correctly forecasts purchases on four of the eight days they occurred.

Overall, these results suggest that while the statistical significance of the explanatory variables is typically high, the model does not predict USD purchases very well. As noted above, the most likely explanations for this finding are the scarcity of observations for which $BUY = 1$ and the fact that the daily data are unable to capture within-the-day developments in the markets.

3.7 *Probability response functions*

The estimated logit regressions allow us to compute the probability of a purchase as a function of the observed variables. Next we do so using the restricted model estimated on the data for the last sub-sample. Since the functional form of the models is non-linear, the impact of a change in any variable depends on the assumed values for the other variables. Below we compute the probability of a purchase as a function of the interest rate spread, assuming that $SPREAD(t-1) = SPREAD(t-2)$, $SELL(t-1) = 0$ and that $BUY(t-1)$ is either zero or unity.

In Figure 6 we plot the calculated probability of USD purchases, while letting $SPREAD$ vary in the range -2% to $+4\%$.

--- insert figure 6 here ---

Assuming that no purchase took place on the previous day, the solid line in the figure shows that the probability of a USD purchase is about zero when the interest rate spread is zero. As SPREAD turns positive, implying that HKD rates rise relative to USD rates, the probability of a USD purchase increases. This, of course, is merely an indication of the interest rate adjustment mechanism that underlies the functioning of the Currency Board: when HKD rates are high, banks wish to sell USD to relieve interbank liquidity and the HKMA accepts these offers to prevent the exchange rate from appreciating. Thus, when HKD rates are 2% above USD rates, the probability of a USD purchase is about 50%, and when SPREAD rises to 3%, the probability is around 90%.

The dashed line in the figure shows how the probability of depends on whether USD were purchased yesterday. At a SPREAD of zero, the probability of a USD purchase is somewhat below 20% if the Currency Board purchased USD the previous day. Furthermore, a SPREAD of about 0.5% is sufficient for the probability of a purchase to reach 50%. Similarly, at a SPREAD of 2%, the probability is about 90%.

4. Conclusions

In this paper we have studied the functioning of the Currency Board in Hong Kong, using daily data for the period September 1998 to December 2001. The main conclusions are three-fold. First, while the market exchange rate has been maintained very close to the Convertibility Undertaking, overnight interbank rates in HKD frequently moved considerably against USD rates. Furthermore, while one-year HKD rates were much above USD rates in the early part of the sample, they subsequently fell sharply as the Currency Board gained credibility. Interestingly, they even fell to levels below USD rates for extended periods. Second, the process of refining the Currency Board mechanism that was set in motion by the events of August 1998 has been associated with reduced interest rate volatility. Moreover, deviations of the exchange rate from the Convertibility Undertaking have become smaller and less protracted. Furthermore, the purchases and sales of USD by the HKMA are generally smaller and less frequent towards the end of the sample. While this partially may be attributable to a calmer economic environment, it suggests that the Currency Board has functioned more smoothly following the introduction of the *seven technical measures*. Third, while it is possible to use publicly available data to predict USD purchases by the HKMA, it is not easy to do so. One potential explanation for the low predictive power is that rapid

market developments that cause the authorities to take action within the day are not captured by the daily data. Another explanation is that the measures that were undertaken to improve the functioning of the Currency Board mechanism in the first sample period led to a gradual shift of the parameters in the logit equation. It should also be noted that the increasing credibility of the Link has reduced the need for USD purchases. Given the paucity of such operations, the data are inherently not very informative about the probability that they will take place.

The research reported on in this paper raises the question of how to model the likelihood of USD sales by the HKMA. While these operations arise on the initiative of banks (as opposed to the HKMA that decides on USD purchases), there may be some interaction between the two types of operations. If so, it would be of interest to model jointly the probability of USD purchases and sales. This we leave for future research.

References

- Baliño, T.J.T. and C. Enoch (1997), Currency Board Arrangements: Issues and Experiences, IMF Occasional Paper No. 151.
- Chiu, Priscilla (2001), "Hong Kong's Experience in Operating the Currency Board System," Paper prepared for the IMF Seminar on Exchange Rate Regimes, Washington, March 19-20, 2000.
- Greene, W.H. (2000), Econometric Analysis, 4th ed., Prentice-Hall, Upper Saddle River, NJ.
- Enoch, C. and A.-M. Gulde (1997), "Making a Currency Board Operational," IMF Paper on Policy Analysis and Assessment, PPAA/97/10.
- Ghosh, A.R., A.-M. Gulde and H.C. Wolf (1998), "Currency Boards: The Ultimate Fix?," IMF Working Paper WP/98/8.
- Hong Kong Monetary Authority, HKMA (1998), "Strengthening of Currency Board Arrangements in Hong Kong," Quarterly Bulletin, November, 7- 11.
- Hong Kong Monetary Authority, HKMA (1999), "The Currency Board Account and Other Fine-Tuning Measures to Strengthen the Currency Board Arrangements in Hong Kong," Quarterly Bulletin, May, 1- 5.
- Jao, Y.C. (1990), "From Sterling Exchange Standard to Dollar Exchange Standard: The Evolution of Hong Kong's Contemporary Monetary System 1967-89," in Y.C. Jao and F.H.H. King (1990).
- Jao, Y.C. and F.H.H. King (1990), eds., Money in Hong Kong: Historical Perspective and Contemporary Analysis, Centre for Asian Studies, University of Hong Kong.
- World Bank (2001), World Development Indicators 2001, Washington.

