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Do interbank interest rates reflect the financial soundness of borrowing banks?

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Do Interbank Interest Rates Reflect the Financial Soundness of Borrowing Banks?

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ABSTRACT *Uganda has a vibrant interbank market in which most commercial banks participate regularly, mostly in the overnight market. This paper investigates the factors driving the prices paid by individual banks to borrow on the interbank market, using panel data regression on quarterly data of commercial bank's balance sheets and income statements over the period 2011Q4 - 2016Q1. Our results indicate that the bank's financial soundness indicators (FSIs) have an influence on the price paid by a bank to borrow; a bank with weaker FSIs pays more to borrow than a bank with stronger FSIs. We also find that the volume of demand for interbank funds, by each individual bank, relative to its size in the banking market, raises the costs of borrowing, and that in general, 'big' and 'internationally-affiliated' banks incur a lower cost of interbank funds while 'small banks suffer higher rates. These results suggest that interest rate spreads, around the average market rate, in the interbank market contains information about market perceptions of counterparty risk. Therefore, by monitoring the spreads paid by banks in the interbank market, bank supervisors could obtain useful information to guide risk-based supervision strategies, in particular, a bank faced with rising spreads might warrant closer inspection by bank supervisors to determine what the cause could be.*

Keywords: Bank Regulation, Financial Soundness, Interbank Lending
JEL Classification: E43, E52, E58, G21.

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I: INTRODUCTION

Pillar III of the Basel II capital Accord allots a role for the market to monitor and discipline risk taking by banks. One of the channels through which this can occur is the price (the interest rate) which banks pay to borrow wholesale funds. In Uganda, as in many developing countries, the most developed segment of the wholesale fund market is that for interbank loans. As banks might be expected to have a good understanding of the financial position of their counterparts in the interbank market they should be well placed to price the risk entailed in interbank lending. If so, the interbank loan market could provide incentives for more prudent management by banks, as this would be reflected in lower costs of interbank borrowing. In addition, the interest rates paid by individual banks in the interbank market might provide bank supervisors with valuable information about potential fragility in these banks.

Although there is a considerable volume of research on the interbank market in the developed world, mainly on the U.S and the Euro zone (Furfine, 2001; King, 2008; Dinger and von Hagen, 2009 and Summer, 2013), there has been fewer studies on developing and emerging economies (Markose, 2013; Martinez-Jaramillo et al., 2014; and Leon et al,. 2015; Murinde et al., 2016), probably because of their relatively underdeveloped interbank markets compared to the developed economies. Green *et al.*, (2016) notes that overnight interbank trading in many frontiers and emerging markets is relatively thin and not sufficient to support fully a monetary policy based on open market operations.

This paper aims to contribute to our understanding of relationships in interbank markets in developing economies, in particular the impact of perceptions of counterparty risk on borrowing interest rates, by utilising an extensive data set on interbank trades in Uganda generated by the Bank of Uganda, which allows us to identify differences in the interest rates paid by individual commercial banks to borrow on the interbank loan market and to link these to bank specific characteristics. As such it adds to a small but growing body of empirical literature which has investigated the determinants of interbank interest rates in emerging and frontier markets.

We use a time series panel data set of commercial banks' balance sheets and income statements over the period 2011Q3 - 2016Q1 to empirically investigate whether the interbank interest rates paid on overnight loans by individual banks in Uganda are influenced by the financial soundness of the borrowing banks, other characteristics of banks such as size and ownership and the bank specific demand for funds on the interbank market. Our results indicate that different measures of a bank's financial soundness have an influence on the price paid by a bank to borrow; in

particular, a bank with weaker financial soundness indicators (FSI) pays more to borrow than a bank with stronger FSIs. We also find that the volume of demand for interbank funds, by each individual bank, relative to its size in the banking market, raises the costs of borrowing and the spreads for individual banks display a degree of "stickiness". Moreover, in general, 'big' and 'internationally-affiliated' banks incur a lower cost of interbank funds while 'small' banks pay higher rates.

The rest of the paper is structured in five sections. Section II explores the theoretical background pertaining to the interbank money market and the structure of the interbank market in Uganda, while a review of empirical studies is done in Section III. Section IV details the estimation strategy and the bank level data used in the study. Empirical results are given in Section V and Section VI concludes.

II: THEORETICAL BACKGROUND & STRCUTURE OF THE INTERBAK MARKET IN UGANDA

2.1 Theoretical background

Interbank loan markets exist because banks are subject to unanticipated liquidity shocks, such as the unanticipated withdrawal of a large deposit. The credibility of banks depends upon their being able to honour their labilities as they fall due, hence in the absence of an interbank loan market, banks would have to hold a higher volume of highly liquid assets (precautionary reserves) as an insurance against liquidity shocks, thus foregoing the potentially higher returns available through investment in illiquid assets.

In a perfectly competitive interbank market with no credit risk, every bank should be able to borrow (or lend) an unlimited amount of funds at the prevailing market interest rate. The market rate itself might vary between time periods because of fluctuations in aggregate liquidity conditions, but across the market at any point in time there should be no variation between banks. In practise, however, interbank markets are not perfect. We can identify three reasons why the perfect market paradigm might not characterise the interbank market and would lead to differences in interbank borrowing interest rates, or in access to credit, across banks.

