



***CORPORATE LOAN PRICING AND COLLATERAL DECISION IN HONG KONG:
EVIDENCE FROM GRANULAR TRANSACTION-LEVEL DATA***

Key points:

- *This study examines the pricing of corporate loans in Hong Kong using a new granular dataset on banks' corporate loan transactions. In particular, we aim to provide an overview of the structure and pricing behaviour of the Hong Kong corporate loan market, as well as to estimate the relationship between loan pricing and firms' collateral decisions.*
- *We find that the Hong Kong corporate loan market can be divided into two segments with very different characteristics based on loan size. In particular, smaller loans tend to have higher interest rate spreads and lower credit quality. To our knowledge, this is the first study in the literature that provides such insight into the HKD corporate loan market.*
- *Using a two-step selectivity-bias adjusted approach, we find that, for secured loans, firms pledge collateral to minimize borrowing costs, which is consistent with the costly contracting hypothesis. However, there are considerable differences in the pricing behaviour of loans referenced to HIBOR versus PRIME rates. In particular, for unsecured HIBOR loans, borrowers would have lowered their cost if they had provided collateral but chose not to, which may be explained by cross-monitoring motives or collateral costs.*

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The views and analysis expressed in this paper are those of the authors, and do not necessarily represent the views of the Hong Kong Monetary Authority.

I. INTRODUCTION

Corporate loans are the most important channel of credit intermediation in terms of size – FSB (2019) estimates that, globally, loan assets amounted to US\$97.2 trillion as at end-2017, accounting for 57% of total credit assets in the global financial system. In Hong Kong, there are over HK\$8 trillion¹ of corporate loans outstanding in the banking sector, which have more than tripled in the past ten years. However, due to a lack of data availability, most of the existing academic literature on corporate loans has focused on the U.S. market and in particular syndicated loans, with little coverage of the wider corporate loan market outside the U.S, including Hong Kong.

This paper fills the gap by studying the pricing of corporate loans in Hong Kong using a new granular dataset on banks’ corporate loan transactions. The dataset covers a wide range of loan characteristics and enables policymakers to conduct more detailed analysis. In particular, this paper attempts to answer two main research questions:

First, what is the structure and pricing behaviour in the Hong Kong corporate loan market? Using granular transaction-level data, we find that the market can be divided into two segments with very different characteristics based on loan size. In particular, smaller loans tend to have higher interest rate spreads and lower credit quality. To our knowledge, this is the first study in the literature that provides such insight into the HKD corporate loan market.

Second, what are the determinants of loan pricing and collateral decisions? Booth and Booth (2006) find that firms choose to pledge collateral to reduce direct borrowing costs from banks, which is consistent with the costly contracting hypothesis by Smith and Warner (1979). Following Booth and Booth (2006) and using a two-step selectivity-bias adjusted approach, we find that, for secured loans, firms pledge collateral to minimize borrowing costs, which is consistent with prior findings in the literature. However, there are considerable differences in the pricing behaviour of loans referenced to HIBOR versus PRIME rates. In particular, for unsecured HIBOR loans, borrowers would have lowered their cost if they had provided collateral but chose not to, which may be explained by cross-monitoring motives or collateral costs. A further step to examine this relationship would call for research that incorporates more refined details on

¹ Roughly a third of total banking sector assets.

borrower and loan characteristics, such as firm’s financial ratios and collateral valuations.

The paper is organised as follows. Section II describes the granular dataset. Section III provides an overview of the HKD corporate loan market and documents a number of stylised facts. Section IV presents results from the regression analysis on loan pricing and collateral decision. Section V concludes.

II. DATA

Our analysis is based on a new regulatory dataset collected under the HKMA Granular Data Reporting (GDR) Project. The GDR project facilitates the regulatory reporting of data by banks on a transaction basis, thereby providing richer data that could be used flexibly by the HKMA to analyse the complex interconnectedness, concentration and distribution of various risks in the financial system.

The dataset used in this paper covers corporate loans of eight pilot banks participating in the initial phase of the GDR project. It is a snapshot of the outstanding positions, i.e. all the corporate loans that remain active on the banks’ books, as at end-August 2019. In terms of coverage, the reporting banks account for roughly 40% of total corporate loans in the Hong Kong banking sector. Given the limited data coverage, results of the paper may only paint an incomplete picture of corporate lending in Hong Kong.

In total, banks reported 343,948 corporate loan transactions in the dataset. For each transaction, more than 150 data fields are reported on the characteristics of the loan, such as pricing, borrower and collateral. Therefore, the full dataset contains more than 50 million data points. While this paper focuses on loan pricing as an initial attempt, there is expected to be a series of studies in the future looking at other aspects of the corporate loan market.

The coverage of our dataset is comprehensive in a number of dimensions compared with those deployed in the literature. As mentioned previously, most of the existing studies on corporate loans focus on the U.S. market and syndicated loans. Studies on non-syndicated corporate loans often utilize databases such as Loan Pricing Corporation’s DealScan and Compustat, focusing

on bank loan agreements between US banks and US non-financial corporations². These datasets contain information on loan characteristics but lacks details on collateral and borrower such as collateral type and borrower’s economic sector. In addition, a few studies use the Survey of Small Business Finances (SSBF) by Federal Reserve Board of Governors, which provides detailed information on the use of financial services by small businesses³. However, the SSBF dataset is only conducted every five years and covers only small businesses with less than five hundred employees in the US. Compared with the above, the GDR dataset used in this study has a wider coverage of corporates and more information on collateral/borrower characteristics, thereby offering a more holistic view of the corporate loan market in Hong Kong.

The next section provides an overview of the corporate loan market in Hong Kong and its pricing behaviour, based on information reported in this dataset. Given the likely structural differences between corporate loans denominated in different currencies, this paper focuses on HKD corporate loans only, which account for 58% of total corporate loans reported in the dataset.

III. MARKET OVERVIEW

There are a total of 206,434 HKD-denominated corporate loans reported in the dataset, with a total outstanding amount of HK\$ 1,840 billion. The transactions vary significantly in size, with transactions below HK\$ 10 million accounting for 90% of total in terms of number of transactions but only 8% in terms of size (see Chart 1 and 2). Chart 3 shows the average maturity of loans by different size, and we can see that loans with size less than HK\$ 10 million have lower average maturity than other loans. This is likely because smaller loans tend to have shorter maturities than larger loans, as many of them are revolving and trade finance loans (see Chart 4) which have short tenor in nature.

