

# The Impacts of Hong Kong's Currency Board Reforms on the Interbank Market

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**Abstract:** Among the economies with a Currency Board System, Hong Kong is probably the one with (a) the largest and most developed financial sector, and (b) the highest capital mobility. Hence, studying Hong Kong's Currency Board System is not only crucial to Hong Kong, but also important for the understanding of the modern Currency Board System. This paper outlines the major monetary reforms in Hong Kong since the late 1980s. The impacts of these reforms and the 1997/98 Asian Financial Crisis are then examined empirically. We focus on the differentials between the US and Hong Kong interbank interest rates. Generalized autoregressive conditional heteroscedasticity (GARCH) models are used to capture the time-varying level and volatility of the differentials. In light of the empirical results we provide an assessment of the reforms in Hong Kong.

**JEL Classification:** E42, E58

# 1 Introduction

Among the economies with a Currency Board System, Hong Kong is the one with the highest daily turnover in the interbank market, in the foreign exchange market, in the stock market as well as in the stock index futures market.<sup>1</sup> Capital is allowed to flow freely in and out of the economy. Thus, among the economies with a Currency Board System, Hong Kong is probably the one with (a) the largest and most developed financial sector, and (b) the highest capital mobility. Hence, studying Hong Kong's Currency Board System and money market is not only crucial to Hong Kong, but also important to the understanding of the modern Currency Board System.

Since the late 1980s, Hong Kong has adopted a few monetary reforms that may have substantial impacts on the Hong Kong interbank market. The aim of this paper is to examine what effects these monetary reforms have on Hong Kong's interbank interest rates versus the US. In addition, we investigate to what extent the Asian Financial Crisis in 1997/98 had destabilized the interbank market. The latter was widely believed to be the source of pain of the Hong Kong economy during the crisis period. We also test whether the anti-crisis package introduced in September 1998 succeeded in helping to rectify the loophole of Hong Kong's Currency Board System.

The plan of this paper is as follows. In Section 2 we outline the characteristics of the Currency Board System in Hong Kong and some of its monetary reforms that may have impacts on the interbank market. We also discuss the impacts of the speculative attack on the Hong Kong interest rate, and the subsequent reform. In Section 3 we specify the

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<sup>1</sup>The average daily turnover in the Hong Kong dollar interbank market and swap market in 2000 were HK\$87 billion (US\$11 billion) and HK\$106 billion (US\$14 billion), respectively. According to a recent survey the average daily turnover in Hong Kong's foreign exchange market was the fifth largest in the world. The average daily turnover in Hong Kong's stock market in 2000 was HK\$12.3 billion. The average daily turnover in the Hang Seng Stock Index Futures in 2000 was 16,292 contracts, equivalent to a contract value of HK\$13 billion. Among the economies with a Currency Board System, Hong Kong has the largest number of foreign (123) and local (31) banks. In addition to the above, Hong Kong ranks well within the world's top ten in its foreign exchange holdings (US\$108 billion at end 2000), external trade (US\$415 billion in 2000), and stock market capitalisation (US\$604 billion in 2000).

empirical model and the econometric methodology for analyzing the interest-rate data. Section 4 summarizes the empirical results and assesses the impacts of the monetary reforms. Section 5 provides the conclusion.

## **2 A Review of Hong Kong's Currency Board System and Its Monetary Reforms**

Prior to its present Currency Board System, Hong Kong adopted the floating exchange rate system between 1974 and 1983. With the 1983 Sino-Anglo dispute on the return of Hong Kong's sovereignty to China after 1997, a confidence crisis quickly emerged. The HK dollar was under severe pressure (the HK dollar fell from the rate of US\$1 to HK\$5.13 in 1981 to the trough of US\$1 to HK\$9.8 in 1983). To pre-empt the weakening of confidence from deteriorating into a full blown economic crisis, the HK government adopted the Currency Board System on 17 October 1983. Under this system, the money supply in HK is fully backed up by US dollar held at the Exchange Fund (of the Currency Board),<sup>2</sup> and the HK dollar is effectively fixed at the official rate of US\$1 to HK\$7.8. Because of the high capital mobility and the fixed exchange rate system, Hong Kong's interest rate has since then tended to follow the US interest rate fairly closely. Despite of this, there have been moderate differences between the HK and US interest rates from time to time due to various reasons, such as the differences in the economic and political environments, and the occurrence of the Asian Financial Crisis in 1997/98.

Since the late 1980s HK has adopted several monetary reforms to strengthen the Currency Board System. In this section we review the major reforms and their targeted objectives. The effectiveness of these reforms will then be examined empirically in Section 4.

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<sup>2</sup>Under the system, any one of the three note-issuing banks wishing to print HK dollar notes need to surrender an equivalent amount of US dollar (at the official rate) to the Exchange Fund in exchange for the Certificate of Indebtedness (CI), which entitles the note-issuing bank to print that amount of HK dollar. On the other hand, the note-issuing banks can always use their holdings of the CIs and HK dollar notes to redeem an equivalent amount of US dollar from the Exchange Fund.

## 2.1 The Accounting Arrangements

When the linked exchange rate system was first put into place in October 1983, the interbank clearing system was not run by the Currency Board, but by Hong Kong's largest commercial bank, namely, the Hongkong and Shanghai Banking Corporation Limited (HSBC). Under the arrangement, all licensed banks in HK maintained a clearing account directly with the HSBC or indirectly through another settlement bank. HSBC was the controller of the aggregate balance (net clearing balance) of the whole banking system and was therefore in a position to create money. The aggregate balance was determined by the commercial activities of HSBC in the money market and foreign exchange market, as well as by the activities of its customers. When HSBC lent to other banks or bought assets (including foreign exchange), or when HSBC's customers drew cheques and paid them to customers of other banks, the aggregate balance increased. There was no requirement and no need for HSBC to back up this monetary base by foreign exchange. Consequently, there was no arrangement imposed upon HSBC to subject the aggregate balance to the Monetary Rule (foreign exchange backup rule) of the Currency Board System.

