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IMPLICATIONS OF LOAN PORTFOLIO CONCENTRATION FOR CREDIT RISK OF BANKS IN HONG KONG

Key points:

- *This study empirically estimates the net effect of sectoral loan concentration on the credit risk of banks, which is a question that remains inconclusive in banking research due to the potential trade-off between concentration risk and specialisation gains. Based on a panel of regulatory dataset reported by licensed banks to the Hong Kong Monetary Authority, our empirical results find support for the specialisation gain hypothesis, which more than offsets the associated concentration risk.*

- *Specifically, a bank with a more concentrated loan portfolio is estimated to have a lower loan loss provision ratio after controlling for differences in loan composition and common risk factors. A key implication is that the specialisation gains arising from higher loan concentration should be considered in order to have a more balanced assessment of banks' credit risks.*

- *While this finding may, to some extent, alleviate concerns about the rising sectoral concentration in banks' loan portfolios after the crisis, it is important to note that the net impact on a bank's loan loss provision ratio also depends on how far the bank allocates its loan portfolio towards riskier sectors. Therefore, changes in both the sectoral concentration and the composition of banks' loan portfolios should be closely monitored.*

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I. INTRODUCTION

The effects of concentration verses diversification in banks' loan portfolios remain one of the unsettled debates in banking literature. The conventional view in modern finance theory argues that a credit portfolio with high sectoral concentration tends to increase credit risks due to higher default correlations within those sectors (Bebczuk and Galindo, 2007; and Rossi *et al*., 2009). However, recent studies in the banking literature find that by focusing lending to certain industries, banks acquire industry-specific knowledge and thus improve their selection and monitoring abilities (Acharya *et al*. 2006, Jahn *et al*. 2016 and Tabak *et al*. 2011). In part, this could in part help reduce banks' credit risks and improve their performance. Because of this possible trade-off between concentration risks and specialisation gains, the net effect of loan concentration is therefore ambiguous. To help shed light on this important policy question, our study uses the Hong Kong banking sector as an example and empirically investigates the net effect of loan sectoral concentration on the credit risk of banks in Hong Kong.

Based on a regulatory panel dataset of licensed banks in Hong Kong, our empirical results find support for the specialisation gain hypothesis and the results are robust across two different measures of loan concentration. Specifically, the results suggest that a bank with a more concentrated loan portfolio tends to have a lower overall loan loss provision ratio after controlling for the differences in loan composition and common credit risk factors. A key implication here is that the potential specialisation gains from higher loan concentration should be considered in order to achieve a more balanced assessment of banks' risks.

The remaining part of this paper is structured as follow: section 2 describes the data and the empirical framework, section 3 discusses the estimation results and implications, and section 4 concludes.

II. DATA AND EMPIRICAL MODELS

In this section, we first describe the construction of the measures for loan concentration and followed by the empirical models in estimating the impact of loan concentration on banks' credit risk.

2.1 Measures of loan portfolio concentration ($M_{i,t}$)

Following the literature, two different concentration indexes are constructed in this study as proxies for the sectoral concentration of a bank's loan portfolio. In particular, the normalised HHI is used as our baseline measure. To construct the measure for each bank, we first calculate the share of bank *i*'s loan exposure in sector *j* to its total loan exposure at each quarter *t* (w_{ijt}). The share is squared and sum across all loan sectors, which is subsequently normalised into a $[0, 1]$ scale. Specifically, the normalised HHI is calculated as:

$$hhi_{i,t} = \left(\sum\nolimits_j w_{i,j,t}^2 - 1/N\right)/(1 - 1/N) \qquad (1)$$

where N denotes the number of loan sectors to which a bank can lend. By construction, $hhi_{i,t}$ is equal to 1 if a bank fully concentrates its loan portfolio in one sector. Conversely, $hhi_{i,t}$ will attain its minimum value of 0 for a fully diversified loan portfolio (i.e. all economic sectors have the same loan share). In our dataset, N is equal to 34 if other loans for use outside Hong Kong are categorised as a sector.[1] A detailed breakdown of the loan sectors and the corresponding loan share for all AIs in Hong Kong at the end of September 2017 is presented in Table A1 in the Appendix.

