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DISLOCATIONS IN FX SWAP AND MONEY MARKETS IN HONG KONG AND POLICY ACTIONS DURING THE FINANCIAL CRISIS OF 2008

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Abstract

When US dollar interbank markets malfunctioned during the global financial crisis of 2008, many non-US financial institutions relied heavily on the foreign-exchange (FX) swap markets for US-dollar funds. This one-sided market induced a risk premium of the FX swap-implied US-dollar rate across a range of funding currencies, i.e. a deviation from the covered interest parity (CIP) condition. The turbulence in the global interbank markets therefore spilled over to the FX swap markets, including that in Hong Kong. This paper analyses the effectiveness of the policy actions taken by the Hong Kong Monetary Authority and the Government in responding to the dislocations and stress in the local interbank and FX swap markets. Our results show that the policy actions effectively ameliorated the FX swap market dislocations after the failure of Lehman Brothers, i.e. reducing the CIP deviations.

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Executive Summary:

- *When US-dollar interbank markets malfunctioned during the recent financial crisis, many non-US financial institutions relied heavily on FX swap markets to raise US dollars using local currencies. This one-sided market induced a risk premium of the FX swap-implied US dollar rate (across a range of funding currencies) that the non-US financial institutions had to pay over the corresponding dollar LIBOR rate, i.e. a deviation from the covered interest parity (CIP) condition.*

- *This unusual pricing behaviour reflected dislocations in the FX swap markets. The turbulence in the global interbank markets therefore spilled over to the FX swap markets, including that in Hong Kong. This paper analyses the effectiveness of the policy actions taken by the Hong Kong Monetary Authority and the Government in responding to the dislocations and stress in the local interbank and FX swap markets.*

- *We find that the policy actions effectively ameliorated the FX swap market dislocations after the failure of Lehman Brothers, i.e. reducing the CIP deviations in the local financial markets. This indicates that the policy actions improved the efficiency of the interbank and FX swap markets in which market liquidity resumed to eliminate arbitrage opportunities. The adverse impact of interbank credit market tensions on the local financial markets was thus mitigated during the global financial turmoil.*

- *In particular, the five temporary measures provided additional longer-term funding to banks against a wider range of collateral at a potentially lower interest rate cost. Banks were more assured about the availability of funds, and more willing to lend in the interbank market. Furthermore, policy actions aimed at containing the solvency risk in the banking system relaxed the counterparty-risk constraint in the markets and thus removed the financial dislocations.*

I. INTRODUCTION

The sub-prime crisis emerged in the United States in mid-2007 and spilled over to other economies. From mid-2007 to mid-2008, the spillovers were relatively modest. The situation began to change in mid-2008. Following the bankruptcy of Lehman Brothers in mid-September 2008, developments took a dramatic turn. One channel for spillovers was severe disruptions in international money markets. Uncertainty about losses incurred in banks increased their liquidity needs as well as their reluctance to lend to each other in money markets. Reflecting these and possibly other factors, interbank short-term interest rates surged substantially after the Lehman failure, and then persisted at high levels, prompting central banks around the world to adopt unprecedented policy measures to supply funds to the banks. The Hong Kong Monetary Authority (HKMA) and the Government also announced a series of measures to help contain the global risks from spilling over to the domestic banking system. In this paper, we conduct an event study to examine the effectiveness of the various policy actions taken by the HKMA and the Government in apprehending the anomalies and distress in the local financial markets, especially after the Lehman failure in mid-September 2008. We investigate how these measures mitigated the adverse impact of the turbulence in the global interbank markets on the local interbank market and foreign exchange (FX) swap market.

