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Capital Management and Leverage of Foreign Bank Subsidiaries in a Host Country: A Case in Hong Kong

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Abstract

The large presence of global banks in Hong Kong offers a well suited empirical setting to study the capital management of foreign bank subsidiaries from a host country perspective. Specifically, this paper uses the trade-off theory of leverage to investigate whether the leverage dynamics of foreign bank subsidiaries in the host country would behave differently to domestic banks. Similar to the behavior uncovered empirically of non-financial firms, we find that the standard determinants of leverage are applicable to banks in Hong Kong. In particular, there is a mean-reverting force which acts as a self-correcting mechanism for their leverage, with over-leveraged banks having a tendency to decrease their leverage, and vice versa. However, the self-correcting mechanism of banks' leverage may in times be unduly disturbed by abundant global liquidity, with the effect on foreign bank subsidiaries tangibly higher than that on domestic banks. The externality generated by current abundant global liquidity affecting foreign bank subsidiaries may require the implementation of macro-prudential policies in the host country to contain the risks stemming from the high leverage of banks and external liquidity shocks.

Keywords: Bank Leverage, Global Banks' Subsidiaries, Speed of Adjustment, Global Liquidity, Trade-Off Theory

JEL Classifications: E44, F36, G21, G32

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1. Introduction

In the aftermath of the global financial crisis, the G20 leaders declared that excessive leverage was one of the root causes for the crisis during the Washington Summit in 2008. Despite the potential problems caused by excessive leverage, given that the key function of banks is to channel fund flows through credit intermediation and maturity transformation, a significant degree of leverage is inevitable for them. In this study, we use Hong Kong as a case study to consider the determinants and dynamics of banks' leverage, and the potential implications for macro-prudential policies from a host country perspective.

As a major international financial centre in Asia, Hong Kong has a highly competitive banking sector, encompassing more than 200 banks with 27 out of 29 of the global systemically important banks (GSIFIs) identified by the Financial Stability Board operating in the form of bank branches and subsidiaries.[1] Figure 1 shows that in 2013, 19 of the top 100 global banking organizations had established a foreign bank subsidiary in Hong Kong and 63 of the top 100 global banking organizations had established operations in the form of foreign bank branches. The strong presence of foreign banks in Hong Kong provides a suitable empirical setting to study the capital management of foreign bank subsidiaries from a host country's perspective. Through the lens of optimal capital structure theory, we investigate whether the leverage dynamics of foreign bank subsidiaries in a host country are different as compared with domestic banks especially in the context of abundant global liquidity conditions.

Since the celebrated irrelevance theorem developed by Modigliani and Miller (1958), the trade-off theory by Kraus and Litzenberger (1973) arguably remains a leading contender to understand the capital structure decisions of a firm. [2] According to the trade-off theory, firms balance the benefits and costs of debt financing in deciding their preferred capital structure. While previous studies offer various interpretations of benefits and costs as emphasized by the trade-off theory, the most commonly known one is the tax-shield benefits of debts against the cost of bankruptcy. The optimal capital structure of a firm can be derived by equating the marginal benefit with the marginal cost of debts. Theoretically, the trade-off argument should apply equally to banks since they are subject to tax and bankruptcy also. If the trade-off theory is applicable to banks, the main implication is that banks would actively optimize their preferred capital structure, as opposed to just keeping the minimum capital level as required by regulations. Hence, the trade-off theory compliments more sophisticated

[1] Foreign bank subsidiaries refer to foreign banks incorporated in Hong Kong, whereas foreign bank branches refer to foreign banks incorporated outside Hong Kong. The Banking Ordinance stipulates that locally incorporated banks (i.e., domestic banks and foreign bank subsidiaries) must maintain a minimum capital adequacy ratio of 8%, whereas banks incorporated outside Hong Kong (i.e., foreign bank branches) are not subject to this statutory capital adequacy requirement as the primary responsibility for supervising capital adequacy rests with the home supervisor.

[2] An alternative theory is the pecking-order theory proposed by Myers (1984) in which firms have a financing order of retained earnings, debts and then equity. According to previous studies, the prediction from the pecking-order theory is typically the opposite of trade-off theory. Shyam-Sunder and Myers (1999) find that while there is some empirical support for the pecking-order theory but could not reject the standard trade-off theory.

theories of optimal bank capital structure in explaining banks' capital management decision.[3]

As argued by Frank and Goyal (2008), the trade-off theory appears in both a static and dynamic form. In the static version, the firm's leverage is determined by a trade-off between various factors that could affect the leverage. The testable implication of the static trade-off theory is to investigate the determinants for a firm's leverage and check whether they conform to the theoretical predictions of the trade-off theory. For US non-financial firms, Frank and Goyal (2009) identifies several key determinants of firms' leverage that are consistent with the trade-off theory.[4] The dynamic version of the model adds further structure on how a firm attains its preferred optimal capital structure.[5] Flannery and Ragan (2006) empirically verify the dynamic trade-off theory by showing that US non-financial firms exhibit target adjustment behavior such that the deviations from the target level of leverage are gradually reduced over time. Berger et al. (2008) and Gropp and Heider (2010) extend the findings for non-financial firms to US and European banks and conclude that banks' behavior towards leverage is not much different from that of non-financial firms.

Specifically, we test both static and dynamic versions of the trade-off theory for banks in Hong Kong. For the static approach, we follow previous studies and examine the effect of various factors on banks' leverage as a simple way of judging whether this differs from non-financial firms. Given the vast amount of empirical results for non-financial firms, the applicability of the trade-off theory can be examined by comparing the sign of the estimated coefficients in the leverage regression for banks with the theoretical predications. Moreover, similar to Gropp and Heider (2010), the regression estimates can be used to examine whether capital requirements constitute the most important determinant of banks' leverage.

For the dynamic trade-off theory, we estimate a partial adjustment model to explain banks' leverage.[6] The model assumes that banks actively manage their capital structure to attain their "target leverage", but the adjustment costs in changing the leverage ratio prevents them from changing this quickly.[7] One implication from the theory is that the dynamics of leverage would display mean-reversion to a target level of leverage. The model is consistent with the survey results by Graham and Harvey (2001). The authors find that 81% of non-financial firms consider a target leverage ratio or range when making their debt decisions. Similarly, a number of studies such as Marcus (1983) and Memmel and Raupach (2010) find evidence of an optimal capital structure for banks in the US and Germany respectively.

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3 See Flannery (1994), Myers and Rajan (1998), Diamond and Rajan (2000) and Allen et al. (2011) for some of the recent advances in the theory of optimal bank capital structure.

4 Rajan and Zingales (1995) find that similar set of variables can also explain the leverage for firms in other G-7 countries.

5 See Fischer et al. (1991) and Strebulaev (2007) for the theoretical aspects of the dynamic trade-off theory.

6 See Flannery and Rangan (2006) and Lemmon et al. (2008) for the empirical implementation of the partial adjustment model for non-financial firms.

7 The partial adjustment model postulates that there is a mean-reverting force which acts as a self-correcting mechanism for banks' leverage, with over-leveraged banks having a tendency to decrease their leverage, and vice versa.

The prevailing abundant global liquidity conditions generated from unprecedented monetary policies adopted by major central banks in the advanced economies may add further complications to the dynamics of banks' leverage. For instance, in a well-known paper, Rey (2013) argues that there is a global financial cycle characterized by large common movements in asset price, capital flows and leverage. Using a vector auto regression model, she finds that one of the determinants of the global financial cycle is monetary policy in the US, which affects the leverage of global banks, capital flows and credit growth in the international financial system. Meanwhile, Bruno and Shin (2014) build a theoretical model explaining how global liquidity conditions and banks are related. Specifically, they construct a model of banking where regional banks borrow US dollars from global banks in order to lend to local corporate borrowers. They verify the findings empirically by showing how global liquidity can influence banks' leverage worldwide via cross border borrowing and lending activities.

For Hong Kong, the strong presence of global banks in form of both bank branches and subsidiaries suggests that the banking sector could expose to external liquidity shocks. Banks in Hong Kong could be affected through the internal capital market channel from the parent-and-subsidiary relationship within the GSIFIs, or indirectly through the interbank market.[8] In the absence of confidential regulatory data detailing intra-group fund flows between global banks and their subsidiaries in Hong Kong, we can only test whether foreign bank subsidiaries behave like domestic banks in responding to external liquidity shocks.[9] Specifically, we extend our empirical models by allowing for changes in global liquidity in the partial adjustment model and examine how it affects the dynamics of leverage of foreign bank subsidiaries as well as the domestic banks in the local banking sector. To our knowledge, this paper is the first to highlight that the mean-reverting force of leverage as postulated in the partial adjustment model may in times be unduly disturbed by changes in global liquidity conditions.