² See Booth and Booth (2006) and Gottesman and Roberts (2004)

³ For details on SSBF and the latest survey results in 2003, see Mach, Traci L., et al (2006) and <https://www.federalreserve.gov/pubs/oss/oss3/ssbf03/ssbf03home.html>

Chart 1: % of total outstanding amount by loan size

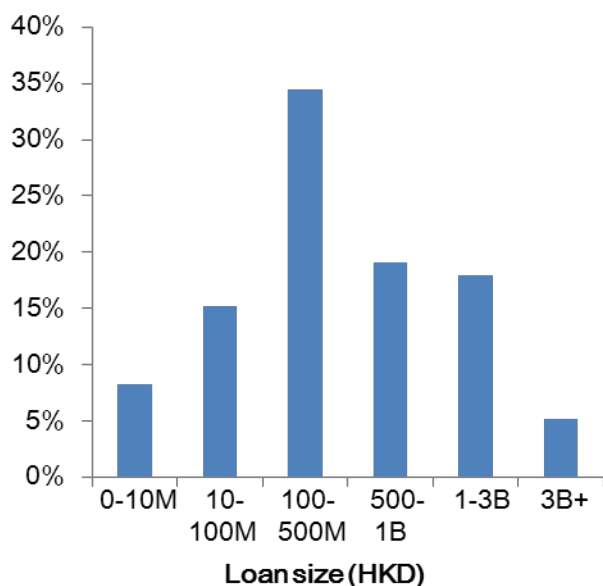
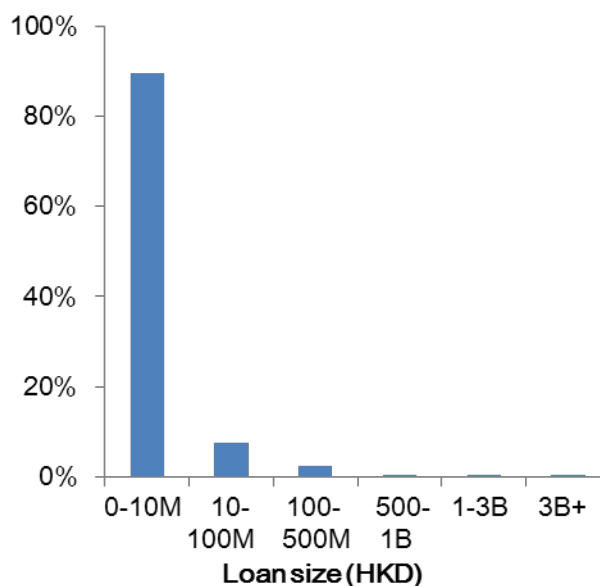


Chart 2: % of total number of loans by loan size



Note: HKD loans only.

Chart 3: Distribution of corporate loans by size and average maturity (months)

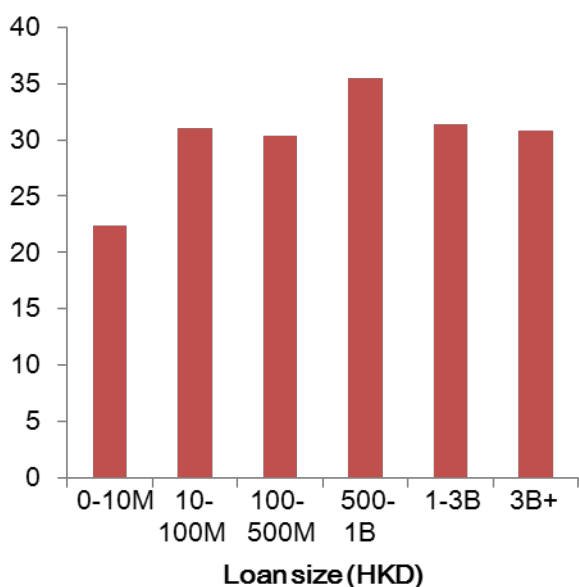
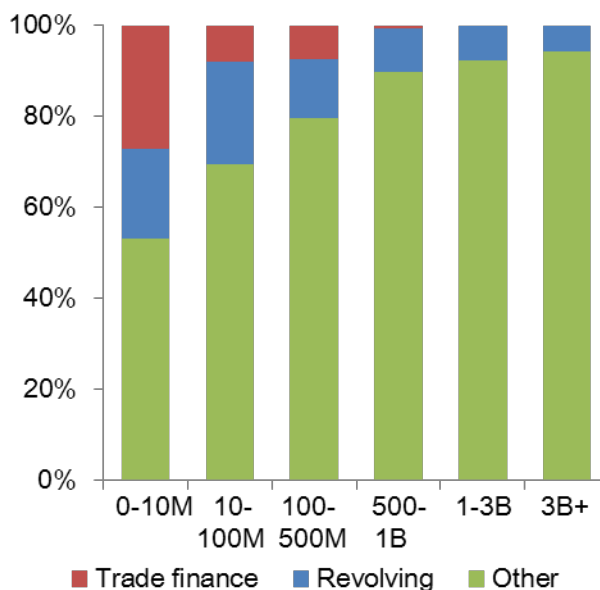


Chart 4: Distribution of loan type by loan size



Note: HKD loans only. % of loans based on outstanding amount. Average maturity is original maturity weighted by loan size. "Other" mainly include term loans, financial leases and mortgage loans.

HKD-denominated corporate loans can be priced on a floating or fixed basis, and floating-rate loans are typically based on two types of reference rates: Hong Kong Interbank Offered Rate (HIBOR) and the PRIME rate (best lending rate). The HIBOR is a benchmark interest rate for lending between banks in

the HKD market, derived from banks’ quotes determined by the Hong Kong Association of Banks (HKAB). In comparison, the PRIME rate is set at banks’ own discretion, although banks typically adjust their PRIME rates infrequently and at the same time. As can be seen from Chart 5, the majority of HKD corporate loans are HIBOR-based, accounting for 87% of total loans, while PRIME-based and fixed-rate loans only account for 3% and 10% respectively. In particular, PRIME-based loans are concentrated in loans with size less than HK\$ 10 million, while larger loans tend to be almost entirely HIBOR-based.

Chart 5: Distribution of loan reference rate by loan size

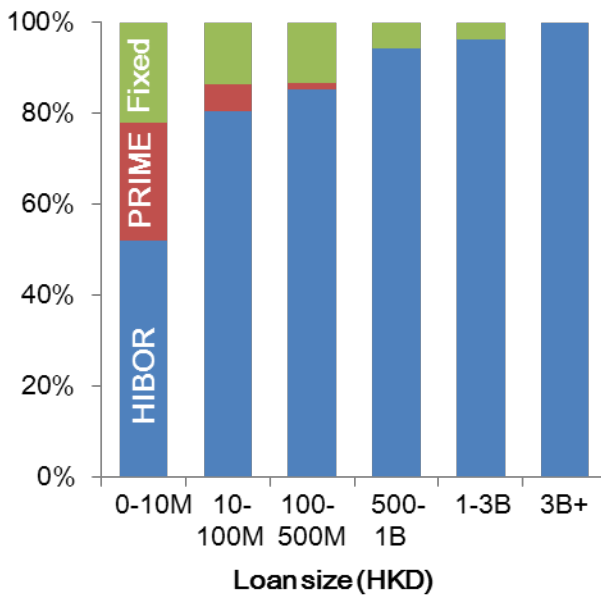
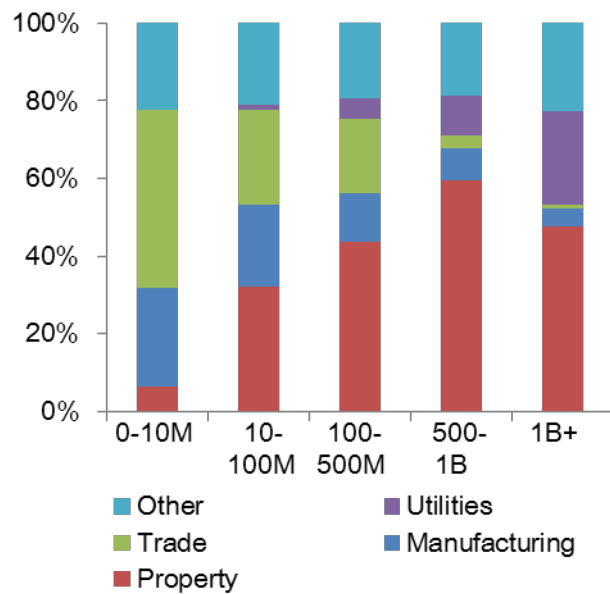


Chart 6: Distribution of borrower economic sector by loan size



Note: HKD loans only. % of loans based on outstanding amount. Trade includes wholesale and retail trade as well as import/export.

