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Malaysian residential mortgage loan default: a micro-level analysis

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Received 10 March 2020
Revised 22 June 2020
Accepted 25 June 2020

Abstract

Purpose – This study investigates factors contributing to residential mortgage loans default by utilizing a unique dataset of borrowers' default data from one of the pioneer lending institutions in Malaysia that provides home financing to the public. Studies on mortgage loan default have been extensively examined, but limited studies utilize the individual borrower's data, as financial institutions generally hesitant to reveal their customers' data due to confidentiality issue.

Design/methodology/approach – This study uses logistic regression model to analyze 47,158 housing loan borrowers' data for the year 2016.

Findings – The findings suggest that male borrowers, Malay and other type of ethnicity, guarantor availability, loan original balance, loan tenure, loan interest rate and loan-to-value (LTV) ratio are the significant factors that influence mortgage loans default in Malaysia.

Research limitations/implications – Future studies may expand the sample by employing data from other types of financial institutions that would give greater insights as findings might vary due to differences in objectives, functions and regulations. In addition, the findings are subjected to the censoring bias where future studies could perform the survival analysis to control for censoring bias and re-validating the findings of the present study.

Practical implications – The findings provide valuable insights for lending institutions and the government to formulate housing loan policy in Malaysia.

Originality/value – To the best of the authors' knowledge, this is the first study in the context of emerging economies that uses financial institution's internal data to investigate factors of mortgage loan default.

Keywords Mortgage loan default, Housing loan Malaysia, Loan default factors, Micro-level

Paper type Research paper

1. Introduction

The subprime mortgage crisis in 2007 has revealed that an increase in the delinquency rate of mortgage loans is due to the deterioration in the loan quality and poor loan performance (Demyanyk and Van Hemert, 2011). A deterioration in bank loan quality could weaken a bank's net worth as too many impaired loans in its financial statements may threaten its solvency (Sathye *et al.*, 2003). This, in turn, may prevent banks from granting new loans that hinder economic growth and, in bad times, cuts in bank lending activity might trigger a credit crunch. Studying the determinants of residential mortgage loan default is important as residential loans generally make up a substantial amount of total loan portfolio. The non-repayment will affect the bank's cash flow and income and eventually will have a direct impact on the shareholders' wealth. The worst-case scenario, it could end up triggering a financial debacle for banks and financial institutions.

In relation to this, empirical studies on mortgage default conclude that the general causing factors of default are loan characteristic factors, socio-demographic factors and

We are most thankful to Valuation and Property Service Department, Ministry of Finance, Malaysia for awarding us the NAPREC Grant to carry out this research project. This paper has been presented at the Singapore Economic Review Conference 2019 (SERC 2019) held in Singapore from 5th to 7th August 2019.

Review of Behavioral Finance

1940-5979
DOI 10.1108/RBF-03-2020-0047

macroeconomics factors (see Jones and Simons, 2015 for extensive review on mortgage default literature; Tajaddini and Gholipour, 2017; Foote and Willen, 2018; Gerardi *et al.*, 2018). The existing academic studies have generally been examined from the macro-level perspective using publicly available data or focusing on advanced economies.

This study extends existing research on mortgage loan default by examining default factors from the micro-level perspective, by utilizing a unique dataset of borrowers' default data extracting from one of the lending institutions in Malaysia that provides home financing to the public. Research examining micro-level data specifically using borrowers' default data are relatively limited, as financial institutions generally reluctant to reveal their customers' data due to Personal Data Protection Act (PDPA).

Additionally, examining micro-level data provides advantage as borrowers are regarded as heterogeneous units (Ritsila and Tervo, 2002). Thus, the present study would be able to explore individual's characteristics and determine their pure effects on mortgage default and get further insights into the relationship between loan default and factors triggering default. As suggested by Foote and Willen (2018), research on mortgage default still lacking in the aspect of borrower's personal data that can help to identify other default triggers. Moreover, Geishecker (2008) emphasizes that micro-level data can address problems such as aggregation and potential endogeneity bias. Demyanyk and Van Hemert (2011) also suggest that loan and borrower characteristics factors are very important in explaining the cross-section of loan performance.