First, the small size of the interbank market or market concentration may not allow all borrowers to face a perfectly elastic supply curve for interbank funds. Instead they would face an upward sloping supply curve and as such, an increase in demand for interbank funds by an individual

bank might be sufficiently large to drive up the interbank interest rate. Second, the interbank market may be segmented (Oduor et al, 2014). Segmentation may reflect perceptions of credit risk as discussed below, but it could also arise from other factors which are at least partly independent of any objective measure of credit risk, such as the size of the bank or its reputation or that of its parent bank or lack of reliable information about the financial condition of banks. Third, unless interbank loans are fully collateralised with readily realisable securities or are insured by a third party (such as a deposit protection fund), interbank lending involves credit risk. The credit risk arises because the borrowing bank may default on the repayment of its interbank liabilities, because of financial distress. As credit risk is partly idiosyncratic to banks – it depends on the individual characteristics of each bank rather than just general market conditions – perceived credit risk will differ across banks.

The interbank market can respond to the presence of credit risk in two ways. Lenders could add a risk premium to the interest rate charged to the borrower, which should reflect the lender's perception of that risk and thus the probability that the interbank loan will not be repaid. Banks might be expected to have a good understanding of the financial condition of their counterparts in the interbank market and to use this knowledge to price risks, provided that they will actually bear the risk of lending (Rochet and Tirole, 1996). Lending banks might also ration credit to banks they regard as especially risky, or to banks whose financial condition is not transparent. Thus there could be both a quantity and a price effect of perceived credit risk, or probably some combination of the two. If markets are segmented, and some borrowing banks are only able to borrow from a sub-set of the market, these banks might face higher interbank interest rates than would be the case if they were not credit rationed, because the banks willing to lend them funds would have a greater degree of market power.

There are factors which might mitigate credit risk, however. A large, systemically important bank might be perceived by the market as being "too big to fail' (TBTF) in that the bank regulator and/or government would provide support to prevent its failure in the event that it suffered financial distress, because the adverse economic consequences of its failure would be too great. A bank which is TBTF would, therefore, be able to borrow funds more cheaply on the interbank market because of the implicit support it enjoys from the government. The credit risk of a bank which is a subsidiary of a large reputable, well established international bank might also be mitigated if it is perceived to enjoy the implicit support of its parent, because the failure of a subsidiary would damage the global reputation of the parent. This support is explicit in the case of subsidiaries of international banks which are deemed to be globally systemically important (G-

SIBs). Under proposals by the Financial Stability Board, G-SIBs are being required to hold sufficient resources, termed total loss absorbing capacity (TLAC) at the global level to cover all potential losses in their materially significant subsidiaries without jeopardising financial stability or causing losses to taxpayers and to ensure the continuity of their critical functions (Financial Stability Board, 2014).

2.2 Structure of the interbank Market in Uganda

Since the late 1990s, commercial banks in Uganda have participated in an interbank market. Volumes of transactions traded in Uganda shillings have grown from 0.1 trillion in 2000 to 6 trillion and 26 trillion in 2011 and 2017, respectively. Though commercial banks are the only participants, the market is heterogeneous, with banks differentiated based on ownership and size. Ownership depends on the country of origin of the majority shareholder and as such, banks can be regarded as local or foreign. The latter can be further divided into regional banks, with a parent bank in Africa, and global banks, with a parent bank outside of Africa. Following the closure of one domestic bank in early 2017, there are currently seven globally owned banks, 15 regional banks and two domestic banks.

Banks can further be disaggregated into three groups according to their size. For the purposes of this study, a bank has been designated as small if its total assets account for less than *one* percent of the banking industry's total assets. As at December 2017, 9 banks were considered small with a combined market share of 6 percent. We define medium sized banks as those whose share of total assets in the industry fall between *one and eight* percent. There are 10 medium sized banks with a combined market share of 32 percent. Large banks are those with a market share of above *eight* percent, of which there are 5 with a total market share of 62 percent. **Table 1** indicates activity in the interbank (lending and borrowing) by bank size, over the period 2011 to 2017 for overnight loans.

Table 1: Volume of Interbank Transactions disaggregated by the Size of the Participant as a Percentage Share of Total Lending and Borrowing

