FEATURE ARTICLE

Impact of IPO activities on the Hong Kong-dollar interbank market

By Frank Leung and Philip Ng of the Research Department

Fund-raising activities related to the initial public offering boom in Hong Kong in recent years have often been accompanied by large capital flows resulting in transitory and sharp increases in credit demand, which exert substantial funding and liquidity pressures on the banking system. Qualitative analysis of the payment flows of a typical equity IPO suggests that these pressures on the banking system seem to be strongest on the closing date and the refund date of an IPO, when the associated payment flows are very large relative to the level of the Aggregate Balance.

Empirical estimates in this study find that during 2005-2007, funding needs on the closing date increase the level and volatility of the overnight and one-week HIBORs, but not those of the longer-term HIBORs. On the other hand, estimated models for HIBORs with different maturities do not detect any statistically significant effect of the IPO variable on HIBORs on the refund date.

Introduction

Hong Kong has experienced an equity initial public offering (IPO) boom since 2005. In three years (2005-2007), the main board of the Hong Kong Stock Exchange raised a total of HK$788 billion through IPOs, far exceeding the HK$558 billion raised in the previous 19 years (1986-2004). The IPOs have been heavily over-subscribed, registering an average over-subscription ratio of 190 times and concentrating more than HK$40 trillion in the receiving banks.

These equity fund-raising activities, particularly those related to H-shares, are often accompanied by large capital flows.[1] According to the Balance of Payments statistics, gross private capital inflows and outflows have been increasing rapidly since 2005, exceeding 100% of nominal GDP in 2007. The keen demand for new shares often results in transitory and sharp increases in credit demand as well, occasionally showing up as sharp spikes in domestic loan growth figures. For example, share-financing loans surged by 991% year on year in March 2007, by 1,259% in June 2007 and by 258% in September 2007, reflecting IPO activities at the end of the quarters.

The large capital flows and sharp increases in credit demand associated with equity IPOs have put substantial funding and liquidity pressures on the banking system. Anecdotal evidence suggests that, on occasions, IPOs pushed up interbank interest rates, increased interest-rate volatility and caused inversion of the interbank yield curve at the short end. In addition, when the HKMA conducted foreign exchange operations in May 2005 and October

[1] H-share IPOs have played a particularly important role in the fund-raising boom, reflecting Hong Kong's prominent role as an international fund-raising centre for Mainland firms. H-share IPO activities affect the Balance of Payments statistics in a number of ways. Hong Kong residents buying H-shares through IPOs are treated as equity portfolio investment outflows, which can be offset later by Hong Kong citizens selling H-shares to non-residents. Mainland companies newly listed on the Hong Kong Stock Exchange may temporarily place their IPO proceeds in Hong Kong's banking system. This is recorded as "other" investment inflows. On the other hand, a repatriation of IPO funds out of the domestic banking system by Mainland issuers are treated as "other" investment outflows.

2007, it appeared to have taken into account the expected effects of IPO activities on market exchange rates and interest rates.[2]

Against this backdrop, this article presents the results of a study that analyses and quantifies the impact of IPO activities on interbank interest rates.[3] The rest of the article is organised as follows. The next section describes the payment flows of a typical equity IPO and discusses the conditions under which the banking system may experience funding and liquidity pressures, leading to fluctuations in Hong Kong Interbank Offered Rates (HIBORs). Qualitative analysis of the whole IPO process reveals that interbank funding pressures are most likely to emerge on the closing date and the refund date. The third section adopts a time-series event-study methodology to empirically estimate the impact of IPO activities on the level and conditional volatility of interbank interest rates of different maturities. It found that funding needs on the closing date of an IPO increase the level and conditional volatility of the overnight and one-week interbank interest rates, while the impact of funding needs on the refund date is statistically insignificant. The final section concludes.

The payment flows of a typical equity IPO

This section describes the payment flows of a typical IPO and discusses their implications for interbank interest rates.[4] There are four important dates in a typical IPO, namely the prospectus date, the closing date, the refund date and the listing date. Funding and liquidity pressures on the banking system seem to be at their highest levels on the closing date and the refund date, when the associated payment flows are very large relative to the level of the Aggregate Balance.

