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Measuring bank risk-taking behaviour

The risk-taking channel of Monetary Policy in Malaysia

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Measuring Bank Risk-taking Behaviour: The Risk-taking Channel of Monetary Policy in Malaysia

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Abstract

Using a proprietary micro-dataset on loan defaults in Malaysia, we introduce a simple fixed effects model to extract a measure of bank lending standards from the observed default rates of loan portfolios. We then use this measure to investigate the risk-taking channel of monetary policy in a panel fixed-effects regression. We find limited evidence of the risk-taking channel of monetary policy in Malaysia. This could in part be a reflection of the effects of a pre-emptive monetary policy stance and the implementation of policies from a broader toolkit in leaning against financial imbalances in Malaysia.

Keywords: bank lending, risk-taking channel, monetary policy

JEL classification: E50, E52, G21

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Contents

1. Introduction

One of the key roles of the financial system is to intermediate funds efficiently and to allocate resources in a risk-informed manner towards productive uses in the economy. The Global Financial Crisis of 2008-09 highlighted misalignments in the financial system that distorted the incentives of financial institutions from serving this function effectively.[3] Indeed, the softening lending standards of banks has been argued to be one of the contributing factors of the crisis, amid an environment of prolonged loose monetary policy, weak supervision standards and rampant securitisation activity in several major advanced economies.[4] This risk-taking behaviour by banks fuelled unsustainable growth in asset prices and facilitated a build-up in leverage that ultimately unravelled in a disorderly manner.[5] This line of argument gave impetus to new strains of theoretical and empirical literature on the risk-taking behaviour of banks and its interaction with monetary policy.

The 'risk-taking channel of monetary policy', coined by Borio and Zhu of the BIS, refers to the impact of policy rate changes on risk perceptions or risk-tolerance. Under this channel, prolonged low levels of interest rates could lead to higher riskiness of portfolios, mispricing of assets, and looser price and non-price terms in the extension of funding.[6] There are several hypotheses on how bank risk-taking behaviour interacts with monetary policy. This includes through the misperception and mispricing of risks amid excess liquidity and inflated asset prices, sensitivity of bank behaviour to prudential regulatory requirements, exacerbated agency issues, and nominal frictions in expected investment returns leading to 'search for yield' behaviour.[7] On the other hand, some studies argue for the opposite effect of tight monetary policy encouraging bank risk-taking. Reasons for this line of argument include high interest rates increasing the attractiveness of risky assets due to higher opportunity cost of holding cash buffers and high interest rates reducing the net worth of banks, inducing banks to "gamble for resurrection".[8] Given competing theories, the net effect of monetary policy on bank risk-taking is thus an empirical question.

Naturally, there is great interest among regulators to monitor the risk-taking behaviour of banks and to understand the nexus between monetary policy and bank risk-taking. The foremost challenge is to measure banks' risk-taking behaviour, a key aspect of which is the loan underwriting standards (used interchangeably with lending standards) of banks. Bank loans account for more than 60% of private sector domestic debt-based financing in Malaysia, hence bank risk-taking through changes in underwriting standards could have significant implications on financial stability and the broader macroeconomy. This paper makes three key contributions. Firstly, we

3 Misalignments of incentives can arise from financial institutions being "too big to fail" and having "no skin in the game", among others. See Goldstein and Veron (2011) and Taleb and Sandis (2013).

4 See Taylor (2008), Allen and Carletti (2009), Acharya and Richardson (2010) and Rajan (2010).

5 The dynamics of credit-driven cycles are explored in Borio and Lowe (2002) and Schularick and Taylor (2010).

6 Borio and Zhu (2008). See also Adrian and Shin (2009), Brunnermeier et al (2009) and Shin (2009).

7 See Stiglitz and Greenwald (2003), Rajan (2005), Dell'Ariccia and Marquez (2006), Allen and Gale (2007), Diamond and Rajan (2009), Acharya and Naqvi (2012) and Adrian and Shin (2010).

8 See Kane (1989), Hellman et al (2000) and Smith (2002).

introduce a simple and flexible method of computing bank lending standards that could be widely applicable given the relatively light data requirements. Secondly, we provide a measure of Malaysia's retail bank lending standards. Thirdly, we use the estimated measure of lending standards to explore some of the hypotheses on the risk-taking channel of monetary policy for Malaysia.