Malaysia offers a unique perspective to be examined as this emerging economy was reported as having high household debt to Gross Domestic Product (GDP) in 2019, reaching 82.7% from around 60% in 2008 [1]. For comparison, its neighboring countries, Thailand and Singapore recorded lower household debt to GDP, which are 78.7 and 65% in 2019, respectively. In relation to this, residential loans continue to be the largest contributor to Malaysian household debt, followed by personal financing and loans for the purchase of securities. Euromonitor International (2014) indicates that mortgage default rates in Malaysia were the second highest in the Asia and Pacific Region after the Philippine, while The Edge Markets on 27 February 2017 reported that bankruptcy cases in Malaysia resulting from housing loan defaults were the second highest after car loan defaults for years 2010, 2011 and 2013.

Thus, the present study is expected to shed some light into factors of residential mortgage loan default in Malaysia by analyzing 47,158 housing loan borrowers' data for the year 2016. The findings indicate that two borrowers' characteristic factors, gender and ethnicity, have significantly influenced mortgage default in Malaysia. This implies that loan defaults are higher among male borrowers compared to female borrowers, while Malay and other types of ethnicity have higher loan default compared to the other major ethnic groups in Malaysia. As for loan characteristic factors, guarantor availability, loan original balance, loan tenure, loan interest rate and loan-to-value (LTV) ratio are the significant factors that influence mortgage loans default in Malaysia. This indicates that loan without guarantor will have higher chance of default compared to loan with guarantor. Moreover, the larger the loan original balance, the longer the loan tenure, the higher the interest rate, and the higher the LTV; the higher the probability of default would be.

The findings of this study have implications for the housing finance policy in Malaysia. It is suggested that a simple test on the basic money management skills can be executed during the loan evaluation process as a way to reduce the probability of mortgage loan default. Moreover, since women are more responsible in their loan repayment, Malaysian lenders may create a new mortgage loan product specifically for female borrowers. Lenders should also request for guarantor if the borrower's debt-to-income ratio is considerably high. In addition, lower interest rate can be charged to the low-income borrowers so that they can service the loan. To further reduce the probability of default, the loan tenure can be shortened from 35 to

30 years. Finally, the maximum loan-to-value (LTV) ratio should be capped at 70% for the borrowers to purchase their second home to minimize loan default.

This study contributes to loan default literature in two ways. First, it utilizes a unique dataset of borrowers' data that gives greater insight into factors of mortgage default. Second, it contributes to the loan default literature in the context of an emerging market economy especially Malaysia as high household debts remains an issue in the country, with residential property loans are the key driver of debt growth.

2. Malaysia housing finance market

Mortgage originators in Malaysia can be divided into three categories namely private sector, public sector and secondary mortgage corporation. Private sector plays an essential role in housing development in Malaysia where commercial banks (conventional and Islamic banks) are the most important originators of housing loans in Malaysia. Other types of private sector include development financial institutions (DFIs) and others (insurance companies, co-operatives and developers). Prior to the 1970s, the bulk of housing loans was provided by the building societies, in which they were established as part of the government's initiative to ensure the availability of funds for the housing sector and to promote home ownership, particularly of low- and medium-cost houses. However nowadays, the role is taken over by the commercial banks.

In 2018, the total value of financial institutions' exposure to the domestic property market reached RM901.3 billion (USD216.9 billion). According to the Central Bank of Malaysia, household impairments continue to be driven by residential property loans, where the growth of impaired loans for residential properties has increased from 3.4% in 2017 to 7% in 2019. In addition, the ratio of residential loan approval to loan application showed a decreasing trend from 50.1% in 2011 to 42.5% in 2019 due to the rising house price. Affordability remains an issue in the Malaysian residential property market due to a pronounced and prolonged mismatch between demand and supply of residential property.

Among the noticeable characteristics of housing loans in Malaysia are the maximum loan tenure is 35 years and the maximum loan-to-value (LTV) ratio can reach up to 90%. In addition, the loan structure can be in the form of conventional or Islamic, based on borrowers' preference. The Malaysian government policy is to encourage house ownership among its citizen, besides enhancing accessibility to housing finance supply. This can be shown through the introduction of housing schemes to provide adequate, affordable and quality houses for Malaysians in various income levels, such as Housing Credit Guarantee Scheme, My First Home Scheme, Youth Housing Scheme and Housing Special End Financing Scheme.