Control over the aggregate balance was eventually brought under the Currency Board in July 1988 through the so called Accounting Arrangements. These arrangements reversed the customer-banker relationship between the Currency Board and HSBC in that HSBC was required to operate a clearing account with the Currency Board. As HSBC was still the management bank of the Clearing House and all other licensed banks still maintained clearing accounts directly or indirectly with it, HSBC was further required to conduct its interbank activities so that the net clearing balance of the rest of the banking system was not bigger than the balance in its account at the Currency Board. The aggregate balance thus operated as a cap on HSBC's ability to create money, beyond which the Accounting Arrangements imposed a penal rate of interest

on the excess. Given that the aggregate balance can only be altered when transactions were conducted with the Currency Board, this balance was then defined and subject to the indirect control of the Currency Board.

The Hong Kong Monetary Authority (HKMA) (see HKMA, 1994) argued that

Before the introduction of Accounting Arrangements, there tended to be a downward bias in local interest rates relative to the US dollar interest rates, as there was a lack of effective control over the extension of credits in the interbank market. The Accounting Arrangements built in such control and has therefore helped to narrow the gap between HK dollar and US dollar interest rates. In terms of the three-month rates, for instance, the differential was about 100 basis points in favor of the US dollar during the period November 1983 to June 1988. During the period July 1988 to October 1994, the differential was a mere 23 basis points.

We will examine in Section 4 whether HSBC's special position (in creating money without foreign exchange backup) during the period before the Accounting Arrangements had on average reduced the local interest rates relative to the US interest rates. We will also investigate whether the HSBC position has contributed to a higher or lower volatility of the interest-rate differential.

## **2.2 The Liquidity Adjustment Facility**

The Liquidity Adjustment Facility (LAF) introduced on 1 July 1992 is the HK version of discount window.<sup>3</sup> Under the facility, licensed banks can borrow over-night funds from the HKMA through repurchase agreements of eligible securities at the offer rate and can place surplus funds over-night with the HKMA at the bid rate. The HKMA

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<sup>3</sup>In general, as the LAF is directly related the over-night rate and only indirectly related to the three-month rate, the impact of the LAF on the over-night is more significant and pronounced than that on the three-month rate.

argued that this facility has effectively set the floor and ceiling of the over-night interest rate. Through the licensed banks' demand for and utilization of the facility, the HKMA can also supply additional liquidity or mop up excess liquidity from the whole banking system.

According to the HKMA, the facility has helped reduce the volatility of the over-night rates during periods of transitory tight liquidity such as substantial over-subscriptions of initial public offers (IPOs) (see HKMA, 1994):

There were a total of 63 IPOs in 1993, involving enormous amounts of subscription monies. The most notable example was the IPO of Denway which was about 600 times over-subscribed. Subscription monies involving \$240 billion had to be recycled through the interbank market on the closing date. Over-night rate firmed up 50 basis points above the LAF offer rate as many banks were aggressively bidding for funds. In response, the HKMA increased the level of interbank liquidity to provide some relief to the market. On the whole, the intraday volatility in the interbank market was much lower compared with the situation before the introduction of the Accounting Arrangements and LAF. For example, the Cathay Pacific IPO in 1986 and the Oriental Press IPO in 1987 resulted in a rise of 12.75 percentage points and 6 percentage points respectively in HIBOR.

It is interesting to note that the facility could have in fact fuelled the already high over-subscription rates of the IPOs in HK. We will examine in Section 4 whether the LAF did in fact reduce the volatility of the over-night interbank rate and reduce the gap between the HK and US over-night interbank rates. As the lending rate is more related to longer-term (e.g., three-month) interbank rates instead of over-night interbank rate, reducing the volatility of over-night rate may not have much impact on the economy if the volatility of the longer-term rates remains unchanged. Therefore, we will also

investigate whether the LAF had any impacts on the three-month interbank rate.

### **2.3 The Revised Mode of Monetary Operations**

Realizing that the over-night rate may still breach the range set by the LAF, the HKMA adopted a revised mode of monetary operations from mid-March 1994. Under the revised mode, the HKMA targeted short-term interbank interest rate instead of the level of interbank liquidity in its money-market operations (see HKMA, 1994):

This entails the injection or withdrawal of liquidity to prevent the over-night HIBOR from breaching the range set by the LAF Bid and Offer Rates. The actual amount will therefore be determined by the prevailing market conditions.

Thereafter, the HKMA made far more active short-term interventions during both the IPOs and seasonal (month-end or quarter-end) period (see HKMA, 1994):

For example, towards the end of March (1994), money market conditions tightened considerably as banks became cautious in lending before the quarter-end which coincided with a long weekend. The HKMA injected (HK)\$3.8 billion into the interbank market, thereby preventing the over-night HIBOR from breaching the LAF Offer Rate. The excess liquidity was withdrawn in early April when market conditions started to ease.

In Section 4 we will examine whether the revised mode of monetary operations had helped reduce the level and volatility of the HK-US interest-rate differential. We will also investigate whether the impact of the reform on over-night rate is different from that on the three-month interbank rate.

Before we turn to the next reform, we make a comment on the reforms discussed so far. According to the classical Currency Board System, the monetary authority should

let the market demand determine the local quantity of money supply and refrain from creating liquidity – no matter short-term or long-term – without a parallel increase in foreign exchange backup. In such a system, interest rates and money supply should be determined by market forces. Nevertheless, with the reforms discussed above we observe that the HKMA had a tendency to introduce and justify some freedom in monetary operations (i.e., a tendency to deviate from the classical Currency Board System). In addition to arguing that the provision of short-term liquidity to finance the huge over-subscription of IPOs and seasonal demands may or may not be desirable, we believe that a shift towards the revised mode of monetary operations may represent a dangerous step away from the monetary rule (foreign exchange backup rule) of the Currency Board System (i.e., the local money supply is also affected by the HKMA intervention). For example, suppose some speculators borrow a large amount of HK dollar through the foreign exchange swap market. According to the mechanism inherent in the Currency Board System, this will tend to bid up the HK interest rate, which would in turn attract capital inflows through interest arbitrage. Under the revised mode of monetary operations, the HKMA supplies short-term liquidity when they see a rise in the HK interest rate. By the same token, some fundamental changes could create an upward/downward pressure on interest rate, which would in turn change the local money supply through the standard mechanism. If this is not recognized, the HKMA may supply additional liquidity without a parallel increase in foreign exchange backup. It is noted, however, that HKMA's interventions have been so far short-term in nature.