Subscription and closing periods

During the subscription period from the prospectus date to the closing date, public investors submit their IPO applications to selected branches of receiving banks, which have been commissioned by the issuer of the IPO to collect application forms and subscription monies from investors on behalf of the issuer. Apart from using their own money to fund the applications, interested investors may borrow from their banks, which are their *sponsoring banks* in this context. As most investors submit their applications to receiving banks on the closing date, significant payment flows from sponsoring banks to receiving banks occur on that date.

Funding pressures on sponsoring banks could arise during this payment process because payment flows may be many times the prevailing level of the Aggregate Balance.[5] For example, the Bank of China IPO in May 2006 involved some HK$200 billion in application monies while the level of the Aggregate Balance at that time was only around HK$1.3 billion. To meet the payment obligations, sponsoring banks usually make borrowing arrangements from the receiving banks so that the amount borrowed can largely pay for the payment obligations. This can result in a large amount of interbank fund flows in both directions: for instance, the initial transfer of funds from the sponsoring banks to the receiving banks and the subsequent recycling of funds from the receiving banks to the rest of the banking system.[6] In theory, funds that are concentrated in the

[2] See *HKMA Annual Report 2005*, p. 49, and *HKMA Annual Report 2007*, p. 53.

[3] For a working paper version of this study, see Leung and Ng (2008).

[4] This section draws heavily from HKMA (2006) "History of Initial Public Offerings from Payment System's Perspective".

[5] The Aggregate Balance is the sum of clearing account balances of banks kept with the HKMA. The amount of the Aggregate Balance is a narrow measure of the supply of liquid funds in the interbank market.

[6] On the IPO closing date (Day C), sponsoring banks have to pay, on behalf of their customers, the application monies to receiving banks. All these payments in the form of cheques have to be settled at the bulk settlement run on the day immediately after the IPO closing date (Day C+1). Before 4 December 2007, the payment arrangement also required all e-IPO payments to be transferred to one designated receiving bank (known as the lead receiving bank) on Day C+1 for the same bulk settlement run.

receiving banks can be recycled by them back to the interbank market, thereby not necessarily reducing the supply of funds in the interbank market. However, because of prudential considerations such as bilateral credit limits, concentrated funds may not be effectively recycled, thereby pushing up interbank interest rates.

Refunding period

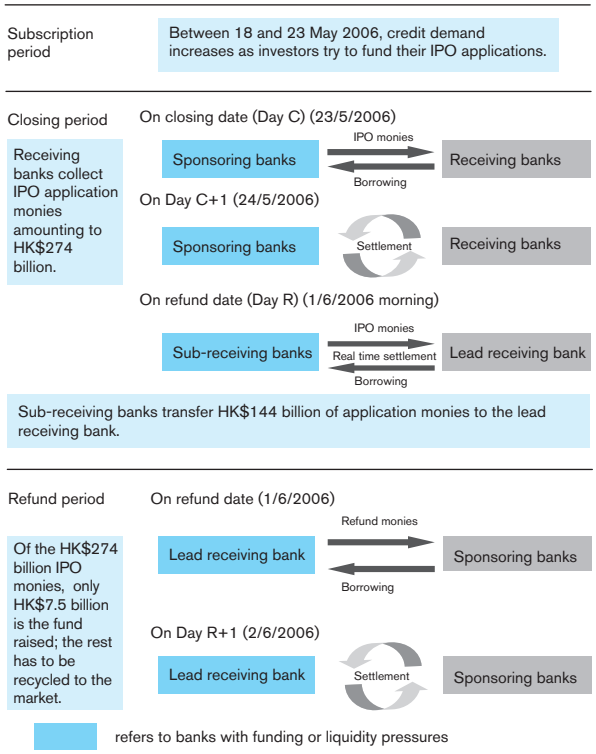
About one week after the closing date, application monies collected by the receiving banks will be transferred to one designated receiving bank (known as the *lead receiving bank,* the rest are known as the *sub-receiving banks*) on the refund date.[7] Funding needs on sub-receiving banks emerge because these banks have to transfer the application monies they earlier receive from investors to the issuer via the lead receiving bank within the refund day. Consequently, the sub-receiving banks have to borrow from the lead receiving bank so they can cover their payment obligations. In addition, the payments are settled in real time through the Real Time Gross Settlement (RTGS) System, instead of the next day.

