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Determinants of Survival Time of Government Securities Held by Banks in Uganda

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Abstract

This study used survival analysis to establish the determinants of the hazard for bank liquidation of government securities in order to identify possible measures to limit the occurrence of liquidation. The findings showed that increases in capital lead to declines in the rediscounting hazard and increases in the liquidation hazard of using securities as collateral for borrowing from the Central Bank. Both primary dealership and the spread increased the hazard for rediscounting securities and reduced the hazard for liquidating securities through their use as collateral. Measures to minimize liquidity shortages in the interbank market and development of the secondary market are recommended for the reduction of liquidation of issued securities.

Keywords: commercial banks; survival analysis; duration of government securities

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1. Introduction

Understanding why some banks liquidate their securities is important given much reliance by Government and the Central Bank on securities for conducting fiscal policy and influencing monetary policy respectively. For instance, if it is the practice of a bank to reallocate its assets between securities and loans or cash on the basis of liquidity considerations, then the Central Bank's prediction of bank behavior would need to focus more on bank liquidity indicators. On the other hand if the reallocation were to be for the most part explained by profit motives, then the Central Bank's predictions of bank behavior would have to focus more on bank profitability indicators. Similarly, the stability of domestic financing through issuance of Government securities can significantly be affected by large liquidations which can compromise budget execution. This underscores the importance of the ability of both the Central Bank and fiscal authority to predict banks reactions to both monetary policy and fiscal financing needs. In addition, since the secondary market in Uganda is still growing, it is likely that liquidation of securities will remain an important option for holders of securities that urgently require funds.

Most of the analysis on the liquidation of securities held by banks focuses on the amount of securities that are liquidated as the dependent variable. However, as noted by [1], it is also useful to understand bank habits and characteristics which influence the frequency of liquidation of securities. Factors influencing the frequency of liquidation could provide additional insights that may be missed if the dependent variable is a nominal quantity. In addition, understanding determinants of the duration of Government securities held by banks can be useful for ascertaining the ideal distribution of securities by maturity to be issued. Such analysis requires the use of duration models, which although have their background in analytical studies in the fields of industrial engineering and biomedical sciences, have over time gained prominence in addressing special economic event problems.

This paper therefore, investigates the factors that influence the duration of Government securities liquidated by banks. The duration of Government securities may be shortened through a sale of the security to the BOU or provision of the security to BOU as collateral. In either case, the holder exchanges the security for cash from BOU. Attributes of the securities and holders of the securities should therefore be important factors that influence the duration of securities. Subsequently, the following potential hypotheses were investigated:

- Primary dealership of a bank results in a shorter duration of Government securities held by the bank
- Foreign ownership of a bank results in a longer duration of Government securities held by the bank
- Increase in bank capitalization results in a longer duration of the Government securities held by the banks

The rest of the paper reviews the literature on the determinants of duration of securities, describes the data and methodology used for the study, and presents the results and discussion of the results and the conclusions emerging from the findings.

2. Literature review

Reference [2] provides a detailed review of some of the applications of duration analysis to economic problems. However, in the field of finance, duration analysis has for the most part been applied to problems of trades in financial markets and debt default and prepayment. On default and prepayment of debt, studies that have been conducted include identifying the determinants of mortgage default or prepayment, and corporate bond default [3,4,5]). On trades in financial markets, studies have assessed whether behavioral biases exist among investors [6,7]. Other studies have used duration analysis to analyze bank relationships [8,9]. The studies on the duration of bank relationships are of particular interest to this study given the similarity between bank-borrower relationships in such studies with bank-Central Bank liquidation relationships. Reference [8] analyzed bank relationships with firms focusing on the willingness and ability for terminations of relationships by Norwegian firms between 1979 and 1995. The study tracked firm's relationships with banks from when they started to when they ended the relationships and when they switched to other banks. More importantly, the study employed hazard function estimation to infer the determinants of each relationship's duration. The explanatory variables included firm characteristics and financial information such as sales, age, profitability, Tobin's Q, leverage, multiple relationship dummies and ownership concentration. The study found that small, young and highly leveraged firms maintained the shortest relationships.

Reference [9] studied interbank relationships using 11 years of monthly bank data for Italian banks. The analysis was based on a duration model of bank-bank relationships defined as the period from when a bank lends for the first time to another bank or borrows from it, to when the interbank exposure dries up. The hazard model used incorporated both lending and borrowing banks characteristics. The characteristics included among others borrowers and lenders size, capital, bad loans, income structure, return on investment, rating, liquidity situation, and volatility of liquidity. The study found that interbank relationships were longer where borrowing banks were illiquid, small, unrated, and involved in large lending to non-banks. On the other hand, for lenders, relationships were durable if they were liquid, well capitalized and less heavily engaged in other kinds of business. The borrower's characteristics that affected relationships as identified by [9,8], are of interest in this study. This is because, borrowers or borrower banks can be regarded to be synonymous with banks that hold securities and liquidate them while lending banks would be synonymous with the Central Bank which can accept securities offered as collateral in return for loan extension to banks. Looked at from this perspective, some parallels can be drawn from the determinants highlighted in the respective studies for investigation in this study.

Other studies that have applied survival analysis methods in the field of finance investigated the determinants of survival of hedge funds [10,11,12]. These studies are quite similar to this study in the sense that they investigated the determinants of survival of a financial instrument in this case hedge funds while this study investigates the determinants of survival of treasury securities which are also a financial instrument. Reference [12] examined the factors that influence the duration of individual hedge funds in the Lipper Trading Advise Selection System database. The study considered attributes such as return on properties, investment strategies, fund size, competitive pressure, funds flows, drawdown, leverage, incentive scheme, liquidity constraints and minimum investment amount. The methodology used included the non-parametric Kaplan-Meier (KM) analysis, Cox proportional hazard model and panel logit model. The study found that funds with higher returns, assets

under management, recent fund flows and funds with lower volatilities and higher skewness of returns had higher survival probabilities. The study also found that incentive schemes mattered, for survival for instance funds with higher incentive fees had lower survival. In addition, funds that had a longer redemption notice period and a lower redemption frequency had higher survival probabilities.

Reference [11] also studied the effects of fund-specific characteristics such as age, assets under management, current and lagged returns and flows to and out of the funds on the likelihood of liquidation for the funds. They found that age, assets under management, cumulative returns and fund flows increased liquidation probability. Reference [10] applied a Cox semi-parametric hazard model and found that hedge funds which had negative returns for two consecutive years had a higher risk of closing down. The different studies demonstrated the suitability of survival analysis methods for determining the effects of numerous variables on the duration of financial instruments. However, the focus of the studies conducted by [10,11,12] was mainly on the role of the financial instruments' characteristics on its survival. This contrasts with the focus of this study which is on the characteristics of the holders of the financial instruments on its survival.