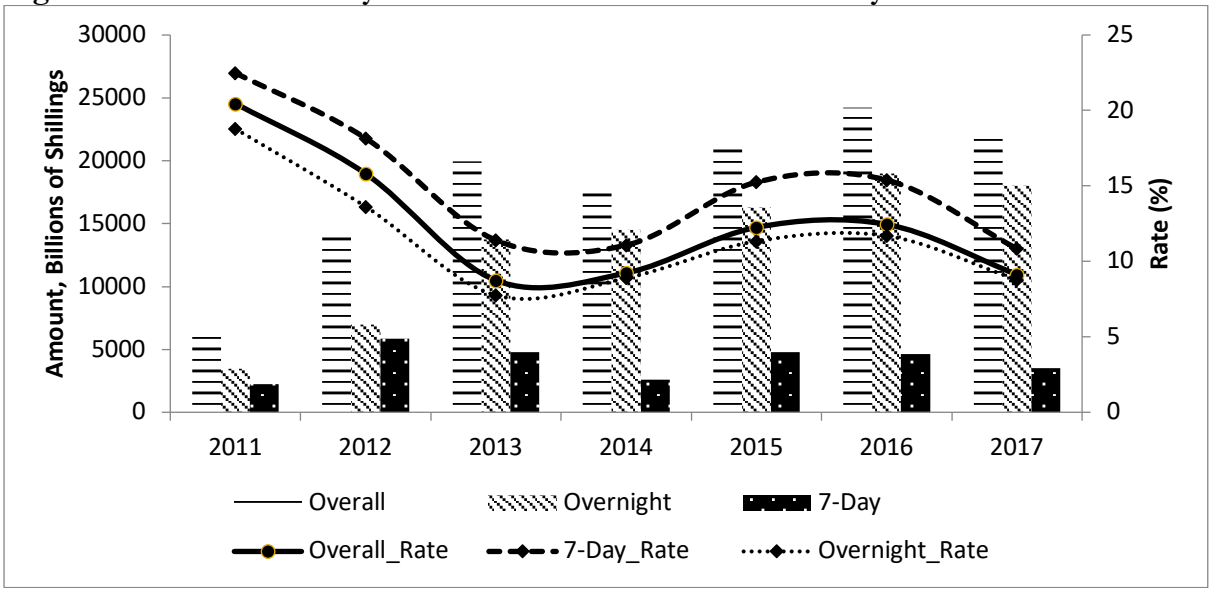
SIZE CATEGORY→	SMALL		MEDIUM		LARGE	
YEAR↓	Borrowing	Lending	Borrowing	Lending	Borrowing	Lending
2011	7.6	2.1	92.2	33.8	0.2	64.1
2012	6.9	1.5	93.1	36.0	0.0	62.5
2013	26.5	7.1	70.5	43.9	3.0	49.0
2014	26.4	8.6	68.8	38.2	4.8	53.2
2015	38.6	14.8	55.8	40.3	5.6	44.9
2016	24.9	6.2	72.3	42.4	2.8	51.4
2017	30.2	9.8	66.2	38.2	3.6	51.9

Source: Bank of Uganda and Authors' compilation

It can be observed that lending by these three categories of banks is consistent with their asset share, i.e., large banks lend the most and small banks the least. However, medium sized banks borrow much more than they lend, accounting for more than 70 percent of borrowing in the overnight market on average, albeit their share has reduced from 92 percent in 2011 to 66 percent in 2017. Large banks on the other hand lend much more than they borrow which reflects the fact that they hold more liquidity than the other categories of banks.

The main instruments on the interbank market are unsecured interbank loans with the majority being overnight and 7-day tenors (**Figure 1**), although occasionally there are loans for longer maturities such as 14 and 30 days.

Figure 1: Volume of activity and interest rates in the Interbank by Tenor of Loans

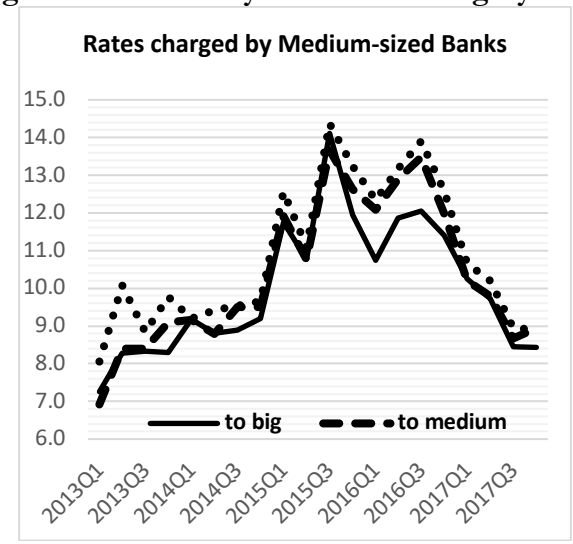


Source: Bank of Uganda and Authors' compilation

Generally, large banks have the lowest borrowing costs in the interbank market except for when borrowing from other large banks (**Figure 2**). Small banks incur the highest costs irrespective of the lender. On average, small banks pay more for interbank loans relative to medium and big banks, by approximately 1 and 2 percentage points, respectively.

These differences indicate imperfections within the interbank market. They suggest, either that large banks can exploit market power over smaller banks, or that lending to smaller banks is perceived as more risky than lending to larger banks, possibly because the former are less diversified.

Figure 2: Overnight Interbank Weighted Average Interest Rate by Asset-size Category



Source: Bank of Uganda and Author's compilation

Interbank market imperfections also arise because some banks impose limits on the amount which they will lend to certain other banks, or even refuse to lend to some other banks at all,

although these credit limits, which are often determined by their parent banks are not transparent. As such, the Ugandan interbank market is segmented and can be classified as having an incomplete market structure.

In conclusion, the analysis of the structure of the interbank market highlights key findings which guide our selection of variables, model specification and empirical analysis: First, the Ugandan market is segmented on the basis of volume of transactions according to bank size and ownership. Generally, small and medium sized banks borrow more relative to large banks. Second, over 90 percent of the transactions in the interbank are overnight trades. Third, big banks are more liquid than small banks and medium banks and hence are the main suppliers of liquidity with themselves having a lower demand for borrowed funds on the interbank market. This has resulted into lower lending and borrowing rates for the large banks compared to the other two size categories of banks. Moreover, as aforementioned, some large banks are constrained in their lending to other banks by credit limits imposed by their parent banks, and these banks sometimes have to offload surplus liquidity at interest rates well below the average interbank market rates to the few banks that both require funds and are not constrained by the credit limits of the lender. And lastly, there is more volatility in both the rates and amounts observed amongst transactions between small banks relative to transactions where bigger banks are involved.