Table 1: Descriptive Statistics
Sample period: 9/03/1998 – 12/25/2001

	Current			Lagged		
	BUY	AGGBAL	DISTANCE	SPREAD	BUY	SELL
Mean	0.058	1.387	-0.115	-0.531	0.066	0.059
Median	0	0.766	-0.060	-0.420	0	0
Maximum	1	7.968	0	3.630	1	1
Minimum	0	-3.900	-1	-5.510	0	0
Std. Dev.	0.233	1.610	0.144	1.115	0.249	0.236
Observations	815	815	815	815	815	815

Table 2: Conditional Means
Sample period: 9/03/1998 – 12/25/2001

Variable:	AGGBAL	DISTANCE	SPREAD	BUY	SELL
Mean for:					
BUY(t) = 0	1.429	-0.111	-59.294	0.049	0.062
	(0.058)	(0.005)	(3.922)	(0.008)	(0.008)
BUY(t) = 1	0.711	-0.181	48.855	0.259	0.056
	(0.234)	(0.021)	(15.855)	(0.032)	(0.033)

Note: Standard error in parentheses.

Table 3: Logit Models

Logit estimates. Dependent variable is BUY; the regressors are lagged once.

Sample period	9/03/98 – 3/31/99		4/01/99 – 8/11/2000		8/14/2000 – 12/25/2001	
CONSTANT	-4.315 [0.018]	-3.545 [0.000]	-3.029 [0.000]	-3.072 [0.000]	-5.534 [0.000]	-5.408 [0.000]
DISTANCE	-1.096 [0.672]		-12.153 [0.000]	-11.513 [0.000]	-3.414 [0.353]	
AGGBAL	0.171 [0.697]		-0.526 [0.024]	-0.497 [0.028]	-0.716 [0.462]	
SPREAD	2.049 [0.022]	1.628 [0.020]	0.535 [0.094]	0.540 [0.092]	1.202 [0.061]	1.445 [0.005]
Lagged SPREAD	1.561 [0.057]	1.119 [0.079]	0.852 [0.011]	0.807 [0.012]	1.279 [0.032]	1.464 [0.004]
BUY	-0.876 [0.558]		-0.480 [0.423]		3.711 [0.011]	4.031 [0.001]
SELL	-36.931 [1.000]		-0.098 [0.931]		5.782 [0.002]	5.755 0.002]
Observations	135	135	325	325	321	321
Log likelihood	-13.391	-14.860	-67.904	-68.241	-15.474	-16.333
McFadden R-sq	0.454	0.395	0.270	0.266	0.587	0.564
Restrictions, p-value		0.568		0.714		0.424

Notes: p-values in brackets []

Table 4: Predictive Ability

Panel A

Sample period: 9/03/1998 –3/31/1999

	BUY = 0	BUY = 1	Total
Predicted BUY = 0	127	4	131
Predicted BUY = 1	2	2	4
Total	129	6	135
Percent correct	98.5	33.3	95.6
Percent incorrect	1.5	36.7	4.4

Note : Assuming a success cut-off rate of 50%

Panel B

Sample period: 4/01/1999 –8/11/2000

	BUY = 0	BUY = 1	Total
Predicted BUY = 0	292	23	315
Predicted BUY = 1	6	4	10
Total	298	27	325
Percent correct	98.0	14.8	91.1
Percent incorrect	2.0	85.2	8.9

Note : Assuming a success cut-off rate of 50%

Panel C

Sample period: 8/14/2000 – 12/25/2001

	BUY = 0	BUY = 1	Total
Predicted BUY = 0	312	4	316
Predicted BUY = 1	1	4	5
Total	313	8	321
Percent correct	99.7	50.0	98.4
Percent incorrect	0.3	50.0	1.6