Chart 6 shows the distribution of loans by the economic sector of borrowers. Borrowers in manufacturing and trade-related sectors tend to borrow in smaller size, whereas borrowers of larger loans are concentrated in the property and utility sectors.

There is also evidence that loan pricing and loan quality can be driven by both loan size and the economic sector of borrowers. We measure loan pricing by the interest spread of HIBOR-based loans, and loan quality by classified loan ratio, the equivalence of non-performing loan ratio. We find that loans to utilities and property-related borrowers tend to be cheaper and have lower classified loan ratio (Chart 7). We also find that larger loans tend to have lower spread and classified loan ratio, even after removing borrowers in property- and

utilities-related sectors (Chart 8).

The stylized facts above suggest that the HKD corporate loan market can be divided into two segments based on loan size with different characteristics:

- smaller loans: a large number of transactions, shorter maturity, more PRIME-based loans, more borrowers in manufacturing and trade-related sectors, higher loan spreads and higher classified loan ratio;
- larger loans: a small number of transactions, longer maturity, mostly HIBOR-based, more borrowers in the property and utility sectors, lower loan spreads and lower classified loan ratio.

Chart 7: Average spread and classified loan ratio by borrower economic sector

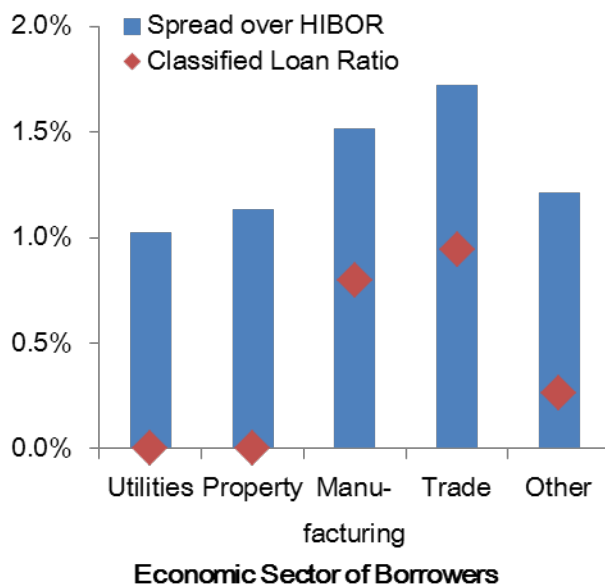
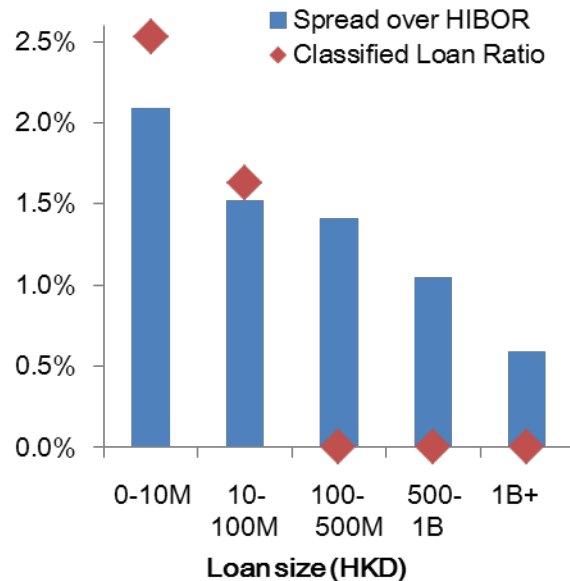


Chart 8: Average spread and classified loan ratio by loan size



Note: HKD loans only. Average spread is spread of HIBOR-based loans weighted by loan size. RHS chart excludes loans to borrowers in property- and utilities-related sectors.

IV. REGRESSION ANALYSIS

In the previous section, we highlight some important features of the HKD corporate loan market. However, we have not yet explored the dimension of collateral, which is also an important factor affecting loan pricing. However, it is difficult to do so using summary statistics given that collateral's impact on loan

pricing can also be influenced by other factors. In this section, we will study borrowers' collateral decisions and use regression analysis to estimate the effect of collateral decisions on firms' borrowing cost.

In terms of data sample, we will focus on HKD-denominated loans with reference to HIBOR or PRIME rates. We exclude syndicated loans, credit card loans, financial leases, overdrafts, trade receivables and residential mortgage loans because these loans have different pricing behaviour from regular revolving and term loans. We also drop transactions where information on maturity, loan size, loan purpose, borrower economic sector and collateral was not reported. The final sample consists of 19,513 corporate loans originated during 1997-2019.

4.1 *Summary Statistics*

Overall, around 90% of loans in our final sample are secured by collateral. This is roughly in line with the findings in the literature on corporate loans in the United States.⁴ Table 1 below shows the summary statistics of the sample, grouped by loans' security status.

Table 1: Sample characteristics of corporate loans originated between 1997 and 2019

	Overall	Secured	Unsecured	% Secured
Number of loans	19513	17571	1942	90.05%
Mean				
Loan size (HKD mns)	22.01	17.92	59.02	
Loan maturity (months)	31.92	30.55	44.29	
Term loan				
Number of loans	5598	5376	222	96.03%
Loan size (HKD mns)	67.98	51.11	476.51	
Loan maturity (months)	45.46	45.72	39.22	
Revolving credit and trade finance				
Number of loans	13920	12199	1721	87.64%
Loan size (HKD mns)	2.46	3.29	5.16	
Loan maturity (months)	26.47	23.86	44.95	
Loan purpose (Number)				
Property purchase	164	138	26	84.15%
Other	5573	5352	221	96.03%
Trade financing	5903	5766	137	97.68%
Unspecified	7872	6316	1556	80.23%
Borrower sector (Number)				
Financials	100	80	20	80.00%
Real estate	1632	1588	44	97.30%

⁴ Related literature has mostly focused on corporate loans in the US obtained through Compustat and LPC Dealscan databases. Booth and Booth (2006) used a sample with 75% secured loans, while other authors such as Hubbard, Kuttner and Palia (2002) reported 85% of their sample to be secured loans.

Utilities	53	16	37	30.19%
Other real economy activities	15951	15094	857	94.63%
Trade financing	1777	793	984	44.63%

It can be observed that term loans are more likely to be secured than revolving credit and trade finance loans. By loan purpose, trade financing loans have the highest percentage of being secured.⁵ By borrower sector, the real estate sector has the highest percentage of secured borrowing, while the utilities sector has the lowest.

Table 2 below provides information on the security status of loans referenced to HIBOR/PRIME rates.⁶ Note that negative loan spreads are common for PRIME loans. For HIBOR loans, secured and unsecured loans have similar average loan spreads, while unsecured loans have much lower spreads for PRIME loans. This could be because PRIME borrowers that are able to borrow unsecured from banks are deemed much more creditworthy than other PRIME borrowers (which are riskier on average than HIBOR borrowers as seen previously).