In the empirical literature studying the effects of monetary policy on bank risk-taking, there are two main approaches to measuring bank lending standards, differentiated by the source of data used. The first approach uses survey data of bank loan officers, most commonly the Federal Reserve Senior Loan Officer Opinion Survey (SLOOS) and the Euro Area Bank Lending Survey (BLS). Survey responses are used to construct indices that capture various aspects of bank lending standards, which are subsequently verified against other proxies of bank risk-taking and regressed against a host of factors to identify the determinants of bank risk-taking behaviour.[9] The second approach utilises large micro-datasets, typically centralised credit registers containing detailed credit information at the individual and account level. This approach is less common due to the unavailability of and restricted access to such datasets. Within this approach, two ex-post performance measures are common - the observed defaults of loans and the time to default of loans, usually analysed within standard probit or logit discrete choice models or hazard-based duration models.[10]

Fewer studies have incorporated and compared both approaches. In a recent study, Vojtech, Kay and Driscoll (2016) are the first to match individual bank responses from the SLOOS with mortgage application information from the Home Mortgage Disclosure Act (HMDA). The authors also use geographical variation in the Lender Processing Services Applied Analytics (LPS) database to study if delinquency rates were correlated with lending standards as indicated by the SLOOS. The results showed that areas with higher exposure to banks with tightening lending standards also had significantly lower delinquency rates two years after the tightening, suggesting that lending standards are an important determinant of the credit quality of bank loans. This finding provides support for our methodology.

Using micro-data from the Central Credit Reference Information System (CCRIS), a credit register database administrated by Bank Negara Malaysia (BNM) containing account-level credit information on all borrowers from all banks in Malaysia[11], we extract a measure of bank underwriting standards for retail borrowers in Malaysia using the observed default rate (ODR) of loans.[12] As this measure is also intended as an indicator for surveillance, our empirical approach is guided by three key considerations. Firstly, as a surveillance indicator, the measure needs to be timely.

9 See Maddaloni and Peydró (2010), Buch et al (2014), Bassett et al (2012) and Koen and Hoeberichts (2013).

10 See Jiménez et al (2008), Ioannidou et al (2009) and Bonfim and Soares (2013).

11 Coverage encompasses all 65 licensed commercial, Islamic, investment and development banks, and 10 large non-bank financial institutions. The system has records on approximately 9 million borrowers and contains details on the profile of the borrower, credit applications and credit accounts.

12 The reason corporate loans are excluded from this study is due to the nature of such loans in Malaysia. Corporate loans are less homogenous in characteristics and tend to display more idiosyncratic behaviour, with long-term corporate-bank relationships playing an important role in financing decisions. This renders the simplifying assumptions in our model less appropriate for corporate loans. To study the behaviour of bank risk-taking in corporate loans, a method that fully exploits account level information is more appropriate.

Secondly, related to the first consideration, we exercised preference for parsimony in the data requirements of the model. Thirdly, the method should be replicable and easily interpreted for difference slices of the data, so as to preserve the flexibility of our measure.

Extending a vintage analysis (VA) framework, we propose a simplified fixed effects model (referred to as the DUMS default rate model[13]). The key assumption is that after controlling for performance year and months-on-book (MOB) fixed effects, variation in ODR between different cohorts primarily reflect differences in underwriting standards. The model meets our key considerations - it requires only the ODR and several time dimensions for estimation; the data is reported on a monthly basis; and given that CCRIS represents the population, the model can be replicated and interpreted for different subsets of the dataset. Using this measure of lending standards, we then investigate the risk-taking channel of monetary policy via a second-stage panel fixed effects regression. We find limited evidence of the risk-taking channel of monetary policy in Malaysia.

The rest of the paper is organised as follows. Section 2 outlines the empirical strategy and data in more detail. Section 3 presents the results and section 4 elaborates on limitations and further work. Finally, section 5 concludes.

[13] The reason for the name will be apparent in section 2.