Subsequently, the refund monies associated with unsuccessful applications have to be returned from the lead receiving bank to investors on the refund date as well. The fund flows will be in the reverse direction as those in the closing period. In particular, the lead receiving bank will have to make cheques and e-IPO payments to all investors, who will then bank in the proceeds to repay loans borrowed from their sponsoring banks.[8] If an IPO is heavily subscribed, the refund monies involved can be enormous and the lead receiving bank may experience funding pressures at this stage. To prepare sufficient funding for the next-day bulk settlement, the lead receiving bank may need to borrow from the sponsoring banks.

To summarise, interbank funding pressures are most likely to emerge on the closing and refund dates. Increased funding needs and heightened demand for interbank liquidity may push up interbank interest rates, reflecting the fact that the interbank payments involved can be hundreds of times larger than the Aggregate Balance.[9] Chart 1 recapitulates the whole process and uses data from the Bank of China IPO in May 2006 as an illustration.

CHART 1

Payment flows of an IPO



Note: The amount of the Aggregate Balance during the IPO was around HK$1.3 billion.

Source: Authors' modification from Diagram 1 in HKMA (2006).

[7] It is noted that before 4 December 2007, the payment arrangement also required all e-IPO payments, which may account for 70% to 80% of total application monies, to be transferred to the lead receiving bank on the day immediately after the IPO closing date. After 4 December 2007, the sub-receiving banks need only to transfer e-IPO monies to the lead receiving bank on the refund date.

[8] Most of these payments are to be settled in the bulk settlement run on the day immediately after the refund date. Electronic IPO (e-IPO) payment services also allow investors to transfer their application monies directly through bank accounts, without having to write cheques.

[9] The payment system may also help create fluctuations in interbank interest rates. For example, payments may queue up and be delayed if banks do not arrange borrowing from the appropriate parties to fund their payment obligations. For more details on payment system issues, see HKMA (2006).

Empirical models and estimates

This section adopts a time-series event-study methodology to estimate the effect of IPO activities on HIBORs.[10] First, dynamic error-correction models for daily HIBOR movements are estimated to gauge the effect of IPO activities on changes in HIBORs on the closing date and the refund date. Secondly, Generalised Autoregressive Conditional Hetereoskedasticity (GARCH) models are estimated to assess the impact of IPO activities on the conditional volatility of HIBORs.

A dynamic model for HIBOR

A dynamic model for daily HIBOR movements is formulated as follows.

$$\Delta HIBOR_t = c + \sum_{i=0}^{p} \alpha_i \Delta LIBOR_{t-i} + \sum_{i=1}^{q} \beta_i \Delta HIBOR_{t-i} + \lambda(HIBOR_{t-1} - \delta LIBOR_{t-1}) + \sum_{i=0}^{r} \eta_i \Delta AB_{t-i} + \theta_1 IPO_{closing,\,t} + \theta_2 IPO_{refund,\,t} + \text{stochastic error term} \quad (1)$$

where

$\Delta HIBOR_t$ = change in the day-end HIBOR over the previous trading day

$\Delta LIBOR_t$ = change in the day-end LIBOR over the preceding trading day

ΔAB_t = change in the day-end Aggregate Balance over the previous trading day

$IPO_{closing,\,t}$ = proxy variable for funding pressures on the closing date of an IPO

$IPO_{refund,\,t}$ = proxy variable for funding pressures on the refund date of an IPO

Δ = the difference operator

p, q, r = the number of lags

Under the Linked Exchange Rate system, movements in HIBORs ($\Delta HIBOR_t$) should broadly track those in the corresponding LIBORs ($\Delta LIBOR_t$). However, in reality, the interest rate pass-through is not instantaneous and complete, and the short-run dynamics can be complex. In equation (1), the error-correction term, λ ($HIBOR_{t-1}$ - $\delta LIBOR_{t-1}$), intends to capture long-run interest rate pass-through from LIBORs to HIBORs, while the lag terms of the HIBOR and LIBOR account for short-run dynamics. Changes in the level of the Aggregate Balance (ΔAB_t) capture changes in the supply of liquid funds in the interbank market and are expected to be negatively related to HIBORs .