III: EMPIRICAL STUDIES

Murinde et al. (2016) provide a comprehensive review of the empirical literature on the peer monitoring role of the interbank market. This issue has mainly been empirically investigated in developed countries; in particular the US and Europe, and the results provide confirmatory evidence of peer monitoring influencing pricing in the interbank market. The seminal study by Furfine (2001) on peer monitoring in the interbank examined whether the interest rates paid in the overnight Federal Funds market (the US interbank market) reflected measures of the borrower's credit risk. The empirical estimation was based on a sample of more than 17,000 Federal Funds transactions from which the interest rate was regressed on proxies for credit risk and other bank characteristics, such as bank size. Furfine found a statistically significant impact of credit risk on lending rates, with the expected signs. The study also found a positive correlation between the loan size relative to the borrower's capital and the lending rate. However, the size of the borrowing bank was negatively correlated with lending rates; large

banks received more favourable terms in the interbank market. Furfine concluded that "banks can distinguish credit risk among their peers and price loan contracts accordingly" (page 54).

A similar finding was made in a later study on the US interbank market by King (2008) who found a statistically significant interbank interest rate response to credit risk. King's study also showed that the response of the interbank yields increased in magnitude as a result of regulatory reforms made in the mid-1990s that imposed more of the costs of bank failure on uninsured creditors. King employed Heckman's (1976) two-stage model, which entails estimation of Probit and OLS regressions, to examine the credit risk pricing and rationing as well as the particular types of risk that interbank lenders in the sample responded to. The study was based on a sample of 2,029 banks in the US interbank market and analysed two sub periods, 1986 to 1995 and 1996 to 2005, before and after regulatory reforms. Bank real assets, Home Loan Bank membership, deposit growth, non-pledged securities/assets growth and loan growth were used as control variables in the model. In addition, the study also found that there was no difference between quantity rationing and pricing effects in response to the increased risk borne by uninsured creditors

The study by Dinger and von Hagen (2009) turned the question round and examined whether banks which borrowed in the interbank market were characterised by lower risk. They used a large sample of banks in central and Eastern Europe, in markets which are two tiered with large incumbent banks, enjoying implicit guarantees from government, being able to mobilise deposits cheaply and lend through the interbank market to new entrant smaller banks which faced higher costs than the large banks in deposit markets. Measures of risk incurred by each bank were regressed on the bank's position in the interbank market (net lender or net borrower) and macroeconomic control variables. Dinger and von Hagen found that interbank borrowing was associated with substantially lower risk incurred by borrowing banks.

The empirical evidence from emerging economies also supports the peer monitoring hypothesis. The study on the interbank market in China by Geng, Grivoyannis, Zhang and He (2016) provides c evidence of the hypothesis based on annual data from 2001 to 2012 for all 16 Chinese listed banks whose assets accounted for over 65 percent of the assets of the Chinese banking industry in 2012. A positive correlation between the interbank market rate and bank risk was found. The study by Sarmiento (2016) on the Colombian interbank market also investigated the effect of bank characteristics on interest rates paid by borrowing banks in the interbank market

using a sample of daily overnight bilateral unsecured operations among 53 banking institutions from January 2011 to December 2014. The study employed a Heckman regression model in order to correct for the sample selection bias towards borrowing banks. Sarmiento found a positive correlation between the riskiness of borrowing banks and the price paid in the interbank market and a negative correlation with the quantity of funds borrowed. Furthermore, a negative correlation was found between the capitalisation and liquidity and the price paid by the borrowing banks, and a positive correlation with access to the interbank market. The study also found that borrowing banks paid higher prices and hoarded liquidity during periods of large disparities in bank liquidity positions and monetary policy tightening and this effect was found to be higher for small banks. .

The evidence in Rajkamal and Jose-Luis (2011) on the interbank market in India highlights the importance of bank relationships and fundamentals in determining bank contagion arising from one of the banks in the interbank market failing. The study used the failure of one of India's cooperative banks as a natural experiment for bank contagion in India's interbank market. The findings revealed that high interbank exposures to the failed bank led to withdrawals in bank deposits. In addition, the withdrawals were highest for banks with weak fundamentals. Linkages amongst the surviving banks, other than the linkage to the failed bank, further propagated the contagion

Studies on Kenya have contributed to closing the gap in the literature on peer monitoring in the interbank market in developing countries. The findings for Kenya are a good reference point for countries in the East African region as several Kenyan banks have subsidiaries in the other East African countries. In Uganda, about four banks are Kenyan owned. The evidence from Kenya further supports the peer monitoring hypothesis in the interbank market. Murinde *et al.* (2016) investigated whether the interbank market in Kenya was effective as a peer monitoring and market discipline device over the period 2003q1-2011q1 for 43 banks which participated in the interbank activity. Using OLS regression, the Generalized Method of Moments (GMM) and Two-Stage Least Squares regression, they uncovered a stable inverse relationship between interbank activity and bank risk levels (after controlling for other bank risk determinants and financial crisis). The study also found a non-linear relationship between interbank activity and bank risk i.e. if a bank increased its interbank position up to a certain level, the impact on bank risk reversed from risk-reducing to risk-increasing due to possible contagion effect. Furthermore, the study found that when banks were grouped by different characteristics, less risky banks

(including larger, listed, foreign and older banks) the risk reduction effect due to peer monitoring was smaller. A more recent study on Kenya and Malawi by Tiriongo and Esmie (2019) also found evidence supporting the interbank market discipline hypothesis based on both quantity and pricing in the interbank market in the case of Kenya while the empirical evidence for Malawi was confirmatory of the hypothesis only with regard to pricing.