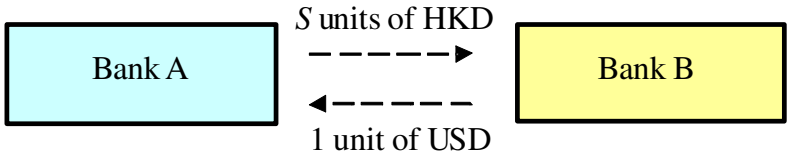
II. DISLOCATION IN THE FX SWAP MARKET AND THE STRESS IN THE HONG KONG DOLLAR INTERBANK MARKET

A FX swap is a contract in which two parties agree to borrow and lend two currencies by entering into FX spot and forward contracts. For instance, a financial institution in Hong Kong, when in need of US-dollar (USD) funds, can either (i) borrow directly in the USD uncollateralised cash markets or (ii) borrow in the Hong Kong-dollar (HKD) uncollateralised cash market and convert the HKD proceeds into USD at the FX spot rate while contracting to exchange in the reverse direction at maturity at the FX forward rate.[2] Chart 1 provides a simple illustration of the cash flows in a HKD/USD FX swap transaction.

[2] While we use a financial institution as an example, other entities such as exporters and importers, as well as institutional investors also employ FX swaps to fund their foreign-currency needs or to hedge their positions against the FX risk.

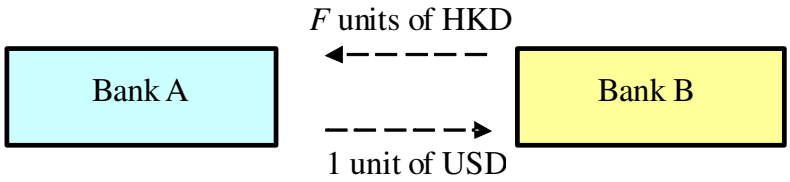
Chart 1. Cash flows in a FX swap transaction

— At initiation of the FX swap contract ($t = 0$)



S = spot exchange rate (HKD/USD)

— At maturity of the FX swap contract ($t = T$)



F = forward exchange rate (HKD/USD)

When uncollateralised USD money markets malfunctioned and the interbank interest rates shot up during the turmoil, many non-US financial institutions relied heavily on FX swap markets to raise USD using local currencies. FX swap-market premiums rose, as many non-US financial institutions found themselves facing similar USD funding shortages. Heightened concerns over liquidity and counterparty risk rationed them out of the USD money market, and they all bid for USD in the FX swap market, creating a one-sided market. From the beginning of the financial turmoil in August 2007, there emerged a risk premium of the FX swap-implied USD rate (across a range of funding currencies) that the non-US financial institutions had to pay over the corresponding USD LIBOR rate, while such risk premium had normally been close to zero. This unusual pricing behaviour reflected dislocations in the FX swap market.

It is a well-established and well-tested theory in international finance that the return of investing a sum of money in a domestic interest-bearing asset for a certain period of time is the same as the return of investing in a similar foreign interest-bearing asset by converting the sum into a foreign currency while simultaneously purchasing a futures contract to convert the investment back at the end of the period. If the returns are different, an arbitrage transaction could, in theory, produce a risk-free return. This condition is commonly known as the covered interest parity (CIP) condition. The CIP condition holds if the interbank and FX swap markets function normally and efficiently.

The CIP condition is observed almost all the time. However, there are times and situations in which the condition breaks down.[3] One possibility is that in times of financial turmoil the risks as perceived by market participants might change, rendering the assumptions of the CIP condition inapplicable. Indeed, Baba and Packer (2008) and Genberg et al. (2009) find that in the recent global financial crisis the turbulence in money markets spilled over to FX swap markets amid a reappraisal of counterparty risks.

During the financial crisis, the turbulence in the global interbank markets spilled over to the local financial markets in which deviations from the CIP condition were observed in terms of the difference between the FX swap-implied USD rate and the USD LIBOR as shown in the following equation:

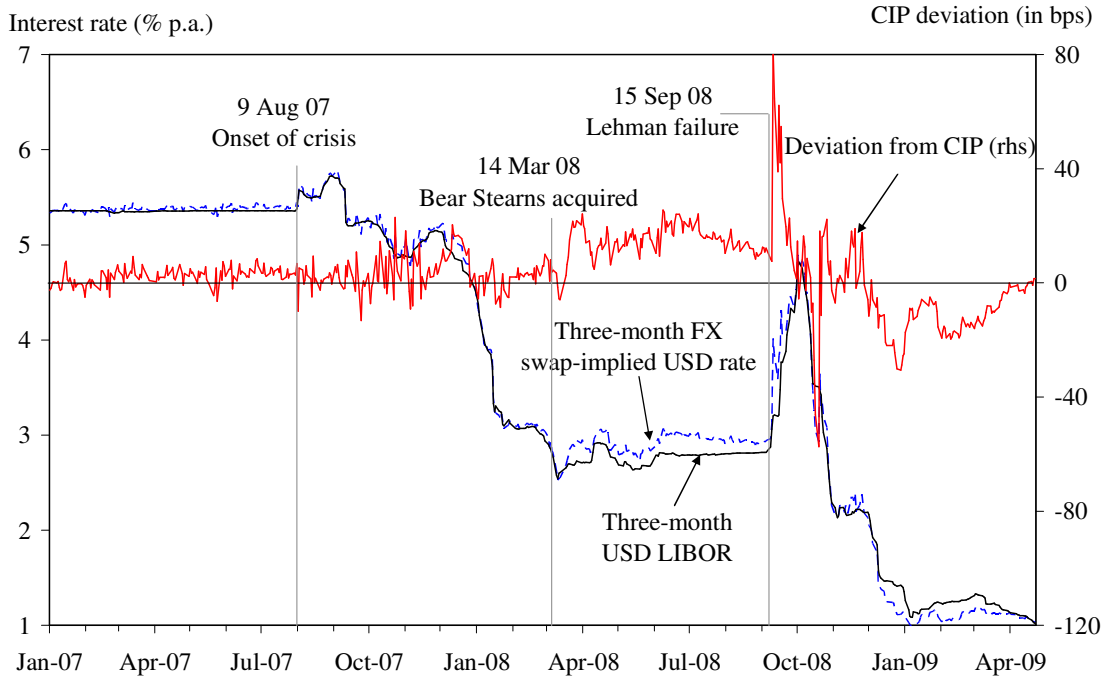
$$CIP\ deviation = \underbrace{\frac{F_{t,t+x}}{S_t}\left(1 + r_{t,x}^{HKD}\right)}_{FX\ \ swap-implied\ \ USD\ \ rate} - \underbrace{\left(1 + r_{t,x}^{USD}\right)}_{USD\ \ interbank\ \ rate} \tag{1}$$

where S_t is the HKD per USD spot rate at time t. $F_{t,t+x}$ is the HKD per USD forward rate contracted at time t for exchange at time $t + x$. $r_{t,x}^{HKD}$ and $r_{t,x}^{USD}$ are the corresponding uncollateralised HKD and USD interest rates at time t with a tenor of x, proxied by the HKD interbank rate (HIBOR) and the USD interbank rate (LIBOR) respectively with the same tenor.

In Chart 2, the red line measures how much the FX swap implied three-month USD funding rate deviates from the corresponding USD LIBOR – the risk premium demanded by dollar lenders in the swap market or the departure from CIP in the local financial markets. As can be seen, before Summer 2007 it oscillated around 0 basis points (bps) but after that it started to follow an upward trend. Around the beginning of September 2008, it fluctuated wildly.

[3] See Taylor (1989) for such occasions during the flotation of sterling in 1972 and the inception of the European Monetary System in 1979.