One study that was found to have focused on the characteristics of the holders of financial instruments on the survival of the respective financial instruments is by [1]. The study investigated the reasons behind the reduced need for liquidation of securities among 246 banks in the USA using the elapsed time between successive visits over the weeks from January 1981 through December 1995. A survivor function was estimated for individual bank borrowers on the elapsed time measured in weeks between successive borrowings from the discount window. The estimation was done using accelerated failure time models on account of their flexibility in defining the underlying distribution and related hazard function. The main focus of the study was to show that financial risk factors prompted banks to avoid the discount window. In addition, the model used also controlled for other critical variables that influence bank borrowing including variables capturing conditions in the money markets (the federal funds-discount rate spread and the federal funds-repo rate spread), and the effect of rate expectations measured by the expected change in the federal funds spread. The effects of financial conditions were measured using the average Standard and Poor's credit rating of banks as the primary measure and the Salomon Brothers 35-bank holding company stock return index as the secondary measure.

In addition to applying a unique methodological approach to measure bank reluctance to borrowing from the discount window on the basis of elapsed time between successive borrowings, [1] also controlled explicitly for heterogeneity among the banks. The variables that were used included capital strength of the borrowing institution measured as the share of equity to total assets and size of banks measured using the logarithm of banks assets. The size variable was included to control for the effect of non-price rules that enable small banks to borrow more frequently. Further, dummy variables for each quarter were used to control for seasonal variation in adjustment borrowing. The study also tested the effect of banks' capacity to manage reserves using the coefficient of variation of reserve liabilities. The findings of the study suggested that the growing reluctance to borrow by banks stemmed from the deteriorating financial position of banks during the period of analysis. In particular, banks avoided the discount window because they feared that market participants would interpret their visits as a signal of serious funding difficulties.

This study is largely informed by the work of [1] but adds three new dimensions to the analysis. Firstly, [1] applied parametric models for estimation of duration which although is simple to use may distort the hazard rates as they impose much structure on the data. This study used Cox's approach to the proportional hazard model which is semi-parametric, imposes fewer restrictions and is thus likely to provide a more accurate representation. Nonetheless, parametric models were also estimated although their use was mainly for comparison purposes. Secondly, the study modelled rediscounting and borrowing against securities as collateral simultaneously in a competing risks model. As noted earlier, banks can liquidate securities held through two main ways. The first is a simple and outright sale of the security to the Central Bank also known as rediscounting. The second method is to offer the security as collateral against borrowing from the Central Bank. This study also attempted to investigate whether the influence of the different determinants of the duration of securities varied for the different methods of liquidation.

Thirdly, the study investigated the effects of additional factors not considered by previous studies such as primary dealership and ownership of banks. Through their role as market makers, primary dealer banks are required to continuously quote bid/ask prices with a predetermined spread or less for a prescribed trading lot on a firm basis. For this role, they receive in exchange the privilege of exclusively bidding for and distributing new issues of Government securities [13]. Primary dealers may therefore find themselves with more securities than they require for their own investment purposes especially when liquidity in the secondary market is constrained. This would imply that primary dealer banks may have a higher likelihood of liquidating securities especially during phases of tight liquidity. In addition, [14] noted that primary dealers may be forced to sell their securities if they cannot access borrowing against securities as collateral. The tight liquidity conditions in the USA during the two weeks prior to March 16, 2008 were cited as having significantly affected dealers in the USA resulting in the creation of a Primary Dealers Credit Facility to alleviate funding pressures on primary dealers. In the case of Uganda, the non-existence of such a facility implies that primary dealers are more likely to be constrained during tight liquidity conditions forcing them to liquidate securities. As noted by [14], the existence of such a facility (primary Dealers Credit Facility) may be a critical recourse for primary dealers during tight market conditions as was observed during the Lehman Brothers bankruptcy in 2008.

The importance of controlling for bank ownership stems from the arguments that foreign banks when compared to local banks tend to have better access to funds due to a more diversified funding base [15]. In addition, foreign banks have also been associated with improved efficiency. For instance, [16] concluded that foreign bank entry in Latin America was associated with a reduction in the profit margins and increased efficiency. Reference [17] came to similar conclusions on better efficiency and access to funding available to foreign banks. The conclusions were linked to the higher average loan growth, higher average provisioning expense, and greater loss-absorption capacity. Given that foreign banks are likely to have better access to funding and higher efficiency, it is expected that the likelihood of liquidating securities reduces if a bank is foreign owned.

The study also due to the absence of measures for all banks in Uganda based on credit ratings and stock return indices for determining the financial conditions used alternative proxies comprised of reserve adequacy and profitability respectively.

3. Data description and methodology

3.1. Data description

The data used for the analysis comprised of 2,074 securities which were rediscounted between June 2006 and December 2012 among 11 banks. The 11 banks were selected on the basis of having been operational in each of the six and half years of the study period (from June 2006 to December 2012). Liquidation of securities over the period occurred on different days but the data on the covariates was measured on a monthly basis. There was therefore no practical way for measuring the influence of the different covariates on the duration measured in days between issuance and the failure event without modifying the duration. Subsequently, the duration was modified from days to months by dividing the number of days by 30 and rounding up. The covariates considered included dummy variables for primary dealership indicating whether the holder of the security was a primary dealer bank or not; ownership of the bank indicating whether the bank was foreign owned or not; and security type indicating whether the security liquidated was a treasury bill or a treasury bond. Bank ownership was based on majority ownership criteria with banks classified as foreign owned if more than 50 percent of the shares were owned by non-residents. The size variable was determined on the basis of individual banks' loan assets and deposit liabilities. The distribution of the banks by ownership, size and dealership status is as shown in Figure 1. The sample had 9 foreign banks and 2 local banks of which 4 were large and 7 were small based on deposits. In addition, 4 of the banks were primary dealers and 7 were non-primary dealers.