IV: DATA AND THE ESTIMATION STRATEGY

4.1 Data, Variables and Summary Statistics

The financial sector in Uganda is dominated by commercial banks which account for an average of 83.2 percent of the country's total financial assets and nearly 100 percent of the financial system deposits (Apaa et al. 2019). Commercial banks report, on a monthly basis, detailed balance sheets and income statements to the BoU – the regulator. As of December 2017, there were 24 regulated commercial banks in Uganda, of which 19 had been operational throughout the period 2011Q4 – 2016Q1 – a period during which there was greater scope for the overnight (not directly targeted by the BoU) to deviate from the CBR. From about 2016Q2, the BoU changed its liquidity management procedures to manage substantial volumes of structural liquidity that banks hold by deliberately supporting the overnight rate alongside the 7-day rate as the bank's operating target.

We apply quarterly balance sheet data of commercial banks reported to the BoU; daily data on banks' lending and borrowing in the interbank market and the interest rates applied to these transactions, averaged over each quarter. Average interbank rates at any point in time are determined by monetary policy, but individual banks borrow at a spread, above or below the average rate depending on their own idiosyncratic characteristics. We therefore capture the difference between the prevailing weighted average interbank interest rate on the day the transaction took place and the interbank overnight interest rate paid by each borrowing bank using the weighted average overnight spread, which we have computed according to **eqn.1**.

$$waspread_{it} = QAR_{it} - WAIR_{it} \tag{1}$$

Where

$$WAIR_{it} = \sum_{i=1}^{19} \left(\frac{trade\ share_{it}}{industry\ total\ trade_{it}} \right) QAR_{it}$$

And QAR_{it} is bank level quarterly average interest rate; and WAIR is quarterly weighted average interest rate.

For the bank specific characteristics, we include measures of riskiness of a borrowing bank. The most common indicator to describe asset quality of a bank is the ratio of nonperforming loans to total outstanding loans (NPL). The riskiness of a bank creates the possibility that it might default on its interbank liabilities because of financial distress which implies that it would be charged a risk premium on the price it pays to borrow on the interbank market. Therefore, it would be expected that riskier banks, *ceteris paribus*, pay higher interest rates than less risky banks. In addition, we include, in the financial soundness indicators, a measure of profitability: the ratio of profits to total assets (return on assets, ROA) or the ratio of profits to total capital (return on equity, ROE). Our conjecture is that more profitable banks are perceived as being less of a credit risk and can therefore borrow at lower interest rates on the interbank market.

We also include bank specific demand for funds on the interbank market relative to its size, which is obtained by dividing the interbank market trade share of each of the 19 banks by their asset shares, defined as in **eqn. 2**.

$$O/N\ trade\ asset\ share_{it} = \frac{trade\ share_{it}}{asset\ share_{it}} \tag{2}$$

Where

$$trade\ share_{it} = \frac{O/N\ trading_{it}}{Total\ industry\ O/N\ trade}$$

And

$$Asset\ share_{it} = \frac{Asset_{it}}{Total\ industry\ assets} \tag{3}$$

Essentially, if banks face an upward sloping supply curve for funds, we would expect that a larger trade asset share would lead to higher borrowing rates. We also include the structure of the banking market in terms of the size and ownership of the 19 commercial banks in our sample. In the study, the size of each commercial bank is measured in terms of its asset share relative to the industry total. A bank is designated as small, medium and large if its total assets account for less

than *one* percent, fall between *one and eight* percent and above *eight* percent of the banking industry total assets. The relative assets share is defined according to **eqn. 3** above.

The variables in eqns. 1, 2 and 3 as well as FSI measures are transformed in log equivalent, so then the parameter estimates are interpreted as elasticities and are sourced from commercial banks' balance sheets and income statements submitted to the BoU by commercial banks.

In terms of ownership, the 19 commercial banks are disaggregated according to the country of origin of the majority shareholder and are as such regarded as foreign (global and regional) and domestic. The latter constitute banks with a parent bank outside of Uganda but either in Africa or outside of Africa (U.S, U.K, India, South Africa, Kenya and Nigeria). Big and internationally-affiliated banks are assumed to have access to resources (e.g. from their parent bank) which provides some degree of insurance against default which is independent of their actual financial condition, and would thus be expected to borrow at lower rates. Large banks could also be perceived by the regulator as "too big to fail" and therefore have a degree of implicit support from the state in the event of financial distress. Small banks on the other hand are perceived to have access to fewer resources than larger banks to support them in the event that they suffer financial distress; e.g. they are less likely than a larger bank to be recapitalized or provided with liquidity by their owners to prevent a default on the interbank market. Given this, they would be expected to be charged higher rates to borrow on the interbank market irrespective of their financial soundness indicators.

In the estimation model, bank ownership takes form of a dummy. We construct three dummies: a dummy for global ownership (*D_global*), regional ownership (*D_regional*) and domestic ownership (*D_domestic*) - noting that two of the only three domestic banks (including one that was closed in early 2017) in the sample are part of the five big banks in Uganda. In an effort to implement estimation in a manner careful enough not to fall into a dummy trap, only two of the three dummies are included in the regression model, the other is treated as a residual. For brevity, the set-up of any of these dummies, considering for example, a dummy for global ownership, takes the form in **eqn.4**:

$$D\_Global = \begin{cases} 1: & if\ global \\ 0: & otherwise \end{cases} \tag{4}$$

The statistical description of the bank level data is given in **Table 2**. A comparison of the minimum, maximum and standard deviation suggests wide dispersion of the data. The mean and median for almost all the series are not numerically different, suggesting either that there are no significant outliers in the data or that if there are they are symmetric around the mean.