## **2.4 The Crisis and Subsequent Reforms**

Hong Kong's financial market was under severe speculative attack during the Asian Financial Crisis in October 1997. The strategy of the speculators was to bid up Hong Kong's interbank rate and subsequently benefit from the huge short positions they had

built up in the stock futures market prior to the launch of their attack.<sup>4</sup>

In view of the surge in interest rate, the plunge in asset prices and hence the harms done to the HK economy, Chen and Chan (1998), Tsang (1999),<sup>5</sup> Miller (1998) and Yip (1999)<sup>6</sup> have made proposals to bring down the interest rate and hence the economic pain. Of particular interest are the proposals by Tsang and Yip. Tsang first argued that because of institutional imperfections, cash arbitrage (between the market exchange rate and official linked rate) was never operative in Hong Kong's linked exchange rate system. He proposed to modernize Hong Kong's Currency Board by adopting the "convertible reserves mechanism" of Argentina, Estonia and Lithuania (the AEL model), under which arbitrage could be done electronically without moving cash around. In the design, each bank will have an account with the central bank, in which deposit reserves as well as other balances are kept. The central bank guarantees the full convertibility of these bank balances at the official exchange rate. Tsang believed this would correct the institutional imperfections and make cash arbitrage operative. He also mentioned the possibility of interest arbitrage under this system. However, Tsang did not explicitly elaborate the mechanism to remove the exchange rate risk of interest arbitrage, which some researchers (see Yip, 1999) believe is the main reason that stops the HK interest rate from falling to the US rate during the crisis.

In addition to Tsang's suggested set up, Yip proposed to use the electronic Certificate of Indebtedness as a guarantee to remove the exchange rate risk of interest arbitrage.<sup>7</sup> With the guarantee, banks would be interested in earning the interest differential by borrowing US dollar (from abroad) at the low US interest rate and lending HK dollar

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<sup>4</sup>The Appendix provides an account of the speculators' strategy.

<sup>5</sup>The proposal was first made in 1997, and was subsequently included in Tsang (1999).

<sup>6</sup>The proposal was first made in an internal report in the Bank of China (Hong Kong-Macau Regional Office) in 1997, and was released in a local newspaper (Hong Kong Economic Journal) on 24 February 1998. It was then subsequently included in Yip (1999).

<sup>7</sup>Under the colonial Currency Board System, Certificates of Indebtedness (CIs) are certificates that guarantee the holders can always use the CIs and domestic currency to exchange for an equivalent amount of foreign currency specified in the CIs.

at the high HK interest rate. Thus, with the guarantee, interest arbitrage will continue until the HK interest rate fall back to the US rate.

The HKMA modified and adopted these proposals into its anti-crisis package in September 1998. Meanwhile, speculators were able to repeat their October 1997 speculative strategy (see the details in the Appendix) in January, April, June and August 1998. While speculators earned substantial profits from these attacks, Yip (1999) reported that the harm done to the HK economy far exceeded the speculators' profits. In the speculative attack during August 1998, the HKMA opted for a stock market intervention. Nevertheless, with the weak market sentiment, traditional funds dumped about HK\$100 billion HK shares on 31 August 1998, and the HKMA was forced to purchase all these shares.

To avoid the development in the stock market from deteriorating into a deeper crisis, the HKMA modified the recommendations of the researchers and came up with its own reform package (or modern Currency Board System) on 5 September 1998, highlighted under seven technical measures. Of the seven measures, the most important measures are: (a) an exchange rate guarantee (convertibility undertaking) for the banks' net balance in the account with the HKMA, and (b) a modification of previous practice to a discount window which allows banks substantial freedom to use their holdings of Exchange Fund debts as a collateral for over-night liquidity borrowing from the HKMA (see Yam, 1998).

Measure (a) removes the exchange-rate risk of banks' interest arbitrage activities and hence brings the HK interest rate in line with the US interest rate. Measure (b) aims at allowing an increase in interbank liquidity in case of speculative attack, so that the impact of the attack on the interbank rate can be mitigated. Before this reform, HK banks' clearing balance and interbank liquidity were relatively small.<sup>8</sup> Thus, allowing

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<sup>8</sup>As a result, it took only US\$1-2 billion spot selling of the HK dollar in the foreign exchange market to create a substantial shortage of interbank liquidity on 23 October 1997.

the interbank liquidity to expand when deemed necessary may stop the speculators from squeezing the interbank liquidity (and hence interbank rate) with a relatively small amount of spot selling of the HK dollar. To justify this arrangement, the HKMA re-defined its monetary base to cover the currency issued, the banks' net clearing balance with the HKMA and the debts issued by the Exchange Fund. The HKMA justified their definition of monetary base by arguing that all the three components are fully backed up by their holdings of foreign reserve.<sup>9</sup>

After the introduction of the technical measures, interest rate in HK began to fall gradually towards the US interest rate in the fourth quarter of 1998. By mid-October 1998, the three-month interbank rate was only 6%, as compared to 11.8% on 14 September 1998. With further cuts in the US interest rate and a continued reduction in the interest rate differential, the HK three-month interbank rate fell further to 5.63% on 28 December 1998, which was only 0.4 percentage point higher than the US rate. In Section 4 we will examine the impact of the Asian Financial Crisis and the technical measures on Hong Kong's interbank market.

### 3 The Data and the Methodology

Our data consist of daily observations of the HK and US interbank interest rates, namely, the HIBOR and LIBOR.<sup>10</sup> The over-night and three-month interbank interest rates were obtained from the Datastream. The data set covers the period 87/2/2 through 01/3/30, with 3695 observations in total.

Figures 1 and 2 plot the over-night interbank rates and their first differences, respectively. Similarly, Figures 3 and 4 plot the three-month interbank rates. The figures suggest that the interbank rates are nonstationary, while their first differences are sta-

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<sup>9</sup>No doubt, such definition and arrangement did help discourage speculative attacks. It is, however, interesting to note that HK is probably the only economy in the world that includes long-term bonds as a component of the monetary base.

<sup>10</sup>These stand for the HK Interbank Offer Rate and the London Interbank Offer Rate, respectively.

tionary. In other words, the interbank interest rate series contain a unit root. Table 1 provides some summary statistics for the data, as well as the tests for unit roots using the Augmented Dickey-Fuller (ADF) test. The ADF statistics show that the hypothesis that the US interbank interest rates are nonstationary cannot be rejected at the 10 percent level, while the hypothesis that the HK interbank interest rates are nonstationary cannot be rejected at the 1 percent level.<sup>11</sup>

Figure 5 plots the differential between the HK and US interbank rates. Except for the period prior to the first reform (Accounting Arrangements) and during the Asian Financial Crisis, where there were signs of regime shift, the differential series appear to be stationary. Johansen’s likelihood ratio statistics of cointegration are 130.721 and 34.098, respectively, for the over-night and three-month rates.<sup>12</sup> Thus, there is evidence in support of the hypothesis that the HK and US interbank rates are cointegrated, both for the over-night and three-month interest-rate data.