Table 2: Average loan spreads for sample loans originated between 1997 and 2019

	Overall (N=19513)	Secured (N=17571)	Unsecured (N=1942)
Loan spread (bps)			
<i>Prime</i>			
Number of loans	9277	8541	736
Mean	91	97	26
STDEV	347	353	268
Range	-350-1187	-325-1187	-350-1187
<i>HIBOR</i>			
Number of loans	10241	9034	1207
Mean	246	249	220
STDEV	96	95	104
Range	35-862	35-862	35-700
Type of collateral (Number)			
Pledged financial assets*		2982	
Guarantee**		8294	
Property***		3072	
Other protection		3223	

Note: Loan spreads in bps are calculated for all loans that quote a spread over the reference rate. PRIME rates for some banks are adjusted downwards to account for their lower PRIME rate versus other sample banks.

⁵ This is consistent with the nature of trade finance loans that they tend to be collateralized, e.g. by letters of credit.

⁶ Note that the definition of security status in the paper is somewhat different from the HKMA regulatory definition. Loans covered by guarantees from entities that are not banks or central governments are considered as secured loans in this paper, but not in the regulatory definition (see Supervisory Policy Manual CR-G-7).

*Pledged financial assets include pledged deposits, debt and equity securities, life insurance policies and trade receivables.

**Guarantee include parent/affiliate guarantee and bank guarantee.

***Property include commercial and residential property.

Finally, Table 3 below shows summary statistics of the sample, grouped by reference rate type. It can be observed that HIBOR loans are less likely to be secured than PRIME loans in general, except for trade financing loans. This could be due to the fact that invoice discounting, which uses trade receivables as collateral, is a very common form of trade finance, whereas HIBOR loan borrowers tend to be larger clients and banks have better information about them.

Table 3: Sample characteristics of corporate loans originated between 1997 and 2019, grouped by reference rates of the loan

	HIBOR	% Secured	PRIME	% Secured
Number of loans	10241	88.21%	9277	92.07%
Mean				
Average loan size (HKD mns)	39.46		2.75	
Average loan maturity (months)	23.86		40.81	
Term loan				
Number of loans	3144	94.34%	2454	98.21%
Loan size (HKD mns)	116.10		6.34	
Loan maturity (months)	38.09		54.91	
Revolving credit and trade finance				
Number of loans	7097	85.50%	6823	34.90%
Loan size (HKD mns)	5.50		1.45	
Loan maturity (months)	17.56		35.74	
Loan purpose (Number)				
Property purchase	111	81.08%	53	90.57%
Other	3151	94.35%	2423	98.18%
Trade financing	3054	100.00%	2849	95.19%
Unspecified	3923	74.31%	3951	86.08%
Borrower sector (Number)				
Financials	59	76.27%	41	85.37%
Real estate	1219	96.47%	413	99.76%
Utilities	52	28.85%	1	100.00%
Other real economy activities	8006	92.31%	7945	96.97%
Trade financing	901	44.84%	877	44.24%

Altogether, these findings imply that collateral decision is correlated with the inherent default risk of the loan, which could also affect the borrowing cost. This introduces a selectivity bias problem when estimating regression equations as described in Booth and Booth (2006). Therefore, to determine the effect of collateral on borrowing cost, it is important to control for the interdependence between collateral decision and cost of borrowing. This is explained in the sub-section below.

4.2 *Methodology*

Theoretically, a firm's decision to provide collateral for a loan is affected by the difference between spread⁷ on secured loan (R_{si}) and spread on unsecured loan (R_{ui}), while both spreads are affected by a vector of loan characteristics (L_i) and borrower characteristics (B_i). In particular, borrowing costs for secured and unsecured loans are determined by the equations below:

$$R_{si} = \alpha_{s0} + \alpha_{s1}L_i + \alpha_{s2}B_i + \mu_{si} \quad (1)$$

$$R_{ui} = \alpha_{u0} + \alpha_{u1}L_i + \alpha_{u2}B_i + \mu_{ui} \quad (2)$$

where μ_{si} and μ_{ui} are random residuals assumed to be $N(0, \sigma_s^2)$ and $N(0, \sigma_u^2)$. However, given the interdependence between borrowing costs and collateral decision, the OLS estimation of Eq (1) and (2) will be biased. That is, corporate borrowers would self-select themselves into secured borrowing or unsecured borrowing, depending on their risk characteristics. This selection process is not observable to us.

To mitigate this issue, we use a Heckman two-step model to obtain a consistent and unbiased estimation of borrowing cost equations. The first step involves estimating a Probit model on the probability of securing the loan. Then in step two, it is possible to estimate the borrowing cost equations conditional on the choice of securing the loan, using a selectivity-bias adjustment term (also known as the Inverse Mills ratio) calculated from the first step. Appendix 1 provides further details on this.

The Inverse Mills Ratios measure the probability of borrower's decision to secure the loan, conditional on observable borrower and loan characteristics (Table 4). A significant coefficient indicates that borrowing costs are affected by the decision to secure the loan, thereby confirming the existence of a selectivity bias. The sign of the coefficient determines the direction of the bias, i.e. a negative coefficient means that provision of collateral is associated with lower borrowing costs, and vice versa.

⁷ Spreads refer to the interest rate margin over the benchmark rate of the floating rate loan.

Table 4: Loan and borrower characteristic variables

Variable name	Definition	Formula
Vector Li		
Ln_Amount	Natural log of loan size	=Ln (loan size)
Ln_Maturity	Natural log of loan maturity	=Ln (loan maturity)
Type_term	Dummy variable for term loan	=1 if loan is a term loan, 0 otherwise
PRIME	Dummy variable for PRIME reference loans	=1 if loan uses PRIME rate as reference rate, 0 otherwise
Purpose_property purchase	Dummy variable for loans with property purchase purpose	=1 if loan purpose is property purchase, 0 otherwise
Purpose_Other	Dummy variable for loans with other purposes	=1 if loan purpose is specified as other purposes, 0 otherwise
Ln_INTBPS	Natural log of 500 basis points plus loan spread relative to reference rate in basis points (to mitigate negative values, i.e. -350 bps, which refers to loan spread 350 bps below reference rate, would be calculated as natural log of (-350 bps+500 bps)	=Ln (interest spread + 500 bps)
Collateral_pledged financial asset	Dummy variable for loans with financial assets as collateral, including deposits, debt and equity securities, life insurance policies and trade receivables.	=1 if loan collateral type is deposits, debt and equity securities, life insurance policies and trade receivables, 0 otherwise
Collateral_guarantee	Dummy variable for loans with guarantee as collateral, including parent/affiliate guarantee and bank guarantee	=1 if loan collateral type is parent/affiliate guarantee or bank guarantee, 0 otherwise
Collateral_property	Dummy variable for loans with property as collateral, including commercial and residential property	=1 if loan collateral type is commercial or residential property, 0 otherwise
Vector Bi		
Sector_Financial	Dummy variable for loans with borrower sector in financials	=1 if loan borrower belongs to financial sector, 0 otherwise
Sector_Utilities	Dummy variable for loans with borrower sector in utilities	=1 if loan borrower belongs to utilities sector, 0 otherwise
Sector_Real estate	Dummy variable for loans with borrower sector in real estate	=1 if loan borrower belongs to real estate sector, 0 otherwise
Borrower_private and partnership	Dummy variable for loans with borrower entity being sole proprietorship, partnership and private companies	=1 if loan borrower is sole proprietorship, partnership or private companies, 0 otherwise

4.3 Results (Step One)

Table 5 below provides the estimated coefficients from the Probit model in the first step of the model. The significance of coefficients and marginal effects indicates that most of the borrower and loan characteristics variables have an impact on the decision of pledging collateral.