Chart 2. FX swap-implied USD rate, USD LIBOR and CIP deviation

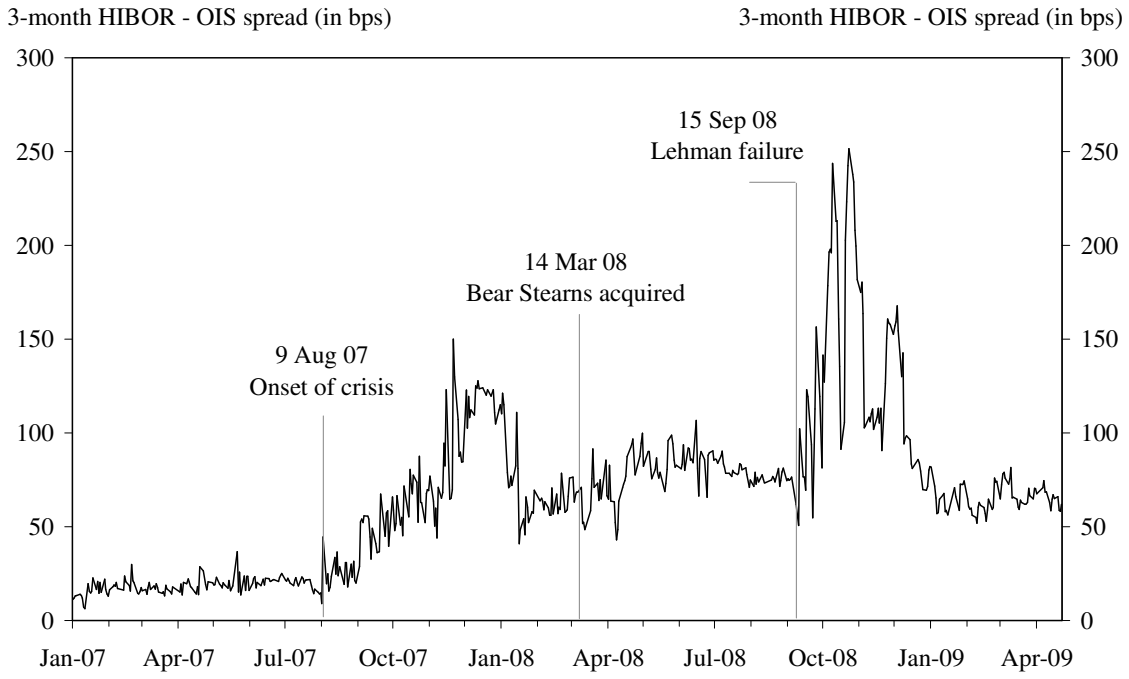


Sources: Bloomberg and HKMA staff estimates.

In addition to the dislocations in the local FX swap market reflected by the CIP deviations, the HKD interbank market was also under stress during the crisis. We use the spread of the three-month HIBOR relative to the three-month overnight index swap (OIS) rate as a measure of stress in the local interbank market.[4] Chart 3 shows that the three-month HIBOR–OIS spread increased when the crisis emerged in August 2007 and surged to more than 200 bps after the Lehman failure. This study uses the CIP deviation and the HIBOR–OIS spread as measures to assess whether the policy actions taken by the HKMA and the Government improved market efficiency and reduced the stress on the local financial markets.

[4] An OIS is an interest-rate swap in which the floating leg is linked to a published index of daily overnight rates. The two parties agree to exchange at maturity, on an agreed notional amount, the difference between interest accrued at the agreed fixed rate and interest accrued through the geometric average of the floating index rate. Since the overnight interest rates generally bear lower counterparty and liquidity risks, the credit and liquidity risk premiums contained in the OIS rates should be small. Therefore, the three-month HIBOR–OIS spread generally reflects the counterparty and liquidity risks in the interbank market.

Chart 3. Three-month HIBOR–OIS spread



Sources: Bloomberg and HKMA staff estimates.

III. KEY POLICY ACTIONS AND ANALYSIS FRAMEWORK

In response to the stress in the HKD interbank market following the Lehman failure in mid-September 2008, the HKMA and the Government announced a series of temporary measures to help contain the liquidity and solvency risks in the domestic banking system. Table 1 presents the policy initiatives since September 2008.[5] If these policy actions were effective, they should be able to alleviate the dislocations in the FX swap market and reduce the CIP deviations.[6]

[5] Refer to HKMA (2008) for more details on measures undertaken by the HKMA and the Government in response to the global financial crisis.

[6] The policy measures helped reduce counterparty credit risk concerns, ensured the availability of backstop liquidity and increased banks' willingness to lend in the interbank market. These actions are expected to eliminate arbitrage opportunities as market liquidity resumes to normalcy.