As discussed in the last section, we will examine the impacts of the monetary reforms introduced since the late 1980s and the effects of the Asian Financial Crisis on the level and volatility of Hong Kong’s interbank rates relative to their US counterparts. Thus, we separate the sample period into the following six sub-periods:

Sub-period	Reform/Crisis
P <sub>1</sub> : 87/2/2 – 88/6/30	No monetary reform
P <sub>2</sub> : 88/07/01 – 92/05/31	Accounting Arrangement
P <sub>3</sub> : 92/06/01 – 94/03/15	Liquidity Adjustment Facility in addition to the above
P <sub>4</sub> : 94/03/16 – 97/07/01	Revised mode of operation in addition to the above
P <sub>5</sub> : 97/07/02 – 98/09/04	Asian Financial Crisis
P <sub>6</sub> : 98/09/05 – 01/3/30	Post-crisis, technical measures introduced

We denote the HK interbank rate (over-night or three-month) at time  $t$  by  $r_{Ht}$  and the corresponding US interbank rate (over-night or three-month) by  $r_{Ut}$ . Let  $y_t = r_{Ht} - r_{Ut}$

<sup>11</sup>The results of these tests are based on the critical values given by MacKinnon (1991).

<sup>12</sup>See Johansen (1988) for the use of the likelihood ratio test for cointegration. The critical values of the tests can be found in Osterwald-Lenum (1990).

denote the interest-rate differential. As  $r_{Ht}$  and  $r_{Ut}$  are found to be nonstationary while  $y_t$  is found to be stationary, we model the dynamics of the interest-rate differential  $y_t$  using an autoregressive process. Furthermore, we allow the volatility of the interest-rate differentials to be time-varying. In addition, dummy variables are introduced in the conditional-mean and conditional-variance equations to capture the effects of the reforms and the Asian Financial Crisis. We define  $D_i$ ,  $i = 1, \dots, 6$ , as a dummy variable such that  $D_{it} = 1$  if  $t$  belongs to the sub-period  $P_i$ . Thus, the conditional-mean equation is given by

$$y_t = \sum_{i=1}^6 \delta_i D_{it} + \sum_{j=1}^p \phi_j y_{t-j} + \varepsilon_t$$

so that  $y_t$  follows an autoregressive process of order  $p$ . The time-varying intercept  $\delta_i$  captures the average interest-rate differential in each sub-period.

We assume the conditional-variance of the residual  $\varepsilon_t$  follows a generalized autoregressive conditional heteroscedasticity (GARCH) process. The GARCH model was first suggested by Bollerslev (1986) following the earlier work of Engle (1982), and has since been applied extensively in the empirical finance literature.<sup>13</sup> Thus,  $\varepsilon_t | \Phi_{t-1} \sim N(0, \sigma_t^2)$ , namely, conditional on the information set  $\Phi_{t-1}$  at time  $t - 1$ , the residual  $\varepsilon_t$  is distributed as a normal variable with mean zero and variance  $\sigma_t^2$ . In particular, we assume a GARCH(1, 1) model such as

$$\sigma_t^2 = \sum_{i=1}^6 \gamma_i D_{it} + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

In this equation the conditional-variance is allowed to shift according to the sub-period. The parameter  $\gamma_i$  determines the volatility of the interest-rate differential in sub-period  $P_i$ .

We estimate the parameters of the conditional-mean and conditional-variance equations jointly using quasi-MLE (QMLE) method (see Bollerslev and Wooldridge, 1992). The standard errors are then computed using robust (to nonnormality) estimates. We

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<sup>13</sup>See, for example, Bollerslev, Chou and Kroner (1992) for a survey.

adopt a general-to-specific approach by testing the restrictions on the dummy variables, which are tests of the impact of the reforms and the Asian Financial Crisis.

## 4 The Empirical Results

Table 2 summarizes the estimated general models for the over-night and three-month interbank-rate differentials. As can be seen from  $\hat{\delta}_1$ , Hong Kong's over-night and three-month interbank rates were statistically significantly lower than their US counterparts prior to the Accounting Arrangements (i.e., in sub-period  $P_1$ ). Thus, there is some support for HKMA's claim that during this period the HSBC was able to exploit its position as a clearing bank by creating money without an appropriate increase in the US dollar backup, causing a downward bias in the differential between the HK and US interest rates. Of particular interest is that the downward bias for the over-night rate (303 basis points) was markedly higher than that for the three-month rate (88 basis points). This suggests a very interesting behavior of the HSBC: The HSBC was more willing to create money for very short-term (over-night) loans/transactions rather than longer-term (three-month) loans/transactions. The HSBC's lower (higher) willingness to take risk in the longer (shorter) term has in turn led to larger downward bias in the over-night rate.

With the introduction of the Accounting Arrangements since July 1988, the HSBC was no longer capable of creating HK dollar as mentioned. As a result, the HK-US interest-rate differential returned to positive during the Accounting-Arrangements (i.e., in sub-period  $P_2$ ). Hong Kong's over-night and three-month interbank rates were on the average 18.1 basis points and 31.1 basis points above their US counterparts, respectively. If we take the differential during this period as a "normal" reflection of the political and economic risk premium between HK and the US, we can infer that HSBC's special position during the pre-Accounting-Arrangements period led to a downward bias of

Hong Kong's over-night and three-month interbank rates by 3.21 percentage points and 1.19 percentage points, respectively. The  $t$  statistics for  $H_0 : \delta_1 = \delta_2$  are 12.92 and 4.64, respectively, for the over-night and three-month rates.<sup>14</sup> Thus, the null hypothesis of no change in the differential is convincingly rejected for both cases. A comparison of the estimates of  $\gamma_1$  and  $\gamma_2$  also shows that the HSBC's special position led to a higher volatility in Hong Kong's interbank rates. The  $t$  statistics for  $H_0 : \gamma_1 = \gamma_2$  are 15.32 and 4.38, respectively, for the over-night and three-month rates. Thus, the volatility of Hong Kong's interest rate during the pre-Accounting-Arrangements sub-period  $P_1$  was significantly higher than that in sub-period  $P_2$ . This shows that HSBC's special position in sub-period  $P_1$  did not only cause downward bias in Hong Kong's interest rate, but also higher volatility in the interest-rate differentials. Again, because of HSBC's higher risk aversion over the longer end, the volatility of over-night rate was markedly higher than that of the three-month rate.