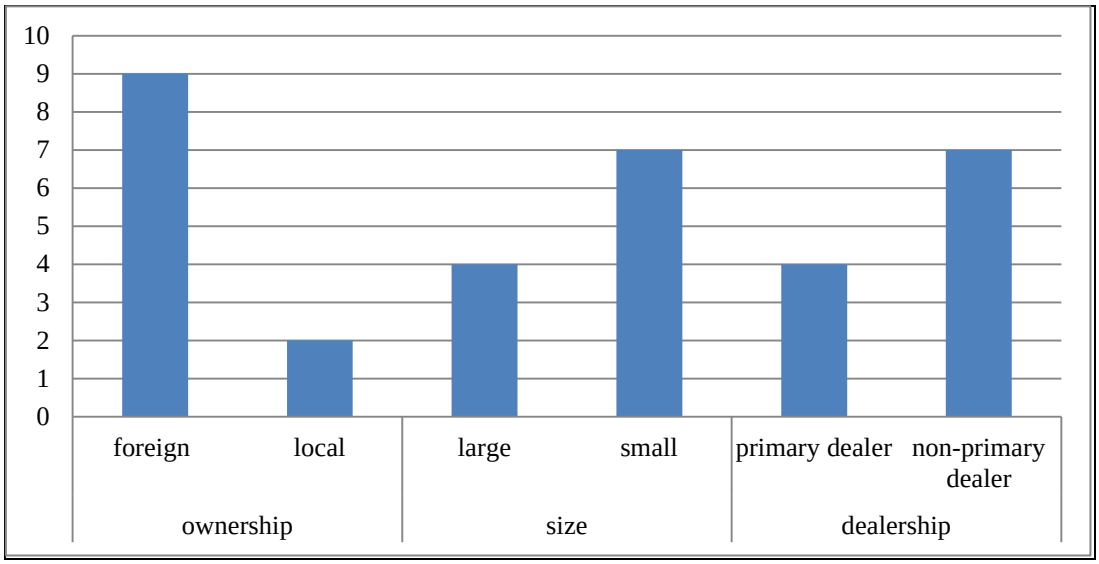

Figure 1: Distribution of banks by ownership, size and primary dealership status

Besides the dummy variables, sometime-varying covariates were used in the analysis consisting of a measure of the opportunity cost of holding securities, capitalization, deposit liabilities, loan assets, and reserve adequacy. The opportunity cost of holding securities was measured as the spread between the monthly average 7 day interbank rate which is the rate at which banks lend to each other and the rediscount rate. On average, the 7-day interbank rate was lower than the rediscount rate by 282 basis points reflecting the punitive nature of the rediscount rate. However, as shown by the maximum value of the spread, there were instances when funds in the interbank market dried up to the extent of the interbank rate exceeding the rediscount up to a maximum of 222

basis points during the period of analysis. Overall, there were three months (July 2009, January 2012 and March 2012) when the interbank rate exceeded the rediscount rate. In the 2012 period, the BOU had commenced easing after having hiked interest rates to curb inflation. The July 2009 high interbank rate could have been associated with the usual beginning of financial year tight liquidity conditions associated with delays in the release of funds to Government agencies as Government waits for parliamentary approval of the budget.

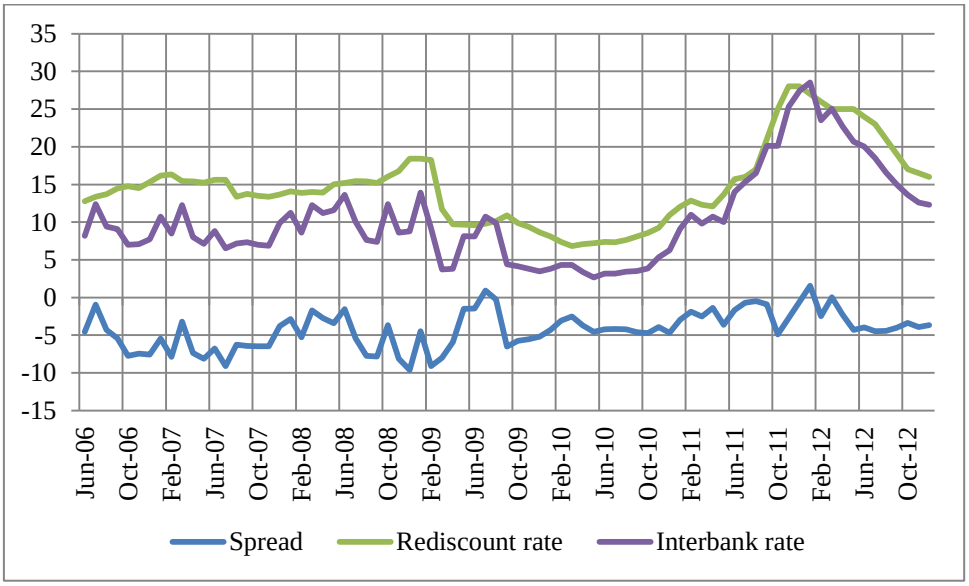

Figure 2: Evolution of the rediscount and interbank rates and the spread between the rediscount and interbank rates (percent)

Capitalization was measured as the ratio of tier 1 capital to total assets. Deposit liabilities were measured as the ratio of deposits to total liabilities and loan assets were measured as the ratio of loans to total assets. On average, most of the liability side of bank's balance sheets was comprised of deposits estimated at 71 percent of the total. Reserve adequacy was measured as the ratio of reserves to assets. As shown in Table 1, bank's reserves comprised on average about 9 percent of total assets and they ranged between 4 percent and 16 percent.

Table 1: Descriptive statistics of the time-varying determinants of bank securities' survival time

Variable	Mean	Std. Dev.	Min	Max
Spread	-2.82	2.5446	-9.69	2.22
Capitalization	0.09	0.0300	0.04	0.39
Deposit liabilities	0.71	0.1122	0.22	0.85
Loan assets	0.41	0.1017	0.18	0.60
Reserves	0.09	0.0264	0.04	0.16

Source: Author's computations

The dependent variable was the survival time of liquidated securities. The Kaplan Meier (KM) survival estimates show the survival rate of liquidated securities over time in Figure 3. As shown by the figure, the

survival rate of liquidated securities past 5 months is about 75 percent. The survival rate falls fairly fast to about 50 percent beyond 10 months and then falls at a slower pace to about 35 percent past 15 months and 25 percent past 20 months. There are no surviving securities beyond 47 months.