The empirical results of our paper have important policy implications. From a financial stability perspective, it is crucial to understand how global liquidity conditions affect the capital management of foreign bank subsidiaries and whether the impact differs from domestic banks. A better understanding of the impact of global liquidity conditions on banks' leverage can help host country policymakers to formulate effective countercyclical measures to lean against external liquidity shocks and strengthen the resilience of the host country's banking system.

The paper is organized as follows. Section 2 compares the leverage of Hong Kong's banking sector with other banking systems. Section 3 describes the models employed in this study. Section 4 presents the data. Section 5 discusses empirical results. The final section concludes.

[8] See Cetorelli and Goldberg (2012) and Kwan, Wong and Hui (2014) for the empirical evidence of internal capital market transmission channel between the head office and the foreign bank branches.

[9] A potential research area in the future would be to disentangle the identification of the internal capital market channel and the cross border funding channel, although this would require the use of confidential regulatory data of the foreign bank subsidiaries.

2. The Leverage of Hong Kong Banks

There are various measures to gauge banks' leverage. Figure 2 compares the median Tier 1 capital leverage (risk-weighted assets divided by Tier 1 capital), a commonly used measure by regulatory authorities, of the Hong Kong banking sector with those of the US and Europe. Despite sharing the common trend of a rise in leverage prior to the onset of the global financial crisis, banks in Hong Kong have not so far experienced an extended period of deleveraging when compared with banks in the US and Europe. This could partly reflect a more benign level of leverage of Hong Kong banks over the observed period.[10] Figure 3 plots the aggregate capital adequacy ratio for banks in Hong Kong. The fact that the capital adequacy ratio has been consistently higher than the minimum international standard suggests that banks in Hong Kong are well capitalized, and that capital requirements may not be a binding constraint for banks in Hong Kong.

It is noteworthy that although the Tier 1 capital leverage can better reflect how the riskiness of banks' assets may have evolved with the change in market conditions over the study period, there is a problem of data comparability since the definition of risk-weighted assets has been refined significantly with the adoption of Basel II in 2004. Alternatively, while the upcoming Basel III leverage ratio requirement, defined as Tier 1 capital[11] to total exposure (all on-balance sheet plus off-balance sheet exposures), may serve as a good measure of banks' leverage, it has yet to be finalized and certain data such as banks' off-balance sheet exposures are not readily available from public sources.[12] In order to obtain a close approximation for the soon-to-be-adopted leverage ratio, an asset-to-equity ratio is used. The denominator of the ratio is the shareholders' funds[13], which are the major components of Tier 1 capital. In the absence of off-balance sheet data of banks, total assets are a useful proxy for banks' total exposure. The asset-to-equity ratio therefore represents a workable approximation to capture the leverage ratio of banks, and has the advantage of a sufficiently long enough time series for our analysis. In view of this, this study uses the asset-to-equity ratio as a measure of banks' leverage in the econometric analysis.[14]

[10] Since the mild deleveraging that took place shortly after the global financial crisis, the leverage of Hong Kong banks has remained broadly stable, although there was a slight pick-up in leverage in 2010. The increase was partly attributable to strong credit growth resulting from an expansion of banks' Mainland business during the period. Total loan and advances in Hong Kong grew by 29% in 2010, of which the non-bank Mainland exposure grew by 61%.

[11] The Basel Committee on Banking Supervision (BCBS) is considering alternatives to Tier 1 capital, including Common Equity Tier 1 and Total regulatory capital.

[12] A "testing minimum" Basel leverage ratio of 3% has been set by the BCBS for the purpose of regulatory monitoring.

[13] According to Bankscope (which is the source of bank data used in this paper), shareholders' funds are defined as the sum of common equity, non-controlling interest, securities revaluation reserves, foreign exchange revaluation reserves and fixed asset revaluations and other accumulated other comprehensive income.

[14] It is noteworthy that the asset-to-equity ratio is favoured by some regulators. For example, Haldane and Madouros (2012) argue that the risk weight calculated in the capital adequacy ratio is way too complex and generates unnecessary uncertainty.

3. The Empirical Models

3.1 The Static Trade-Off Theory

Although the simple tradeoff theory emphasises the balance between the tax-shield benefit and cost of bankruptcy, it's not difficult to think of other reasons that support the trade-off hypothesis. For example, by increasing leverage through relying more on debt (deposits), and less on equity financing, banks could potentially benefit from a lower funding cost to fund profitable projects. However, banks with higher leverage would become more vulnerable to a withdrawal of funds. High leverage may also be accompanied with by an undue relaxation of lending standards and the risk of asset price bubbles.[15] We follow Berger et al. (2008) and Gropp and Heider (2010) and include the standard determinants of leverage in the following regression:

$$LEV_{i,t} = \beta_0 + \beta_1 ROE_{i,t-1} + \beta_2 MTB_{i,t-1} + \beta_3 COL_{i,t-1} + \beta_4 TA_{i,t-1} + \beta_5 LLR_{i,t-1} + c_i + c_t + \varepsilon_{i,t} \quad (1)$$

The dependent variable leverage (LEV) is the book value asset-to-equity ratio. The explanatory variables are profitability (ROE), the market-to-book ratio (MTB), the share of the sum of cash, fixed assets and total securities to total assets (COL), the logarithm of total asset (TA) and the loan loss reserves to total loans ratio (LLR) (all lagged by one year) for bank *i* in year *t-1.*[16] c_i and c_t are the bank fixed effect and the time effect respectively to control for the unobserved heterogeneity. Finally, $\varepsilon_{i,t}$ is the error term of the regression.

In Eq. (1), the first four determinants are among the most important factors in explaining the capital structure decisions of publicly traded American firms between 1950 and 2003 as identified by Frank and Goyal (2009). In particular, ROE, MTB, COL and TA are used to proxy a firm's profitability, growth potential, tangibility and size respectively.[17] LLR is used to proxy the bank's asset quality.

We measure profitability by return on equity, which is a common proxy in the literature. According to the trade-off theory, more profitable firms should prefer more debt financing over equity and hence have a higher leverage for the following two reasons. First, the benefit of tax-shield is more valuable for a profitable bank. Second, the probability of a bank run as perceived by depositors should be lower for a profitable bank. As a result, we expect β_1 to be positive.

The growth potential of a bank is measured by its market-to-book ratio (MTB), which is the most

[15] See Reinhart and Rogoff (2011) for a comprehensive study that discusses how excessive leverage is related to banking crises.

[16] See Appendix 1 for the definition of the variables.

[17] Frank and Goyal (2009) identify six factors in total. The two factors that are omitted in Eq. (1) are the median industry leverage and expected inflation (π_t^E). We will explain in the empirical analysis section why they are omitted in Eq. (1).

reliable proxy for growth opportunities as argued by Adam and Goyal (2008). Myers (1977) presents a model in which highly leveraged firms pass up valuable investment opportunities, which is referred as an under-investment problem. To minimize this problem, Myers (1977) shows that firms with high growth potential would avoid overstretching themselves too much and maintain relatively lower debt. Hence, we expect β_2 to be negative. It is noteworthy that the market-to-book ratio is generally not available for most banks since many banks in Hong Kong are not listed. To impute the ratio for non-listed banks, we use an empirical model to establish the relationship between banks' fundamentals (using accounting book measures) and the market-to-book ratio for listed banks. Using the estimated relationship, the mark-to-book ratios for non-listed banks can be imputed. The details of the imputation are provided in Appendix 2.

The variable COL measures the tangibility of a bank. Tangible assets can be used as collateral for funding and prevent bank distress. Therefore, from a trade-off perspective, a bank with a higher share of collateralisable assets is able to leverage more. Hence, we expect β_3 to be positive.

Bank size is measured by the natural logarithm of total assets. Intuitively, larger banks should have a more diversified business plan and more sophisticated risk management systems that lead to lower default risk than smaller banks. Moreover, larger banks tend to have higher financing flexibility as they are likely to be able to access the capital market more easily. Indeed, many GSIFIs have actively engaged in mergers and acquisitions to grow following the global financial crisis. Larger banks tend to have advantages in both wholesale and retail funding over smaller banks because of reputational effects. Hence, from a trade-off perspective, larger banks are expected to have higher leverage and, consequently, β_4 is expected to be positive.