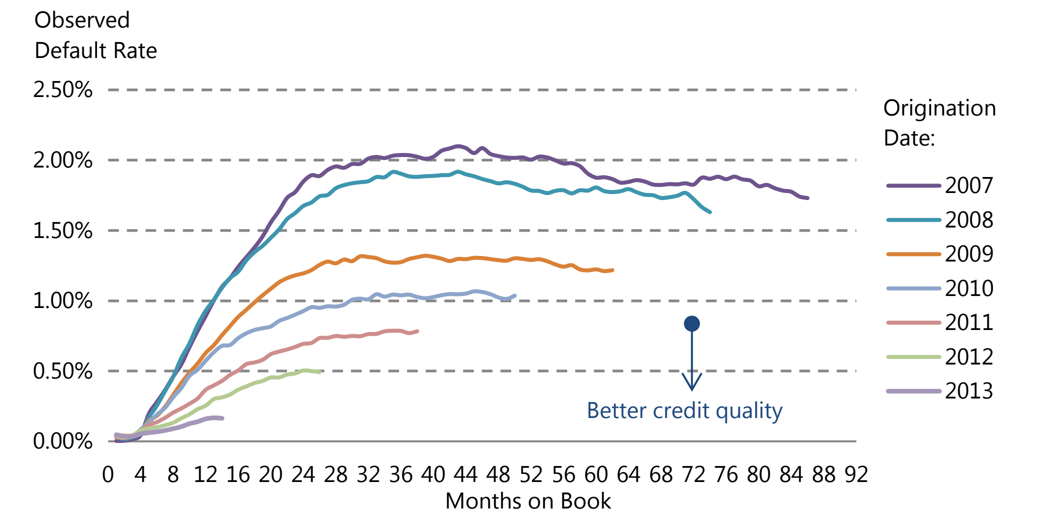
2. Empirical Strategy and Data

DUMS Default Rate Model

Our approach begins with a VA framework, based on the underlying premise that there is a direct relationship between ODR and the underwriting standards of banks. In a standard VA, loans are first segmented based on their origination date (vintage). The ODR of each vintage is then tracked over the age of the cohort (MOB) and arranged into a triangular dataset, with origination date on one axis and MOB on the other. Holding constant the age of the loan, a lower ODR for a given cohort is then interpreted as a sign of better credit quality.

Example of Vintage Analysis

Figure 1



Beyond MOB effects, if the remaining variation in default rates is driven solely by bank lending standards, then a VA would suffice to measure lending standards. However, there are other factors that affect loan defaults, such as the macroeconomic cycle, the type of loan (e.g. retail vs corporate) and consumer behaviour (e.g. retail mortgages typically default last among all retail loans). Guided by the VA framework, we propose the DUMS default rate model which characterises the default rate as being driven by three main factors, in the following form:

$$D_{ij} = D_0 U_i M_j S_{(j-i)} \varepsilon_{i,j} \tag{1}$$

where,

D_{ij} is the default rate of origination cohort *i,* at time *j*;

D_o is the cycle neutral default rate;

U_i is the underwriting standards for origination cohort *i,* which capture both borrower and bank characteristics as well as macroeconomic variables such as monetary policy at the point of origination. This factor corresponds to origination date in VA;

M_j captures variation in the macroeconomic cycle at time *j,* including changes in borrower characteristics post-origination;

$S_{(j-i)}$ is the seasoning effect of a loan cohort after being seasoned by *(j-i)* periods. This factor corresponds to the MOB variable in VA; and

$\varepsilon_{i,j}$ is the idiosyncratic error term.

Equation 1 captures the compounding effect that different factors can have on the default rate. For example, if loose lending standards result in low borrower creditworthiness for cohort i (captured by U_i), should there be a negative macroeconomic shock in the period j (captured by M_j), one would expect borrowers in this cohort to be more affected by the shock than borrowers in cohorts with higher creditworthiness. In other words, D_{ij} would decrease, and by more than $D_{i'j}$. We also control for further variation in default rates by applying the model separately for loans of different purposes.

Using a log-transformation, we estimate the DUMS model using ordinary least squares (OLS):

$$\log(D_{i,j}) = D_0 \; + \; \beta U_i + \partial M_j + \gamma S_{(j-i)} + \varepsilon_{i,j} \tag{2}$$

where U_i, M_j and $S_{(j-i)}$ are vectors of dummy variables, respectively for each individual cohort origination date (i), performance year (j), and MOB (j-i). This specification indirectly accounts for all factors that are unvarying for a given cohort, performance year, and months-on-book, without having to explicitly specify individual factors. For instance, a negative shock to GDP that causes defaults to increase in period 'a' would be captured by dummy variable M_a, while a change in regulation that causes tightening in underwriting standards in period b would be accounted for by dummy variable U_b. In this way, this specification offers a condensed form as a simplified alternative to those in the literature. Our measure of underwriting standards is then obtained from β, the estimated coefficients for the vector of dummies U_i.

A key challenge in measuring bank risk-taking is identification as measures of underwriting standards typically reflect the confluence of both supply and demand factors. To study the risk-taking behaviour of banks, it is often necessary to disentangle changes in the demand for loans from changes in the supply of loans. Specifically, it would be ideal to isolate the component of underwriting standards that reflects only intended risk-taking by banks. To illustrate, when interest rates are low, investments which were previously not financially viable could become profitable given the lower cost of credit, thus increasing the demand for credit. Such loans could have a higher risk profile than the existing loan portfolio, given the relatively lower returns on investment.[14] Similarly, when interest rates are low, the resulting boost to net worth could make an otherwise non-creditworthy borrower appear creditworthy. Both these cases could lead to banks approving loans with relatively higher default rates, yet do not necessarily imply greater intended risk-taking by banks. In cases where loans are observably of higher risks, banks may fully account for these risks in the pricing or terms and conditions of the loan, in line with a consistent level of risk appetite. In cases where higher risks are not observed by banks, including when

[14] However, this is not necessarily the case. Kashyap and Stein (2000) show that lower rates lead to increase in credit demand, but not necessarily only from risky borrowers.

masked by inflated incomes and asset prices, the greater risks taken on by banks could be unintended.