3. Literature review

Studies on mortgage loan default can be traced back since late 1960s in the United States. Earlier studies by Von Furstenberg (1969), Vandell (1978) and Campbell and Dietrich (1983) suggest that loan-to-value (LTV) ratio at the time of origination, borrowers' personal characteristics and borrowers' income are among the important factors in determining residential mortgage default. Since then, a great number of studies have examined factors of mortgage default and in reviewing literature on residential mortgage default, Jones and Sirmans (2015) highlight that there are four primary determinants of default: (1) loan characteristics, trigger events and transaction costs, (2) borrower characteristics, (3) local housing market and macroeconomic conditions and (4) legal structures of the default-foreclosure process.

Loan characteristic factors are factors related to loan attributes such as initial LTV ratio (Deng *et al.*, 1996; Hakim and Haddad, 1999; Elul *et al.*, 2010; Quercia *et al.*, 2012),

amount of initial loan (Yang *et al.*, 1998; Hakim and Haddad, 1999; Kelly, 2008; Soyer and Xu, 2010 and Quercia *et al.*, 2012), mortgage age (Campbell and Dietrich, 1983; Quercia and Stegman, 1992; Springer and Waller, 1993; LaCour-Little, 2004; Ghent and Kudlyak, 2011), negative equity (Deng *et al.*, 2000; Linn and Lyons, 2019) and call option value (LaCour-Little, 2004; Quercia *et al.*, 2012). Trigger events are defined as loss of employment (Quercia and Stegman, 1992; Deng *et al.*, 1996, 2000; Capozza *et al.*, 1997; Elmer and Seelig, 1999; Elul *et al.*, 2010; Quercia *et al.*, 2012; Linn and Lyons, 2019) and divorce (Capozza *et al.*, 1997; Deng *et al.*, 2000).

Borrower characteristics factors are factors related to borrower attributes such as payment-to-income ratio (Stansell and Millar, 1976; Vandell, 1978; Springer and Waller, 1993; Yang *et al.*, 1998; LaCour-Little and Malpezzi, 2003; Bajari *et al.*, 2008; Kelly, 2008 and Archer and Smith, 2013), borrower income (Yang *et al.*, 1998; Hakim and Haddad, 1999; Jones, 1993; LaCour-Little and Malpezzi, 2003; Feldman and Gross, 2005; Quercia *et al.*, 2012; Linn and Lyons, 2019) and other borrower characteristics such as age, job position and number of dependents (Jones, 1993). Local housing market and macroeconomic factors that might contribute to mortgage loan default as reported in the existing studies are house price volatility (Capozza *et al.*, 1997; Yang *et al.*, 1998), interest rate spread (Springer and Waller, 1993; Capozza *et al.*, 1997) and interest rate volatility (Quigley and Van Order, 1995).

Nevertheless, research on other borrower characteristic factors such as ethnicity has received less attention in the existing studies. As highlighted by Burton (1996), ethnicity and cultural differences should be fully integrated when examining consumer financial behavior. Malaysia is a multi-ethnic [2] and multi-cultural country and it is presumed that racial and cultural differences might influence the financial behavior of households. Existing studies on race and loan default typically address issues in the United States, particularly the comparison between Whites and Blacks in repaying housing loans. For example, Anderson and VanderHoff (1999) report that Black households have higher marginal default rates in the United States, controlling for differences in borrower and property characteristics. In addition, Martin and Hill (2000) document that minority loan default rates are higher than comparable white default rates in the United States. The relationship between major ethnic groups in Malaysia and mortgage loan default has hardly been rigorously studied, and existing empirical evidence is limited. Accordingly, this study attempts to investigate whether ethnicity plays a role in mortgage loan default among Malaysians.