**Table 5: Reduced-form Probit estimates of loan security status
(Dependent variable =1 if loan is secured)**

Independent variable	Coefficient	Marginal effect
Ln_Maturity	-0.048*** (0.01)	-0.006*** (0.00)
Ln_Amount	0.054*** (0.01)	0.006*** (0.00)
Type_term	0.827*** (0.05)	0.097*** (0.01)
Purpose_property purchase	0.518*** (0.13)	0.061*** (0.02)
Purpose_Trade	1.118*** (0.04)	0.131*** (0.00)
PRIME	0.401*** (0.03)	0.047*** (0.00)
Borrower_private and partnership	1.169*** (0.04)	0.137*** (0.01)
Sector_Financial	-0.536*** (0.15)	-0.063*** (0.02)
Sector_Utilities	-1.932*** (0.20)	-0.226*** (0.02)
Sector_Real estate	0.208*** (0.08)	0.024*** (0.01)
Intercept	-0.963*** (0.16)	
Pseudo R-squared	0.225	
No. of obs	19513	

Note: ***, **, and * denotes statistically significant at the 0.01, 0.05 and 0.10 levels, respectively. Standard errors in parentheses. Marginal effects are calculated at means. For binary independent variables, say d , marginal effect is calculated as $\text{Prob}[Y=1|x^*, d=1] - \text{Prob}[Y=0|x^*, d=0]$, where Y is the binary dependent variable and x^* is the mean of all other independent variables in the model.

Ln_Maturity is the natural log of loan tenor in months. Ln_Amount is the natural log of loan size in Hong Kong Dollar. Type_term is a binary variable that equals 1 if the loan is a term loan, and 0 otherwise. Purpose_property purchase is a binary variable that equals 1 if the loan purpose is commercial or residential real estate purchase, and 0 otherwise. Purpose_Trade is a binary variable that equals 1 if the loan purpose is trade financing, and 0 otherwise. PRIME is a binary variable that equals 1 if the loan is indexed to PRIME rate, and 0 otherwise. Borrower_private and partnership is a binary variable that equals 1 if the borrower is an individual, sole proprietorship or partnership, and 0 otherwise. Sector_Financial is a binary variable that equals 1 if the borrower is in financial industry, and 0 otherwise. Sector_Utilities is a binary variable that equals 1 if the borrower is in utility industry, and 0 otherwise. Sector_Real estate is a binary variable that equals 1 if the borrower is in real estate industry, and 0 otherwise.

The negative and significant coefficient for *Ln_Maturity* suggests that an increase in loan maturity will lower the probability of the loan being secured. The positive and significant coefficient for *Ln_Amount* indicates that loans larger in

size are more likely to be secured. The variable for term loan *Type_term* is positive and significant at 1%, meaning that term loans are more likely to be secured than other loans. PRIME-based loans are also more likely to be secured than HIBOR-based loans.

In terms of loan and borrower characteristics, loans with the purpose of property purchase (*Purpose_property purchase*) and trade (*Purpose_trade*) are all more likely to be secured than other loans.⁸ Borrowers that are individuals or partnerships are also more likely to provide collateral for their loans, possibly due to their higher default risk comparing to public companies. In terms of sector, borrowers from utilities and financial sectors are less likely to provide collateral while borrowers from the real estate sector are more likely to provide collateral.

4.4 *Results (Step Two)*

Table 6 below shows estimated coefficients of borrowing cost equations for HIBOR and PRIME loans, grouped by loans' security status. Inverse Mills ratios, calculated from the Probit model in step one, are included in the estimation as adjustments for selectivity bias.

Results show that borrower and loan characteristics affect borrowing costs of HIBOR- and PRIME-based loans somewhat differently. In terms of maturity (*Ln_Maturity*), longer maturity would lead to higher borrowing costs for both secured and unsecured HIBOR loans, but the opposite for PRIME loans. A possible explanation is that, given most PRIME borrowers have high credit risk, those PRIME borrowers that are able to borrow loans with a long maturity tend to have much lower credit risk than other PRIME borrowers and hence can enjoy a lower credit spread.

⁸ This is consistent with the nature of property purchase loans and trade finance loans that they tend to be collateralized with property collateral and bank guarantees respectively.

Table 6: Selectivity-bias-adjusted estimate of loan spread
Dependent variable: Natural log of loan spread over respective reference rate

Independent variable	HIBOR		PRIME	
	Secured (N = 9026)	Unsecured (N = 1207)	Secured (N = 8541)	Unsecured (N = 735)
Ln_Maturity	0.006*** (0.00)	0.004 (0.00)	-0.067** (0.00)	-0.050*** (0.01)
Ln_Amount	-0.025*** (0.00)	-0.025* (0.00)	-0.096*** (0.00)	-0.061*** (0.01)
Type_term	-0.047*** (0.01)	0.116** (0.05)	-0.267*** (0.11)	-0.579*** (0.07)
Purpose_property purchase	-0.069*** (0.01)	0.045 (0.03)	-0.362*** (0.09)	-0.395*** (0.15)
Purpose_Other	-0.039*** (0.01)		-0.296** (0.09)	
Borrower_private and partnership	-0.154*** (0.01)	0.164*** (0.06)	-2.486*** (0.09)	-0.500*** (0.06)
Sector_Financial	0.017*** (0.02)	-0.066*** (0.03)	1.242*** (0.10)	-0.259*** (0.08)
Sector_Uilities	0.269*** (0.03)	-0.279*** (0.08)	2.796*** (0.09)	
Sector_Real estate	-0.083*** (0.00)	0.022 (0.02)	-0.246*** (0.01)	-0.704*** (0.07)
Collateral_pledged financial asset	0.050*** (0.00)		0.005 (0.02)	
Collateral_guarantee	0.039*** (0.00)		-0.081*** (0.02)	
Collateral_property	-0.008*** (0.00)		-0.073*** (0.01)	
Inverse Mills ratio	-0.350*** (-0.02)	-0.171*** (0.07)	-4.722*** (0.13)	0.691*** (0.06)
Intercept	7.182*** (0.02)	7.017*** (0.04)	10.867*** (0.11)	6.383*** (0.14)
R-squared	0.554	0.311	0.799	0.467
RMSE	0.087	0.110	0.269	0.282

Note: ***, **, and * denotes statistically significant at the 0.01, 0.05 and 0.10 levels, respectively. White's heteroskedasticity-consistent standard errors in parentheses.

Ln_Maturity is the natural log of loan tenor in months. Ln_Amount is the natural log of loan size in Hong Kong Dollar. Type_term is a binary variable that equals 1 if the loan is a term loan, and 0 otherwise. Purpose_property purchase is a binary variable that equals 1 if the loan purpose is commercial or residential real estate purchase, and 0 otherwise. Purpose_Trade is a binary variable that equals 1 if the loan purpose is trade financing, and 0 otherwise. PRIME is a binary variable that equals 1 if the loan is indexed to PRIME rate, and 0 otherwise. Borrower_private and partnership is a binary variable that equals 1 if the borrower is an individual, sole proprietorship or partnership, and 0 otherwise. Sector_Financial is a binary variable that equals 1 if the borrower is in financial industry, and 0 otherwise. Sector_Uilities is a binary variable that equals 1 if the borrower is in utility industry, and 0 otherwise. Sector_Real estate is a binary variable that equals 1 if the borrower is in real estate industry, and 0 otherwise. Collateral_pledged financial asset is a binary variable that equals 1 if pledged collateral is deposits, debt and equity securities, life insurance policies or trade receivables, and 0 otherwise. Collateral_guarantee is a binary variable that equals 1 if collateral is parent/affiliate guarantee or bank guarantee, and 0 otherwise. Collateral property is a binary variable that equals 1 if pledged collateral is commercial/residential real estate, and 0 otherwise. Inverse Mills Ratio is calculated from the Probit model estimated in Table 5.