Finally, we introduce a measure of asset quality for banks in Eq. (1). From a trade-off perspective, a bank with deteriorating asset quality in their loan portfolio may refrain from maintaining high leverage because of solvency concerns. The regulator may also force the bank to reduce its leverage by restraining its credit growth. To capture this feature in the model, we use LLR to measure a bank's capacity to absorb future loan losses.[18] β_5 is expected to be negative. While LLR is an ex-post estimate by banks themselves and may not fully capture the possible ex-ante risks, we opt to use it due to the following reasons. First, ex-ante indicators such as credit default swap (CDS) or credit ratings are not available for many banks in Hong Kong. And second, the use of LLR is not uncommon in the banking literature; specifically, Chiaramontea and Casu (2013) find that LLR is a significant determinant of banks' CDS spreads in both pre- and post- crisis period for major European banks.

3.2 The Dynamic Trade-Off Theory

While Eq. (1) is developed to examine whether the static version of trade-off theory is applicable to banks in Hong Kong, it is well known that the presence of adjustment costs may prevent banks from

[18] Better credit risks measures such as non-performing loans and net charge-offs are subjected to missing data issue in our sample.

attaining their preferred leverage level instantaneously. Indeed, the dynamic trade-off theory postulates that an individual bank adjusts its leverage toward its unobservable bank-specific target level gradually; deviations from target are assumed to diminish over time. We follow previous studies and extend Eq. (1) to model the target leverage level $LEV_{i,t}^{*}$ as a function of the bank's characteristics:

$$LEV_{i,t}^{*} = \gamma_0 + \gamma_1 ROE_{i,t-1} + \gamma_2 MTB_{i,t-1} + \gamma_3 COL_{i,t-1} + \gamma_4 TA_{i,t-1} + \gamma_5 LLR_{i,t-1} \quad (2)$$

where the determinants of the target leverage (LEV^{*}) are the same as in Eq. (1). It is noteworthy that the major difference between Eqs. (1) and (2) is that the dependent variable in Eq. (1) is actual leverage, while in Eq. (2) it is an unobservable variable which must be inferred empirically by adding more structure to the regression. Typically, the partial adjustment model assumes that a firm closes a constant proportion of the gap between its current and target leverage each period. Because of the prevailing abundance of liquidity globally, which could complicate the dynamics of bank leverage under the global financial cycle hypothesis put forward by Rey (2013), we extend the partial adjustment model to capture the effect of global liquidity conditions. Specifically, we have:

$$LEV_{i,t} - LEV_{i,t-1} = \lambda(LEV_{i,t}^{*} - LEV_{i,t-1}) + \theta VIX_{t-1} + b_i + b_t + \xi_{i,t} \quad (3)$$

where λ is the speed of adjustment parameter and θ is a scalar. b_i, b_t and $\xi_{i,t}$ are the bank fixed effect, the time effect and the error term of the regression. Following previous studies, we use the Chicago Board Options Exchange Market Volatility (VIX) to proxy global liquidity conditions, where a lower than historical average value of VIX indicates more abundant global liquidity conditions, and vice versa. Rey (2013) documents that capital flows are generally negatively correlated with VIX. Specifically, it is observed that during normal periods when uncertainty and global risk appetite are low, capital flows and leverage are higher. Their finding is consistent with Forbes and Warnock (2012), who find that VIX is an important determinant of gross capital flows. Although VIX is a common proxy for capital flows and global liquidity, we consider alternative measures of global liquidity conditions for robustness checks.

According to Eq. (3), each bank has its own target leverage, and all banks adjust the gap at the same rate λ.[19] In the standard partial adjustment model where the global liquidity effect is absent (i.e., θ = 0), a bank's actual leverage growth is mean-reverting if the estimated coefficient of λ is between zero and one. Specifically, an over-leveraged bank with $LEV_{i,t-1} > LEV_{i,t}^{*}$ tends to reduce its actual leverage (i.e., $LEV_{i,t} - LEV_{i,t-1} < 0$). Conversely, an under-leveraged bank finds its actual leverage increasing over time. In our model, we conjecture that mean-reversion of banks' leverage is affected by global

[19] It is noteworthy that a more general empirical model, which allows λ to differ across banks, could be used. But such modelling technique would require a sufficiently large cross-sectional dataset. Given that our sample has only 19 cross-sectional units, λ is therefore assumed to be the same across all banks

liquidity conditions. For instance, it's not difficult to imagine that a slightly over-leveraged bank would take advantage of abundant liquidity to further increase its leverage and boost profits. As a result, we expect the coefficient θ to be negative.

In estimating the partial adjustment model, we substitute Eq. (2) into Eq. (3) which yields the following regression model:

$$LEV_{i,t} = (1-\lambda)LEV_{i,t-1} + \lambda(\gamma_0 + \gamma_1 ROE_{i,t-1} + \gamma_2 TA_{i,t-1} + \gamma_3 COL_{t-1} + \gamma_4 LLR_{i,t-1}) + \theta VIX_{t-1} + b_i + b_t + \xi_{i,t} \quad (4)$$

To better understand how global liquidity conditions affect the mean-reverting feature of our model, we provide a graphical illustration of the partial adjustment model. In Figure 4, the upward sloping line indicates actual leverage of a bank and the horizontal line is its target leverage, which is assumed to be a constant for simplicity.[20] The intersection of the two lines occurs when a bank is neither over-leveraged nor under-leveraged. On the left side of the intersection (Region 1), a bank is under-leveraged while the same bank is over-leveraged on the right side (Region 2). Suppose a bank is initially in Region 1, the mean-reverting factor predicts that the bank increases its leverage to narrow the gap. Given that favorable liquidity conditions also induce bank to increase leverage, this accelerates the bank's adjustment towards its target. However, the net impact is uncertain when a bank's leverage is above its target (Region 2). As shown by the opposite direction of the arrows, while the mean-reverting factor predicts a decrease in leverage, more abundant global liquidity exerts an opposite effect which could lead to an increase in leverage; the net impact depends on which force is bigger. If the mean-reverting factor dominates, the net impact is a decrease in leverage, however, if global liquidity is a more important factor, the net impact is an increase in leverage and a further widening of the gap.

4. Data

The data used in this study are drawn from banks' consolidated balance sheets and income statements from the Bankscope database of the Bureau van Dijk. The data comprise annual observations between 1998 and 2012. The start and end point of our sample is determined by the data available from Bankscope. As data for branches of foreign banks in Hong Kong are not available in Bankscope, we focus on 19 major locally incorporated banks in Hong Kong, of which 13 are foreign bank subsidiaries and 6 are domestic banks.[21] As such our sample includes both domestic banks and foreign bank subsidiaries (but excludes small and/or family owned banks) which is a good snapshot of the Hong Kong banking sector.[22] Our sample consists of 271 bank-year observations. Small and

[20] In the actual estimation, the target leverage for any individual bank can be determined residually by Eq. (3) by inserting the estimated coefficients of λ and θ, together with the fitted value of the bank's actual leverage.

[21] See Appendix 3 for more details.

[22] In terms of total asset, the 19 banks amount over 80% of the Hong Kong banking sector in 2012.

family owned banks are excluded from the sample because they are not major loan providers in Hong Kong, and they tend to have a different business and capital structure compared with other banks. It is also noteworthy that only the balance sheet data of the locally incorporated foreign bank subsidiaries, which mainly represents their operations in Hong Kong and in the Asia Pacific region, are used in the estimation. Thus, the balance sheet data of their parent banking group are not included in the sample.

Table 1 provides descriptive statistics for the variables used in this study. It is useful to compare the leverage of Hong Kong's banks with the leverage in other banking systems. We use Gropp and Heider (2010) for this comparison. The median book leverage of Hong Kong banks is around 10 times while the median book leverage of US and European banks is 13.5 times as reported in Gropp and Heider (2010). This suggests that Hong Kong banks in general are less leveraged than US and European banks.

It is worth noting that the cross-sectional data of the 19 selected banks in the sample exhibit considerable heterogeneity. For instance, the mean and median of total book assets are HK$357 billion and HK$98 billion respectively, while the standard deviation is HK$790 billion. This suggests the presence of fat tails in the bank size distribution, which is consistent with the empirical evidence on non-financial firms.[23] Meanwhile, out of the 19 local banks in the sample, 13 of them have their parent banking group situated outside Hong Kong.[24] The presence of a large number of global banks in Hong Kong is consistent with the fact that Hong Kong is a funding hub in the region. Given its significant role in facilitating cross broader funding activities, the Hong Kong banking sector might be significantly affected by global liquidity conditions as suggested by the findings by Rey (2013) and Bruno and Shin (2014).