The estimates of the coefficient  $\delta_3$  tell a rather different story about the impacts of the Liquidity Adjustment Facility (LAF). For the over-night rate,  $\hat{\delta}_3$  is not significantly different from zero, suggesting that the LAF virtually removed the risk premium between the HK and US over-night rates. The  $t$  statistic for  $H_0 : \gamma_2 = \gamma_3$  is 3.97, showing that the reduction in the volatility of the interest-rate differential is significant. For the three-month interbank rate,  $\hat{\delta}_3$  is significantly different from zero, suggesting that there is still a risk premium between the HK and US three-month rates. The  $t$  statistic for  $H_0 : \delta_2 = \delta_3$  is 1.46, showing that the reduction in the risk premium due to the LAF is not statistically significant. However, the  $t$  statistic for  $H_0 : \gamma_2 = \gamma_3$  is 20.33, showing that the LAF reduced the volatility of the three-month interbank-rate differential significantly.

We now come to the revised mode of monetary operations introduced since March 1994. The estimates of  $\delta_4$  are negative for both the over-night and three-month rates,

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<sup>14</sup>All  $t$  statistics reported in this section are the Wald tests based on the robust estimates of the variance matrix of the unconstrained QMLE (see Bollerslev and Wooldridge, 1992) not presented in Table 2.

suggesting that the revised mode of monetary operations led to a downward bias in Hong Kong's interbank rate versus the US. That is, with the HKMA more inclined to inject short-term liquidity to finance huge over-subscription of IPOs and seasonal demand for liquidity, the interest rate in HK, especially at the shorter end, tended to be lower than the US counterpart. As can be seen from the mean differentials given in Table 2, the downward bias was more pronounced for the over-night rate (38 basis points) compared to the three-month rate (11 basis points). The  $t$  statistics for  $H_0 : \delta_3 = \delta_4$  are 3.28 and 3.34, respectively, confirming that the revised mode of monetary operations did have significant impacts on the level of the interbank-rate differentials. However, tests for the equality of  $\gamma_3$  and  $\gamma_4$  only confirm that the revised mode of monetary operations reduced the volatility of the over-night rate differential ( $t = 9.93$ ), but not the three-month rate differential ( $t = 1.23$ ). One possible reason for this is that the revised mode of monetary operations is mainly meant for short-term liquidity injection, which would be reversed once the event is over.

The  $t$  statistic for  $H_0 : \delta_4 = \delta_5$  is 2.06, suggesting that the Asian Financial Crisis did lead to an increase in Hong Kong's three-month interbank rate versus the US. There is a risk premium of 90.9 basis points between the HK and US three-month rates. However, the  $t$  statistic of 0.14 for  $H_0 : \delta_4 = \delta_5$  for the over-night rate is statistically insignificant, suggesting that the Asian Financial Crisis did not have any significant impact on the average level of Hong Kong's over-night rate versus the US.<sup>15</sup> One possible reason for this is that the HKMA would soon provide additional short-term liquidity (say, through the LAF or other channels) whenever there was any shortage of liquidity in the interbank market. As a result of these actions, the over-night rate reversed quickly within one or two days. As for the volatility, the  $t$  statistics reject  $H_0 : \gamma_4 = \gamma_5$  strongly for both the over-night and three-month rates, confirming that the Asian Financial Crisis led to a

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<sup>15</sup>This is despite the surge of the HK over-night rate in several days. The average of the differential during the Asian Financial Crisis, however, was negative.

rise in the volatility of the interbank market.

Finally, comparing  $\hat{\delta}_5$  with  $\hat{\delta}_6$  for the three-month rate suggests that the seven technical measures introduced since September 1998 contributed to the decline in the three-month interbank-rate differential arising from the crisis. Indeed,  $\hat{\delta}_6$  is not statistically significantly different zero. This may be due to the success of the “convertibility undertaking” of the seven technical measures in removing the exchange risk of interest arbitrage between the HK and US dollars. With the interest-arbitrage activities revitalized, the HK three-month interbank rate once again fell to the US level, thus solving the problem of interest-rate hike created by the speculative attack during the crisis period. The  $t$  statistic for  $H_0 : \gamma_5 = \gamma_6$  is 9.16, suggesting that the seven technical measures contributed to the decline in the volatility of the three-month interest-rate differential. The case for the over-night rate is, however, slightly different. As the Asian Financial Crisis did not have any significant impact on the average level of the over-night differential, the seven technical measures also did not have any impact on the average level of the over-night differential. The likelihood ratio statistic of 0.0226 for  $H_0 : \delta_4 = \delta_5 = \delta_6$  shows that  $H_0$  cannot be rejected. Rather surprisingly, the  $t$  statistic for  $H_0 : \gamma_5 = \gamma_6$  is 4.73, showing that the volatility of the over-night rate differential was higher since the latest reform compared to the period of the Asian Financial Crisis.<sup>16</sup>

## 5 Conclusion

In this paper, we have outlined the monetary reforms in Hong Kong’s Currency Board System since the late 1980s. We have estimated the impacts of these reforms and the 1997/98 Asian Financial Crisis on the interest-rate differential between US and HK, both in terms of the level and the volatility. We find support for the HKMA’s claim that, prior to the Accounting Arrangements introduced in July 1988, the HSBC was able to

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<sup>16</sup>One possible reason for this could be a change in the HKMA’s reaction (reversal) to market changes during the crisis and post-crisis period.

exploit its position as a clearing bank by creating money without an appropriate increase in the US dollar backup, causing a downward bias in the differential between the HK and US interest rates. Of particular interest is that the downward bias for the over-night rate was markedly higher than that for the three-month rate. One possible reason for this is that risk consideration has made the HSBC more willing to create money for very short-term (over-night) loans/transactions rather than longer-term (three-month) loans/transactions. With the introduction of the Accounting Arrangements since July 1988, the HSBC was no longer capable of creating HK dollar as mentioned. As a result, the HK-US interest-rate differential returned to positive during the Accounting-Arrangements period. In addition to the downward bias, it is found that the HSBC's special position in the Pre-Accounting-Arrangements period led to higher volatility in the interest-rate differential. Again, because of HSBC's higher risk aversion over the longer end, the volatility of the over-night rate was significantly higher than that of the three-month rate.