Studies using survey data largely rely on vector-autoregression-based identification strategies to isolate the component of variation in standards that are orthogonal to the determinants of loan demand.[15] For studies using micro-datasets, the common approach is to control for demand factors at the loan level by including a host of variables to capture macroeconomic factors, borrower characteristics, bank variables[16], and loan features. The remaining variations in lending standards are then interpreted as supply-driven. To distinguish between intended and unintended bank risk-taking, these studies also compute corroborating ex-ante measures of bank risk-taking using variation in borrowers' credit history at the time of application.[17]

The DUMS model does not in itself address the issue of identification. As highlighted above, the vector β captures all cohort-specific variables, including demand factors. This means that our measure of underwriting standards could show deterioration due to risks that are either accounted for by banks in the pricing and terms of the loan or unintentionally taken on, or due to banks deliberately increasing their risk appetite, approving loans which they would have otherwise rejected.

The DUMS model also makes the trade-off between data requirements of the model and the scope for direct inference. The model minimises the amount of data required for estimation, at the expense of a limited scope for immediate inference. For example, in contrast to common specifications in the literature, the DUMS model does not allow for immediate comparison of the relative importance of GDP and interest rates in influencing the default rate, as the variables of interest would be subsumed under the relevant fixed effects dummies along with other factors. In this sense, the DUMS model does not replace existing specifications in the literature, rather, it offers a pragmatic midway approach between using banks' ODR directly as the measure of underwriting standards and estimating data-intensive models with full specification of variables of interest.

Second-Stage Panel Regression

To address the two limitations of the DUMS model raised above, we attempt to expand the scope for inference and pursue more rigorous identification of supply-driven changes in standards through second-stage regressions. Using a panel regression with fixed effects for each bank, we regress the estimated underwriting standards of individual banks against relevant cohort-related macroeconomic, loan and bank variables, to partial out demand-driven changes in the series. We do not include time fixed-effects as the variation we want to study - the response of

15 See Lown and Morgan (2006), Ciccarelli et al (2010), and Cappiello et al (2010). Using a different strategy, Bassett et al (2012) utilised variation in individual bank responses to partial out changes in standards that are due to demand factors.

16 Changes in bank-specific characteristics could reflect both purely exogenous reasons (e.g. business decision by banks) and partly endogenous reasons (e.g. economic shocks that influence loan demand). Hence, separating out the effects of bank characteristics from the remaining variation in lending standards could lead to an understatement of the degree of exogenous or supply-driven changes in banks' underwriting standards (Bassett et al, 2012).

17 See, for example, Jiménez et al (2008) and Ioannidou et al (2009).

standards to monetary policy - is time-varying and common to all banks. While identification is conducted at the aggregate level, thus discarding variation at the individual loan level, the loss of efficiency and accuracy in estimation arising from this is muted given the current limitations of the CCRIS database.[18]

Following the empirical approach of Jiménez et al (2008) and Ioannidou et al (2009), our second-stage regression is specified as follows:

$$U_{t,b} = c_b + \theta_1 MP_{t-1} + \theta_2 Macro_{t-1} + \theta_3 Bank_{t-1,b} + \theta_4 Loan_t + \varepsilon_{t,b} \quad (3)$$

where,

$U_{t,b}$ is the measure of bank b's underwriting standards in period t, where t refers to the origination date for each cohort (corresponding to β in the DUMS model);

MP_{t-1} is the main variable of interest, capturing monetary policy in the period prior to the origination of the loan cohort. A negative coefficient would suggest evidence of the risk-taking channel of monetary policy;

$Macro_{t-1}$ are macroeconomic control variables common to all banks in the period prior to the origination of the loan cohort;

$Bank_{t-1,b}$ are bank characteristics for bank b in the period prior to the origination of the loan cohort; and

$Loan_t$ are loan characteristics of the loan cohort.

The existing literature also finds evidence that changes in bank risk-taking behaviour in response to monetary policy could differ depending on bank characteristics such as the liquidity and capital positions of banks. As such, we also include interaction terms between monetary policy and bank characteristics to capture potential non-linear effects.

We estimate the panel regression using a cross-section SUR generalised least squares weights specification, which allows for conditional correlation between heteroskedastic contemporaneous residuals for the cross-section of banks, but restricts residuals to be uncorrelated between different time periods. To estimate the coefficient covariance, we use the cross-section SUR panel corrected standard error (PCSE) methodology without the leading degree of freedom correction term.