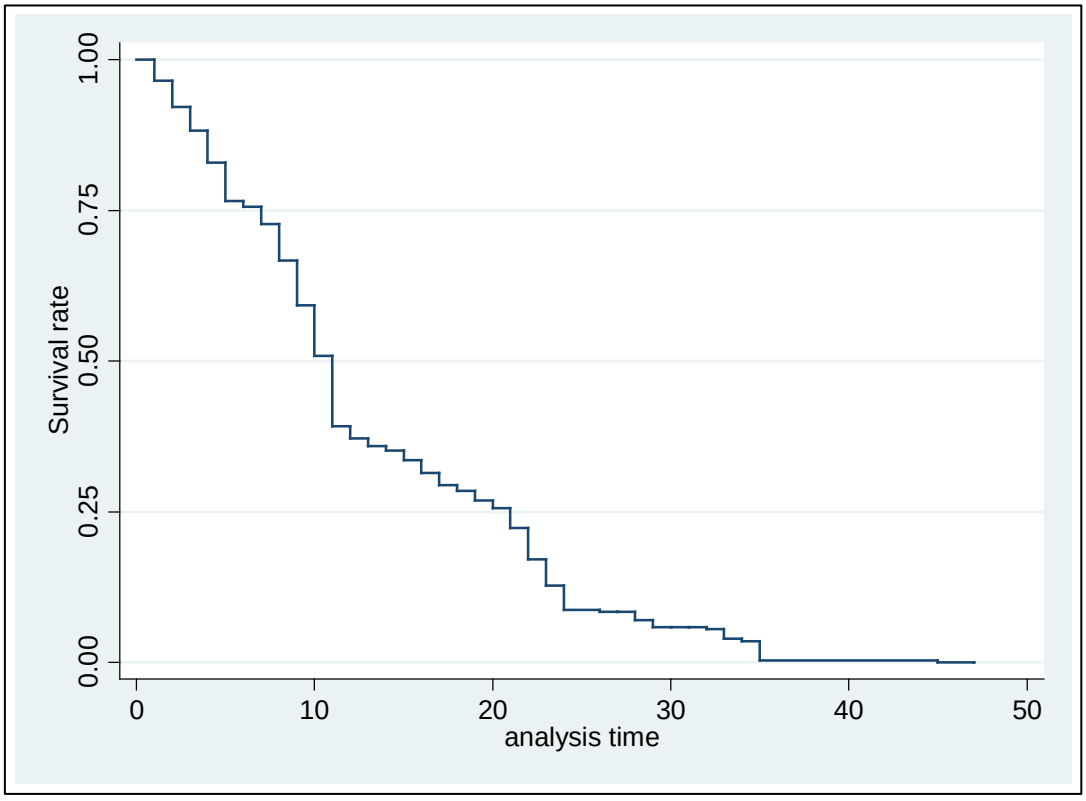

Figure 3: KM survival estimate of securities

3.2. Methodology

The variable of interest is the duration of securities defined as the length of time or spell that elapses from issuance of the security until it is liquidated. The observations are therefore comprised of durations $t_1, \ldots, t_n$ which are based on the time to liquidation. A hazard function can be estimated to establish the determinants of the rate at which spells are completed after time t +Δt (i.e. the security is liquidated at time t +Δt) given that they last until T (they have been held until time T).

3.2.1. Cox proportional hazard model

The hazard function used for the analysis was modelled first as a Cox Proportional Hazards model [18] with the hazard taking the form

$$h(t) = h_o(t)\exp(\beta_1 x_1 + \cdots + \beta_k x_K) \quad (1)$$

$h_o(t)$ is the baseline hazard and $\beta_1, \ldots, \beta_k$ are the coefficients of the respective k covariates $x_1, \ldots x_k$. For purposes of analysis the coefficients as opposed to hazard ratios were reported. The covariates included in Equation (1) were primary dealership which takes on a value of 1 if the security was liquidated by a primary dealer or 0 if not, ownership which takes on a value of 1 if the security was rediscounted by a bank that is foreign owned and 0 otherwise and security type which takes on a value of 1 if the security liquidated was a treasury bill and 0 if it was a treasury bond. Banks, whose majority shareholders were foreign, were classified as foreign owned banks.

The variables reflecting primary dealership status, ownership and type of securities remained unchanged during the analysis period. However, other variables considered varied over the period of analysis. For such variables, the hazard ratio may not be constant over the period of analysis and as a result the proportional hazards assumption may be violated. Subject to the proportional hazards test results, the Cox proportional hazards model was modified to include time dependent variables as follows:

$$h(t) = h_o(t)\exp\{\beta_1 x_1 + \cdots + \beta_k x_K + g(t)(\Upsilon_1 z_1 + \cdots + \Upsilon_m z_m)\} \quad (2)$$

where $z_1, \ldots, z_m$ are m time-varying covariates and $\Upsilon_1, \ldots, \Upsilon_m$ are the coefficients for the covariates $g(t)(z_1), \ldots, g(t)(z_m)$ that are a function of current time. The time varying covariates included in the model were profitability, capitalization, deposit liabilities, loan assets, and the opportunity cost of holding securities.

3.2.2. Accelerated failure time models

In addition to semi-parametric estimation using the Cox proportional hazards model, accelerated failure time models were estimated for comparison. In the accelerated failure time models, the natural logarithm of survival time t_j is modelled as a linear function of the covariates and takes the following form:

$$\log(t_j) = x_j\beta + z_j \quad (3)$$

where x_j is a vector of covariates, β is a vector of regression coefficients, and z_j is the error with density $f(\cdot)$. The distributional form of the error term determines the regression model. If $f(\cdot)$ is the normal density, then the lognormal regression model is obtained; if $f(\cdot)$ is the logistic density, then the log logistic regression model is obtained and if $f(\cdot)$ is the extreme-value density, then the exponential and the Weibull regression models are obtained.

3.2.3. Competing risks model

To address the competing risks among the alternative options for liquidating securities, the method used by [19] to estimate competing risks regressions was used. The method used by [19] was selected for modelling competing risks because it is easy to see the effects of the covariates compared to the alternative of using the cumulative incidence function. In the formulation, consider the hazard for the event of interest, $h_1(t)$, and that for the competing event, $h_2(t)$. Both hazards can be estimated from available data and when combined form the total hazard that any event will occur equal to $h(t) = h_1(t) + h_2(t)$. As risk accumulates according to h(t),

event times T are observed. Whether these events turn out to be failures of interest (Type 1) or competing events (Type 2) is determined by the two component hazards at that precise time. [19] specified a model of the hazard for the sub-distribution formally defined for failure Type 1 as

$$\bar{h}_1(t) = \lim_{\delta \to 0} \left\{ \frac{P(t<T\leq t+\delta \text{ and event type 1}) | T>t \text{ or} (T\leq t \text{ and not event type 1})}{\delta} \right\} \quad (4)$$

The cumulative incidence function can be obtained as

$$CIF_1(t) = 1 - \exp\{-\bar{H}_1(t)\} \quad (5)$$

where $\bar{H}_1(t) = \int_0^t \bar{h}_1(t)dt$ is the cumulative sub-hazard.

The model for the hazard of the sub-distribution is semi-parametric since the baseline sub-hazard $\bar{h}_{1,0}(t)$ (i.e. for covariates set at zero) is unspecified while the effects of the covariates x are assumed to be proportional.

$$\bar{h}_1(t|x) = \bar{h}_{1,0}(t)\exp(x\beta) \quad (6)$$

Estimation of Equation (6) provides estimates of β or exponentiated coefficients that are sub-hazard ratios. Positive values mean that the effect of increasing the respective covariate is to increase the sub-hazard and thus increase the cumulative incidence function across the board.

Before estimating the Cox Proportional Hazards model, the Schoenfelds residual test was conducted to establish whether the explanatory variables observed the proportional hazards assumption. Comparisons were also made between the different accelerated failure time models estimated to identify the model with the best fit using the Akaike Information Criteria (AIC) and the Log-likelihood estimates.