Table 2: Summary Statistic for Bank Level Variables

Variable description	Mean	Median	Std. Dev	Max.	Min.
Overnight weighted average spread	-0.00	-0.01	1.67	6.58	-13.11
NPL to total gross loans	5.47	4.57	4.85	48.85	0.00
Return on equity	7.71	12.78	35.99	52.44	-658.16
Return on asset	1.45	1.89	3.29	8.08	-25.01
O/N trade asset share	1.19	0.76	1.25	6.63	0.00
Asset share	0.05	0.03	0.04	0.20	0.00
Banks with Global ownership	0.22	0.00	0.41	1.00	0.00
Banks with regional ownership	0.63	1.00	0.48	1.00	0.00
Banks with domestic ownership	0.16	0.00	0.36	1.00	0.00

Obs = 332

Source: Authors' computations

Table 3 reports correlations among the variables. There is a positive correlation between the weighted average overnight spread for bank *i* and its loan quality (*npl*), demand for funds on the interbank market (trade *1_day share*) and banks with regional ownership. The correlation is negative for asset share, return on assets, and banks with global and domestic ownership.

Table 3: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WASPREAD_1D (1)	1							
LNPL (2)	0.142*	1						
	(0.002)							
O/N TRADE ASSETSHARE (3)	0.081***	-0.078***	1					
	(0.076)	(0.091)						
ASSET_SHARE (4)	-0.228*	-0.115**	0.492*	1				
	(0.000)	(0.012)	(0.000)					
LROA (5)	-0.226*	-0.605*	0.309*	0.489*	1			
	(0.000)	(0.000)	(0.000)	(0.000)				
GLOBAL (6)	-0.184*	-0.169*	0.602*	0.653*	0.342*	1		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
REGIONAL (7)	0.226*	0.149*	-0.360*	-0.643*	-0.459*	-0.684*	1	
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)		
DOMESTIC (8)	-0.092**	-0.006	-0.206*	0.113**	0.222*	-0.227*	-0.554*	1
	(0.045)	(0.883)	(0.000)	(0.014)	(0.000)	(0.000)	(0.000)	

Notes: Obs = 332; in parentheses are *p*-values which reflect the significance of each correlation value. * p<0.01, ** p<0.05 and *** P<0.10.

Source: Authors' computations

4.2 Model Specification and estimation strategy

To estimate the impact of bank characteristics, structure, demand for funds on the interbank market and business cycle on the weighted average overnight spread in Uganda, we estimate the following panel regression model:

$$1_{day}waspread_{it} = \vartheta_0 + \vartheta_1 \boldsymbol{x}_{it} + \vartheta_2 O/N\ trade\ asset\ share_{it} + \vartheta_3 asset\ share_{it} + \vartheta_4 D_{global} + \vartheta_5 D_{domestic} + \delta_i + \delta_t + \varepsilon_{it} \quad (5)$$

Where $\boldsymbol{x}$ is a vector of bank specific financial soundness indicators; o/n trade asset share is the bank specific demand on a particular trading day, asset share is the size of the bank, D_global, and D_domestic are dummies capturing ownership of banks, while δ_i and δ_t are bank specific and time fixed effects, and ε_{it} is the idiosyncratic error term, assumed to be normally distributed with a zero mean and homoskedastic variance, i.e., $\varepsilon_{it} \sim N(0, \delta^2)$. $\vartheta_i (i = 0,1, \dots ,5)$ are coefficients to be estimated. We have two categories of FSIs, one capturing risk (*npl*) while the other captures profitability (roa/roe). We disaggregate eqn.5 into three different equations, one for each FSI. Thus **eqn.5** is rewritten as in **eqns**. 6-8:

$$1_{day}waspread_{it} = \vartheta_0 + \vartheta_1 npl_{it} + \vartheta_2 O/N\ trade\ asset\ share_{it} + \vartheta_3 asset\ share_{it} + \vartheta_4 D_{global} + \vartheta_5 D_{domestic} + \delta_i + \delta_t + \varepsilon_{it} \quad (6)$$

$$1_{day}waspread_{it} = \vartheta_0 + \vartheta_1 roa_{it} + \vartheta_2 O/N\ trade\ asset\ share_{it} + \vartheta_3 asset\ share_{it} + \vartheta_4 D_{global} + \vartheta_5 D_{domestic} + \delta_i + \delta_t + \varepsilon_{it} \quad (7)$$

$$1_{day}waspread_{it} = \vartheta_0 + \vartheta_1 roe_{it} + \vartheta_2 O/N\ trade\ asset\ share_{it} + \vartheta_3 asset\ share_{it} + \vartheta_4 D_{global} + \vartheta_5 D_{domestic} + \delta_i + \delta_t + \varepsilon_{it} \quad (8)$$

The FSIs described so far characterize the financial soundness of banks. We supplement our analysis by using the Z-score – a measure commonly used in the literature to reflect a bank's probability of insolvency (Kanga et al., 2019; Cummins et al., 2017; Schaeck and Cihak, 2014). The Z-score is computed as follows:

$$Zscore = \frac{ROA + CAR}{\delta(ROA)} \tag{9}$$

Where ROA is as defined above; CAR is bank's capital-to-asset ratio; and $\delta(ROA)$ is the standard deviation of the return on assets. Z-score combines banks' buffers (capital and profits) with the risks they face (measured by the standard deviation of returns). An increase in the Z-score shows a decrease in the bank's insolvency risk and should therefore be expected to lower interest rate spread. This notwithstanding, the Z-score may not be a significant explanatory variable as the individual FSIs. This is because it includes the CAR and the CAR tends to be high for small banks as they must also meet the minimum capital value of Shs. 30 billion even when this entails a far higher CAR than the regulatory minimum CAR of 12%. Reflecting the Z-score, we estimate a variate, but condensed version of eqns. 5-7 of the form in **eqn.10**.