Note : Assuming a success cut-off rate of 50%

Figure 1
Exchange Rate Objective and Market Rate

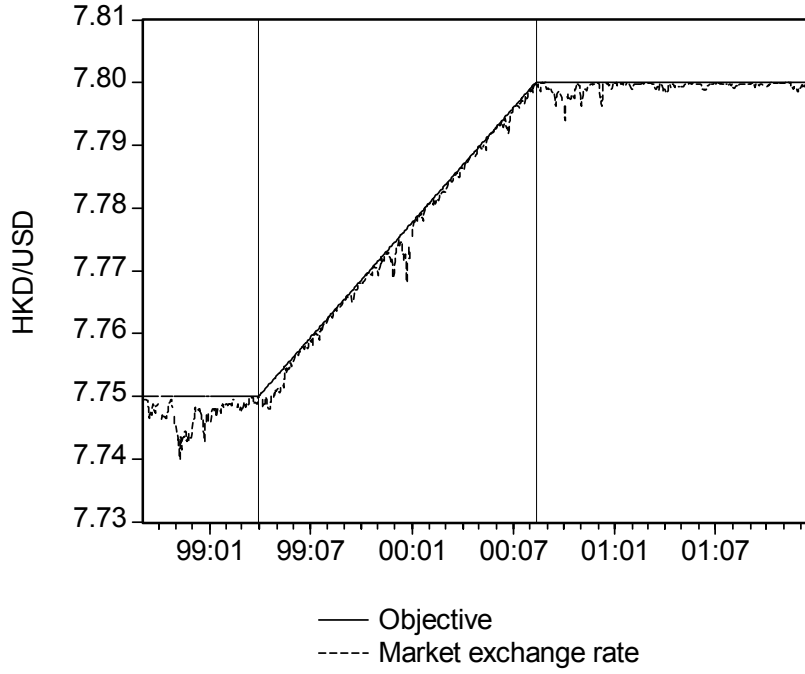


Figure 2
Distance Between Exchange Rate Objective and Market Rate, and USD Operations