Another widely used concentration measure is Shannon (1948)'s entropy ($s_{i,t}$), which is calculated as:

$$s_{i,t} = \sum\nolimits_j w_{i,j,t} \ln\left(1/w_{i,j,t}\right) \qquad (2)$$

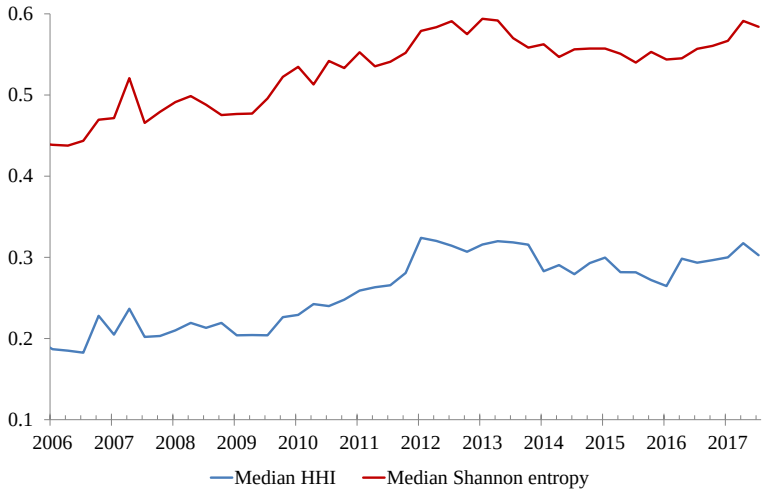
[1] It is worth noting that a geographical breakdown in loans for use outside Hong Kong is not available. We find that our empirical results remain valid in a robustness analysis which divides the loans for use outside Hong Kong into two sub-groups: (a) loans for use in Mainland China (proxied by external loans to Mainland China) and (b) other loans for use outside Hong Kong and Mainland China. The robustness analysis will be available in a forthcoming working paper in the HKIMR working paper series.

where a larger value of s_{it} refers to a less concentrated position.[2] To ensure that all concentration measures point in the same direction, we multiply -1 to $s_{i,t}$ and rescale the measure to a $[0, 1]$ range. We define $\hat{s}_{i,t}$, the new measure, by:

$$\hat{s}_{i,t} = \left[-s_{i,t} + \ln(N)\right]/\ln(N) \qquad (3)$$

where again $N = 34$. This construction is designed such that $\hat{s}_{i,t}$ will be equal to 0 when it is fully diversified and equal to 1 when it concentrates lending in one sector only. Chart 1 presents the median value of the two concentration indexes over time. As seen in the chart, the two concentration indexes tend to move in tandem over time and have exhibited an upward trend after the global financial crisis. This suggests that banks in Hong Kong, on average, have become more concentrated following the 2008 global financial crisis.

Chart 1: Median value of $hhi_{i,t}$ and $\hat{s}_{i,t}$



Source: Authors' calculation based on data from the HKMA.

[2] If $w_{i,j,t} = 0$, $1/w_{i,j,t}$ would be undefined. We follow Theil (1972) to set $w_{i,j,t}\ln\left(1/w_{i,j,t}\right) = 0$ when $w_{i,j,t} = 0$ to avoid this problem.

2.2 Empirical models

We then describe the empirical framework for examining the effect of higher loan portfolio concentration ($M_{i,t-1}$) on the credit risk of banks, where risk is measured by the banks' overall specific loan loss provision to the total loan ratios ($q_{i,t}$). To single out the effect of banks' loan concentration on $q_{i,t}$, it is also important to control for differences in sectoral composition among banks' loan portfolios. This is because a bank which specialises lending in riskier sectors is likely to result in a higher $q_{i,t}$ than another bank that specialises lending in less riskier sectors, even though the two banks have the same level of concentration.