On the other piece, a recent study by Owusu-Manu *et al.* (2019) highlight that females are more likely to default on credit than their male counterparts in Ghana. In relation to this, women's participation in the labor force in Malaysia has increased from 45.7% in 2008 to 56.1% in 2019. This might shape the behavior of consumer in relation to demand for financial products and services as financial behavior of men and women differs significantly (Walczak and Pienkowska-Kamieniecka, 2018). In China, Lin *et al.* (2011) conclude that the default probability of male borrowers is significantly higher than that of female borrowers for mortgage loans. In this regard, research examining the relationship between gender and mortgage loan default in Malaysia is relatively limited. Accordingly, it is vital to explore whether gender influences mortgage loan default in Malaysia.

As for loan characteristic factors, there are relatively limited studies examine other loan-specific attributes such as guarantor availability, loan tenure and loan interest rate and see their influence on mortgage default particularly in Malaysia. In bank lending, guarantor acts as a back-up for borrower, meaning that the guarantor will honor a part or the totality of the claim in case of loan default (Godlewski and Weill, 2008). Loan tenure is the time given for the borrower to repay the loan and in Malaysia, housing loan tenure can reach up to 35 years; raising the possibility of unexpected events that may increase the probability of default. Loan interest rate is the interest rate charged on individual loan and in practice, bank has the

discretion to charge lower interest rate to borrowers with a good credit rating. Thus, the present study investigates whether those additional three loan characteristic factors will influence mortgage loan default in Malaysia.

Former empirical literature on mortgage loan default in Malaysia is relatively scarce. Most studies on Malaysian housing have focused on housing affordability (see, e.g. Olanrewaju and Wong, 2020; Leng, 2020; Yap and Ng, 2018; Zainon *et al.*, 2017; Ling and Almeida, 2016; Bujang *et al.*, 2010; Hashim, 2010). Some others examining the housing price (See Latif *et al.*, 2020; Wong *et al.*, 2019; Kok *et al.*, 2018; Reen and Razali, 2016; Pillaiyan, 2015; Osmadi *et al.*, 2015; Ibrahim and Law, 2014; Lean and Smyth, 2013; Hui, 2010; Chin *et al.*, 2004). The question of factors triggering mortgage loan default remains under-explored in the literature. Hence, this study is the first in Malaysia examining mortgage default factors utilizing a micro-level data. The use of household-level data will allow the present study to perform a detailed analysis and get further insights into the relationship between loan default and factors triggering default in Malaysia.

4. Methodology

4.1 Data

The micro-level data was obtained from the lending institution based on the items on loan application form for individuals. A total of five meetings were conducted with the lending institution to ensure that the data obtained was clean and fulfill the requirements of this study. However, the data obtained was subject to institution's online data availability. For example, the variable for education level was not available since it is not in the institution's online database.

A total of 47,158 loan accounts of individual borrowers, spanning years 2003–2016 were obtained which was retrieved by the lending institution on 31 October 2016. The data includes the account with full disbursement from 2004 to 2014 (except 15 accounts which are on years 2015 and 2016). Out of 47,158 loan accounts data, a total of 5,186 loan accounts was default. The data obtained is cross-section with the date of loan's first disbursement and the status of default (as at 31 October 2016) is provided.

4.2 Variable description

The dependent variable in this study is mortgage loan default (P_i), which equals 1 for defaulted loans and otherwise equals 0. Following Babii *et al.* (2019), the default status is defined as the loan installment in arrears for three or more than three months. The explanatory variables that representing borrower characteristics are age (AGE), gender (GENDER), ethnicity (MALAY, CHINESE, INDIAN, OTHER), marital status (MARSTAT) and types of occupation (OCCGOVT, OCCSS, OCCMGMT, OCCEXEC, OCCNEXEC, OCCSELFEMP, OCCUNEMP).

AGE is the age of the borrower at the year of loan disbursement (as at 31 October 2016). Psychological study by Deakin *et al.* (2004) suggests that the risk-taking behavior decreases with age, while Kuang *et al.* (2019) document that older borrowers are more responsive to an increase in the interest rate than younger borrowers; implying the low risk-taking behavior among older borrowers. Jones (1993) suggests that the older borrowers (higher age) have the lower the probability of default. Thus, this study hypothesizes that AGE will have a negative association with the mortgage loan default.