Table 1. Policy measures undertaken by the HKMA and the Government from September 2008 to March 2009

Announcement date	Measures
2008	
(1) 30 September	Five temporary liquidity measures
(2) 8 October	Modification of the Base Rate formula
(3) 14 October	Two precautionary measures to support confidence in the Hong Kong banking system
(4) 20 October	Additional supply of three-month Exchange Fund Bills
(5) 6 November	Two refinements to the temporary liquidity measures
(6) 24 November	Additional supply of three-month Exchange Fund Bills
2009	
(7) 26 March	HKMA to continue the provision of liquidity assistance to banks

Sources: HKMA (2008) and HKMA press releases.

In this study, we analyse (a) the CIP deviation based on the difference between the three-month FX swap-implied USD rate and LIBOR and (b) the interbank market stress in HKD measured by the HIBOR–OIS spread. Our sample covers the period from 16 September 2008 to 31 March 2009, which is the period immediately after the Lehman failure when the policy actions announced and took place. The sample ends on 31 March 2009 since by that time the three-month CIP deviation had already vanished. Table 2 reports the unit root test results of the dependent variables under the sample period.

Table 2. Augment Dickey-Fuller (ADF) Unit Root Test Results

	In the level	In the first difference
CIP deviation	–2.297	–3.887*
Three-month HIBOR–OIS spread	–1.926	–3.621*

Note: * indicates significance at the 5% confidence level. The critical value at the 5% level of the ADF test is –2.883.

The ADF tests suggest that all the series are nonstationary in the level but they are stationary in the first difference. Therefore, the empirical analysis is based on the daily changes in these series. Given that the policy actions may influence both the level and volatility of the CIP deviations and three-month HIBOR–OIS spread, we follow Genberg et al. (2009) to model the effect of policy actions under a standard exponential GARCH (EGARCH) model proposed by Nelson (1991). The EGARCH model has been widely used in analysing the effects of policy events on financial markets,

as the model captures the asymmetric effect in the volatility of financial time series.[7] A policy-action dummy variable is used in the analysis, where the variable is equal to one on the days with policy actions / announcements and zero on other days.

In the EGARCH framework, the dislocations in the HKD-USD FX swap market, measured by the changes in the CIP deviations, are assumed to be associated with the relative risk of the banking systems of Hong Kong and the US, along with the policy-action dummy.[8] The policy-action dummy is also put into the conditional variance equation to study whether it has any effects on the degree of volatility. The conditional mean equation of the EGARCH model is written as:

$$\Delta CIP_t = a + \sum_{i=1}^{n} b_i \Delta CIP_{t-i} + c\Delta RRB_t + d\,PA_t + \varepsilon_{CIP,t}, \quad \varepsilon_{CIP,t} \sim N(0, \sigma^2_{CIP,t}) \tag{2}$$

where Δ is the first-difference operator. CIP_t is the CIP deviation (in bps) at time t for the respective crisis period. RRB_t is the variable for the relative risk of the banking systems of Hong Kong and the US at time t, which is measured by the difference (in bps) between the HIBOR–OIS spread and the USD LIBOR–OIS spread during the global credit crisis of 2008. PA_t is the dummy variable for policy action announcement at time t. Lags of the dependent variable are included in Equation (2) to control for the serial correlation, if necessary. As discussed in Genberg et al. (2009), if the relative risk of the banking systems is a determinant of the premium or discount as reflected in the swap-implied USD rate, the estimated coefficient c in Equation (2) should be positive and statistically significant. If the policy actions are helpful in reducing the CIP deviations, the estimated coefficient d should be negative (and it should also be statistically significant if the policy actions have a material impact on the CIP deviations).

In the EGARCH (p, q, r) model, the conditional variance equation is given as:

$$\ln(\sigma^2_{CIP,t}) = \varpi + \sum_{j=1}^{q} \beta_j \ln(\sigma^2_{CIP,t-j}) + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{CIP,t-i}}{\sigma_{CIP,t-i}} \right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{CIP,t-k}}{\sigma_{CIP,t-k}} + \vartheta PA_t \tag{3}$$

The coefficient ϑ measures the potential impact of the policy actions on the degree of volatility. If the policy actions have the desirable effect of reducing the volatility of the CIP deviation, the estimated coefficient ϑ is expected to have a negative sign.