To account for this, we follow the empirical strategy in Jahn et al. (2016) by computing a variable that captures the differences in the credit risk that are solely due to differences in the loan composition among banks' loan portfolios. More specifically, the variable is computed in the following steps. First, a loan loss provision ratio of a hypothetical loan portfolio ($hq_{i,t}$) for a bank is constructed based on the bank's actual loan composition, but the banking-sector's average loan loss provision ratio for each loan sector ($Q_{j,t}$) is applied.

$$hq_{i,t} = \sum_j w_{i,j,t} Q_{j,t} \tag{4}$$

Second, $hq_{i,t}$ is then subtracted from and scaled by the average overall loan loss provision ratio of the banking sector (Q_t) (i.e. the benchmark portfolio) to construct the loan composition factor (Δhq_{it}):

$$\Delta hq_{i,t} = \left(hq_{i,t} - Q_t\right)/Q_t \tag{5}$$

As the hypothetical and benchmark portfolio share the same average loan loss provision ratio for each loan sector, Δhq_{it} effectively reflects the relative difference in the sectoral composition between the bank's loan portfolio and the benchmark portfolio (i.e. the aggregate banking sector portfolio). By construction, a positive value of $\Delta hq_{i,t}$ indicates that the bank tends to overweigh (relative to the benchmark portfolio) its loan allocation more towards sectors with higher risks and vice versa.

Based on these variables, our baseline specification for examining the effect of loan concentration on a bank's risk is detailed as follows:

$$q_{i,t} = \beta_0 + \beta_1 Q_{t-1} + \beta_2 \Delta hq_{i,t-1} + \beta_3 M_{i,t-1} + \sum_a \beta_a X_{i,t-1} + \gamma_i + \varepsilon_{i,t} \quad (6)$$

where $q_{i,t}$ is the overall specific loan loss provision ratio of bank *i* at time *t*. $M_{i,t-1}$ is the concentration measure of the loan portfolio of bank *i*. As mentioned previously, $\Delta hq_{i,t-1}$ is included to control for a bank's composition factor. In addition, the average overall loan loss provision ratio of the banking sector (Q_{t-1}) is included in the model to account for the common credit risk factor in Hong Kong. The model also includes a vector of bank control variables ($X_{i,t-1}$) such as the natural logarithm of the bank's total assets, the deposits to asset ratio and loans to asset ratio. All the explanatory variables are lagged by one quarter to alleviate the potential problem of endogeneity.[3] The bank fixed effect (γ_i) is also included to capture unobservable time-invariant characteristics of banks in Hong Kong.

The coefficient of key interest is β_3, which captures the effect of loan concentration on banks' risk after controlling for common risk and loan composition factors. A negative statistically significant β_3 will indicate that a more concentrated loan portfolio is on average associated with a lower bank risk, suggesting that the specialisation gains arising from improved selection and monitoring abilities will more than offset the associated rise in the concentration risk.

We also consider a modified model to study whether there is a non-linear relationship between $q_{i,t}$ and $M_{i,t-1}$. In particular, we conjecture that the marginal gains from improved selection and monitoring abilities tend to diminish as a bank's credit portfolio becomes more concentrated. To test this, we add a squared term of $M_{i,t-1}$ into Eq. (6) to allow for a non-linear relationship as shown in Eq. (7). Specifically, a negative β_3 and a positive β_4 are expected if our conjecture holds true.

[3] One typical endogeneity problem is the reverse causality where the dependent variable also affects the independent variables contemporaneously. While the problem of reverse causality is difficult to be fully eliminated in any empirical analysis, one common practice in the literature to partly reduce this issue is to include the lagged independent variables instead (see Buch *et al*. 2013, Tabak *et al*. 2011). This is because the lagged independent variables are arguably less likely to be influenced by the contemporaneous dependent variable.

$$q_{i,t} = \beta_0 + \beta_1 Q_{t-1} + \beta_2 \Delta hq_{i,t-1} + \beta_3 M_{i,t-1} + \beta_4 M_{i,t-1}^2 + \sum_a \beta_a X_{i,t-1} + \gamma_i + \varepsilon_{i,t} \quad (7)$$

The regression models are estimated using a quarterly panel dataset of the largest 100 licensed banks by asset size[4] in Hong Kong spanning 2000Q1 to 2017Q3.[5] The bank-level data are constructed using confidential regulatory data filed by banks in Hong Kong to the Hong Kong Monetary Authority. In particular, the data of banks' specific loan loss provisions are obtained from the HKMA's *quarterly analysis of loans and advance and provisions*. The bank control variables are constructed from data obtained from the HKMA's *return of assets and liabilities*. Table 1 presents the summary statistics for the variables used.