The IPO-related variables ($IPO_{closing,\,t}$ and $IPO_{refund,\,t}$) measure IPO-related funding pressures on the closing or refund date and are expected to be positively related to HIBORs. The $IPO_{closing,\,t}$ variable is proxied by the ratio of the amount of funds transferred to the receiving banks on the closing date to the level of the Aggregate Balance. The amount of funds transferred on the closing date is calculated as the product of the subscription price, the number of shares offered for subscription[11] and the oversubscription ratio. If more than one IPO falls on the same closing date, the subscription funds of each IPO are added together. Defined in this way, the funding pressure variable can capture the impact of overlapping IPOs on HIBORs. The calculated sum of subscription funds is then divided by the level of the Aggregate Balance to measure funding pressures relative to the prevailing supply of liquid funds. The $IPO_{refund,\,t}$ variable is similarly defined as the ratio of the refund monies to the Aggregate Balance, where the refund monies are calculated as the difference between the initial transferred subscription

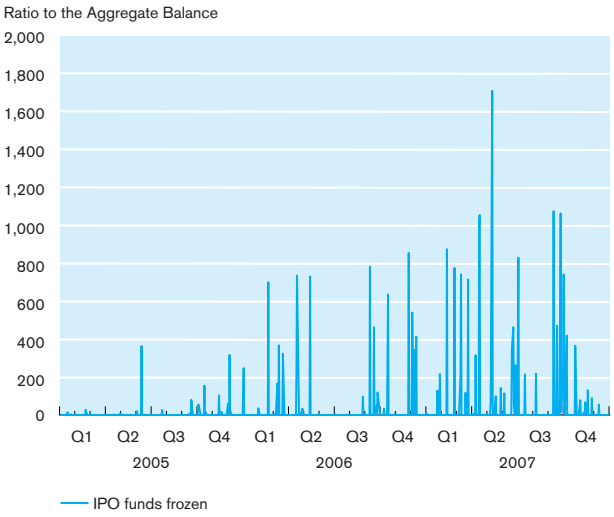
[10] Neely (2005) provides more details on this methodology.

[11] This includes both the offer for subscription and the offer for sale by subscription in Hong Kong.

funds and the funds raised. Charts 2 and 3 plot the two IPO variables and indicate that there were more heavily subscribed IPOs in 2007 than in 2005 and 2006.

CHART 2

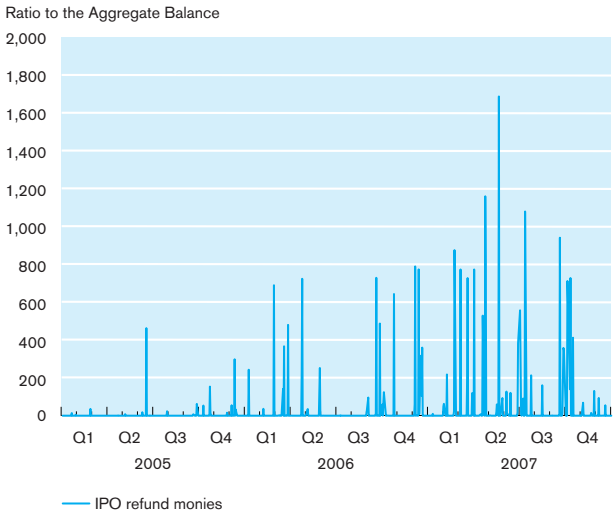
Proxy variable for funding pressures on the closing date



Sources: Authors' calculation and HKEx website.

CHART 3

Proxy variable for funding pressures on the refund date



Sources: Authors' calculation and HKEx website.

The effect of IPO-related funding pressures on overnight HIBOR

Equation (1) is first estimated using overnight HIBOR and LIBOR.[12] The sample consists of trading-day data from 10 January 2005 to 31 December 2007. Following a general-to-specific approach, variables are eliminated in the estimation process if their coefficients are either insignificant or of the wrong signs. The final specification is as follows (Table 1).