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[7] Primarily, the EGARCH model captures the idea that bad news (negative shocks) tends to have a greater impact on the conditional volatility than good news (positive shocks) of the same magnitude.

[8] The relative risk of the banking system can be considered as the funding liquidity risk, see Hui et al. (2009).

The coefficient β measures the persistence effect in the dynamics of the conditional variance σ^2, while the coefficient γ_k captures the asymmetric effect of news.

A similar framework is applied to analysing the relationship between the interbank stress measured by the HIBOR-OIS spread and the effectiveness of the policy actions. Fung and Yu (2009) find that during the credit crisis of 2008, the distress in the USD interbank market had a material impact on the HKD interbank market. Thus, in the conditional mean equation of the EGARCH model, the interbank-stress indicator for the HKD is assumed to have a linear relationship with the stress measure of the USD interbank market. The conditional mean equation is specified as:

$$\Delta IS_t^{HK} = a + \sum_{i=1}^{n} b_i \Delta IS_{t-i}^{HK} + cIS_{t-1}^{HK} + d\Delta IS_{t-1}^{US} + ePA_t + \varepsilon_{IS,t}, \quad \varepsilon_{IS,t} \sim N(0, \sigma_{IS,t}^2) \qquad (4)$$

where Δ is the first-difference operator. IS_t^{HK} and IS_t^{US} are the interbank-stress indicators for HKD and USD (in bps) respectively at time *t*, which are the HIBOR–OIS spread and USD LIBOR–OIS spread. The lagged term of the HKD interbank-stress indicator (IS_{t-1}^{HK}) is included as a control variable in case the changes of the spread depend on its level.[9] PA_t is the dummy variable for policy-action announcement at time *t*. Lags of the dependent variable are included in Equation (4) to control for the serial correlation, if necessary. If policy actions can ease the distress in the HKD interbank market, then it is expected that the estimated coefficient *e* should be negative (and should also be statistically different from zero if the policy actions have a material impact on the interbank-stress indicator).

Similarly, the conditional variance equation in the EGARCH model is given as:

$$\ln(\sigma_{IS,t}^2) = \varpi + \sum_{j=1}^{q} \beta_j \ln(\sigma_{IS,t-j}^2) + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{IS,t-i}}{\sigma_{IS,t-i}} \right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{IS,t-k}}{\sigma_{IS,t-k}} + \vartheta PA_t \qquad (5)$$

The coefficient ϑ measures the potential impact of policy actions on the degree of volatility. Again, if policy actions have any effect on reducing the volatility of the HIBOR–OIS spread, then the estimated coefficient ϑ is expected to have a negative sign.

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[9] The inclusion of the lagged term of the spread as a control variable is similar to McAndrews et al. (2008) in their analysis of the relationship between the change in the USD LIBOR-OIS spread and the Term Auction Facility announced by the Federal Reserve.

IV ESTIMATION RESULTS

Table 3 reports the EGARCH estimation results of the CIP deviation, the HIBOR–OIS spread and the effectiveness of the policy actions for the global credit crisis of 2008.

Table 3. Estimation results on the CIP deviation, HIBOR–OIS spread and the effectiveness of policy actions for the global credit crisis of 2008