5. Estimation Results and Discussion

5.1 Discussion of the Results

Eq. (1) is estimated by OLS and the results are presented in Table 2. The signs of the estimated coefficients can shed light on whether the trade-off theory or pecking-order theory is more applicable to banks' behaviour in Hong Kong. The estimates in column 1 support the predictions of the trade-off theory. Profitability, tangibility and size are positively related to leverage, while the effect of growth opportunities is estimated to be negative. In column 2, we further examine whether expected inflation (π_t^E), an important factor found by Frank and Goyal (2009), is relevant for banks' leverage in Hong Kong.[25] We find that this factor is not significant at conventional significance levels. Finally, in column

[23] In view of concern that the results are driven by outliers, we estimate separate regressions excluding the largest and smallest banks and find that the results are consistent. The results are available upon request.

[24] Out of the 19 banks in our sample, 5 of them are the subsidiaries of GSIFIs.

[25] Another important factor found in Frank and Goyal (2009) is the median industry leverage, which controls for the differences in leverage across different industries. Given that only one industry is examined in this paper (i.e., the banking sector), this variable is therefore not included in the empirical model.

3, we test whether the hypothesis, that a dividend paying bank tends to have lower leverage, is valid for banks in Hong Kong.[26] Our results suggest that this is not the case for Hong Kong.[27]

It is noteworthy that if capital requirements are a binding constraint for banks, we should expect all the coefficients to be insignificant. This would mean little variation in banks' leverage since banks would stick to their respective regulatory capital ratio. In fact, Gropp and Heider (2010) find that standard determinants of leverage become insignificant for banks once their capital ratios are very close to the minimum capital requirement (i.e., the requirement is binding for these banks). However, as argued in Section 2, banks in Hong Kong are well capitalized, with the capital adequacy ratio well above the minimum requirement. This suggests that capital requirements may not be a binding constraint on banks in Hong Kong.[28]

To estimate Eq.(4), we use the GMM methods developed by Arellano and Bond (1991) and Blundell and Bond (1998), as OLS leads to biased estimates in the presence of lagged dependent variables and the bank fixed effect in the regressions.[29] Table 3 presents the estimation results. In column 1, we discard global liquidity conditions and find that the determinants of leverage are significant and consistent with those in Eq. (1). Moreover, the estimated coefficient on the lagged dependent variable is significant and bounded between zero and one. This provides empirical evidence that the dynamic tradeoff theory is applicable to banks in Hong Kong. It is estimated that a bank, on average, would close about 40% of the gap between its target and actual leverage levels in one year.

In column 2, we use the VIX index as an indicator of global liquidity conditions; the estimated coefficient is negative at conventional significance levels. This means that abundant global liquidity (as indicated by values lower than the historical mean of the VIX index) induce banks to increase their leverage, other things being equal. We further examine the robustness of the relationship between global liquidity conditions and banks' leverage by using two alternative quantity-based measures of global liquidity. The first measure is the leverage of the US broker dealer sector (global leverage) from the Flow of Funds account published by the US Federal Reserve. As argued by Bruno and Shin (2014), this proxy captures the ability of global banks to facilitate cross-border lending, thereby increasing leverage in the whole banking system. The second measure is the year-on-year growth rate in international bank claims of all BIS reporting economies (Δ International claims), as suggested by BIS (2014). In columns 3 and 4, we find that the coefficients of the two measures are significantly positive, consistent with the baseline regression in Eq. (3) that abundant liquidity conditions are

[26] Groop and Heider (2010) find that this is the case for both European and US banks. Presumably, dividend-paying firms are less financially constrained which allow them to raise equity if needed and have lower leverage.

[27] In an unreported regression, we include all the above-mentioned factors and found that our results established in columns 1 - 3 remain valid. The results are available upon request.

[28] Berger et al. (2008) and Gropp and Heider (2010) provide empirical evidence that for banks that are close to their respective minimum requirement, there is no explanatory power from a regression of the standard determinants of leverage. The fact that capitalization of banks in Hong Kong is well above the regulatory standards precludes us from conducting a similar analysis.

[29] See Flannery and Hankins (2013) for a discussion of the source of bias in the partial adjustment model and Monte Carlo evidence on how GMM methods can accurately estimate the model.

conducive to banks' leverage growth.

However, it might be argued that a significant fall in banks' leverage followed by a rising VIX index was due to heightened risk aversion during crisis periods and that the estimation results are merely an artifact of this development. To test the generality of the results during normal periods, we re-estimate the model for the pre-crisis period (i.e. prior 2008) and find that VIX remains statistically significant and with the expected sign (column 5). This suggests that global liquidity conditions generally have an impact on banks' leverage dynamics.

5.2 Would the Impact of Global Liquidity Conditions on Banks' Leverage be Different between Foreign Bank Subsidiaries and Domestic Banks?

As global liquidity conditions are estimated to have a significant impact on banks' leverage dynamics, it would be of interest to investigate whether the impact varies between foreign bank subsidiaries and domestic banks. As suggested, this may have implications for macro-prudential policies in the host country. Our sample of banks in Hong Kong, which has a mix of foreign bank subsidiaries and domestic banks, provides a suitable empirical setting to examine this issue.

We first estimate the partial adjustment model for domestic banks and foreign bank subsidiaries separately without incorporating global liquidity conditions. Column (2) – (3) of Table 4 reports the estimation results for domestic banks and foreign subsidiaries respectively. The results for domestic banks support the predictions from the dynamic tradeoff theory, as the coefficients on the determinants of leverage are all estimated to be statistically significant and with the expected signs. The results for the foreign bank subsidiaries do not show any significant differences suggesting that the leverage behavior of the foreign bank subsidiaries in the host country is largely similar to that of the domestic banks.

We next incorporate VIX into the regressions to investigate whether the impact of global liquidity conditions differs between the two groups. In column (5) – (6) of Table 4, VIX is estimated to be negative at conventional significance levels in both groups, suggesting that global liquidity conditions could induce banks to increase leverage irrespective of whether they are domestic banks or foreign bank subsidiaries. It is also noteworthy that the coefficient of VIX is estimated to be larger in the foreign bank equation indicating that foreign bank subsidiaries' leverage responds more sensitively to global liquidity conditions than that of the domestic banks.

5.3 Implications of Global Liquidity Conditions for Banks' Leverage

Our regression results broadly support the trade-off theory of leverage. On the whole, they indicate that the standard determinants of non-financial firms' leverage are equally valid for banks. Meanwhile, the results regarding the lagged dependent variable and the proxy for global liquidity conditions in Eq. (4) suggest that under specific circumstances the self-correcting mean-reversion inherent in leverage

dynamics could be counteracted by the effect of the global liquidity conditions. As a graphical illustration, Figure 5 plots the actual and target leverage levels for the median bank in our sample. Theoretically, the mean-reverting force suggests that when a bank's actual leverage is high relative to its target, it would have a tendency to reduce its leverage, and vice versa. However, we observe in Figure 5 that leverage continued to increase between 2006 and 2008 despite the fact that it was above target, which could be largely due to the banks taking advantage of more favorable liquidity conditions during the period.

The net impact of the mean-reverting force and global liquidity conditions on banks' leverage depends on how far leverage deviates from its target. Table 5 provides a simulation analysis of how the gap between actual and target leverage is affected by its initial value and global liquidity conditions. In the row shaded in yellow, we fix the VIX index to its historical mean level to illustrate the mean-reverting phenomenon of leverage, in which an over-leveraged bank is estimated to experience a decline in leverage and vice versa. Meanwhile, there are instances when the mean-reverting force would be more than offset by favorable global liquidity conditions. For example, in one simulation, it is estimated that when the initial state of the bank is over-leveraged by 0.25 time and there is abundant global liquidity (indicated by a ten percentage points below the historical mean of VIX index), bank leverage increases by 0.43. This leads to a further widening of the deviation from target leverage, instead of a narrowing of the gap as predicted by the standard partial adjustment model. This suggests that the self-correcting mechanism of banks' leverage may in times be disturbed by abundant global liquidity. Such externalities generated by abundant global liquidity on banks' behavior may require the implementation of macro-prudential policies to constrain banks' credit growth or require banks to hold more capital, with a view to containing systemic risks arising from an excessive increase in leverage in the banking system.[30]

6. Conclusion

Given its role in credit intermediation and maturity transformation, a significant degree of leverage is inevitable for banks. This paper examines whether the trade-off theory of leverage is applicable to banks in Hong Kong, with a view to examining the need of macro-prudential policy from a host country's perspective. Using the trade-off theory of leverage, we examine whether capital management is different between foreign bank subsidiaries and domestic banks in Hong Kong.