Table 1: Summary statistics of variables for the estimation sample

	Mean	Median	Standard deviation	25th Percentile	75th Percentile
Credit risk					
$q_{i,t}$ (% pt.)	0.8530	0.1650	1.8625	0.0000	0.8017
Q_t (% pt.)	0.5909	0.3352	0.5505	0.2236	0.6458
Composition and concentration measures					
$\Delta hq_{i,t}$	0.3542	0.2744	0.6453	-0.0686	0.6571
$hhi_{i,t}$	0.3433	0.2555	0.2528	0.1378	0.4893
$\hat{s}_{i,t}$	0.5602	0.5247	0.2082	0.3775	0.7284
Bank characteristics					
Log assets $_{i,t}$	17.4156	17.5174	1.7420	16.4349	18.5759
Deposits/Assets $_{i,t}$ (% pt.)	45.3364	44.9953	27.8590	19.6199	72.3050
Loans /Assets $_{i,t}$ (% pt.)	33.3232	46.0539	17.9328	20.2341	46.0539

[4] Based on the banks' total assets at the end of 2016.
[5] The sampled banks account for 98% of total loans of all AIs at the end of Sep 2017.

III. ESTIMATION RESULTS AND IMPLICATIONS

3.1 Estimation results

We first focus on the estimation results regarding the impact of a higher loan concentration on a bank's loan loss provision ratio (Table 2). Columns 1 and 2 present the results for the baseline model (Eq. 6) for the two concentration indexes respectively, while columns 3 and 4 present the results for allowing a non-linear effect of loan concentration on a bank's risk (Eq. 7).

Table 2: Estimation results of Eq. (6) and (7)

Dependent variable:	(1)	(2)	(3)	(4)
$q_{i,t}$	$M = hhi$	$M = \hat{s}$	$M = hhi$	$M = \hat{s}$
Q_{t-1}	1.241***	1.254***	1.283***	1.289***
	(0.057)	(0.058)	(0.059)	(0.059)
$\Delta hq_{i,t-1}$	0.610***	0.614***	0.595***	0.611***
	(0.088)	(0.087)	(0.088)	(0.088)
$M_{i,t-1}$	-0.815***	-1.313***	-3.078***	-3.587***
	(0.180)	(0.251)	(0.495)	(0.933)
$M^2_{i,t-1}$			2.277***	2.086***
			(0.518)	(0.808)
Constant	-2.372***	-1.950***	-2.603***	-1.607**
	(0.518)	(0.525)	(0.511)	(0.544)
Bank characteristics:				
Log assets $_{i,t-1}$	0.175***	0.173***	0.199***	0.187***
	(0.026)	(0.026)	(0.026)	(0.026)
Deposits/Assets $_{i,t-1}$	0.005**	0.005**	0.005**	0.005**
	(0.002)	(0.002)	(0.002)	(0.002)
Loans/Assets $_{i,t-1}$	-0.010***	-0.010***	-0.010***	-0.010***
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	5,832	5,832	5,832	5,832
R-squared	0.401	0.401	0.403	0.402
Cluster	Bank	Bank	Bank	Bank
Time fixed effect	N	N	N	N
Bank fixed effect	Y	Y	Y	Y

Note: ***, ** and * denote statistical significance at 1%, 5% and 10% respectively. Standard errors are in parenthesis.

Overall, our estimation results indicate that, on average, a bank with a more concentrated loan portfolio tends to have a lower loan loss provision ratio after controlling for the difference in the loan composition of banks as well as the common risk factor. This can be shown by the negative statistically significant coefficient for $M_{i,t-1}$ (i.e. β_3) across the two loan concentration measures (as shown in columns 1 to 4 of Table 3). The estimated coefficient for $M_{i,t-1}^2$ (i.e. β_4) is found to be positively significant (see columns 3 and 4), suggesting that the extent of the marginal impact on banks' loan loss provision ratio is dependent on the initial level of $M_{i,t-1}$.[6] Specifically, the estimated marginal impact of a higher loan concentration on a bank's loan loss provision ratio tends to be smaller if the bank has already held a very concentrated loan portfolio *ex ante*, possibly reflecting a diminishing marginal benefit from improved selection and monitoring abilities. In terms of its economic significance, a one-standard-deviation increase in $hhi_{i,t}$ from its mean value (i.e. an increase by 0.25) while holding other things constant, is estimated to reduce the bank's overall loan loss provision ratio by 24 bps. This is significant given the sample mean of a bank's loan loss provision ratio is 0.85% (see Table 1).