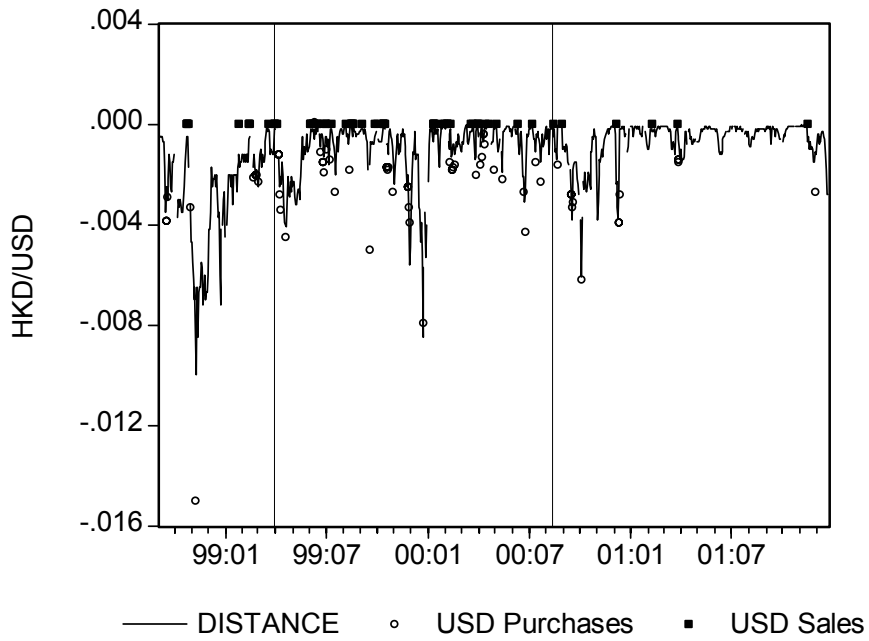


Figure 3
Market Operations

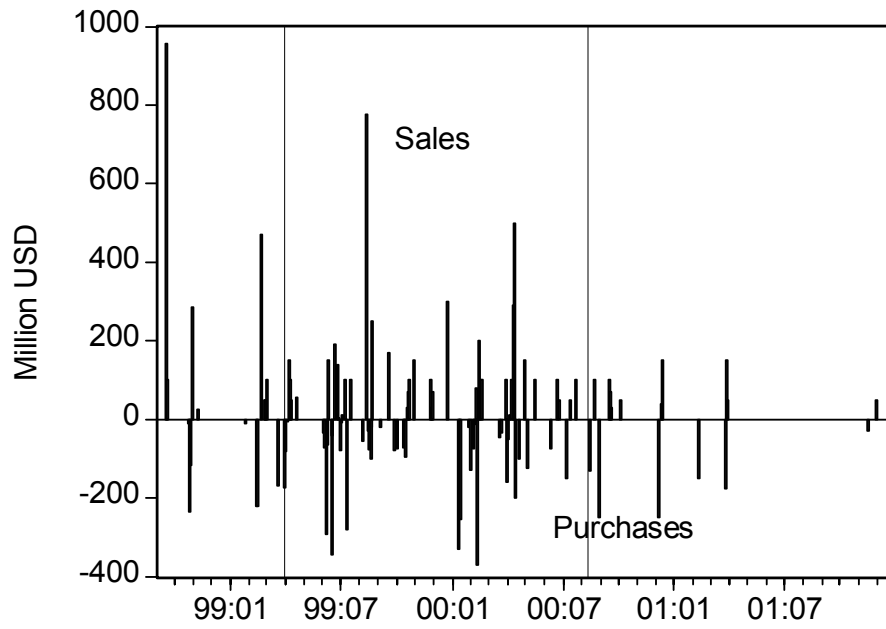


Figure 4
Interest Rate Spreads

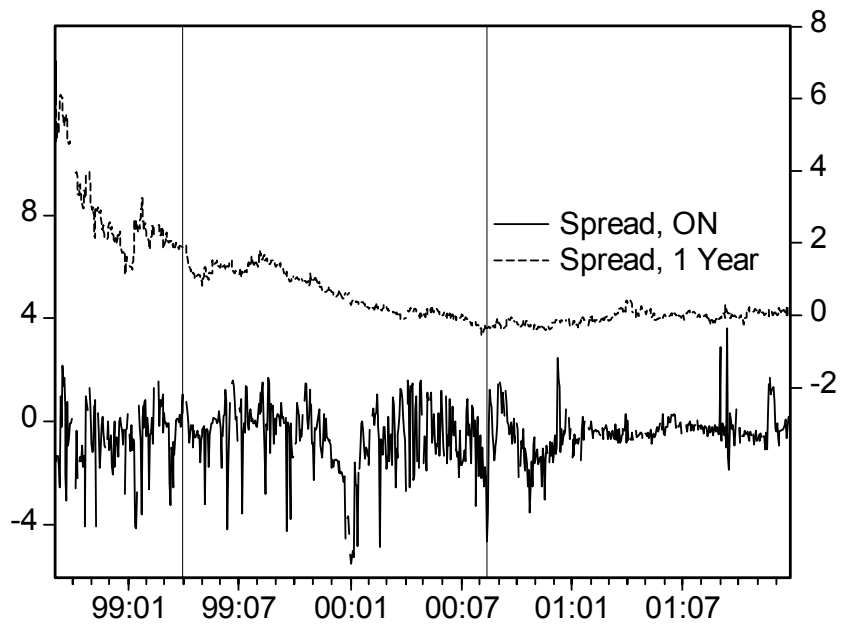


Figure 5
Aggregate Balance

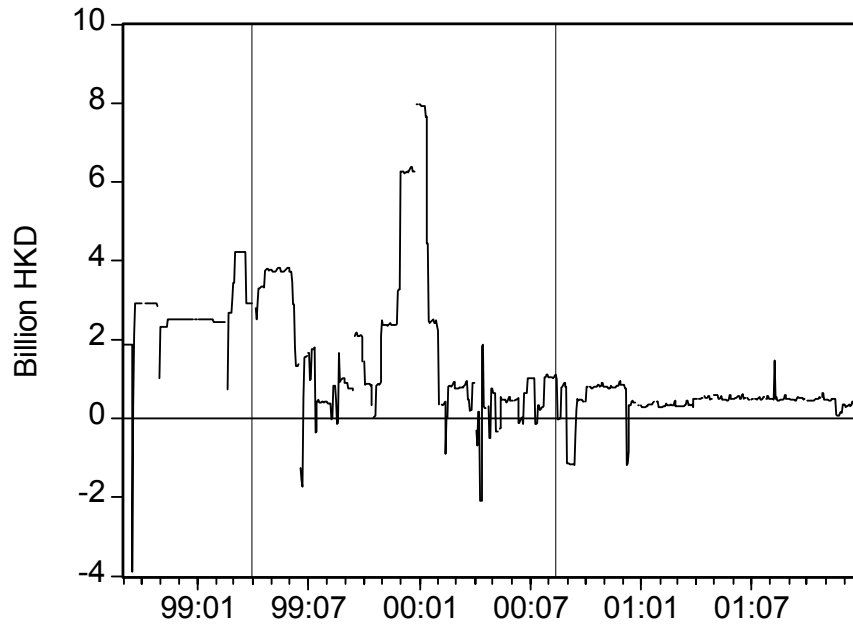


Figure 6
Probability of USD Purchase
as a Function of Interest Rate Spread