Consistent with existing studies on other banking systems, we find that the standard determinants of leverage are applicable to banks in Hong Kong. Regarding the dynamics of banks' leverage, we find

[30] In connection with the very rapid growth of loans during 2010-11, the Hong Kong Monetary Authority (HKMA) issued a circular on 11 April 2011 to require all AIs to reassess their business plans and funding strategies for the remainder of 2011 and submit the assessment results to the HKMA for review. In addition, in October 2013, the HKMA introduced the Stable Funding Requirement (SFR) to require certain banks with significant loan growth exceeding the banking sector's average to maintain longer term stable funds. The HKMA will regularly assess the market conditions and adjust the measure when necessary. The prudential measures introduced by the HKMA are to ensure that banks have sufficient capacity to address potential risks arising from possible significant fund outflows from Hong Kong. The SFR can be perceived as an on-going supervisory measure.

that there exists a mean-reverting feature for individual banks' leverage dynamics for banks in Hong Kong: when banks are over-leveraged, they tend to lower their leverage subsequently, and vice versa. We further find that the self-correcting force could under certain circumstances be more than offset by abundant global liquidity. Such externalities on banks' behavior may require the implementation of macro-prudential policies to contain the systemic risks stemming from the induced high leverage of banks. Moreover, compared with domestic banks, we find that the effect of global liquidity on banks' leverage is tangibly higher for foreign bank subsidiaries.

Given that excessive leveraging or rapid deleveraging of banks could pose risks to financial stability, this paper provides a rationale for host country policymakers to formulate countercyclical measures to lean against external liquidity shocks and contain risks arising from sharp changes in banks' leverage.

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Table 1. Descriptive Statistics

	Mean	*Median*	*St. Dev*	*Max*	*Min*
TA (HK$ bn)	356.831	98.119	789.937	5,812.755	11.506
LEV	10.921	10.380	3.820	32.350	5.240
MTB	1.063	1.056	0.063	1.285	0.875
ROE (%)	12.824	11.122	13.657	190.533	-22.472
COL (%)	26.220	25.263	11.180	57.904	1.753
LLR (%)	1.508	0.920	1.552	12.257	0.171

Note:
(1) TA denotes bank's total assets. LEV denotes banks' book asset-to-equity ratio. MTB denotes market-to-book ratio. ROE refers to return on equity. COL denotes the share of the sum of cash, fixed assets and total securities to total assets. LLR denotes the loan loss reserves to total loans ratio.

(2) For non-listed banks, their market-to-book ratios are imputed using their accounting variables. For details, see Appendix 2.

Table 2. Determinants of Banks' Book Leverage

The table shows the results of estimating static trade-off model on banks' leverage:

$$LEV_{i,t} = \beta_0 + \beta_1 ROE_{i,t-1} + \beta_2 MTB_{i,t-1} + \beta_3 COL_{i,t-1} + \beta_4 TA_{i,t-1} + \beta_5 LLR_{i,t-1} + c_i + c_t + \varepsilon_{i,t}$$

The dependent variable is book leverage. In column 1, the explanatory variables are return on equity (ROE), market-to-book ratio (MTB), collateral-to-total assets ratio (COL), size (TA) and loan loss reserves to total loans ratio (LLR). In column 2, inflation expectation (π_t^E) is added to the explanatory variables. In column 3, a dummy variable (Dividend), which takes on a value one if the bank pays a dividend in a given year, is added to the list of explanatory variables. To control for the unobserved heterogeneity, bank fixed effect and time effect are introduced. All standard errors are adjusted for clustering at the bank level.

Estimation results of Eq. (1)

	(1)	(2)	(3)
Dependent variable	$LEV_{i,t}$	$LEV_{i,t}$	$LEV_{i,t}$
$ROE_{i,t-1}$	0.221***	0.220***	0.223***
	(0.059)	*(0.059)*	*(0.061)*
$MTB_{i,t-1}$	-12.423*	-13.100	-12.040*
	(6.498)	*(7.850)*	*(6.016)*
$COL_{i,t-1}$	0.054**	0.053**	0.053**
	(0.021)	*(0.023)*	*(0.021)*
$TA_{i,t-1}$	1.520**	1.566**	1.557**
	(0.591)	*(0.652)*	*(0.556)*
$LLR_{i,t-1}$	-0.215	-0.225	-0.210
	(0.160)	*(0.169)*	*(0.152)*
π_t^E		0.071	
		(0.351)	
$Dividend_{i,t}$			-0.177
			(0.610)
Constant	2.755	2.848	2.035
	(11.182)	*(11.300)*	*(10.135)*
Bank fixed effect	Y	Y	Y
Time effect	Y	Y	Y
R-squared	0.712	0.714	0.708

Notes:
(1) ***, ** and * denote significance levels at 1%, 5% and 10% respectively.

(2) Figures in parentheses refer to standard error.

Table 3. Bank Leverage Dynamics and the Effect of Global Liquidity Condition

The table shows the results of estimating a partial adjustment model on banks' leverage and a modified version of the model which captures the effect of global liquidity conditions:

$$LEV_{i,t} = (1-\lambda)LEV_{i,t-1} + \lambda(\gamma_0 + \gamma_1 ROE_{i,t-1} + \gamma_2 TA_{i,t-1} + \gamma_3 COL_{t-1} + \gamma_4 LLR_{i,t-1}) + \theta VIX_{t-1} + b_i + b_t + \xi_{i,t}$$

Column 1 presents the standard partial adjustment model on banks' leverage which omits the proxy for global liquidity conditions (i.e., θ=0). The dependent variable is bank's book leverage. The explanatory variables are lagged bank leverage, and the same set of explanatory variables as presented in the table 2. The parameter λ represents the speed of adjustment. It measures the fraction of the gap between last period's leverage and this period's target that banks close in a year. Column 2 – 4 each presents the modified version of the partial adjustment model, which includes three alternative proxies for global liquidity conditions (i.e. the VIX index, global banks' leverage and yearly growth rate of international bank claims of all BIS reporting economies). Column 5 presents the result of column 2 for pre-crisis periods. "Full period" denotes 1998-2012. "Pre-crisis" denotes 1998-2007. To control for the unobserved heterogeneity, bank fixed effect and time effect are introduced. All standard errors are adjusted for clustering at the bank level.

Estimation results of Eq. (4).

Dependent variable	(1) $LEV_{i,t}$ (Full period)	(2) $LEV_{i,t}$ (Full period)	(3) $LEV_{i,t}$ (Full period)	(4) $LEV_{i,t}$ (Full period)	(5) $LEV_{i,t}$ (Pre-crisis)
$LEV_{i,t-1}$	0.603***	0.603***	0.594***	0.605***	0.468**
	(0.155)	*(0.155)*	*(0.151)*	*(0.156)*	*(0.204)*
$ROE_{i,t-1}$	0.084*	0.080*	0.083*	0.077	0.183**
	(0.046)	*(0.048)*	*(0.047)*	*(0.047)*	*(0.076)*
$MTB_{i,t-1}$	-9.912*	-11.369**	-11.922**	-11.867**	-17.611***
	(5.121)	*(4.901)*	*(4.913)*	*(4.848)*	*(5.950)*
$TA_{i,t-1}$	0.501*	0.555*	0.564**	0.568*	0.333
	(0.288)	*(0.292)*	*(0.288)*	*(0.296)*	*(0.301)*
$COL_{i,t-1}$	0.026*	0.022	0.024	0.024	0.039
	(0.015)	*(0.016)*	*(0.015)*	*(0.015)*	*(0.031)*
$LLR_{i,t-1}$	-0.398**	-0.426**	-0.400**	-0.522***	-0.592***
	(0.196)	*(0.186)*	*(0.185)*	*(0.156)*	*(0.212)*
VIX_{t-1}		-0.053*			-0.285*
		(0.032)			*(0.152)*
Global leverage $_{t-1}$			0.032*		
			(0.019)		
Δ International claims $_{t-1}$				0.051*	
				(0.030)	
Constant	7.683*	8.806**	7.784	8.798**	15.605**
	(4.611)	*(4.380)*	*(4.637)*	*(4.213)*	*(5.866)*
Bank fixed effect	Y	Y	Y	Y	Y
Time effect	Y	Y	Y	Y	Y
Arellano-Bond test for AR(2) (p-value)	0.157	0.202	0.201	0.232	0.157

Notes:
(1) ***, ** and * denote significance levels at 1%, 5% and 10% respectively.