Other explanatory variables are also found to have the expected signs. In particular, a bank that overweighs its loan portfolio towards riskier sectors relative to the benchmark portfolio (i.e. a positive value of $\Delta hq_{i,t-1}$) will have a higher loan loss ratio with other things being held constant. The estimation results also suggest the existence of a significant positive relationship between the common risk factor (Q_{t-1}) and the loan loss provision ratio, suggesting the overall credit risk environment also plays a key role in affecting the credit risk of an individual bank's loan portfolio.

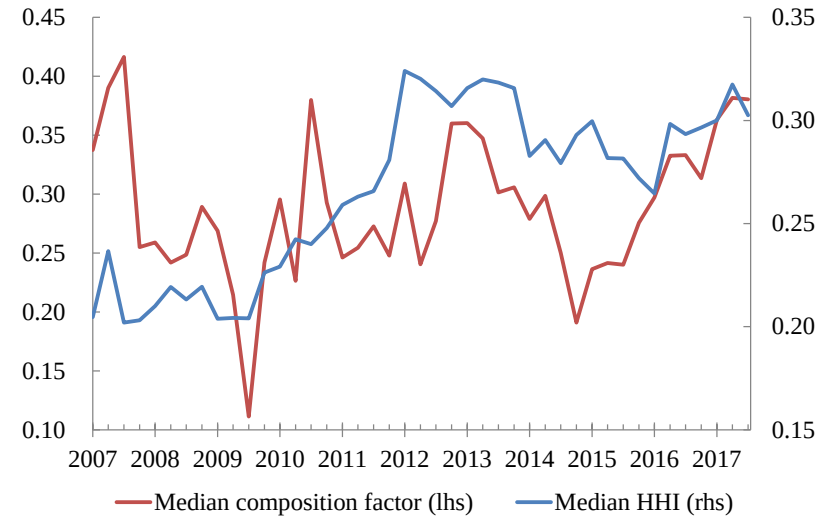
3.2 Net impact of rising loan concentration on bank's loan loss provision ratio after the crisis

Although a higher loan concentration *per se* is found to be negatively related with the risk to banks, the net impact on that risk is also dependent on how far the bank allocates its loan portfolio in riskier sectors (proxied by the composition factor, $\Delta hq_{i,t}$). Chart 2 presents the development of the median value of $hhi_{i,t}$ and the composition factor for our sampled

[6] The marginal impact of higher loan concentration can be calculated by taking the first partial derivative of the dependent variable with respect to $M_{i,t-1}$, which is equal to $\beta_3 + 2 * \beta_4 M_{i,t-1}$.

banks over time. As can be seen in the chart, the median $hhi_{i,t}$ (i.e. the blue line) increased from 0.23 at the end of March 2010 to 0.30 at the end of September 2017, while the median composition factor (i.e. the red line) rose slightly from 0.30 to 0.38 during the same period. Together, these suggest that banks in Hong Kong have, on average, increased the focus of their loan business slightly towards riskier sectors after the global financial crisis.