TABLE 1

Impact of IPOs on changes in overnight HIBOR

Dependent variable: Δ overnight HIBOR (bp)	Estimated coefficient	Standard error	p-value
constant	-0.8247	5.7742	0.8865
$\Delta LIBOR_t$	0.6633	0.3822	0.0831
$HIBOR_{t-1}$	-0.1212	0.0221	0.0000
$LIBOR_{t-1}$	0.0910	0.0204	0.0000
ΔAB_t	-0.0091	0.0042	0.0308
$IPO_{closing,\ t}$	**0.0433**	**0.0117**	**0.0002**
Adjusted R^2	0.1031		
Mean of the dependent variable	0.1017		
Standard deviation of the dependent variable	38.3642		

Notes: 1 The sample period is between 10 January 2005 and 31 December 2007. The number of observations is 708. The Aggregate Balance is in HK$ million.

2 Heteroskedasticity-and-autocorrelation-consistent standard errors are used.

3 Interest rate variables are expressed in basis points.

Estimation results show that movements in the overnight HIBOR are, as expected, positively associated with the contemporaneous changes in the corresponding LIBOR and negatively related to movements in the Aggregate Balance. The ratio of the estimated coefficients on the level of LIBOR and HIBOR reveals that the long-run pass-through of a 100-basis-point increase in the overnight LIBOR to the overnight HIBOR is 75 basis points.[13] In relation to the IPO variables, it is found that the amount of

[12] Augmented Dickey-Fuller tests and KPSS tests show that the overnight HIBOR and LIBOR are non-stationary in levels and stationary in first difference. Johansen tests confirm that they are co-integrated.

[13] The 75-basis-point pass-through from the LIBOR to the HIBOR is equal to 0.0910 divided by 0.12121.

IPO monies transferred on the closing date ($IPO_{closing,\ t}$) is positively correlated with changes in the overnight HIBOR. This variable captures funding pressures on the closing date when the sponsoring banks have to borrow from the receiving banks. The estimated coefficient on $IPO_{closing,\ t}$ suggests that when the IPO monies on the closing date is 100 times the level of the Aggregate Balance, the overnight HIBOR increases on average by 4.33 basis points (100 x 0.0433).[14] For example, the China Construction Bank IPO was 43 times over-subscribed on 19 October 2005 and is estimated to involve, according to the definition of the variable, HK$200 billion of IPO (application) monies, which was about 156 times the level of the Aggregate Balance. As a result, the predicted increase in the overnight HIBOR is 6.75 basis points.

Unreported estimation results show that the effect of funding pressures associated with the refund monies on the refund date ($IPO_{refund,\ t}$) is not statistically significant. There are two possible explanations. First, although funding pressures arise on the refund date when sub-receiving banks transfer the application monies to the lead receiving bank, the monies transferred are settled on a real-time basis in the morning instead of being settled the next day, resulting in intra-day funding pressures that do not show up in day-end data of interbank interest rates. Secondly, overnight funding pressures on the refund date may also be less acute if the lead receiving bank, which is usually a large and well-funded local bank, simply reverses the credit lines extended to the sponsoring banks previously on the closing date.

Do funding pressures spread to longer-term HIBORs?

Estimation of similar models using one-week HIBOR and LIBOR suggests that IPO monies on the closing date also influence the one-week HIBOR (Table 2).[15] The estimated coefficient on $IPO_{closing,\ t}$ in Table 2 reveals that when IPO monies on the closing date are 100 times the size of the Aggregate Balance, the one-week HIBOR increases by 1.54 basis points on average, lower than the 4.33 basis points increase in the overnight HIBOR. This statistically significant result suggests that some sponsoring banks resort to longer-term funding on the closing date. However, the effects of the IPO variables are no longer present when equations for HIBORs with maturities of one-month and above are estimated.

TABLE 2
Impact of IPOs on changes in one-week HIBOR

Dependent variable: Δ one-week HIBOR (bp)	Estimated coefficient	Standard error	p-value
constant	2.6967	3.5860	0.4523
$\Delta LIBOR_{t-1}$	0.3469	0.1694	0.0410
$HIBOR_{t-1}$	-0.0638	0.0173	0.0002
$LIBOR_{t-1}$	0.0453	0.0152	0.0030
ΔAB_t	-0.0037	0.0014	0.0066
$IPO_{closing,\ t}$	**0.0154**	**0.0047**	**0.0011**
Adjusted R^2	0.0587		
Mean of the dependent variable	0.3777		
Standard deviation of the dependent variable	21.7680		

Notes: 1 The sample period is between 10 January 2005 and 31 December 2007. The number of observations is 708. The Aggregate Balance is in HK$ million.