(2) Figures in parentheses refer to standard error.

Table 4. Bank Leverage Dynamics and The Effect of Global Liquidity Condition by Group of Domestic Banks and Foreign Bank Subsidiaries

The table shows the results of estimating a partial adjustment model on banks' leverage and a modified version of the model which captures the effect of global liquidity conditions:

$$LEV_{i,t} = (1-\lambda)LEV_{i,t-1} + \lambda(\gamma_0 + \gamma_1 ROE_{i,t-1} + \gamma_2 TA_{i,t-1} + \gamma_3 COL_{t-1} + \gamma_4 LLR_{i,t-1}) + \theta VIX_{t-1} + b_i + b_t + \xi_{i,t}$$

Column 1 - 3 present the standard partial adjustment model on banks' leverage which omit the proxy for global liquidity conditions (i.e., θ=0). Column 1 is the same as the column 1 in Table 3 which includes all sample banks. Column 2 presents the result of standard partial adjustment model on domestic banks only. Column 3 presents the result on foreign bank subsidiaries only. Column 4 - 6 present the modified version of partial adjustment model on banks' leverage which include the VIX index as a proxy for global liquidity conditions. Column 4 is the same as the column 2 in Table 3 which includes all sample banks. Column 5 presents the result on domestic banks only. Column 6 presents the results on foreign bank subsidiaries. To control for the unobserved heterogeneity, bank fixed effect and time effect are introduced. All standard errors are adjusted for clustering at the bank level.

Estimation results of Eq. (4) by group of domestic banks and foreign bank subsidiaries

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	$LEV_{i,t}$	$LEV_{i,t}$	$LEV_{i,t}$	$LEV_{i,t}$	$LEV_{i,t}$	$LEV_{i,t}$
	(All sample banks)	(Domestic banks)	(Foreign subsidiaries)	(All sample banks)	(Domestic banks)	(Foreign subsidiaries)
$LEV_{i,t-1}$	0.603***	0.611***	0.583***	0.603***	0.733***	0.558***
	(0.155)	*(0.044)*	*(0.157)*	*(0.155)*	*(0.048)*	*(0.149)*
$ROE_{i,t-1}$	0.084*	0.123***	*0.095**	0.080*	0.054	0.086*
	(0.046)	*(0.040)*	*(0.052)*	*(0.048)*	*(0.037)*	*(0.048)*
$MTB_{i,t-1}$	-9.912*	-18.199***	-10.715*	-11.369**	-13.723***	-12.858**
	(5.121)	*(3.170)*	*(6.276)*	*(4.901)*	*(3.121)*	*(5.796)*
$TA_{i,t-1}$	0.501*	0.547***	0.462	0.555*	0.369***	0.631*
	(0.288)	*(0.080)*	*(0.322)*	*(0.292)*	*(0.087)*	*(0.349)*
$COL_{i,t-1}$	0.026*	0.035**	0.024	0.022	0.028**	0.021
	(0.015)	*(0.014)*	*(0.022)*	*(0.016)*	*(0.014)*	*(0.024)*
$LLR_{i,t-1}$	-0.398**	-1.189***	-0.480*	-0.426**	-1.344***	-0.468*
	(0.196)	*(0.397)*	*(0.254)*	*(0.186)*	*(0.315)*	*(0.240)*
VIX_{t-1}				-0.053*	-0.040**	-0.071*
				(0.032)	*(0.019)*	*(0.039)*
Constant	7.683*	16.174***	9.115	8.806**	13.031***	9.862*
	(4.611)	(2.583)	*(6.289)*	*(4.380)*	(2.932)	(5.538)
Bank fixed effect	Y	Y	Y	Y	Y	Y
Time effect	Y	Y	Y	Y	Y	Y
Arellano-Bond test for AR(2) (p-value)	0.157	0.588	0.212	0.202	0.181	0.275

Notes:
(1) ***, ** and * denote significance levels at 1%, 5% and 10% respectively.

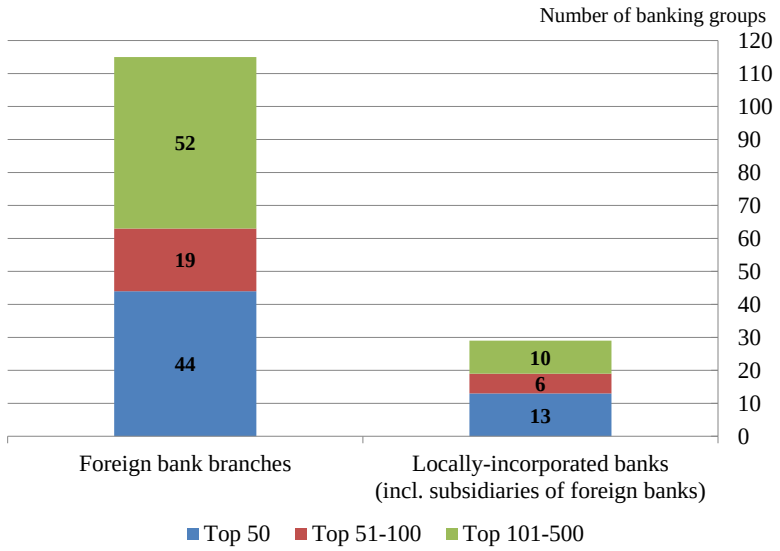
(2) Figures in parentheses refer to standard error.

Table 5. Net Impact of Global Liquidity Conditions on Bank Leverage

	D(leverage)	Over-leverage (target - leverage) <0				GAP	Under-leverage (target - leverage) >0			
		-1	**-0.75**	**-0.5**	**-0.25**	**0**	**0.25**	**0.5**	**0.75**	**1**
improved liquidity condition	**-20**	0.67	0.77	0.87	0.97	1.06	1.16	1.26	1.36	1.46
	-18	0.56	0.66	0.76	0.86	0.96	1.06	1.16	1.26	1.35
	-16	0.46	0.55	0.65	0.75	0.85	0.95	1.05	1.15	1.25
	-14	0.35	0.45	0.55	0.65	0.75	0.84	0.94	1.04	1.14
	-12	0.24	0.34	0.44	0.54	0.64	0.74	0.84	0.94	1.04
	-10	0.14	0.23	0.33	0.43	0.53	0.63	0.73	0.83	0.93
	-8	0.03	0.13	0.23	0.33	0.43	0.53	0.62	0.72	0.82
	-6	(0.08)	0.02	0.12	0.22	0.32	0.42	0.52	0.62	0.72
	-4	(0.18)	(0.08)	0.01	0.11	0.21	0.31	0.41	0.51	0.61
	-2	(0.29)	(0.19)	(0.09)	0.01	0.11	0.21	0.30	0.40	0.50
VIX-historical mean	**0**	(0.40)	(0.30)	(0.20)	(0.10)	0.00	0.10	0.20	0.30	0.40
worsen liquidity condition	**2**	(0.50)	(0.40)	(0.30)	(0.21)	(0.11)	(0.01)	0.09	0.19	0.29
	4	(0.61)	(0.51)	(0.41)	(0.31)	(0.21)	(0.11)	(0.01)	0.08	0.18
	6	(0.72)	(0.62)	(0.52)	(0.42)	(0.32)	(0.22)	(0.12)	(0.02)	0.08
	8	(0.82)	(0.72)	(0.62)	(0.53)	(0.43)	(0.33)	(0.23)	(0.13)	(0.03)
	10	(0.93)	(0.83)	(0.73)	(0.63)	(0.53)	(0.43)	(0.33)	(0.23)	(0.14)
	12	(1.04)	(0.94)	(0.84)	(0.74)	(0.64)	(0.54)	(0.44)	(0.34)	(0.24)
	14	(1.14)	(1.04)	(0.94)	(0.84)	(0.75)	(0.65)	(0.55)	(0.45)	(0.35)
	16	(1.25)	(1.15)	(1.05)	(0.95)	(0.85)	(0.75)	(0.65)	(0.55)	(0.46)
	18	(1.35)	(1.26)	(1.16)	(1.06)	(0.96)	(0.86)	(0.76)	(0.66)	(0.56)
	20	(1.46)	(1.36)	(1.26)	(1.16)	(1.06)	(0.97)	(0.87)	(0.77)	(0.67)

Note: This table provides a simulation analysis on how the gap between the actual and target leverage levels is affected by its initial value and the state of global liquidity conditions.