Another variable that affects HIBOR and PRIME loans differently is guarantee as collateral for secured loans. As suggested by coefficients for *Collateral_guarantee*, HIBOR loans that have guarantee as collateral would have higher spreads, while the reverse is true for PRIME loans. This difference could be explained by the different characteristics of HIBOR and PRIME loan borrowers. HIBOR loans, which tend to be larger in size, are mostly extended to more creditworthy borrowers. As suggested by Berger and Udell (1998), guarantee is a weaker form of collateral than pledged assets and thus could be associated with higher default risks, especially for HIBOR borrowers that may have other pledge-able financial assets. For PRIME loans, which tend to be smaller in size, they are usually offered to smaller borrowers such as small and medium-sized enterprises (SMEs). Empirically, it is common practice for loans extended to SMEs to be secured by guarantee, as SMEs often do not have sufficient assets to serve as collateral.⁹ According to studies by Berger and Udell (1998), around 60% of loans extended to SMEs are secured by guarantees.

Other factors tend to have similar effects on borrowing costs for both HIBOR and PRIME loans. For example, a larger loan size is associated with lower borrowing costs, and loans secured by property tend to have lower spreads, for both secured and unsecured loans. This is intuitive because borrowers of larger loans and loans with property collateral could be considered to have lower credit risk.

Coefficients of Inverse Mills Ratio are significant at 99% confidence interval for all regressions, suggesting the existence of selectivity bias mentioned previously. For secured loans, coefficients of Inverse Mills Ratio are negative for both HIBOR and PRIME indexed loans, implying that the decision to pledge collateral lowers borrowing costs for such loans. This supports the view that collateral can be used to lower credit risk and lower borrowing costs, often referred to as the costly contracting hypothesis by Smith and Warner (1979). For unsecured loans, the coefficient of Inverse Mills Ratio is positive for PRIME loans, suggesting that the decision to pledge collateral will result in higher borrowing costs. This suggests that high-quality firms tend to borrow unsecured loans as they are not able to further reduce their loans spreads by pledging collateral, which is consistent with the findings of Booth and Booth (2006). However, for unsecured HIBOR loans, the

⁹ Often, banks would require personal guarantees from SME owners with potentially unlimited liability. This can be considered to be better credit protection compared with guarantees from subsidiaries (which is common in the case of large corporates borrowing HIBOR-based loans).

coefficient of Inverse Mills Ratio is negative, indicating that these borrowers would have lowered borrowing cost if they had pledged collateral. This finding may be explained by a number of factors. One possible explanation, as pointed out by Booth and Booth (2006), is the cross-monitoring hypothesis suggested by Booth (1992) that firms may have incentives to pay a higher spread and borrow unsecured loans, as unsecured borrowing requires more general monitoring from the lender that could provide more useful information about the borrower to other creditors. Another possible explanation is that, given it can be costly to pledge collateral (see, for example, Chan and Kanatas (1985)), borrowers may not find it optimal to pledge collateral if the collateral costs outweigh the potential reduction in loan spread, which tends to be much smaller for HIBOR loans as can be seen from the magnitudes of the Inverse Mills Ratio coefficients.

Again, the different nature of selectivity-bias for HIBOR and PRIME-based unsecured loans, as demonstrated by different signs of Inverse Mills Ratio coefficients, can be explained by the characteristics of the two market segments. For PRIME unsecured loans, those borrowers that are able to borrow unsecured would already be much more creditworthy than other PRIME borrowers, and hence it may not be necessary for these firms to provide collateral. For HIBOR unsecured loans, as most of these borrowers often have better access to funding markets and enjoy more bargaining power, it might be sensible for them to intentionally choose unsecured borrowing if the potential benefit of pledging collateral is limited.

4.5 Robustness Checks

In addition to the selectivity-adjusted model described above, we also estimated a simple OLS regression model without adjusting for selectivity bias. We found that selectivity-bias adjusted models outperform OLS models based on all three goodness-of-fit measures (R-squared, RMSE and AIC). See Appendix 2 for details.

We also estimated borrowing cost equations in a single regression, rather than estimating borrowing cost for HIBOR and PRIME loans separately, using a dummy variable for PRIME loans. Overall, results stayed similar to those presented in Table 6. See Appendix 3 for details.

To mitigate the influence of outliers in the sample, a further

robustness check is conducted using a winsorized sample at 90%. This approach sets data below the 5th percentile to data value at the 5th percentile and data above the 95th percentile to data value at the 95th percentile. The two-step selectivity-bias adjusted regression is carried out and produced statistically similar results to those of Table 5 and 6. Specifically, coefficients of Inverse Mills Ratio have the same sign and significance as those in Table 6, confirming the presence of a selectivity bias. Regression results for the winsorized sample are available upon request.

V. CONCLUSION

This paper studies the pricing of corporate loans in Hong Kong using a new granular dataset on banks' corporate loan transactions. We document a number of stylised facts about the HKD corporate loan market, and find that the market can be divided into two segments with very different characteristics based on loan size. In particular, smaller loans tend to have higher interest rate spreads and lower credit quality. To our knowledge, this is the first study in the literature that provides such insight into the HKD corporate loan market.

We then use regression analysis to examine the relationship between borrowing cost and the decision of providing collateral. We use a two-step selectivity-bias adjusted approach to correct for the interdependence between collateral decision and borrowing costs. We find that, for secured loans, firms pledge collateral to minimize borrowing costs, which is consistent with prior findings in the literature. However, there are considerable differences in the pricing behaviour of loans referenced to HIBOR versus PRIME rates. In particular, for unsecured HIBOR loans, borrowers would have lowered their cost if they had provided collateral but chose not to, which may be explained by cross-monitoring motives or collateral costs. A further step to examine this relationship would call for research that incorporates more refined details on borrower and loan characteristics, such as firm's financial ratios and collateral valuations.

APPENDIX 1: FURTHER DETAILS ON THE TWO-STEP MODEL

We use a two-step selectivity-bias-adjusted model developed by Heckman (1976) to address the simultaneity issue arising from potential interdependence between borrowing costs and collateral decision. The formalized model, following the approach in Booth and Booth (2006), will be explained in the following paragraphs.

Theoretically, a firm's decision to provide collateral for a loan is affected by the difference between spread on secured loan (R_{si}) and spread on unsecured loan (R_{ui}), while both spreads are affected by a vector of loan characteristics (L_i) and borrower characteristics (B_i). The decision process (selection equation) can be formalized by the Probit model below:

$$C_i = b_0 + b_1(R_{si} - R_{ui}) + b_2L_i + b_3B_i + \epsilon_i \quad (1)$$

where C_i is the probability of the loan being secured.

In the meantime, borrowing costs for secured and unsecured loans are determined by the equations below:

$$R_{si} = \alpha_{s0} + \alpha_{s1}L_i + \alpha_{s2}B_i + \mu_{si} \quad (2)$$

$$R_{ui} = \alpha_{u0} + \alpha_{u1}L_i + \alpha_{u2}B_i + \mu_{ui} \quad (3)$$

where μ_{si} and μ_{ui} are random residuals assumed to be $N(0, \sigma_s^2)$ and $N(0, \sigma_u^2)$. Equation (2) and (3) cannot be estimated directly due to the interdependence between Eq (1) and (2), and Eq (1) and (3), since the interdependence leads to correlation between μ_{si} and μ_{ui} and ϵ_i in the selection equation. Thus, μ_{si} and μ_{ui} are correlated with variables in the vector of loan characteristics L_i and borrower characteristics B_i , rendering an OLS estimation of Eq (2) and (3) biased.