4. Results

From the data used, the total incidence rate for liquidation of securities was estimated at 0.08 and the distribution of survival time indicated a median survival time of 11 months. A summary of the survival time is shown in Table 2.

Table 2: Summary statistics of survival time

	Time at risk	**Incidence rate**	**Number of subjects**	**Survival time**		
				25%	50%	75%
Total	27,190	0.08	2,074	7	11	21

Source: Author's computations

The test used to evaluate whether the proportional hazards assumption was valid involved testing of the nonzero slope in a generalized linear regression of the scaled Schoenfeld residuals on time [20]. The null hypothesis of

the test is equivalent to testing that the log hazard ratio function is constant over time. The rejection of the null hypothesis indicates a violation of the proportional-hazards assumption.

Table 3: Schoenfelds residual test for the proportional hazards assumption

	Rho	**Chi2**	**df**	**Prob > Chi2**
Primary dealership	-0.029*	1.65	1	0.199
Foreign ownership	-0.028*	1.37	1	0.241
Security type	0.099	27.11	1	0.000
Capital adequacy	-0.023*	1.17	1	0.279
Deposit size	0.129	37.74	1	0.000
Loan size	0.039	3.63	1	0.056
Reserve adequacy	0.046	3.64	1	0.056
Spread	0.002*	0.01	1	0.923

Source: Author's computations

Notes: * indicates that the variable does not violate the Cox proportional hazards assumption

The test results as shown in Table 3 indicate that the proportional hazards assumption was not violated by four variables (primary dealership, foreign ownership, capital adequacy and the spread between the interest rate and the rediscount rate) out of the nine identified variables for the model. The other 4 variables (type of security, deposit size, loan size, and reserve adequacy) violated the proportional hazards assumption.

4.1. Determinants of duration using the Cox proportional hazard model

Since the proportional hazards assumption was violated by five of the nine explanatory variables, a cox proportional hazards model was estimated in which the variables that violated the proportional hazards assumption were included as time varying covariates. In addition, although the capital adequacy variable did not violate the proportional hazard assumption, it was included in the model together with the other time varying covariates since it is known that capital changes did occur during the period of analysis. The results of the Cox proportional hazards model with time varying covariates are as shown in Table 4.

The results showed that primary dealership significantly reduces the risk of liquidation of securities. The duration of securities increases by 0.30 percent when they are held by banks that are also primary dealers. However, this result is contrary to conventional wisdom since the expectation is that primary dealers may hold more securities than they actually require for their own purposes as they have to take on the role of market makers. It would therefore be expected that primary dealers rediscount or borrow against securities bought for market making purposes which are not taken up by the market. The result of an increasing duration of securities where holders are primary dealers is therefore surprising.

Similarly, an increase in the spread between the rediscount and market interest rate leads to an increase in the

duration of a security of 0.07 percent. Again this result is strange since the expectation is for the holder of a security to liquidate it if the opportunity cost of holding it increases. Therefore, the duration of a security should reduce as the spread increases. The effects of these two determinants are revisited under alternative specifications that follow.

Table 4: Cox proportional hazards model for the determinants of the duration of securities

	Estimates with Robust standard errors
Main variables	
Primary dealership	-0.30
	[0.0608]***
Foreign ownership	0.16
	[0.0633]**
Spread	-0.07
	[0.0086]***
Security type	2.08
	[0.0703]***
Time varying covariates	
Capital adequacy	-0.35
	[0.0576]***
Loan size	0.05
	[0.0188]**
Deposit size	0.02
	[0.0161]
Reserve adequacy	-0.002
	[0.0470]
No. of observations	2074
Log likelihood	-13359.58

Source: Author's computations

Notes: Coefficients and not hazard ratios are reported. Robust standard errors are reported in the parenthesis; * is significant at 10 percent; ** is significant at 5 percent; and *** is significant at 1 percent.

The findings showed that foreign ownership of a bank reduced the duration of a security. The duration of securities held by foreign banks fell by 0.16 percent. This is also another unexpected result given that foreign banks tend to have better access to funds through their large international networks and are generally well capitalized. They are also able and indeed tend to attract and retain experienced and better skilled staff in their treasury departments to manage their funds more efficiently compared to domestic banks. These two factors

would be expected to contribute to the reduced need for liquidation of securities among foreign owned banks and thus result in an increase in the duration of securities held by foreign banks.

The findings also indicated that the duration of securities reduced if the securities were treasury bills. This result is consistent with the expectation of securities with shorter maturities having a higher likelihood of liquidation compared to those with longer maturities. In addition, the regulatory requirement for liquidation of securities through rediscounting only if they have 91 days or less left to maturity makes shorter term securities more readily available to banks for rediscounting purposes when the need arises.

Other findings from the estimation were consistent with the theoretical expectations. For instance, an increase in the capital adequacy of banks leads to an increase in the duration of securities. The results indicate that an increase in capital adequacy of one percent leads to an increase in the duration of securities of 0.35 percent. This result supports the argument that banks with sufficient capital are less likely to face funding shortages that would necessitate the liquidation of some of their assets including securities. Therefore it would be expected that the duration of securities increases as capital adequacy increases.

An increase in the share of loans to a bank's total assets reduces the duration of a security. The estimates show that an increase of 1 percent in the loan assets of a bank reduces the duration of its securities by 0.05 percent. Indeed it is expected that as loan assets of a bank increase, the risk of default or delayed repayments increases which puts pressure on its liquidity management. The result could also mean that banks may liquidate some of their securities to meet loan demand. The two factors would have the effect of lowering the duration of securities as loan assets rise.

The results did not provide any evidence in support of significant effects of changes in bank's deposits and reserves on the duration of the securities. Theoretically, it is expected that these covariates should be important determinants of the duration of securities given their implications on a bank's asset and liquidity management and generally its financial condition. The absence of significant effects of the two variables (deposits and reserves) is also revisited under alternative specifications in the sections that follow.

4.2. Determinants of survival time using accelerated failure time models

The influence of some important variables on the duration of securities such as the reserve adequacy, share of deposits to total liabilities and profitability could not be determined from the Cox Proportional Hazard models. However, the three variables are important for the day-to-day management of a bank as they affect its liquidity needs and asset allocation. In addition, some of the findings from the Cox proportional hazards model such as the effect of primary dealership, foreign ownership, and spread were counter intuitive. Alternative models based on parametric specification were subsequently estimated to establish whether the results would get altered. The accelerated failure time models estimated included the Exponential, Weibull, Log-normal and Log-logistic distributions. Table 5 shows the coefficients presented in accelerated failure time form.