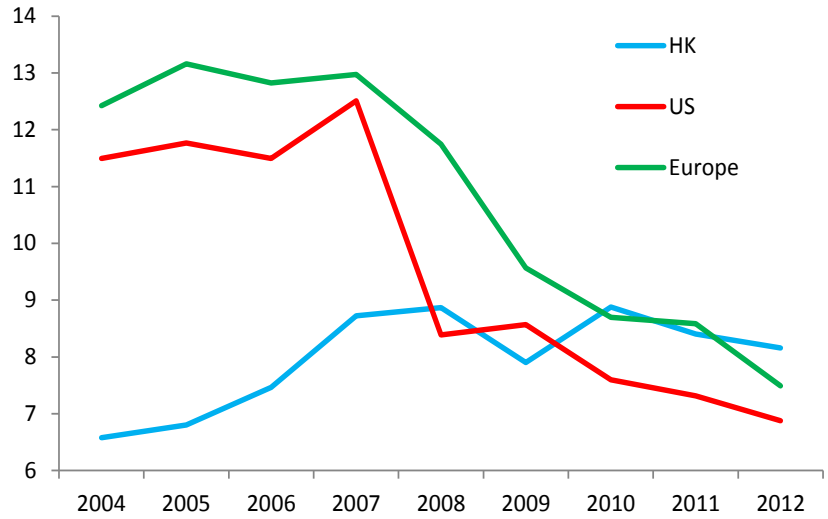
Figure 1. Presence of Global Banks in Hong Kong by Consolidated Asset Size and Mode of Operation



Note: The rank is based on consolidated asset size in 2013. Some global banks operate both branches and subsidiaries in Hong Kong.

Source: HKMA.

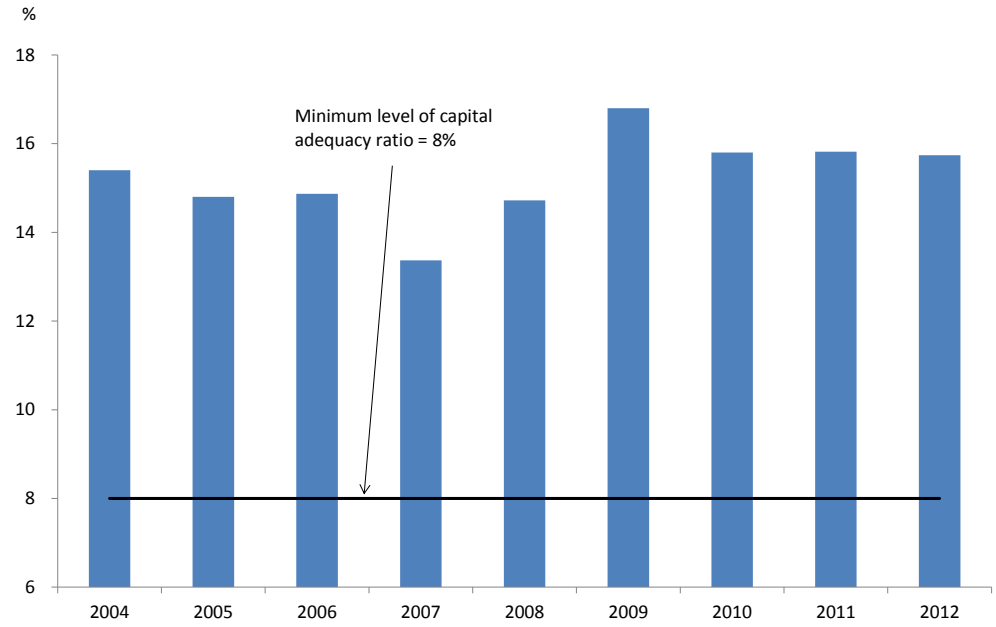
Figure 2. Cross-Country Comparison of Banks' Tier 1 Capital Leverage



Notes:
(1) Figures refer to the median Tier 1 capital leverage of the respective banking sector.

(2) Europe banks refer to Banco Santander, BBVA, BNP Paribas, BPCE Group, Credit Agricole Group, Credit Suisse, Deutsche Bank, ING Bank, Nordea Bank, Societe Generale, UBS, Unit Credit, Barclays PLC, HSBC, Lloyds, Royal Bank of Scotland (The) and Standard Chartered PLC. US banks refer to Bank of America, Bank of New York Mellon, Citigroup, Goldman Sachs, JPMorgan Chase, Morgan Stanley, State Street and Wells Fargo.

Figure 3. Capitalization of Locally Incorporated AIs in Hong Kong



Note: Figures refer to consolidated positions of locally incorporated AIs.

Source: HKMA.

Figure 4. A Graphical Illustration of How Global Liquidity may Affect the Dynamics of Banks' Leverage

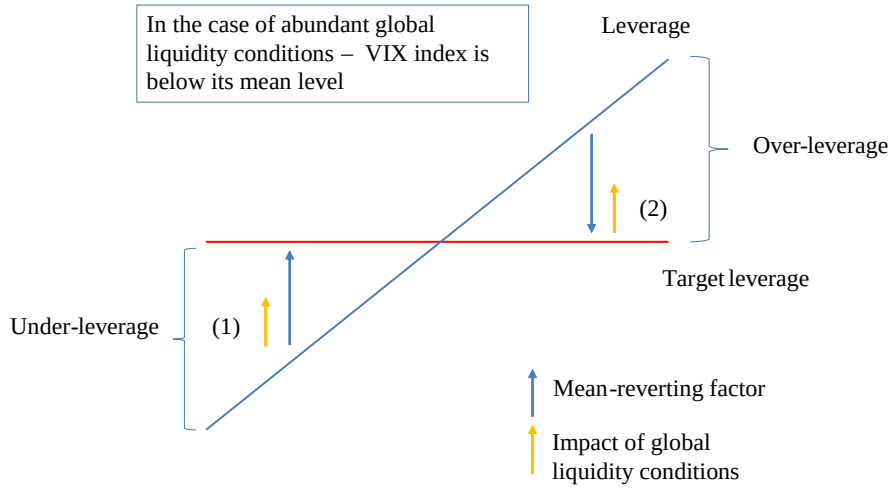
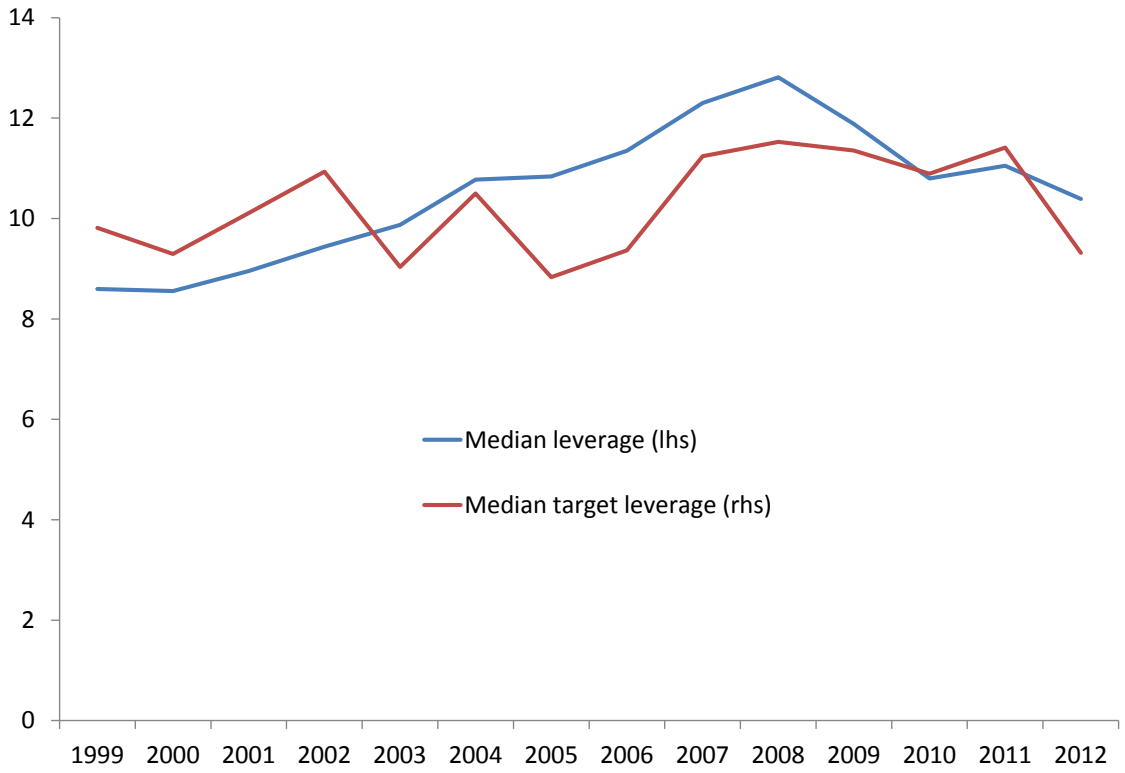


Figure 5. Comparison between Estimated Median Target Leverage and Actual Median Leverage for Banks in Hong Kong



Note: The target leverage for banks can be determined residually from Eq. (3) by inserting the estimated coefficients of λ and θ, together with the fitted value of bank's actual leverage.