GENDER is a dummy variable measured by 1 for male borrowers, 0 for female borrowers. Lin *et al.* (2011) suggest that the default probability of male borrowers is significantly higher than that of female borrowers for mortgage loans in China. Mokhtar *et al.* (2012) also find that the probability of a loan repayment problem is higher for male than female borrowers in

Malaysia. Another study by D'espallier *et al.* (2011) who utilize a global dataset of 350 microfinance institutions (MFIs) in 70 countries also find the similar finding, women perform better than men in loan repayment. Accordingly, it is expected that GENDER will have a positive relationship with the mortgage loan default.

As for ethnicity, each of the ethnic variable is assigned with the dummy variable. There are four types of ethnicity based on the data obtained: Malay, Chinese, Indian and Other. Malay race is represented by dummy MALAY (1 for Malay, 0 otherwise), Chinese race is represented by CHINESE (1 for Chinese, 0 otherwise) and acts as a comparison group, Indian race is proxied by INDIAN (1 for Indian, 0 otherwise) and other types of ethnicity are proxied by OTHER (1 for other type of ethnicity, 0 otherwise). In general, Chinese in Malaysia are wealthier and have more access to sources of funds if any unexpected financial need arises because they usually control and conquer the economic and business sectors in Malaysia (Thillainathan and Cheong, 2016). Accordingly, this study hypothesizes that Chinese ethnic will be less likely to default compared with other ethnics in Malaysia.

Marital status (MARSTAT) is a dummy variable for the personal status of the borrower (1 for married borrower and 0 otherwise). According to Kuang *et al.* (2019), married borrowers are more risk averse while Love (2010) suggests that wealth of married couple increases due to combined assets. Thus, this study predicts that married borrowers will be less likely to default compared with other category of personal status.

Based on the data obtained from the lender, type of occupation is divided into seven categories: government (OCCGOVT), semi-skilled/skilled (OCCSS), management (OCCMGMT), executive (OCCEXEC), non-executive (OCCNEXEC), self-employed (OCCSELFEMP) and unemployed/economically inactive (OCCUNEMP). Similar to ethnicity, each of the type of occupation variable is assigned with the dummy variable (refer Table 1 for complete measurement). Jones (1993) and Lin *et al.* (2011) suggest that job position has a positive relationship with mortgage default. This implies that the higher the borrower's job position, the higher the default probability would be. However, this study hypothesizes that unemployed/economically inactive group will have higher probability of default compared with others due to unstable source of income to pay the housing loan.

The lender's data contains a variety of loan characteristic factors such as payment-to-income ratio (PTI), loan age (LOANAGE), guarantor availability (GUARANTOR), loan original balance (ORIBAL), loan tenure (LOANTEN), loan interest rate (INTRATE) and loan-to-value ratio at origination (LTV).

PTI stands for payment-to-income ratio or equated monthly installment (EMI) to income ratio, the ratio of monthly installment to borrower's income. PTI is regarded as one of the important variables contributing to residential mortgage default, as confirmed by earlier studies such as Stansell and Millar (1976) and Vandell (1978) and later studies such as Yang *et al.* (1998), LaCour-Little and Malpezzi (2003), Kelly (2008) and Archer and Smith (2013). They hold the belief that the higher the PTI ratio, the greater the risk of default would be as borrower's payment obligation relative to his disposable income will be larger. Accordingly, this study expects that the PTI will have a positive relationship with the mortgage loan default in Malaysia.

Mortgage age or loan age (LOANAGE) is the number of days between the loan's first disbursement date and the time the data is collected (31 Oct 2016). Generally, previous studies find that there is a nonlinear relationship between mortgage age and probability of default (Campbell and Dietrich, 1983; Quercia and Stegman, 1992; Hendershott and Schultz, 1993; Springer and Waller, 1993), where the default usually happens in the early years of the mortgage, descend upon in the middle years and steadily declines in the later years. Some studies on the other hand report that there is a positive relationship between mortgage age and default (LaCour-Little, 2004; Ghent and Kudlyak, 2011). Based on the earlier findings, this study predicts that LOANAGE will have a non-linear relationship with the mortgage loan default.