2 Heteroskedasticity-and-autocorrelation-consistent standard errors are used.

3 Interest rate variables are expressed in basis points.

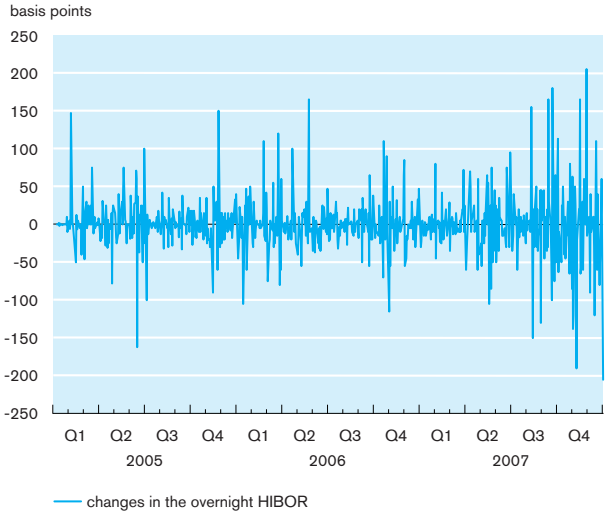
[14] In our sample, the values of this independent variable range from 0.003 to 1717 and average at 182 with a standard deviation of 302.

[15] Augmented Dickey-Fuller tests and KPSS tests show that the one-week HIBOR and LIBOR are non-stationary in levels and stationary in first difference. Johansen tests confirm that they are co-integrated.

Do IPOs influence volatility of interbank interest rates? Evidence from GARCH models

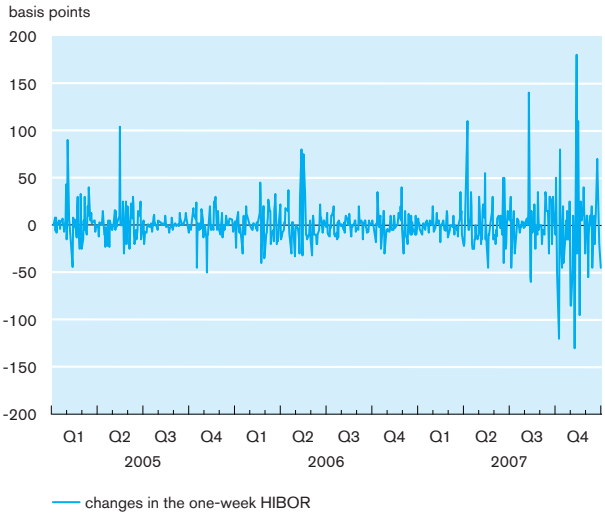
This sub-section analyses the effect of IPO activities on the volatility of interbank interest rates. A cursory look at the data shows that volatility of daily HIBOR movements is time-varying and periods of high or low volatilities tend to cluster together (Charts 4 and 5).[16] GARCH models, which can partly capture these data characteristics, are employed to assess whether funding needs on the closing date and the refund date affect the conditional volatility (variance) of HIBORs.[17]

CHART 4
Volatility clustering: overnight HIBOR



Source: HKMA.

CHART 5
Volatility clustering: one-week HIBOR



Source: HKMA.

A simple GARCH model is formulated, with the following conditional mean and conditional variance equations:

$$\Delta HIBOR_t = c + \xi \Delta LIBOR_t + \lambda (HIBOR_{t-1} - \delta LIBOR_{t-1}) + \eta \Delta AB_t + \varphi_1 IPO_{closing,\,t} + \varepsilon_t \quad (2)$$

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \theta_1 IPO_{closing,\,t} + \theta_2 IPO_{refund,\,t} \quad (3)$$

where $\Delta HIBOR_t$ is the change in the day-end HIBOR over the previous trading day, ε_t is the volatility shock to changes in the HIBOR and σ_t^2 is the conditional variance of changes in the HIBOR.[18] The parameters α and β capture the persistence of shocks. The IPO variables are the same as the ones used in the error-correction models. If the coefficients θ_1 and θ_2 are statistically significant, then IPO-related funding pressures will increase the conditional volatility of HIBORs.