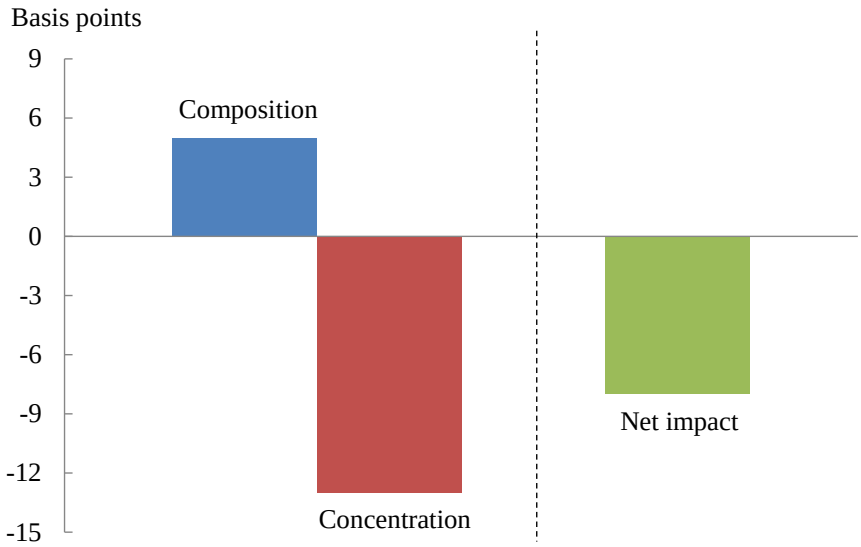
Chart 2: Median HHI and median composition factor of sampled banks



Source: Authors' calculation based on data from the HKMA.

Based on our estimation result of column 3 in Table 2, the rise in loan concentration is estimated to decrease $q_{i,t}$ by 13 basis points, which more than offsets the estimated increase in $q_{i,t}$ of five basis points arising from the increase in $\Delta hq_{i,t}$. Overall, the net effect is estimated to decrease $q_{i,t}$ by about eight basis points (Chart 3). Taken together, our empirical estimate suggests the post-crisis increase in banks' loan concentration has, on average, helped improve their asset quality, partially due to their improved screening and monitoring abilities.

Chart 3: Net impact of increased loan concentration and composition factor on loan loss provision ratio from March 2010 to September 2017



Source: Authors' calculation based on data from the HKMA.

IV. CONCLUSION

Our empirical results suggest that there are potential gains of improved screening and monitoring abilities for banks that buffer the associated concentration risk by focusing lending to certain loan sectors. A key implication is that the potential specialisation gains from higher loan concentration should be taken into consideration for a more balanced assessment of banks' risks.

While this finding may partly alleviate the concerns about the rising sectoral concentration in the loan portfolios of banks after the crisis, it is important to note that the net impact on their loan loss provision ratios depends on how far the banks allocate their loan portfolios towards riskier sectors. In addition, the common credit risk factor, which is exogenous, is found to be a key driver in affecting the credit risk of banks' loans. In view of this, it is essential for banks to maintain prudent credit risk management and stringent underwriting standards of their credit businesses.

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APPENDIX

Table A1: List of economic sectors

No.	Sectors	09/2017
	Loans for use in Hong Kong	
1	Textile	0.2%
2	Footwear and wearing apparel	0.3%
3	Metal products and engineering	0.3%
4	Rubber, plastic and chemicals	0.6%
5	Electrical and electronic	0.7%
6	Food	0.1%
7	Beverages and tobacco	0.1%
8	Printing and publishing	0.1%
9	Other manufacturing miscellaneous	0.9%
10	Property development	7.5%
11	Property investment	8.0%
12	Civil engineering works	0.4%
13	Electricity and gas	1.3%
14	Recreational activities	0.1%
15	Telecommunications	0.6%
16	Other information technology	0.7%
17	Wholesale and retail trade	4.6%
18	Shipping	1.2%
19	Air transport	0.7%
20	Taxis	0.6%
21	Public light buses	0.1%
22	Other transport and transport equipment	1.1%
23	Hotels, boarding houses and catering	1.0%
24	Financial concerns	8.0%
25	Stockbrokers	0.8%
26	Non-stockbroking companies and individuals for the purchases of shares	0.9%
	Professional and private individuals:-	
27	for the purchase of flats covered by the guarantee issued by the Housing Authority under Home Ownership Scheme, Private Sector Participation Scheme and Tenants Purchase Scheme	0.6%
28	for the purchase of other residential properties	13.1%
29	for credit card advances	1.2%
30	for other business purposes	0.1%
31	for other private purposes	5.0%
32	Other miscellaneous	3.7%
33	Trade financing	5.6%
34	Other loans for use outside Hong Kong	30.0%

Source: HKMA.