We also find that the Liquidity Adjustment Facility (LAF) introduced in July 1992 has brought down the level and volatility of Hong Kong's over-night rate. In fact, the LAF has removed the risk premium between the HK and US over-night rates. Nevertheless, as the LAF is only indirectly related to the three-month rate, the impact of the LAF on the three-month rate is less obvious: It only reduced the volatility of Hong Kong's three-month rate but does not seem to show any significant effect on the level of Hong Kong's three-month rate. Rather than jumping to the conclusion that the above "achievements" have benefited the HK economy, we would caution that these could have been achieved at the cost of fueling the already high over-subscription rates of the IPOs in HK. Our reservation is even stronger when it comes to the revised mode of monetary operations. In fact, we have found that the revised mode has led to a downward bias in the HK-US interest-rate differentials. That is, with the HKMA more inclined to inject short-term liquidity to finance huge over-subscriptions of IPOs and seasonal demand for

liquidity, the interest rate in HK, especially at the shorter end, tended to be lower than the US counterparts.

We have found that the Asian Financial Crisis in 1997/98 led to an increase in the level and volatility of Hong Kong's three-month rate. The higher medium-term interest rate was widely believed to be the source of Hong Kong's economic pain during the crisis. We have also found that the anti-crisis package introduced in September 1998 led to a drastic decline in the level and volatility of Hong Kong's three-month rate. In fact, with the convertibility undertaking inherent in the seven technical measures, interest rate arbitrage was revitalized, which in turn brought Hong Kong's three-month rate down to the US level (i.e., Hong Kong's three-month rate was statistically not different from the US counterpart during the post-crisis period). The behavior of Hong Kong's overnight rate was, however, more complicated, as it was also affected by HKMA's reaction (reversal) to market changes.

## **Appendix: Speculative Strategy used by Speculators on the Hong Kong Market during the Asian Financial Crisis**

This appendix provides an account of the strategy used by the speculators on the HK financial markets in September/October 1997. Exploiting the precarious fixed exchange-rate system during the crisis, the speculators adopted a “double-play” strategy in the foreign exchange and stock futures market. Their strategy consists of the following steps.

### **Step 1: Preparation**

The speculators first borrowed, or pre-funded themselves with, substantial amount of medium-term (6-12 months) HK dollar through the swap market (i.e., swapping US dollar for HK dollar). Some speculators also bought HK dollar (and sold US dollar) forward in the forward market. In the stock futures market, the speculators started to build up large short positions. To equip themselves with the ability to create panic selling in the stock market during the formal attack, the speculators also utilized the “loophole” in the stock custodian sector to borrow substantial amount of shares from the custodians and trustees.

### **Step 2: Formal attack**

After the above preparation, the speculators sold their pre-funded HK dollar (and bought US dollar) in the spot market. To maximize the impact of their attack, they sold the HK dollar in the relatively thin offshore markets. When the HKMA attempted to support the HK dollar by purchasing the HK dollar, the interbank liquidity was squeezed. This in turn caused a surge in the interbank rate. In addition to selling in the spot market, the speculators also sold large amount of HK dollar (and bought US dollar) in the forward market. As banks usually did arbitrage between the swap market and the interbank market, the forward selling of HK dollar would also bid up Hong Kong’s interbank rate. This would create a sentiment that the HK dollar was under attack,

thus attracting more speculators to follow.

Concurrently, the speculators attacked the stock market by (a) selling their shares originally borrowed from the custodians; and (b) accelerating their selling in the stock futures market with a high profile (arbitrage would ensure that a fall in the stock futures also caused a fall in the spot stock market). These actions would create panic selling of shares. In fact, these strategies turned out to be very successful and there was substantial fall in Hong Kong's stock index during the attack.

### **Step 3: Profit taking**

Having bid up the interbank rate and pushed down the spot and futures stock indices, the speculators took their profits by closing the short positions in the stock futures market. They also bought back the shares (at much lower prices) and returned them to the custodian. In the foreign exchange market, they closed their short position in forward Hong Kong dollar (and made profit from the lower forward rate), and lent out any surplus HK dollar (at a shorter maturity) earlier borrowed from the swap market.

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**Table 1: Summary statistics of the interbank rates**

Statistic	Over-night rate		Three-month rate	
	HK	US	HK	US
Mean	5.489	5.790	6.276	6.019
Median	5.250	5.563	5.977	5.750
Maximum	23.500	10.750	18.438	10.500
Minimum	0.155	2.813	0.625	3.063
Std Dev	2.159	1.656	2.108	1.668
Skewness	0.812	0.331	0.773	0.308
Kurtosis	5.390	2.799	4.309	2.671
ADF of level	-3.210	-0.943	-3.038	-0.994
ADF of difference	-20.465	-14.723	-30.248	-66.69

**Table 2: Estimation results of the over-night and three-month interbank interest rate differentials**

Parameter	Over-night rate			Three-month rate		
	Estimate	Standard error	Mean differential	Estimate	Standard error	Mean differential
$\phi_1$	0.7055	0.0200		0.7819	0.0212	
$\phi_2$	0.0974	0.0217		0.1710	0.0212	
$\phi_4$	0.0459	0.0134				
$\delta_1$	-0.4569	0.0348	-3.026	-0.0414	0.0107	-0.879
$\delta_2$	0.0273	0.0130	0.181	0.0147	0.0050	0.311
$\delta_3$	0.0010	0.0160	0.007	0.0065	0.0026	0.138
$\delta_4$	-0.0571	0.0079	-0.378	-0.0050	0.0023	-0.106
$\delta_5$	-0.0598	0.0188	-0.396	0.0428	0.0234	0.909
$\delta_6$	-0.0560	0.0135	-0.371	0.0011	0.0035	0.024
$\gamma_1$	0.4183	0.0241		0.0099	0.0008	
$\gamma_2$	0.0773	0.0042		0.0066	0.0002	
$\gamma_3$	0.0616	0.0035		0.0016	0.0001	
$\gamma_4$	0.0275	0.0013		0.0013	0.0001	
$\gamma_5$	0.0500	0.0048		0.0367	0.0038	
$\gamma_6$	0.0812	0.0064		0.0022	0.0002	
$\alpha_1$	0.4327	0.0169		0.3942	0.0118	
$\beta_1$	0.3985	0.0179		0.5423	0.0096	

**Notes:** The mean interest-rate differential in sub-period  $P_i$  is calculated by  $\hat{\delta}_i / (1 - \sum_j \hat{\phi}_j)$ .