Table 5: Accelerated failure time models for the determinants of survival time of securities

Variable	Exponential	Weibull	Lognormal	Log logistic
Primary dealership	0.02	0.07	-0.09	-0.01
	[0.0429]	[0.0316]**	[0.0584]	[0.0620]
Foreign ownership	0.01	0.02	-0.01	0.02
	[0.0430]	[0.0304]	[0.0591]	[0.0637]
Spread	0.03	0.03	0.03	0.04
	[0.0043]***	[0.0035]***	[0.0058]***	[0.0052]***
Security type	-0.97	-0.99	-0.95	-0.95
	[0.0256]***	[0.0214]***	[0.0351]***	[0.0308]***
Capital adequacy	1.06	1.51	-0.02	1.08
	[0.5347]**	[0.3709]***	[0.7125]	[0.7853]
Loan size	-0.51	-0.54	-0.42	-0.55
	[0.1346]***	[0.1117]***	[0.1754]	[0.1671]***
Deposit size	0.81	0.54	1.08	1.11
	[0.1385]***	[0.1211]***	[0.1727]***	[0.1715]***
Reserve adequacy	-0.56	-0.87	0.27	-0.48
	[0.4557]	[0.3705]**	[0.6310]	[0.5704]
Constant	2.58	2.84	2.29	2.32
	[0.1205]***	[0.1096]***	[0.1546]***	[0.1457]***
No. of observations	2074	2074	2074	2074
Log likelihood	-2418.33	-1721.96	-2089.86	-1995.22
AIC	4854.60	3464.88	4179.6	3998.74

Source: Author's computations

Notes: Robust standard errors are used for all models and are reported in parenthesis; * is significant at 10 percent; ** is significant at 5 percent; and *** is significant at 1 percent. The coefficients are presented in accelerated failure time form.

The results did not vary significantly between the different models, although some variables that were significant in the Weibull distribution model were not in the other models. In addition, the findings were for the most part similar to those based on the Cox proportional hazards model. For discussion purposes, an assessment of the different models was done to determine the best model. Based on the log-likelihood estimate, the largest value was for the Weibull model. In addition, the AIC indicated that the Weibull model had the best fit as it had the lowest AIC value. The discussion of the parametric estimates was therefore based on the results from the Weibull model.

The estimates from the Weibull model show that primary dealership increases the survival time of a security. This finding is consistent with the result from the Cox proportional hazards model. In addition, an increase in

the spread leads to an increase in the survival time of a security. Similarly, an increase in a bank's capital leads to an increase in the duration of a security. On the other hand, survival time is reduced if a security is a treasury bill. Further, increases in loan assets of banks lead to a decrease in the duration of the securities. All of these findings are comparable to those obtained using the Cox proportional hazards model.

However, results from the Weibull model did not provide any evidence in support of significant effects of foreign ownership on the survival time of securities contrary to the results from the Cox proportional hazards model. Nonetheless, the Weibull model unlike the Cox proportional hazards model, found significant effects of deposit liabilities and reserve assets on the duration of securities. Increases in deposit liabilities result in an increase in the survival time of securities. This finding supports the argument that deposits complement securities when banks need liquidity. Subsequently, liquidity needs met by raising deposits counter the need to liquidate securities increasing their duration. On the other hand, the results indicated that an increase in reserves leads to a reduction in the duration of securities. This result is plausible especially where some of the reserves are raised using funds obtained by rediscounting securities. However, it should be noted that reserves could be raised using alternative sources such as borrowing, mobilizing deposits, and increasing capital. Further, the estimates do not show any evidence of a significant effect of profitability on the survival time of securities.

4.3. Determinants of survival time using a competing risks model

Given some of the contradicting results relative to theoretical expectations and between the parametric and Cox proportional hazards models, additional analysis was done. The additional analysis was conducted using a competing risks model in which the liquidation of a security through its use as collateral for borrowing was treated as a competing risk to rediscounting. The competing risks model was used to estimate the sub-hazard function for the rediscounting failure event as well as the use of a security as collateral failure event. Figures 4 and 5 show the KM survival estimates for the competing risks.

A comparison of Figures 4 and 5 shows that securities face a higher liquidation risk through their use as collateral as opposed to rediscounting. For instance 50 percent of the securities survive the sub-hazard of rediscounting up to 34 months compared to survival up to only 15 months against the sub-hazard risk of use of securities as collateral. The higher hazard rates for securities on account of their use as collateral demonstrates commercial bank's preference of this method for liquidation.

Table 6 shows the estimates obtained from the competing risks model. The competing risk for the estimates provided in the first column of the table is the event of using securities as collateral while in the second column, rediscounting is the competing failure event. The results in the first column show that foreign ownership of a bank, type of security and capital adequacy have the same effect on the rediscounting hazard as that shown by the Cox proportional hazards model.

However, there are a number of results shown by the competing risks model in column 1 that differ from those indicated by both the Cox proportional hazards model and the Weibull model. These include results on the effects of primary dealership, spread, and reserve adequacy on the duration of securities. Primary dealership

results in an increase in the rediscounting hazard of securities under the competing risks model. It is consistent with the theoretical expectation of an increase in the rediscounting hazard for banks that are primary dealers especially in shallow markets or when liquidity is tight.