18 While the CCRIS database is information-rich in many dimensions, there are gaps in key identifying characteristics, most crucially for this study, the income of the borrower and the pricing of loans at the time of approval. This poses a challenge to model the determinants of default rates at the individual loan level as the income of the borrower would constitute a significant omitted variable. At best, borrower income can be accounted for by an aggregate proxy measure, which is what we do in the second-stage panel regressions. Efforts are currently underway to close these gaps, either through the expansion of the scope of CCRIS or by merging CCRIS with granular income databases of other institutions.

Data

Our sample spans nine years, from January 2007 to December 2015. While data is submitted monthly, extraction was based on quarterly cohorts in view that underwriting standards are structural and not expected to change frequently. The performance of each cohort is then tracked monthly. Separate extractions are carried out for each loan purpose - residential property, personal use, passenger cars and non-residential property.

The definition of default follows the international standard of loans with repayment in arrears of more than 90 days.[19] The computation of the ODR is based on count, is static and allows for repeated defaults. ODR increases when the number of defaults during the period is larger than number of cures, and vice versa.

To avoid missing values for periods where the ODR is zero, we create an index from the ODR series, with 0% and 1% ODR corresponding to 100 and 101 respectively, before taking logs. This gives the resulting estimated coefficients an approximately additive interpretation. For the estimation to be econometrically feasible, we drop the dummy variables corresponding to the 1Q 2007 cohort, first month-on-book and macroeconomic periods October, November and December 2015.

For the second-stage regression, the description and sources of variables included are laid out in Table 1.

Summary of Variables used in Second-Stage Panel Regression — Table 1

Variable	Abbreviation	Definition	Source
Underwriting standards	U	Individual bank underwriting standards by loan purpose	Authors' estimation
Policy Rate	OPR	Overnight policy rate (%)	Bank Negara Malaysia
Monetary Policy Shock	SHOCK	Exogenous monetary policy shocks in Malaysia (%)	Tng and Kwek (2015)
Output	GDP	Annual growth in gross domestic product (%, yoy)	Department of Statistic Malaysia
Prices	CPI	Annual growth in consumer price index (%, yoy)	Bank Negara Malaysia
Capital flows	FLOW	Net capital flows from the balance of payments (RM billion)	Bank Negara Malaysia
House Prices	MHPI	Annual growth in Malaysian House Price Index (%, yoy)	National Property Information Centre
Liquidity Position	LD	Individual bank loan-to-deposit ratio	Bank Negara Malaysia
Capital Position	CAP	Individual bank equity over total assets ratio	Bank Negara Malaysia
Lending Rate Spread	ALROPR	Difference between the average lending rate by loan purpose and the OPR (%)	Bank Negara Malaysia

19 However, there is some variation in the interpretation of this standard among banks, with some interpreting this as 3 months in arrears and others as 4 months.

Summary of Variables used in Second-Stage Panel Regression (Cont) Table 1

Variable	Abbreviation	Definition
Macroprudential Measures	MPP	Dummy variable for periods following the introduction of macroprudential measures by loan purpose
Crisis Periods	GFC	Dummy variable for the periods 3Q08-2Q09
Time Trend	TREND	Time trend over the sample period

3. Results

The estimated measures of aggregate bank underwriting standards are shown in Figure 2. An increase in the measure corresponds to looser underwriting standards and higher default rates. With the exception of non-residential property loans, which underwriting standards have largely remained stable, most loan purposes see a general downward trend in the measure, suggesting general improvement in underwriting standards over the sample period. The measure for personal loans has the largest variation in magnitude, implying that variations in bank underwriting practices have a larger impact on personal loan default rates than other loan portfolios.

The measure for personal loans appears to correspond with the relevant macroprudential measures. Observing unsustainable rapid personal financing growth in the periods prior to 2012, BNM released the Guidelines on Responsible Financing which took effect from 1Q 2012. In 3Q 2013, BNM further imposed a maximum tenure of 10 years for personal financing and prohibited the offering of pre-approved personal financing products. These measures resulted in a marked slowdown in the growth of personal financing, especially among non-bank financial institutions.[20] Correspondingly, we see the underwriting standards for personal loans deteriorate in the run up to 2012, after which the trend reversed.