Figure 1: Over-night interbank rates of Hong Kong and US

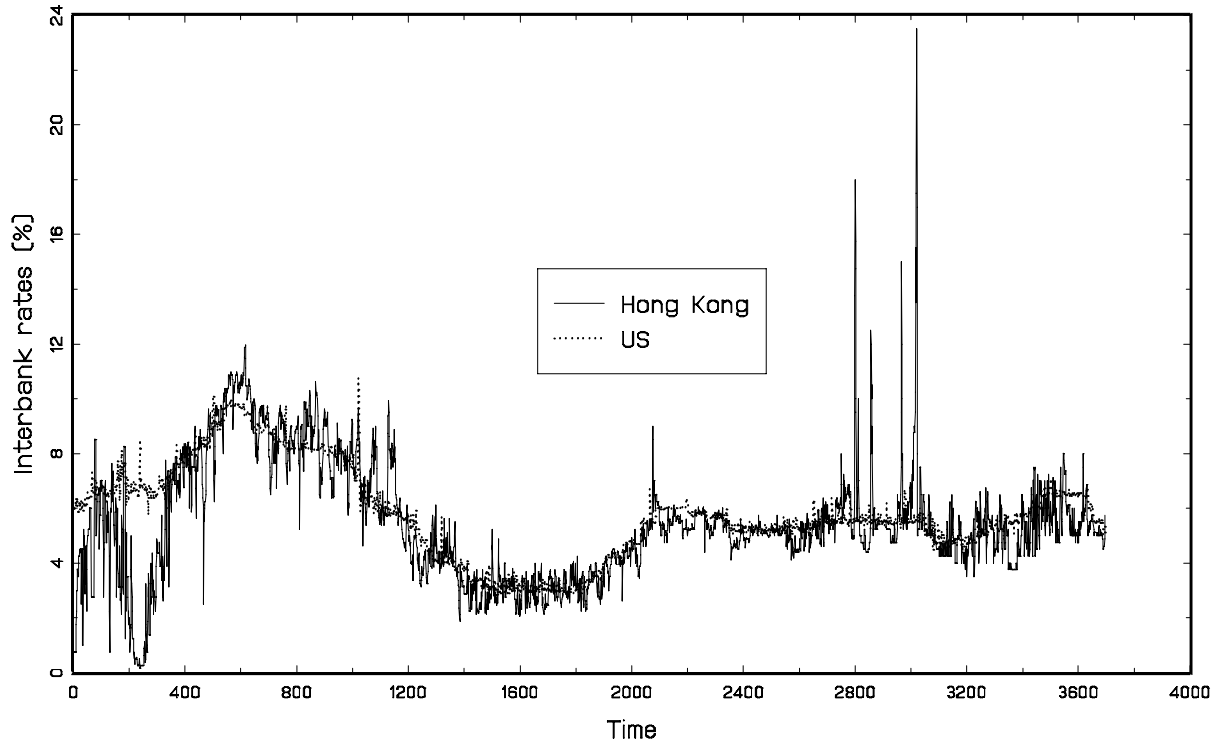


Figure 2: Differenced over-night interbank rates of Hong Kong and US

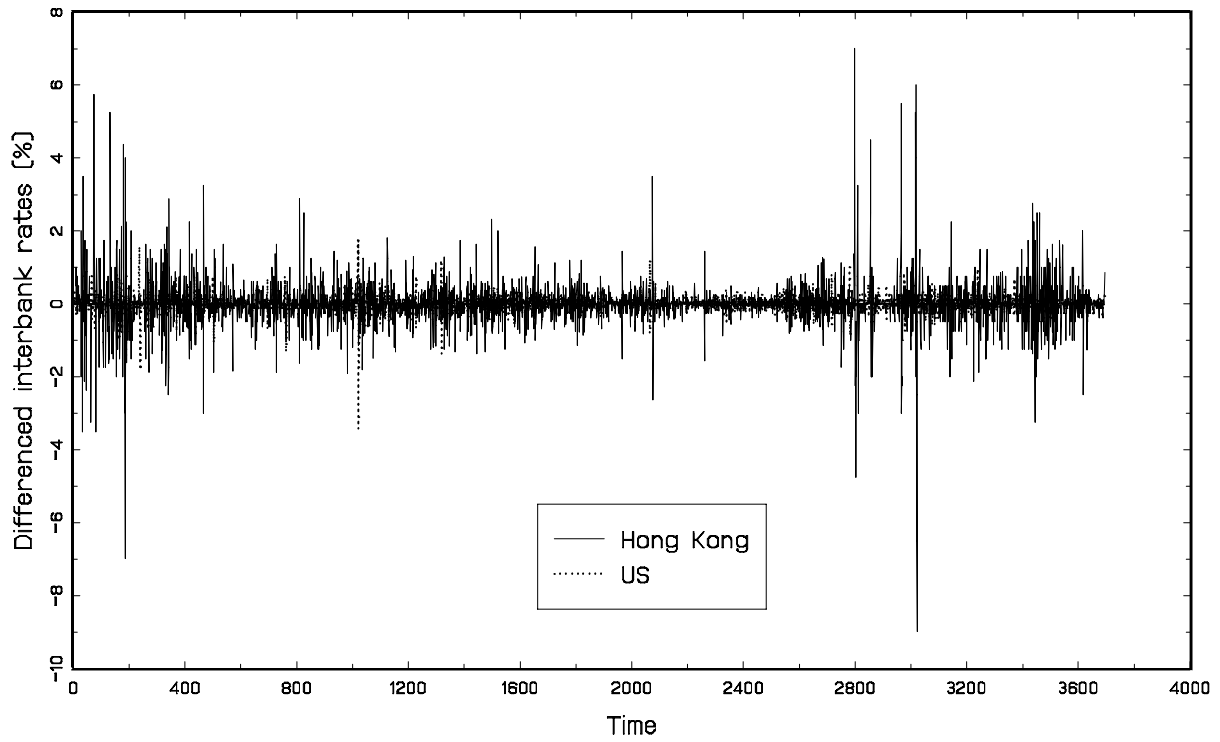


Figure 3: Three-month interbank rates of Hong Kong and US