To put this interdependence into empirical setting, this implies that corporate borrowers would self-select themselves into secured borrowing or unsecured borrowing, depending on their risk characteristics. This selection process

is not observable to us, as we could only observe the final result of borrowers borrowing secured or unsecured. It could be the case that certain unobservable borrower characteristics (for example, management skills and risk appetite of corporates) affect the likelihood of providing collateral. This unobservable borrower characteristic would be left into the residual of Eq (2) and (3) since they are not included in vector L_i and B_i . Arguably, these unobservable borrower characteristics such as management skills and risk appetite of firms are correlated with observable firm and loan characteristics in vector L_i and B_i . This would lead to residuals μ_{si} and μ_{ui} to be correlated with variables in L_i and B_i , resulting in a biased OLS estimation.

To mitigate this issue, this study uses a Heckman two-step model to obtain a consistent and unbiased estimation of borrowing cost equations. The first step involves estimating a Probit model on the probability of securing the loan:

$$C_i = \delta_0 + \delta_1 L_i + \delta_2 B_i + \epsilon_i \quad (4)$$

where L_i and B_i are vectors that include all observable characteristics of the loan and the borrower. C_i is a binary variable which equals 1 if the loan is secured with collateral, and equals 0 otherwise.

Then it is possible to estimate the borrowing cost equations conditional on the choice of securing the loan, using a selectivity-bias adjustment term (also known as the Inverse Mills ratio) calculated from equation (4). Let $\Psi_i = \delta_0 + \delta_1 L_i + \delta_2 B_i$ and $F(\Psi_i)$ be the cumulative distribution function of Ψ_i , and $f(\Psi_i)$ be the probability density function of Ψ_i , which follows a standard normal distribution. Then, the borrowing cost equation conditional on the loan being secured (Eq (2)) becomes:

$$R_{si} = \alpha_{s0} + \alpha_{s1} L_i + \alpha_{s2} B_i + \sigma_{1e} * \left(\frac{f(\Psi_i)}{F(\Psi_i)} \right) + \eta_{si} \quad (5)$$

The borrowing cost equation conditional on the loan not being secured (Eq (3)):

$$R_{ui} = \alpha_{u0} + \alpha_{u1} L_i + \alpha_{u2} B_i + \sigma_{2e} * \left(\frac{f(\Psi_i)}{1 - F(\Psi_i)} \right) + \eta_{ui} \quad (6)$$

where η_{si} and η_{ui} are $E(\eta_{si}|C_i = 1) = 0$ and $E(\eta_{ui}|C_i = 0) = 0$.

The selectivity-bias adjustment terms, $\frac{f(\Psi_i)}{F(\Psi_i)}$ and $\frac{f(\Psi_i)}{1-F(\Psi_i)}$, also called the Inverse Mills Ratios, measure the probability of borrower's decision to secure the loan, conditional on firm's and loan's observable characteristics and security condition of the loan.

After the selection-bias adjusted process above, Equation (5) and (6) can be used to obtain unbiased estimations of borrowing cost for secured and unsecured loans. It also allows for predicting expected borrowing cost if different collateral decisions were made for the loan. If coefficient of the Inverse Mills Ratio is negative for estimation in the unsecured loan group, it would be reasonable to state that holding other loan and borrower characteristics constant, had the borrower pledged collateral, his borrowing cost would be lower. Alternatively, a positive coefficient for the unsecured loan estimation would suggest that holding other things constant, had the borrower pledged collateral, his borrowing cost would in fact be higher. In other words, providing collateral would not have reduced the corporate's borrowing cost under such scenario.

APPENDIX 2: PERFORMANCE COMPARISON WITH SIMPLE OLS MODELS

Results from Table 6 are used to obtain fitted values for borrowing costs of secured and unsecured lending from the selectivity-adjusted model. Another simple OLS regression model is also estimated without adjusting for selectivity bias. To compare performance and goodness of fit of the two models in predicting borrowing costs, root mean squared errors (RMSE) and Akaike Information Criterion (AIC) are calculated for both selectivity-adjusted model and OLS model.

Table 7 below shows the estimated coefficients for OLS and selectivity-adjusted models for borrowing cost, with HIBOR and PRIME being the respective reference rate. It can be observed that for all three goodness-of-fit measures (R-squared, RMSE and AIC), selectivity-bias adjusted models outperform OLS models in prediction accuracy.

For all regressions, the selectivity-bias adjusted models have a lower RMSE, lower AIC and higher R-squared than OLS models, indicating a better prediction of borrowing costs for different borrowers and collateral status. Differences in values and significance of regression coefficients in OLS and selectivity-bias adjusted models also suggest that simple OLS regressions suffer from selectivity bias, which is mitigated by the inclusion of Inverse Mills Ratio in selectivity-bias adjusted models.

Table 7: OLS and Selectivity-bias-adjusted models' estimate of loan spread for secured and unsecured loans
Dependent variable: Natural log of loan spread over respective reference rate

Independent variable	HIBOR				PRIME			
	Secured (N = 9026)		Unsecured (N = 1207)		Secured (N = 8541)		Unsecured (N = 735)	
	OLS	Selection-bias adjusted	OLS	Selection-bias adjusted	OLS	Selection-bias adjusted	OLS	Selection-bias adjusted
Ln_Maturity	-0.000 (0.00)	0.006*** (0.00)	0.004 (0.00)	0.004 (0.00)	-0.130*** (0.00)	-0.067*** (0.00)	0.020** (0.01)	-0.050*** (0.01)
Ln_Amount	-0.023*** (0.00)	-0.025*** (0.00)	-0.025*** (0.00)	-0.025*** (0.00)	-0.090*** (0.00)	-0.096*** (0.00)	-0.106*** (0.01)	-0.061*** (0.01)
Type_term	-0.052*** (0.02)	-0.047*** (0.01)	0.116** (0.05)	0.116** (0.05)	0.129 (0.10)	-0.267*** (0.11)	-0.237*** (0.06)	-0.579*** (0.07)
Purpose_property purchase	0.007 (0.01)	-0.069*** (0.01)	0.045 (0.03)	0.045 (0.03)	0.127 (0.09)	-0.362*** (0.09)	-0.229** (0.12)	-0.395*** (0.15)
Purpose_Other	-0.025 (0.02)	-0.039*** (0.01)			-0.536*** (0.10)	-0.296** (0.09)		
Borrower_private and partnership	0.044*** (0.01)	-0.154*** (0.01)	0.164*** (0.06)	0.164*** (0.06)	0.249*** (0.02)	-2.486*** (0.09)	0.138*** (0.03)	-0.500*** (0.06)
Sector_Financial	-0.022 (0.01)	0.017*** (0.02)	-0.066*** (0.03)	-0.066*** (0.03)	0.341*** (0.08)	1.242*** (0.10)	-0.277*** (0.08)	-0.259*** (0.08)
Sector_Utilities	-0.003 (0.02)	0.269*** (0.03)	-0.279*** (0.08)	-0.279*** (0.08)	-0.517*** (0.01)	2.796*** (0.09)		
Sector_Real estate	-0.069*** (0.00)	-0.083*** (0.00)	0.022 (0.02)	0.022 (0.02)	-0.165*** (0.02)	-0.246*** (0.01)	-0.525*** (0.06)	-0.704*** (0.07)
Collateral_pledged financial asset	0.125*** (0.00)	0.050*** (0.00)			0.476*** (0.02)	0.005 (0.02)		
Collateral_guarantee	0.118*** (0.00)	0.039*** (0.00)			0.482*** (0.02)	-0.081*** (0.02)		
Collateral_property	-0.010*** (0.00)	-0.008*** (-3.23)			-0.159*** (0.02)	-0.073*** (0.01)		
Inverse Mills ratio		-0.350***				-4.722***		0.691***
Intercept	6.859*** (0.01)	7.182*** (0.02)	7.489*** (0.13)	7.489*** (0.13)	7.340*** (0.06)	10.867*** (0.11)	6.383*** (0.14)	6.383*** (0.14)
R-squared	0.524	0.554	0.311	0.311	0.646	0.799	0.242	0.467
RMSE	0.090	0.087	0.110	0.110	0.357	0.269	0.336	0.282
AIC	-18415.771	-17825.291	-1895.239	-1895.239	6678.299	1827.059	486.875	230.381