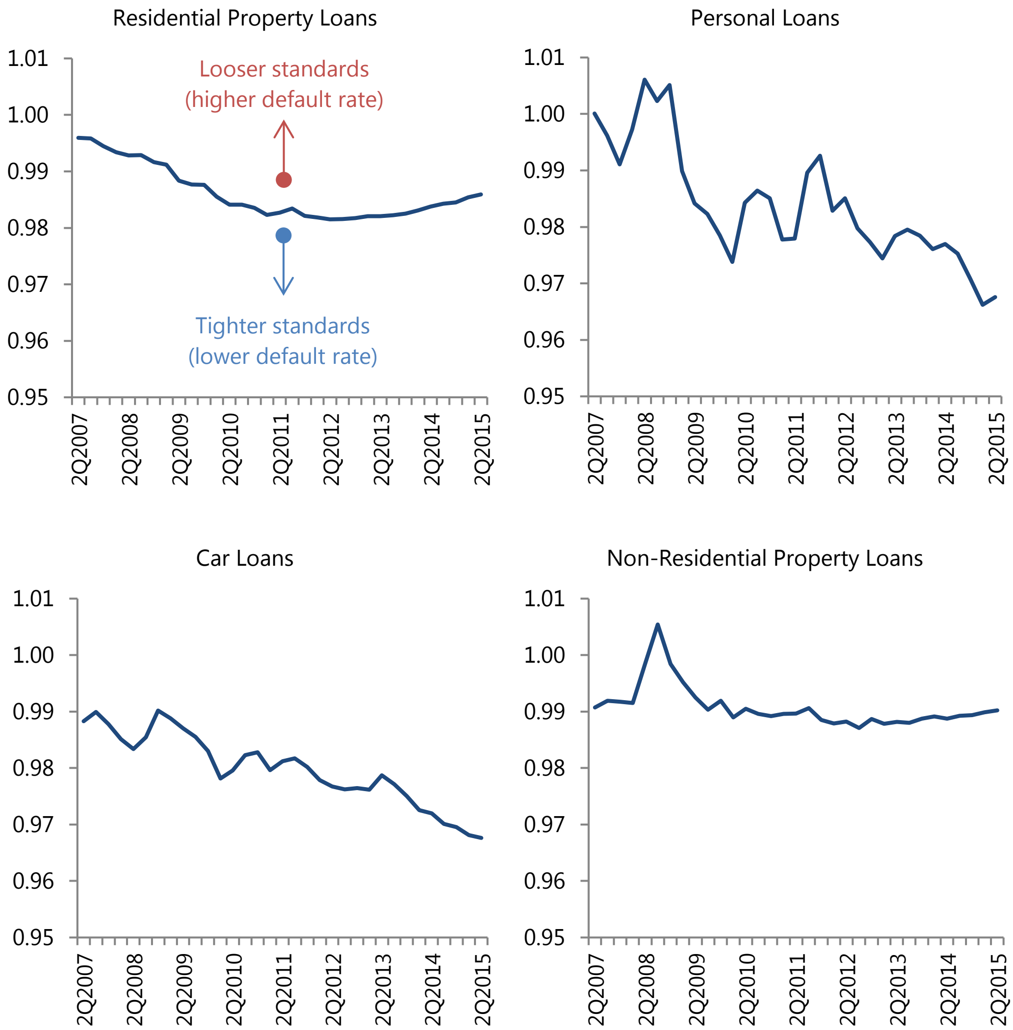
We do not observe a similar depiction for residential property loans, for which macroprudential measures were also imposed, along with microprudential and fiscal measures. This potentially reflects the targeted nature of the housing loan measures[21], which were aimed narrowly at speculative activity that accounted for a small share of total housing financing. The dynamics for housing loan defaults appear instead to correspond with movement in house prices. Following the implementation of measures, the rapid increase in average house price growth stabilised in 2012 before moderating after 3Q 2013, roughly corresponding to the turning points of the estimated series.[18] This suggests that the mild uptrend in the series could be an artefact of slowing house price growth (demand-driven) rather than deteriorating bank underwriting standards (supply-driven).

[20] For more details on the effects of macroprudential measures on personal financing, housing loans and house prices, refer to Chapter 1 of the BNM Financial Stability and Payment Systems Report 2014.

[21] To curb speculative purchases, in Q4 2010, BNM introduced a maximum LTV ratio of 70% for the third and above outstanding housing loan per individual. In the following quarter, BNM increased the risk weights on loans previously disbursed with LTV ratios over 90%, from 75% to 100%. In 3Q 2013, BNM imposed a maximum tenure of 35 years for housing loans. Fiscal measures included the prohibition of Developer Interest Bearing Schemes (DIBS) starting 2014 and a series of increases in real property gains tax (RPGT) from 2010 to 2014.

Aggregate Bank Underwriting Standards for Retail Loans

Figure 2



For car loans, while the trend of underwriting standards is generally an improvement, the pace of improvement increased after 2013. This corresponds with the release of the Risk-informed Pricing guidelines in December 2013[22], which contributed to the alleviation and reversal of continued lending rate compression (a symptom of risk-taking) in car loans that had occurred due to stiff competition among banks.