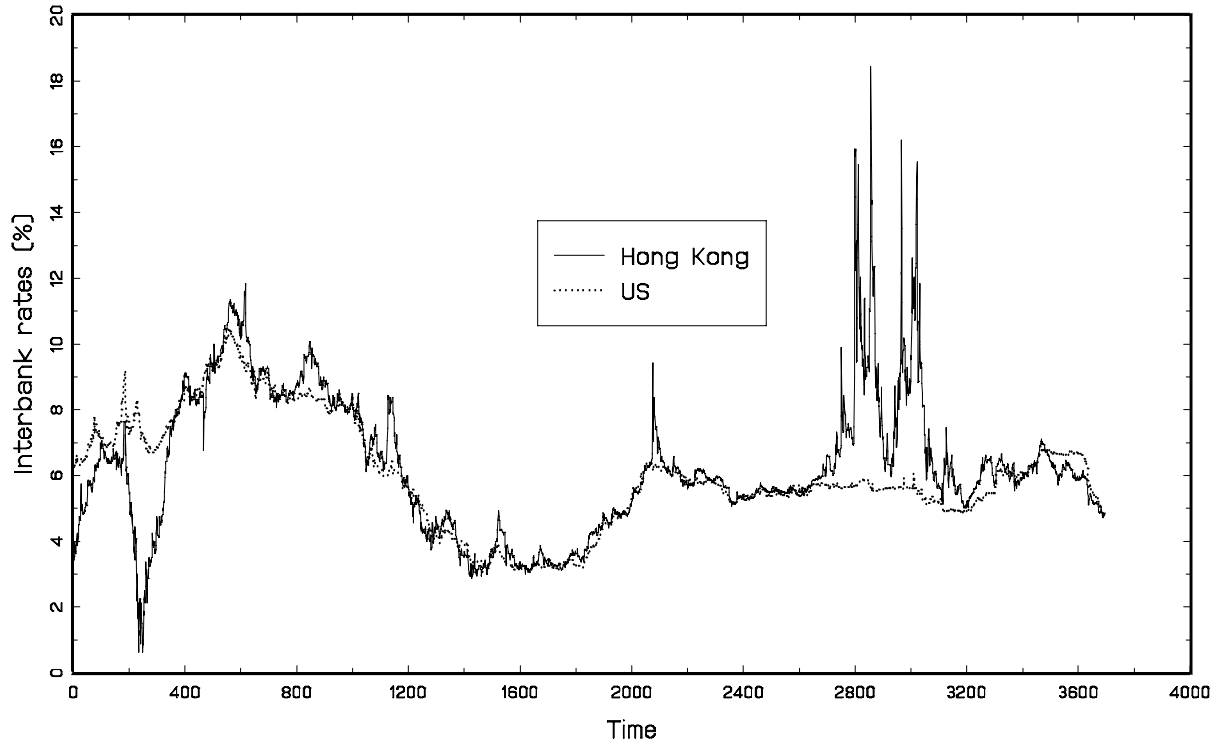


Figure 4: Differenced three-month interbank rates of Hong Kong and US

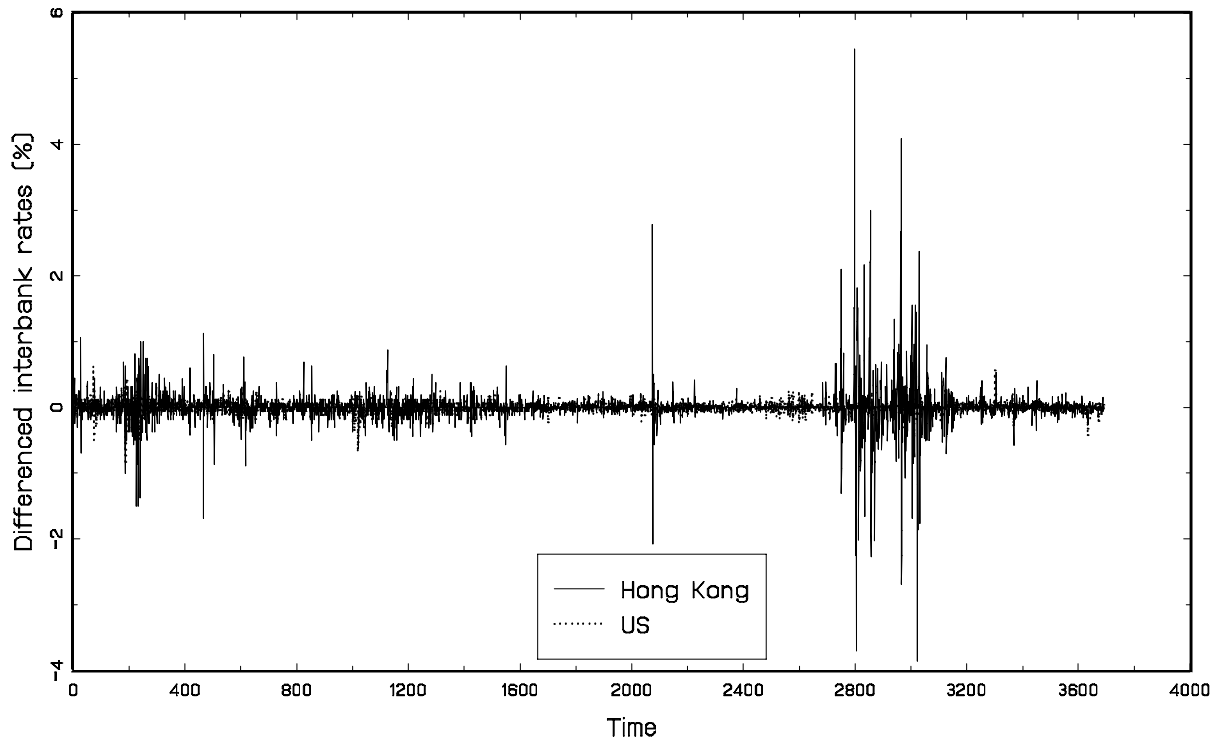


Figure 5: Differentials of interbank rates: Hong Kong versus US