$$\begin{aligned} 1_{day}waspread_{it} = {} & \vartheta_0 + \vartheta_1 zscore_{it} + \vartheta_2 O/N\ trade\ asset\ share_{it} \\ & + \vartheta_3 asset\ share_{it} + \vartheta_4 D_{global} + \vartheta_5 D_{domestic} \\ & + \delta_i + \delta_t + \varepsilon_{it} \end{aligned} \tag{10}$$

BoU operations in the money market clearly affect the interbank rates which banks pay to borrow funds - the 7 day interbank rate is the operating target of monetary policy. This notwithstanding, we do not include central bank operations in the explanatory variables. Our aim is to determine whether the FSIs of banks, along with other factors which are specific to individual banks rather than to all banks in the market, influence interbank borrowing rates. Because we are focussing only on bank specific explanatory factors, rather than those which influence the market as a whole, our dependent variable is measured as the deviation of the rate paid by each individual bank from the market rate, with the latter measured as the average interbank rate which prevailed on each day. The CBR affects the market rate, but it should not affect the deviation in the rate paid by any individual bank from the market rate. When the BoU conducts its open market operations, it deals with all banks in the market on an equal basis, i.e., borrows or lends to all banks at the same rate. Consequently, we think that BoU open market operations should not influence the spread over or below the market rate paid by any individual bank. A similar logic applies to the inclusion as regressors of other macro variables which apply to all banks in the market equally rather than to individual banks on a differentiated basis, such as the output gap.

Similarly, although the Lombard facilities are conducted on a bilateral basis with individual banks, affecting the rate it pays to borrow on the interbank market, it is unlikely that including the use of Lombard facilities as an explanatory variable would be reasonable for several reasons. First, the use of Lombard facilities by most banks is very infrequent. On the vast majority of working days, no bank accesses the Lombard facilities. Second, our data involves quarterly averages, but even when a bank accesses liquidity through the Lombard windows, this is only likely to affect its liquidity position on a minority of the days within that quarter. Third, if access to Lombard facilities were included as a regressor, it is not obvious whether the sign would be positive or negative, because demand and supply side effects would work in opposite directions. A bank which requested liquidity from the BoU would obviously be facing higher borrowing rates in the market, as the Lombard facilities carry a penal rate. But receiving liquidity through the Lombard facilities would lessen the need for the bank to borrow on the market and therefore ease the interest rates it has to pay.

Our panel contains 19 cross sections of commercial banks and 18 points of quarterly time series data. As N(19 banks) > T(18 data points), we deploy in common with practice (of similar data circumstances), the traditional fixed/random effects estimators' methods. The fixed/random effects estimations pools together individual groups such that the slope parameter is homogenous across groups and only the intercepts are allowed to vary. The Hausman (1978) test [$\chi(3)=26.15$ (0.000)] reveals that the preferred model is the fixed effects. Therefore, **eqns**. **6**, **7, 8** and 10 are estimated by fixed effects estimators. We also run the same equations with pooled ordinary least squares, in part, to provide for a robustness check.

V: EMPIRICAL RESULTS

Table 4 presents our FE and POLS regression results. Columns 1, 2, and 3 correspond to equations 6, 7 and 8 respectively. The exclusion of *D_global* and *D_domestic* variables in fixed effects estimates are a natural consequence of the estimation procedure.

Table 4: Pooled OLS and Fixed effects Estimates

Dep. Var → / Regressors ↓	Overnight weighted average spread					
	FE Estimates			POLS Estimates		
	(1)	(2)	(3)	(1)	(2)	(3)
C	0.001 (0.705)	0.003 (0.100)	0.003 (0.127)	0.000 (0.839)	0.002*** (0.060)	0.003*** (0.052)
O/N trade asset share	0.041** (0.017)	0.051** (0.008)	0.053** (0.006)	0.050** (0.011)	0.052** (0.008)	0.0048** (0.014)
Asset share	-0.105* (0.000)	-0.089* (0.001)	-0.106* (0.000)	-0.069* (0.005)	-0.048*** (0.061)	-0.052** (0.048)
NPL	0.048** (0.005)			0.046** (0.008)		
ROA		-0.058** (0.033)			-0.075** (0.005)	
ROE			-0.002 (0.686)			-0.006 (0.155)
D_Global				-0.006** (0.027)	-0.006** (0.024)	-0.007** (0.011)
D_domestic				-0.004 (0.126)	-0.002 (0.335)	-0.004*** (0.095)
Bank effect	Yes	Yes	Yes	no	no	no
Time effect	Yes	Yes	Yes	no	no	no
Cross sections	19	19	19	19	19	19
Total unbal. Panel Obs.	332	332	332	332	332	332
Periods included	18	18	18	18	18	18

Notes: In parentheses are *p*-values which reflect the significance of each correlation value. * p<0.01, ** p<0.05 and *** P<0.10. The coefficient to D_regional (where applicable) is about 0.006 on average, positive and significant at the 5% level

Across all the specifications, the coefficient on the relative trade share of the bank is both positive and statistically significant, indicating that as the share of a bank's borrowing in the market relative to its size (measured by its asset market share) increases, it has to pay higher rates to borrow funds. As such banks do not face an infinitely elastic supply curve for funds.