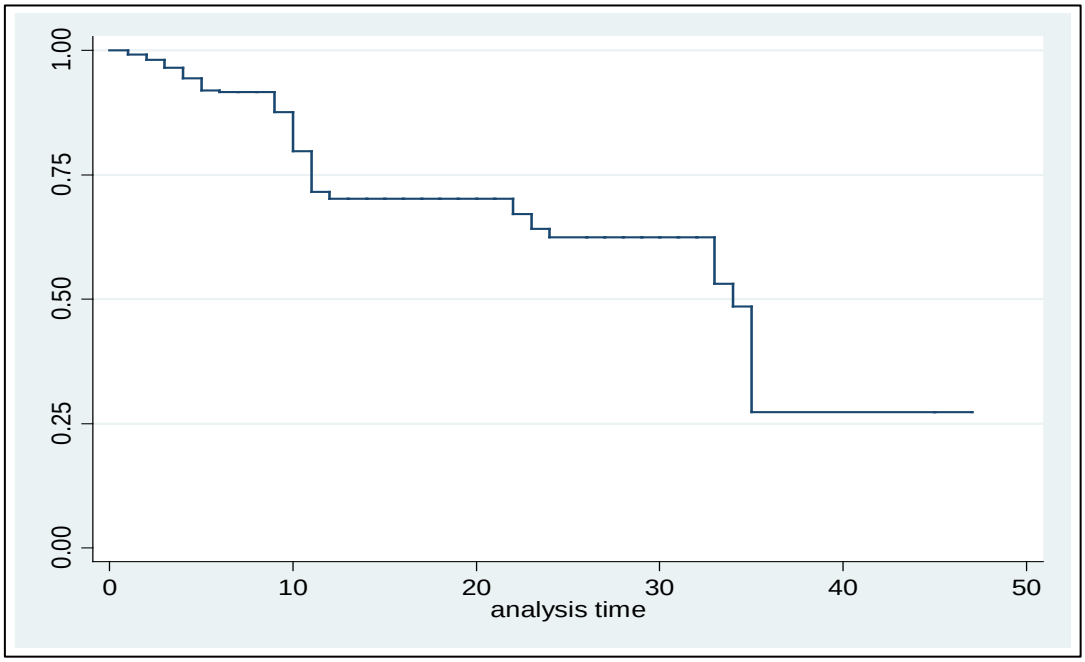

Figure 4: KM survival estimates for the rediscounting sub-hazard

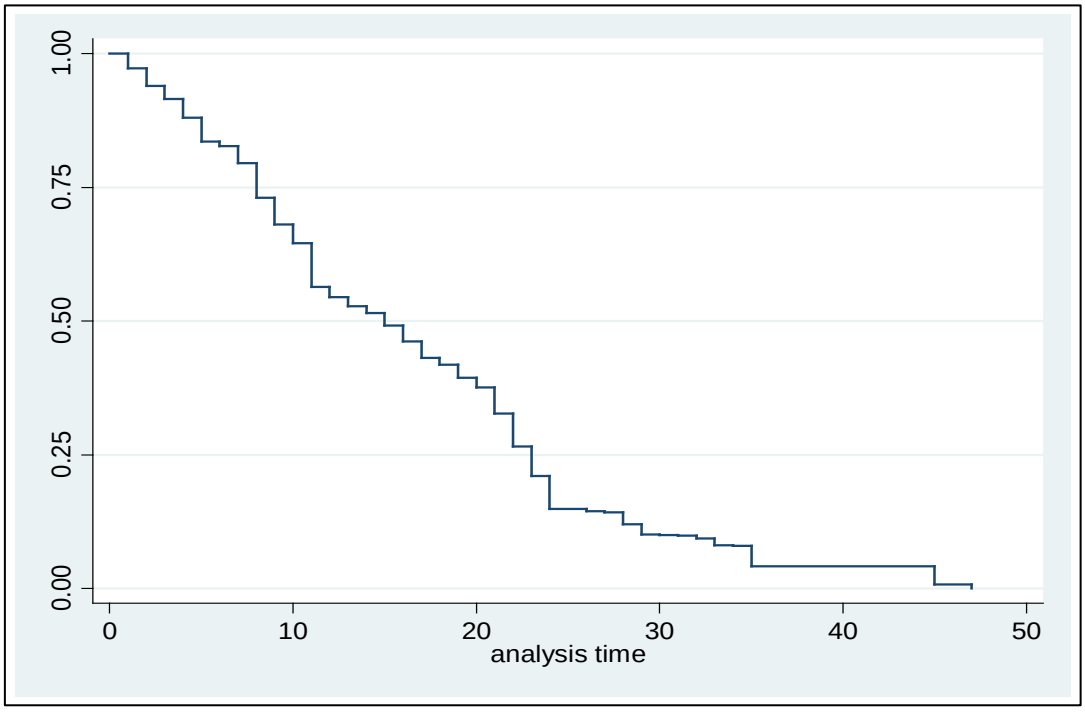

Figure 5: KM survival estimates for the sub-hazard of use of securities as collateral

Table 6: Competing risks model estimates of determinants of survival time of securities

	Competing Event: Securities are offered as collateral	**Competing Event: Securities are rediscounted**
Main variables		
Primary dealership	0.56	-0.22
	[0.1782]***	[0.1033]**
Foreign ownership	1.02	0.12
	[0.2192]***	[0.1186]
Spread	0.10	-0.07
	[0.0180]***	[0.0089]***
Security type	1.96	-0.34
	[0.1166]***	[0.0656]***
Time varying covariates		
Capital adequacy	-0.43	0.40
	[0.1998]**	[0.0767]***
Loan size	0.04	0.10
	[0.0346]	[0.0195]
Deposit size	-0.07	0.04
	[0.0513]	[0.0189]**
Reserve adequacy	0.55	-0.15
	[0.1406]***	[0.0671]**
No. of observations	2074	2074
Log likelihood	-3865.36	-10731.92

Source: Author's computations

Notes: Coefficients and not hazard ratios are reported. Robust standard errors are reported in the parenthesis; * is significant at 10 percent; ** is significant at 5 percent; and *** is significant at 1 percent.

Additionally, an increase in the spread results in an increase in the rediscounting hazard. This result is also consistent with the theoretical argument that an increase in the spread increases the opportunity cost of holding onto the security. Thus as this opportunity cost increases, the securities are rediscounted to invest the funds in alternative investments with higher returns which lessens the duration of the securities. For reserves, the Cox proportional hazard model failed to find any evidence of a significant effect of reserves on the duration of securities. However, the Weibull model showed that increases in reserves reduced the survival time of securities. This finding was confirmed by the competing risks model which showed that an increase in reserves adequacy of one percent resulted in a reduction in the duration of securities of 0.55 percent.

5. Discussion of results

The competing risks model showed that the method used for liquidation mattered. The discussion of the results therefore considers both the aggregate Cox proportional hazard model and the competing risks model. Being a primary dealer bank is associated with a reduced risk of liquidation of securities. This finding contradicts the expectation that being a primary dealer bank should increase the likelihood of liquidating securities owing to their market making role. However, this contradiction could simply be a reflection of the relatively better liquidity positions primary dealer banks. Primary dealer banks are also the largest banks in the banking sector in terms of both deposits and loans partly explaining why they tend to have relatively better liquidity and may therefore have less need for liquidating securities. Indeed, when a competing risks model was used, the results showed that primary dealership increased the risk of liquidation of securities through rediscounting. This contrast in the results may be indicative of primary dealer's sensitivity to liquidity conditions. Under normal liquidity conditions, it is unlikely that primary dealer banks would need to rediscount securities as buyers of securities would be available or lenders in the interbank willing to lend against the securities as collateral would be available. However, under tight liquidity conditions that are systemic, the absence of both buyers of securities and lenders against collateral in form of securities may make the liquidation of securities the only option available for primary dealers. Overall, the results suggest that primary dealer banks are more likely to liquidate their securities through rediscounting. The significance of the effect of primary dealership on rediscounting of securities shown by the competing risks model is consistent with the argument that the secondary market may not have sufficient liquidity to absorb all securities available for sale.