With the exception of a large spike during the Global Financial Crisis, underwriting standards for non-residential property loans have remained relatively stable. Given the timing, magnitude and idiosyncratic nature of the spike, we suspect that similar to the measure for residential property, this spike could be picking up factors other than bank underwriting standards. One possibility is that in these

[22] The Risk-informed Pricing guidelines sets out standards for banks to adopt a risk-informed approach in the pricing of retail loan products, to ensure consistency with an approved risk appetite.

periods of crisis, distressed business owners could have resorted to obtaining funds by refinancing their commercial premises, which for many small and medium enterprises are owned by the individual rather than the business entity. Such a hypothesis remains to be validated.

Overall, the aggregate measures of bank underwriting standards appear in line with our priors and understanding of the evolution of bank lending over the sample. For further validation, we examine the correlation of our measure with loan approval rates. Dell'Ariccia et al (2008) found that rising delinquency rates were linked to lower loan denial rates. We find a similar relationship, between a loosening in our measure of underwriting standards and higher approval rates, as shown in Table 2. Interestingly, with the exception of personal loans, this correlation does not hold for credit growth, suggesting that higher than average credit growth in itself may not necessarily be a sign of weakening underwriting standards. In particular, the large negative correlation for residential property underwriting standards and credit growth could be confounded by property price movements, as discussed above.

Correlation of Underwriting Standards with Approval Ratio and Credit Growth

Table 2

	Residential Property (RP)	Personal Loan (PL)	Car Loan (CL)	Non-residential Property (NRP)
Approval Ratio	0.82	0.63	0.52	0.55
Credit Growth	-0.89	0.67	0.11	-0.24

In the second-stage panel regressions, we find limited evidence of the risk-taking channel of monetary policy across loan purposes, as shown in Table 3 by the positive coefficients on the OPR. This lack of evidence holds when we replace the OPR with Tng and Kwek's (2015) estimate of exogenous monetary policy shocks[23], with the exception of personal loans, which negative coefficient suggests that negative monetary policy shocks lead to looser underwriting standards and the origination of loans with higher default rates.

[23] Technically, identification requires exogenous monetary policy changes. As such, where results diverge, we tend to the estimation which uses exogenous monetary policy shocks as the measure of monetary policy.

Result from Second-Stage Panel Regression								Table 3
Specification	RF		PL		CL		NRP	
	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK
Number of Banks	25		24		21		17	
Number of Observations	850		816		714		578	
Monetary Policy $(MP)_{t-1}$	0.522***	1.463***	1.004***	-0.555***	0.561***	-0.147	0.004	-0.117
GDP_{t-1}	0.004	0.016***	0.008*	0.048***	-0.011***	-0.001	0.006**	0.006***
CPI_{t-1}	0.008	0.017	-0.001	-0.055***	0.001	-0.022	0.015	0.025***
$FLOW_{t-1}$	0.001***	0.001***	0.002***	0.000	-0.001***	-0.002***	0.002***	0.003***
$MHPI_{t}$	-0.046***	-0.034***	-	-	-	-	-0.025***	-0.029***
LD_{t-1}	-1.044***	-1.593***	-5.501***	-4.666***	0.671***	-0.540***	2.118***	1.600***
CAP_{t-1}	0.071***	0.065***	0.247***	0.072***	0.038***	0.040***	0.026**	0.021
$ALROPR_{t}$	-0.351***	-1.103***	-0.128***	0.014	-0.030	-0.351***	-0.152**	-0.147***
MPP*TREND	-0.014***	-0.009***	-0.040***	-0.022***	-0.036***	-0.040***	0.006***	0.130***
GFC	0.005	0.404***	-0.012	0.411***	-0.162**	0.243**	0.088*	0.009***
Unweighted R^2	0.66	0.68	0.66	0.73	0.68	0.68	0.62	0.70

* indicate statistical significance at the 10% level; ** indicate statistical significance at the 5% level; *** indicate statistical significance at the 1% level

Note: Coefficients presented have been multiplied by 100. A coefficient of 1 implies an approximately 1ppt difference in default rates.

Broadly, the results suggest that loans originated during periods with higher GDP growth, net capital inflows and lower house price growth tend to observe higher default rates. Banks with a better perceived liquidity position and higher capital buffer approve loans with higher default rates. A lower credit spread in the pricing of loans is also associated with higher default rates. Loans originated after the implementation of macroprudential measures displayed lower default rates while loans originated during the financial crisis of 2008 saw higher default rates.

To investigate potential non-linear effects between bank characteristics and banks' response to changes in monetary policy in terms of underwriting standards, we interact banks' loan-to-deposit ratio and equity ratio with the monetary policy variable. The estimated coefficients of interest are reported in Table 4. In order to interpret the net effect of a change in monetary policy on bank underwriting standards, we apply the coefficients to the actual data series and compute the proportion of our sample that corresponded with an overall negative monetary policy effect on our measure of underwriting standards.