Note: ***, **, and * denotes statistically significant at the 0.01, 0.05 and 0.10 levels, respectively. White's heteroskedasticity-consistent standard errors in parentheses. AIC (Akaike Information Criterion) is an estimator of prediction error for models, for which an algebraically smaller value would represent a better goodness of fit for models. RMSE (root mean squared errors) is a measure of predictive accuracy, with a value close to 0 representing better model fit.

Ln_Maturity is the natural log of loan tenor in months. Ln_Amount is the natural log of loan size in Hong Kong Dollar. Type_term is a binary variable that equals 1 if the loan is a term loan, and 0 otherwise. Purpose_property purchase is a binary variable that equals 1 if the loan purpose is commercial or residential real estate purchase, and 0 otherwise. Purpose_Trade is a binary variable that equals 1 if the loan purpose is trade financing, and 0 otherwise. PRIME is a binary variable that equals 1 if the loan is indexed to PRIME rate, and 0 otherwise. Borrower_private and partnership is a binary variable that equals 1 if the borrower is an individual, sole proprietorship or partnership, and 0 otherwise. Sector_Financial is a binary variable that equals 1 if the borrower is in financial industry, and 0 otherwise. Sector_Utilities is a binary variable that equals 1 if the borrower is in utility industry, and 0 otherwise. Sector_Real estate is a binary variable that equals 1 if the borrower is in real estate industry, and 0 otherwise. Collateral_pledged financial asset is a binary variable that equals 1 if pledged collateral is deposits, debt and equity securities, life insurance policies or trade receivables, and 0 otherwise. Collateral_guarantee is a binary variable that equals 1 if collateral is parent/affiliate guarantee or bank guarantee, and 0 otherwise. Collateral_property is a binary variable that equals 1 if pledged collateral is commercial/residential real estate, and 0 otherwise. Inverse Mills Ratio is calculated from the Probit model estimated in Table 5.

APPENDIX 3: TWO-STEP ESTIMATION IN A SINGLE POOLED REGRESSION

Instead of estimating borrowing cost for HIBOR and PRIME indexed loans separately, this section combines estimation equations into a single pooled regression, using a dummy variable *PRIME* which equals 1 if the underlying loan uses PRIME rate as the reference rate and 0 otherwise. Table 8 below shows the results of the step two regressions for secured and unsecured loans, including the Inverse Mills ratios.

Overall results are similar to those of Table 6. The negative and significant coefficient of variable *PRIME* in both secured and unsecured regressions implies that loans with PRIME as reference rate have lower borrowing costs comparing to an otherwise identical HIBOR-indexed loan. The negative coefficient of variable *Ln_Maturity* for secured regression suggests that longer maturity loans would have a lower borrowing cost, a result that is different from that of Table 6 where longer maturity loans have higher borrowing cost for HIBOR-indexed loans.

Coefficient of the Inverse Mills Ratio is significantly negative for the secured regression and significantly positive for the unsecured regression. This indicates that for secured borrowers, the choice of pledging collateral lowered their borrowing costs, while the choice of providing collateral would not have lowered borrowing costs for unsecured borrowers. This is in line with the costly contracting hypothesis that companies would choose to provide collateral to minimize their borrowing costs. Pooled regression results in Table 8 also suggest that for those firms that choose to borrow unsecured, they would not be able to reduce their borrowing cost by pledging collateral.

Table 8: Selectivity-bias-adjusted estimate of loan spread
Dependent variable: Natural log of loan spread over respective reference rate

Independent variable	Secured (N = 17571)	Unsecured (N = 1942)
Ln_Maturity	-0.095*** (0.00)	-0.002 (0.00)
Ln_Amount	-0.037*** (0.00)	-0.053*** (0.00)
Type_term	-0.327*** (0.04)	-0.419*** (0.04)
PRIME	-0.480*** (0.01)	-0.711*** (0.02)
Purpose_property purchase	0.106*** (0.03)	-0.264*** (0.04)
Purpose_Other	0.089*** (0.04)	
Borrower_private and partnership	-0.600** (0.03)	-0.439*** (0.04)
Sector_Financial	0.301*** (0.04)	0.077 (0.08)
Sector_Utilities	1.182*** (0.09)	0.780*** (0.07)
Sector_Real estate	-0.022*** (0.01)	-0.092** (0.04)
Collateral_pledged financial asset	0.134*** (0.01)	
Collateral_guarantee	0.133*** (0.01)	
Collateral_property	-0.033*** (0.01)	
Inverse Mills ratio	-1.250*** (0.05)	0.601*** (0.05)
Intercept	8.124*** (0.06)	6.969*** (0.05)
R-squared	0.577	0.579
RMSE	0.310	0.208

Note: ***, **, and * denotes statistically significant at the 0.01, 0.05 and 0.10 levels, respectively. White's heteroskedasticity-consistent standard errors in parentheses.

Ln_Maturity is the natural log of loan tenor in months. Ln_Amount is the natural log of loan size in Hong Kong Dollar. Type_term is a binary variable that equals 1 if the loan is a term loan, and 0 otherwise.

Purpose_property purchase is a binary variable that equals 1 if the loan purpose is commercial or residential real estate purchase, and 0 otherwise. Purpose_Trade is a binary variable that equals 1 if the loan purpose is trade financing, and 0 otherwise. PRIME is a binary variable that equals 1 if the loan is indexed to PRIME rate, and 0 otherwise. Borrower_private and partnership is a binary variable that equals 1 if the borrower is an individual, sole proprietorship or partnership, and 0 otherwise. Sector_Financial is a binary variable that equals 1 if the borrower is in financial industry, and 0 otherwise. Sector_Utilities is a binary variable that equals 1 if the borrower is in utility industry, and 0 otherwise. Sector_Real estate is a binary variable that equals 1 if the borrower is in real estate industry, and 0 otherwise. Collateral_pledged financial asset is a binary variable that equals 1 if pledged collateral is deposits, debt and equity securities, life insurance policies or trade receivables, and 0 otherwise. Collateral_guarantee is a binary variable that equals 1 if collateral is parent/affiliate guarantee or bank guarantee, and 0 otherwise. Collateral_property is a binary variable that equals 1 if pledged collateral is commercial/residential real estate, and 0 otherwise. Inverse Mills Ratio is calculated from the Probit model estimated in Table 5. Detailed formulas for Inverse Mills Ratio can be found in Section 3.1

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