Foreign ownership of banks is associated with an increase in the hazard for liquidating securities. This finding is the same when a competing risks model is estimated for the hazard of rediscounting securities. However, foreign ownership has no significant effect when the hazard for liquidating securities is due to offering securities as collateral for borrowing. This suggests that foreign banks are less likely to borrowing from the Central Bank compared to domestic owned banks. The result corroborates the argument that networks among foreign owned banks including foreign affiliates contribute to improved access to funds for borrowing [17]. The cost of this borrowing from affiliates and other networks may also be cheaper compared to borrowing at the Central Bank. This may also explain why foreign owned banks would be less likely to liquidate their securities through their use as collateral for borrowing from the Central Bank.

An increase in the spread between the rediscount rate and the interbank lending rates results in an unexpected reduction in the overall hazard for liquidating of securities in a Cox proportional hazards model. However, in a competing risks model, the results show that the hazard for liquidating securities through their use as collateral increases as theoretically expected when the spread increases. The estimate of the coefficient for the effect of the spread on rediscounting of securities by banks in Uganda is however lower at 0.07 compared to 0.15 and 0.54 estimated for banks in the USA before and after 1992 respectively by [1]. The size of the effect notwithstanding, the result confirms that profitability is a determinant of rediscounting. The result also suggests that there is a cost benefit from liquidating securities by rediscounting compared to liquidation by offering them as collateral for borrowing. This is indeed confirmed by the difference in the rediscount and bank rates. The rediscount rate is lower than the Bank rate by 100 basis points.

The findings also showed that the hazard of liquidation of treasury bills is higher than that of a treasury bonds. The competing risks model shows that the increase in the hazard for liquidation of treasury bills relative to treasury bonds is valid when the liquidation is through rediscounting. These two results highlight the important influence of the regulatory requirement for rediscounting of securities with 91 or fewer days to maturity. The regulation essentially puts shorter term securities (treasury bills) at an advantage in terms of liquidation compared to longer term securities (treasury bonds).

Improvements in capital adequacy result in a reduction in the hazard of liquidating a security. This result is consistent with the theoretical expectation of the effect of financial strength on the hazard of liquidating securities. The finding is also confirmed by the competing risks model for the hazard for rediscounting which falls as banks improve their capital positions. This finding confirms the contention that well capitalized banks are less likely to face the kind of liquidity shortages that would necessitate liquidating some of their assets. However, [1] found that for banks in the USA, increased financial strength contributed to an increase in the likelihood of liquidation of securities although this was only limited to large banks. For small and medium banks, the effect was not significant.

The estimates also show that as a bank's loan assets increases, the hazard for liquidation of securities increases. This result is consistent with the loan accommodation theory [21] which hypothesizes that banks liquidate their securities to meet loan demand. The result confirms that banks reallocate some of their liquid assets towards provision of loans for their clients. However, increased loans also create other challenges such as increased volatility of cash flows due to delayed repayments by borrowers and debt default which may require liquidation of securities to make up for shortfalls in projected cash flows. In particular, where there is a default, banks are required to provision for the attendant losses which may contribute to the need to liquidate securities.

The aggregate model did not show any effects of deposits and reserves on the hazard for liquidation of securities. However, estimates based on the parametric models and the competing risks models showed significant effects of these variables on the duration of securities. Besides showing that the effects were significant, the results also indicated that the effects were consistent with the theoretical expectations. An increase in deposits resulted in a decrease in the hazard for liquidation of securities. This is to be expected given that increases in deposits improve the liquidity of banks which in turn reduces the need for liquidating securities. Looked at differently, the deposit size of a bank is a reflection of its size and as shown by [1,22], the liquidation hazard of securities decreased with the increase in size of a bank. Reference [1] attributed the finding to the disincentive for liquidating securities that larger banks faced due to their vulnerability to more market scrutiny compared to smaller banks.

In the case of reserves, the parametric and competing risks models showed that as reserves increase, the hazard for liquidating securities increases. There are two possible explanations as to why banks would liquidate their securities to meet reserve needs. The first is due to the requirement for increases in reserves to take effect at very short notice moreover at the same time for all banks. The Central Bank computes reserve requirements every two weeks and all banks are expected to raise the funds required to meet the reserve needs as soon as they take effect. Banks therefore have a very small window to raise their reserves to the required level. Access to funds

through liquidation of securities may be a fairly quick way to address the shortage. The second reason could be associated to the penalties attracted by failure to meet the reserve requirements. Since all banks are required to meet their reserves at the same point in time, borrowing from the interbank can be difficult since all banks have similar requirements of meeting reserves requirements In such a situation, liquidity is tight and therefore foregoing some income on earning assets may be a better alternative to the penalty.

6. Conclusion

In this paper, the determinants of the survival time of securities were investigated. The findings showed that the hazard of liquidation of securities varied depending on whether they were rediscounted or used as collateral for Central Bank borrowing. Bank's increases in deposits and capital lead to declines in the rediscounting hazard and increases in the liquidation hazard of using securities as collateral for borrowing from the Central Bank. On the other hand, improvements in reserve adequacy of banks was associated with an increase in the rediscounting hazard and a decrease in the liquidation hazard of using securities as collateral for borrowing from the Central Bank. In addition, the influence of bank attributes on the liquidation hazard of securities including whether banks are primary dealers or not, and whether they are foreign or domestic owned, depended on the method of liquidation. Banks which were primary dealers had a higher hazard for rediscounting and a lower hazard for liquidation through use of securities as collateral. Foreign banks also had a higher hazard for rediscounting and a lower hazard for liquidation through use of securities as collateral.

The varying effects of the determinants for the different methods of liquidation demonstrate the use of different methods for different motives. For instance, the results suggest that borrowing against collateral of securities was preferred for addressing cyclical liquidity constraints such as falling deposits and capital while rediscounts were used to address transient liquidity needs such as reserves shortages. In effect, disinvestment of long-term securities is penalized at a higher rate through the bank rate relative to short-term securities

The findings indicate that bank level measures aimed at minimizing liquidation of securities to reduce the impact on fiscal and monetary policy are likely to vary depending on the type of liquidation. Nonetheless, the overall hazard for liquidating securities could be reduced by lowering the opportunity cost of holding securities which can be achieved through an increase in the rediscount rate whenever it is necessary to tighten liquidity. General improvements in bank's financial strength including increased capital and reserves adequacy and efficiency are other important policies that could constrain liquidation of securities. Further, in the presence of serious persistent liquidity shortages, banks would still access funds at the bank rate the higher cost notwithstanding. It seems that having a lower rediscount rate relative to the bank rate especially where government policy is aimed at increasing long-term domestic debt relative to short-term domestic debt could be counterproductive. Where it is clear that there is a systemic liquidity crunch, it may be warranted for special access to credit at a rate that is equal to the rediscount rate. The limitation of the study was the omission of the effect of regulatory policy effects, political and geographical effects in the model due to failure to get relevant data.

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