Variable	Definition	Expected sign
Default	Loan default; 1 for defaulted loans, 0 otherwise Following Babii *et al.* (2019), the default status is defined as the loan instalment in arrears for three or more than three months	
Borrower characteristics		
AGE	Age of the borrower at the year of loan disbursement	+/−
GENDER	1 for male borrower, 0 for female borrower	+/−
MALAY	1 for Malay, 0 otherwise	+/−
CHINESE	1 for Chinese, 0 otherwise	Comparison group
INDIAN	1 for Indian, 0 otherwise	+/−
OTHER	1 for other type of ethnicity, 0 otherwise	+/−
MARSTAT	1 for married borrower, 0 otherwise	+/−
OCCGOVT	1 for government type of occupation, 0 otherwise	Comparison group
OCCSS	1 for semi-skilled/skilled type of occupation, 0 otherwise	+/−
OCCMGMT	1 for management type of occupation, 0 otherwise	+/−
OCCEXEC	1 for executive type of occupation, 0 Otherwise	+/−
OCCNEXEC	1 for non-executive type of occupation, 0 otherwise	+/−
OCCSELFEMP	1 for self-employed type of occupation, 0 otherwise	+/−
OCCUNEMP	1 for unemployed/economically inactive, 0 otherwise	+/−
Loan characteristics		
PTI	Payment to income ratio (or equated monthly installment (EMI) to income ratio); the ratio of monthly installment to borrower's income	+
LOANAGE	The age of loan is the number of days between the loan's first disbursement date and the time the data is collected (31 October 2016)	+/−
GUARANTOR	1 for loan with guarantor, 0 otherwise	−
ORIBAL	The original balance of loan amount approved by the lender at the time of application	+
LOANTEN	Loan tenure at the time of application	+
INTRATE	Loan interest rate charged by the lender at the time of application	+
LTV	Loan-to value ratio; the ratio of a loan initial amount to the value of the property	+
Control variables		
D2010	Dummy variable to measure the tightening of lending policy guideline introduced by the Central Bank of Malaysia beginning from 2010 to promote a sound and sustainable household sector 1 if the loan's first disbursement occurs on 2010–2016, and 0 otherwise	−
DCRISIS	Dummy variable to measure crisis years in 2008 and 2009 1 if the loan's first disbursement occurs on 2008 and 2009, and 0 otherwise	+
DLOCATION	Dummy variable to measure borrower's location There are 11 states in the sample; Kedah, Johor, Penang, Sarawak, Perak, Terengganu, Kelantan, Sabah, Pahang, Melaka and Negeri Sembilan 1 for Kedah, 0 otherwise 1 for Johor, 0 otherwise 1 for Penang, 0 otherwise 1 for Sarawak, 0 otherwise 1 for Perak, 0 otherwise 1 for Terengganu, 0 otherwise 1 for Kelantan, 0 otherwise 1 for Sabah, 0 otherwise 1 for Pahang, 0 otherwise 1 for Melaka, 0 otherwise 1 for Negeri Sembilan, 0 otherwise	
PROPSIZE	Property built-up area in square meter	+

Table 1.
Variable definition

Guarantor availability (GUARANTOR) is a dummy variable that indicates 1 for loan with guarantor and 0 otherwise. Guarantor acts as a back-up for borrower, meaning that if a borrower failed to repay, the guarantor will honor a part or the totality of the claim in case of loan default (Godlewski and Weill, 2008). Therefore, the presence of a guarantor mitigates agency problems resulting from adverse selection, in line with the better information owned by the bank on the borrower. Therefore, it is expected that loan with guarantor will be less default compared to loan without guarantor as the borrower will be more responsible to repay the loan.

ORIBAL is the original balance of loan amount approved by the lender at the time of application. Generally, the larger the loan amount, the higher the probability of default would be as it will be more burdensome for borrowers to repay the loan. In relation to this, empirical studies by Kelly (2008), Soyer and Xu (2010), and Quercia *et al.* (2012) indicate that a larger initial loan amount will increase the probability of default. Conversely, some studies suggest that high-income borrowers with larger initial loans will have lower risk of default as they have the capability to repay the loan (Yang *et al.*, 1998; Hakim and Haddad, 1999). Thus, this study predicts that ORIBAL will have a positive relationship with the mortgage loan default.

Loan tenure (LOANTEN) is the tenure of the loan at the time of application. Generally, the longer the tenure, the higher the probability of default would be due to the possible contingencies that may arise during the period of validity thereof. Lee and Liu (2002) suggest that the longer loan tenure will increase the probability of default risk; hence, it is hypothesized that LOANTEN will have a positive association with the mortgage default.