Source: Authors' estimations based on data obtained from Bankscope.

Appendix 1. Definition of Variables

Leverage ratio (Lev) = book value of average assets / book value of average equity

Size (TA) = natural log of book value of total assets

Return on average asset (ROE) = net income/average equity

Collateral (COL) = (fixed assets + total securities + cash)/total assets

Asset quality (LLR) = Loan loss reserve / total loans

π_t^E = 1-year expected inflation of Hong Kong obtained from IMF WEO database

Dividend = a dummy variable which takes on one if bank pays a dividend in a given year

Proxy for global liquidity conditions (VIX) = VIX index minus its historical mean

Proxy for global banks' leverage (Global leverage) = leverage of the US broker dealer sector from the Flow of Funds account published by the US Federal Reserve

Alternative proxy for global liquidity conditions (ΔInternational claims) = the year-on-year growth rate in international bank claims of all BIS reporting economies

Appendix 2. The Approach to Estimating Banks' Market Value of Equity and Market-to-Book Ratio

This appendix documents the approach to estimating the market value of equity and the market-to-book ratio of assets (MTB) for the 19 locally incorporated banks in this study.[31] The market value of equity is a necessary input to estimating banks' MTB, which in turn determines the level of banks' leverage as well as its dynamics. However, the market value of equity is not readily available for all 19 locally incorporated banks for various reasons.

(1) Some locally incorporated banks as well as their banking group are not listed.

(2) While parent groups of some subsidiaries are listed, the subsidiary only accounts for a very thin portion of the total assets of the parent group. Theoretically, the stock prices of the parent group provide only negligible information for the subsidiary and may not serve as a reliable proxy for the growth opportunity of the subsidiary.

(3) While some banks are not separately listed, they account for a significant portion of total assets of their respective listed parent banking group. Thus, the stock prices of the parent banking group could, in theory, provide useful information about the subsidiaries.

To resolve this issue, a regression model is estimated to reveal the determinants of the price-to-book ratio (PB) (i.e. the market value of equity expressed as a multiple of its book value of equity) for the listed banks in Hong Kong. It is noteworthy that using banks' fundamentals as determinants of their PB is not uncommon in the literature.[32] In particular, several studies find significant relationships between the price-to-book ratio and profitability (Hunter and Wall, 1989), net interest margin, bad debt expense and non-performing loans (Yao and Liang, 2005). In line with the literature, our specification postulates that the PB of a locally incorporated bank is determined by the bank's fundamentals (including its profitability, asset quality and credit ratings) after controlling for the stock market condition (proxied by the annual percentage change of the Hang Seng Index).

[31] This approach was employed in estimating Hong Kong non-listed banks' market value of equity and equity volatility for the liquidity stress-testing framework of the IMF's Financial System Stability Assessment on Hong Kong. For details, see People's Republic of China–Hong Kong Special Administrative Region: Financial Sector Assessment Program-Stress Testing the Banking Sector-Technical Note.

[32] See related work by Jordan et al. (2011).

An empirical model for the determinant of the PB for listed banks in Hong Kong:

$$PB_{it}=\alpha+\beta_1 ROE_{it}+\beta_2 LLR_{it}+\beta_3 D08_t+\beta_4 HSI_t+\beta_5 AA_{it}+\beta_6 A_{it}+\beta_7 BBB_{it}+\varepsilon_{it} \quad \text{(A1)}$$

Sample period: 1998H1 – 2012H2.

where

PB : Price-to-book ratio of equity

ROE : Return to equity

LLR : Loan-loss reserves as a ratio to total loans as a proxy for bank's asset quality

D08 : Dummy variable defined as one from 2008H1 and zero otherwise

HSI : Year-on-year changes of the Hang Seng Index

AA : Dummy variable defined as one for bank with rating AA- or above and zero otherwise

A : Dummy variable defined as one for bank with rating from A+ to A- and zero otherwise

BBB : Dummy variable defined as one for bank with rating from BBB+ to BBB- and zero otherwise

Estimation results

Dependent variable:	PB_{it}
ROE_{it}	0.038***
	(0.010)
LLR_{it}	-17.187***
	(4.192)
$D08_t$	-0.532***
	(0.086)
HSI_t	0.004***
	(0.001)
AA_{it}	0.451*
	(0.254)
A_{it}	0.437**
	(0.172)
BBB_{it}	0.333**
	(0.142)
Constant	1.235***
	(0.294)

Figures in parentheses are standard errors

***, ** and * denotes 1%, 5% and 10% level of significance respectively.

The empirical results are statistically significant with the expected sign. A bank that is more profitable with lower credit risk and higher credit ratings would generally have higher PB for its equity. In addition, a bank's PB is affected by financial market conditions. Based on the empirical results, the PB

and the market-to-book ratio of assets for non-listed locally incorporated banks as described in (1)-(3) above can be imputed using the following steps:

(i) Obtain the book value of equity, return on equity, loan loss reserve ratio and credit ratings for the locally incorporated banks. Compute the market information, i.e. the annual percentage change of the HSI.

(ii) Obtain an estimated PB (i.e., $\hat{PB}$) for the bank by using eq. (A1). Estimate the market value of equity by multiplying the book value of equity of the locally incorporated bank by $\hat{PB}$.

(iii) Obtain an estimated market-to-book ratio of assets $\hat{MB}$ of locally incorporated banks by dividing the sum of the market value of equity and book value of liability by the book value of total assets.

For listed locally incorporated banks, market-to-book of bank's assets can be obtained by using their own market-based and accounting-based information.

Appendix 3. List of Sample Banks

	Bank type	Country of ultimate parent banking group	Subsidiary of GSIFIs (Y/N)
Bank of China (Hong Kong Limited	Foreign bank subsidiary	China	Y
Bank of East Asia Limited	Domestic bank	Hong Kong	N
China Construction Bank (Asia) Corporation Limited	Foreign bank subsidiary	China	N
Chiyu Banking Corporation Ltd.	Foreign bank subsidiary	China	N
Chong Hing Bank Limited	Domestic bank	Hong Kong	N
Citibank (Hong Kong) Limited	Foreign bank subsidiary	U.S.	Y
Citic Bank International Limited	Foreign bank subsidiary	China	N
Dah Sing Bank Ltd	Domestic bank	Hong Kong	N
DBS Bank (Hong Kong) Limited	Foreign bank subsidiary	Singapore	N
Fubon Bank (Hong Kong) Limited	Foreign bank subsidiary	Taiwan	N
Hang Seng Bank Limited	Foreign bank subsidiary	U.K.	Y
HongKong and Shanghai Banking Corporation Limited (The)	Foreign bank subsidiary	U.K.	Y
ICBC (Asia)	Foreign bank subsidiary	China	Y
Nanyang Commercial Bank Ltd	Foreign bank subsidiary	China	N
Public Bank (Hong Kong) Limited	Foreign bank subsidiary	Malaysia	N
Shanghai Commercial Bank Ltd	Domestic bank	Hong Kong	N
Standard Chartered Bank (Hong Kong) Limited	Foreign bank subsidiary	U.K.	Y
Wing Hang Bank Ltd	Domestic bank	Hong Kong	N
Wing Lung Bank Ltd	Domestic Bank	Hong Kong	N

Notes:
(1) Hang Seng Bank Limited and The HongKong and Shanghai Banking Corporation Limited are subsidiaries of the HSBC Plc. We therefore treat them as foreign bank subsidiaries in this study.

(2) Although Wing Hang Bank Ltd and Wing Lung Bank Ltd were acquired by foreign banks in 2014 and 2009 respectively, we opt to treat them as domestic banks as these two banks are important players in the retail lending business in the local banking sector during our sample periods.