[16] Formal statistical tests also indicate ARCH effects in HIBORs.

[17] See Campbell et al (1997), among many others, for a discussion on GARCH models.

[18] In general, because a GARCH model with one lag in ε_t and σ_t is sufficient to capture the volatility clustering in the data, higher-order models are rarely used in the empirical literature.

A GARCH model is first estimated using the overnight HIBOR. The sample consists of daily trading-day data from 10 January 2005 to 31 December 2007. The estimated conditional volatility equation is shown in Table 3.[19]

TABLE 3
Impact of IPOs on the conditional volatility of overnight HIBOR

Conditional variance equation	Estimated coefficient	Standard error	p-value
Constant (ω)	65.4056	29.1243	0.0247
ε_{t-1}^2 (α)	0.3123	0.0701	0.0000
σ_{t-1}^2 (β)	0.6358	0.0536	0.0000
$IPO_{closing,}$ (θ_1)	**3.6527**	**1.7103**	**0.0327**
Log-likelihood	-3435.756		

Notes: 1 The sample period is between 10 January 2005 and 31 December 2007. The number of observations is 708.

2 Bollerslev-Wooldridge robust standard errors are used.

The GARCH estimation results show that the sum of α and β (0.97) is close to unity, indicating high persistence of volatility shocks, and the variable $IPO_{closing}$ has statistically significant effect on the conditional volatility (variance) of the overnight HIBOR (Table 3). The "refund date" variable (IPO_{refund}), however, does not have a statistically significant coefficient.

Analysis using one-week HIBOR suggests an even higher level of volatility persistence, smaller estimate of the $IPO_{closing}$ coefficient, and an IPO_{refund} variable of the wrong sign. In addition, we do not detect any IPO-related effect on similar GARCH models for HIBORs with maturities of one month and above.

Concluding remarks

This article assesses how IPO activities affect Hong Kong's short-term interbank interest rates. Qualitative analysis of the IPO process suggests that funding pressures appear to be at their highest on the closing date and the refund date. Empirical results from error-correction models and GARCH models for HIBORs show that funding needs on the closing date increase the level and conditional volatility of the overnight and one-week HIBORs (but not those of the one-month and longer-term HIBORs). The estimation results predict that when the IPO monies on the closing date are 100 times the level of the Aggregate Balance, the overnight HIBOR increases by 4.33 basis points on average, and the one-week HIBOR increases by 1.54 basis points on average. On the other hand, estimated models for HIBORs with different maturities do not detect any statistically significant effect from the IPO variable on the refund date.

[19] The estimated mean equation does not change materially compared to the error-correction model estimated previously and is thus not reported here.

REFERENCES

Campbell, John Y., Andrew W. Lo and A. Craig MacKinlay (1997) *The Econometrics of Financial Markets*. Princeton University Press, Princeton, New Jersey.

Leung, Frank and Philip Ng (2008) "Impact of IPO Activities on the Hong Kong Dollar Interbank Market." *Hong Kong Monetary Authority Working Paper (11/2008)*, July 2008.

HKMA (1994) "Management of Interbank Liquidity." *Hong Kong Monetary Authority Quarterly Bulletin*, No. 1, November 1994.

HKMA (2006) "History of Initial Public Offerings from Payment System's Perspective". Unpublished information paper.

Ho, Simon S.M., Robert Haney Scott and Kie Ann Wong ed. (2004) *The Hong Kong Financial System: A New Age*. Oxford University Press, Hong Kong.

McGuinness, Paul B. (1999) *A Guide to the Equity Markets of Hong Kong*. Oxford University Press, Hong Kong.

Neely, Christopher J. (2005) "An Analysis of Recent Studies of the Effect of Foreign Exchange Intervention." *Federal Reserve Bank of St. Louis Review*, November/December 2005, 87(6), pp. 685-717.