Result from Second-Stage Panel Regression with Interaction Terms Table 4

Specification	RF		PL		CL		NRP	
	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK
Monetary Policy $(MP)_{t-1}$	1.435***	14.37***	-0.251	-23.01***	-0.283***	3.205***	0.442	-1.310
$MP*LD_{t-1}$	-0.414***	-6.430***	0.489***	12.97***	0.141***	-1.478***	-0.265	0.648
$MP*CAP_{t-1}$	-0.018***	-0.085***	0.039***	-0.284***	0.066***	-0.060***	0.009	-0.003
Net negative MP effect (% observations)	1.14	5.26	74.9	68.9	81.7	50.1	11.1	97.1

* indicate statistical significance at the 10% level; ** indicate statistical significance at the 5% level; *** indicate statistical significance at the 1% level

Note: Coefficients presented have been multiplied by 100. A coefficient of 1 implies an approximately 1ppt difference in default rates.

Allowing for non-linear effects, the personal and car loan specifications emerge with statistically significant coefficients and a sizeable proportion of observations corresponding to an overall negative monetary policy effect on our measure of underwriting standards. Focussing on the specifications using exogenous MP shocks, the results suggest that banks with larger capital buffers take on more risks in response to loose monetary policy compared to banks with relatively lower capital ratios. The corresponding estimates for banks' liquidity positions are inconsistent across the loan purposes, thus is inconclusive.

Overall, the empirical evidence in this study on the risk-taking channel of monetary policy is at best mixed, but mostly limited. While controlling for non-linear effects lead to slightly stronger evidence, the general finding is inconclusive.

4. Limitations and Further Work

One of the main complications of the DUMS model arises from the regressors comprising entirely of dummy variables. The use of close to 250 dummy variable series could easily result in multi-collinearity between the regressors, especially for subsets of the data with sporadic missing entries. This issue complicates estimation in two ways. The first complication occurs at the point of estimation. It could be difficult to detect and adjust for the source of multi-collinearity given the scale of the dataset and the various permutations of estimations. The second complication arises at the point of inference. In certain cases, estimation results, and hence our measure of standards, can be sensitive to which dummy variables are dropped as the base case, in particular which cohort dummy forms the base case. While the variations in the resulting measure are mostly quantitative, qualitative differences involving changes to the trajectory of the measure could occur.

A second limitation arises from the triangular nature of the dataset used, resulting in our measure of standards being less reliable for more recent loan cohorts. Due to there being fewer observations of loan performance, the measure of standards estimated for recent cohorts tend to be sensitive to the addition of new data points. Thus far, we have yet to compute standards error bands for our measure, which is an avenue for further work going forward.

Beyond robustness issues, while we attempt to control for demand-driven risk-taking by including loan and macroeconomic controls in our second-stage regression, our estimation could still suffer from omitted variable bias if there remains unobservable factors that correlate with the variables included. Further work can improve identification in two ways. First is to further exploit the data available in CCRIS, deploying more control variables, including loan characteristics such as loan tenure, collateral pledged, and the loan-to-value ratio, where applicable. These data items exist within the system and can potentially add value once sanitised. Second is to validate our findings using ex-ante measures of bank risk-taking, such as those constructed by Jiménez et al (2008) and Ioannidou et al (2009).

Admittedly, the empirical strategy in this paper does not fully resolve all the highlighted issues. It is thus important to appreciate the limits of the method, to complement the measure with corroborating indicators where possible, and to conduct robustness checks for sensitivity before drawing inference. Going forward, this simple measure should be complemented by more explicitly specified or granular methods, for instance, binary response models or hazard-based duration models that are better suited for censored datasets.

5. Conclusion

Using a proprietary micro-dataset on loan defaults in Malaysia, we introduce a simple fixed effects model to extract a measure of bank lending standards from the observed default rates of loan portfolios. In a second-stage panel fixed effects regression, we use this measure to investigate the risk-taking channel of monetary policy. We find limited evidence of bank risk-taking arising from low policy interest rates.

While we do not find significant evidence of the risk-taking channel of monetary policy in this study, it does not imply that the channel does not exist. Rather, it may be the case that this channel has not manifested strongly in Malaysia, possibly in part due to Malaysia's policy approach towards financial stability and the build-up of financial imbalances. In the formulation of monetary policy, BNM has always been cognisant of the risks of financial imbalances.[24] Beyond monetary policy, policies from a broader toolkit, including microprudential, macroprudential and fiscal measures have been implemented pre-emptively in Malaysia to guard against the risks of financial imbalances. It is possible that such concerted policy, regulatory and supervisory efforts have helped to curb any potential manifestations of underlying risk-taking behaviour, including among banking institutions.

[24] For example, refer to BNM's Monetary Policy Statement of July 2014.

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