Sample period: 16 September 2008 to 31 March 2009			
Dependent variable: Changes in CIP deviation (ΔCIP)		Dependent variable: Changes in HIBOR–OIS spread (ΔIS)	
Estimated coefficient in the conditional mean equation			
$\Delta CIP_t = a + \sum_{i=1}^{n} b_i \Delta CIP_{t-i} + c\Delta RRB_t + d\,PA_t + \varepsilon_{CIP,t}$		$\Delta IS_t^{HK} = a + \sum_{i=1}^{n} b_i \Delta IS_{t-i}^{HK} + cIS_{t-1}^{HK} + d\Delta IS_{t-1}^{US} + ePA_t + \varepsilon_{IS,t}$	
a	0.20 (0.84)	a	5.14 (1.94)
b_1	–0.08 (–1.15)	b_1	–
c	0.21* (5.21)	c	–0.08* (–2.04)
PA_t (***d***)	**–1.10**** **(–1.86)**	d	0.32* (2.11)
		PA_t (***e***)	**3.67** **(0.33)**
Estimated coefficient in the conditional variance equation			
$\ln(\sigma_{CIP,t}^2) = \varpi + \sum_{j=1}^{q} \beta_j \ln(\sigma_{CIP,t-j}^2) + \sum_{i=1}^{p} \alpha_i \left\lvert \frac{\varepsilon_{CIP,t-i}}{\sigma_{CIP,t-i}} \right\rvert + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{CIP,t-k}}{\sigma_{CIP,t-k}} + \vartheta PA_t$		$\ln(\sigma_{IS,t}^2) = \varpi + \sum_{j=1}^{q} \beta_j \ln(\sigma_{IS,t-j}^2) + \sum_{i=1}^{p} \alpha_i \left\lvert \frac{\varepsilon_{IS,t-i}}{\sigma_{IS,t-i}} \right\rvert + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{IS,t-k}}{\sigma_{IS,t-k}} + \vartheta PA_t$	
ϖ	0.14 (0.84)	ϖ	–0.11 (–1.10)
β_1	0.98* (165.13)	β_1	0.99* (68.46)
α_1	–0.17 (–0.86)	α_1	0.19* (2.07)
γ_1	–0.02 (–0.34)	γ_1	–0.02 (–0.05)
PA_t (ϑ)	**0.27** **(1.01)**	PA_t (ϑ)	**0.33** **(0.36)**

Note: Figures in parentheses are z-statistics based on Bollerslev-Wooldrige robust standard errors. * indicates significance at the 5% confidence level. ** indicates significance at the 10% confidence level.

Source: HKMA staff estimates.

The results show that the policy actions have a negative impact (with statistical significance) on the CIP deviations, suggesting that the policy actions effectively reduced the CIP deviations during the crisis. This implies that arbitrage opportunities diminished as the financial markets returned to normal to a certain extent. In other words, following the Lehman failure the policy actions taken by the HKMA and the Government helped mitigate the dislocations and therefore improved the efficiency in the money and FX swap markets to facilitate arbitrage transactions. In particular, the five temporary measures provided additional longer-term funding to banks against a wider range of collateral at a potentially lower interest cost. Banks were more assured about the availability of funds, and more willing to lend in the interbank market. Furthermore, policy actions aimed at containing the solvency risk in the banking system relaxed the counterparty-risk constraint in the markets and thus removed the financial dislocations.

Regarding the results on the three-month HIBOR–OIS spread (the indicator of stress in the interbank market), the policy actions had no material impact on the spread, indicating that they did not ease the distress in the longer end of the HKD interbank market after the Lehman failure.[10] This finding is however consistent with the recent study by the IMF (2009) which shows that the liquidity support measures initiated by the central banks in Japan, Sweden, Switzerland, the United Kingdom, the United States and the European Central Bank had an insignificant impact on the LIBOR–OIS spreads after the Lehman failure. The IMF study suggests that the finding does not necessarily mean that the policy actions on providing liquidity to the banking system were not effective, but the actions may have been anticipated by market participants. Therefore, their effects on the LIBOR-OIS spreads are not noticeable in the empirical tests. The same market reactions might also happen in Hong Kong, causing the effects of the policy actions by the HKMA and the Government on the HIBOR–OIS spread not to be visible in our empirical analysis.

V. CONCLUSION

This study investigates the effectiveness of the policy actions taken by the HKMA and the Government to mitigate the anomalies and stress in the FX swap and interbank markets in Hong Kong during the financial crisis of 2008. The results suggest that the policy actions effectively reduced the dislocations in the FX swap market after the Lehman failure. The reduction in the CIP deviations reflected that the policy actions improved the efficiency of the money and FX swap markets in which market liquidity resumed to eliminate arbitrage opportunities.

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[10] Shortly after the measures were implemented, the overnight HIBOR gradually eased.

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