The coefficient on the asset share is negative implying the rate paid to borrow on the interbank market is a decreasing function of the bank's asset size. Larger banks pay lower rates than smaller banks. This is either because larger banks have market power or because they might be perceived by the market to be "too big to fail" in that they would be bailed out by the regulator, or at least

be prevented from failing to honour their liabilities by the regulator, because of the potential systemic consequences of such a failure and thus their liabilities enjoy implicit protection from the state. This is consistent with the coefficient on the cluster of "internationally-affiliated" and domestic banks (two-thirds of which are big asset sized banks), where their ownership and/or size provides a degree of insurance against default which is independent of their actual financial condition, as proxied by their respective financial soundness indicators.

The coefficient on *npl* – the measure of asset quality - is both positive and significant, suggesting that the higher the credit risk, the higher are the interest rates which a bank pays in the interbank market, as lenders add a premium to the interest rate they charge to compensate for the higher probability of default. The ratio of profits to total assets (ROA) is negatively signed and highly significant in both POLS and FE estimates. This suggests that more profitable banks are perceived as being less of a credit risk and can therefore borrow at lower interest rates on the interbank market. The coefficient on ROE has the expected negative sign but is not significant.

Table 5: Pooled OLS and Fixed effects Estimates with the Z-score

Dep. Var → / Regressors	**Overnight weighted average spread**	
	FE Estimates	**POLS Estimates**
C	0.005 (0.123)	0.005** (0.032)
Z-score	-0.001*** (0.083)	-0.0004*** (0.084)
O/N trade asset share	0.071* (0.001)	0.056** (0.005)
Asset share	-0.112* (0.001)	-0.075** (0.003)
D_Global		-0.005** (0.047)
D_domestic		-0.005** (0.028)
Bank effects	Yes	No
Time effects	Yes	No
Cross sections included	19	19
Total unbal. Panel obs.	332	332
Periods included	18	18

Notes: In parentheses are *p*-values which reflect the significance of each correlation value. * p<0.01, ** p<0.05 and *** P<0.10.

Table 5 reports estimated results for eqn. 10, for the Z-score in the place of individual FSIs. The estimated coefficient on the Z-score in both POLS and FE estimates has the correct sign and is significant. This suggests that the less the bank's insolvency risk (consistent with an increase in the z_score), the more likely it is for a bank to borrow at lower interest rates on the interbank

market. The coefficients on the rest of the regressors are consistent with those estimated in **Table 4**, and hence are not reinterpreted.

VI: CONCLUSION AND IMPLICATIONS FOR POLICY

Uganda has a vibrant interbank market in which most commercial banks participate regularly, mostly in the overnight market. This paper has investigated the factors which determine differences in the interest rates paid by individual banks to borrow on the interbank market, using panel data regressions on quarterly data of commercial banks' balance sheets and income statements over the period 2011Q4 - 2016Q1. Average interbank rates at any point in time are determined by monetary policy, but individual banks borrow at a spread, above or below the average rate depending on their own idiosyncratic characteristics.

We found that different measures of a bank's financial soundness – its loan quality and one measure of profitability (return on asset) – each have an influence on the price paid by a bank to borrow. A bank with weaker financial soundness indicators (FSI) pays more to borrow than a bank with stronger FSIs. The market appears to be able to monitor the financial condition of borrowing banks and the implications for default risk and price this into the interest rates charged to borrowers. We obtain a similar result when we use each bank's Z score as an alternate proxy for financial soundness, which confirms the robustness of this finding. Our results are in accord with the previous research by Furfine (2001) and King (2008) on the US interbank market and Geng, Grivoyannis, Zhang and He (2016) on China, Sarmiento (2016) on Columbia, Murinde *et al.* (2016) on Kenya and Tiriongo and Esmie (2019) on Kenya and Malawi, all of which found that interest rates paid by banks to borrow on the interbank market were sensitive to measures of credit risk.

We also find that the volume of demand for interbank funds, by each individual bank, relative to its size in the banking market (proxied by its trade asset share), raises the costs of borrowing, suggesting that each bank faces an upward sloping supply curve for funds.

Our results also show that the structure of the banking market has a significant influence on the overnight rates, where, in general, 'big' and 'internationally-affiliated' banks incur a lower cost of interbank funds while 'small banks pay higher rates. This is consistent with the notion that 'big' and 'internationally-affiliated' banks are price-takers with more power to influence activity in the interbank market but it may also suggest that these banks are perceived as being less likely to

default on their interbank obligations, irrespective of their actual financial condition, because their owners have the financial resources and incentives to support their banks in the event that they incur financial distress or because they are "too big to fail" and as such have implicit support from the state.

These results have implications for bank supervisors. They suggest that interest rate spreads, around the average market rate, in the interbank market contains information about market perceptions of counterparty risk. By monitoring the spreads paid by banks in the interbank market, bank supervisors could obtain useful information to guide risk-based supervision strategies; e.g. a bank whose spreads rise might warrant closer inspection by bank supervisors to determine the cause of this. One possible extension of this research would be to examine whether the interbank interest rate spreads provide an "early warning" of future deterioration of the financial condition of a bank. This might be the case if banks were able to detect, through their knowledge of the banking market, risky behaviour by their peers before this translates into a deterioration of FSIs.

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