Loan interest rate (INTRATE) is an interest rate charged by the lender at the time of application. Lender has the discretion to determine mortgage interest rate charged to borrowers, where in general, borrowers with good credit rating will be charged lower interest rates compared to poor credit rating borrowers. Interest rate is the price of the loan that the borrowers need to pay, where the higher the interest rate, the larger the loan amount would be. Vandell *et al.* (1993) and Goodman and Smith (2010) point out that higher interest rates imply higher debt service payments, which tend to cause default. Thus, it is expected that INTRATE will have a positive relationship with the mortgage loan default.

Loan-to-value ratio at origination (LTV) is the ratio of a loan initial amount to the value of the property and in Malaysia, the LTV ratio can reach up to 90%. As a general rule, the higher the LTV, the higher the risk on the part of the lender, as more money is being lent out to someone with less capital to put up front in the first place as a deposit. Studies by Hendershott and Schultz (1993), Springer and Waller (1993), Deng *et al.* (1996), Hakim and Haddad (1999), Elul *et al.* (2010), Quercia *et al.* (2012), Campbell and Cocco (2015) and Gerardi *et al.* (2018) conclude that initial LTV ratio is positively correlated with the mortgage default. Accordingly, this study hypothesizes that LTV ratio will have a positive association with the mortgage loan default.

Finally, to control for the effects of lending policy guideline in 2010 [3], economics condition and geographic and economic variations of states in Malaysia, control variables such as 2010 lending policy dummy (D2010), 2008–2009 financial crisis dummy (DCRISIS), borrower's location dummy (DLOCATION) and property built-up area in square meter (PROPSIZE) are included. Table 1 provides the detail definition of each variable.

4.3 Logistic regression model

A logistic regression model was used in analyzing the determinants of mortgage loans default in Malaysia. A logistic model has the flexibility of incorporating both the qualitative and quantitative factors and is more efficient than the linear regression probability model. Following Gujarati (2004), a logistic regression model could be specified as below:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum_1^j \beta_j X_{ji} + \sum_1^k \gamma_k W_{ki} + \sum_1^m \delta_m Z_{mi} + \varepsilon_i \quad (1)$$

where

L_i = value of logit

P_i = mortgage loan default status, which equals 1 for defaulted loans, otherwise equals 0

X_{ji} = explanatory variables representing borrower characteristics factors

W_{ki} = explanatory variables representing loan characteristics factors

Z_{mi} = explanatory variables as control variables

ε_i = error terms

The logistic regression model was estimated using maximum likelihood estimation method with a robust variance estimate of Huber–White estimator (also known as Sandwich estimator).

5. Findings

5.1 Descriptive statistics

Table 2 demonstrates that there is a total of 11% defaulters in the portfolio of the residential mortgage loan of the respective lending institution, with a total of 5,186 default borrowers.

Table 3 provides the detailed descriptive statistics analysis of the borrower characteristic factors for default and non-default borrowers. Average age of defaulters is 34 years old compared to 35 for non-defaulter, approximately 70% of the borrowers are male, and Malays are the largest borrowers (66.05% for non-default and 59.29% for default borrowers). On average, 81% of the borrowers are married, and executives are the largest group of occupation that obtain mortgage loan from this lending institution.

In terms of loan characteristics factors as shown in Table 4, the mean value for PTI ratio for defaulter is 0.3308 compared to 0.2584 for non-defaulter. This means that on average, the default borrowers spend 33.08% of their income on housing installment *per se*, excluding other fixed expenses such as hire purchase and personal borrowing. Average loan age at the time the data what collected is 3558.22 days (9.75 years) for default borrower and 3376.29 days (9.25 years) for non-default borrower. On average, half of the loans are secured with guarantor (53.84% for default and 57.31% for non-default category). The average loan original balance (initial loan amount) for both category is approximately RM118,000, while average loan tenure is 324 months (27 years) for default and 309 months (25.8 years) for non-default loan. Average interest rate approved is 8.5% for default borrower, which is higher than non-default borrower (7.54%). Average LTV ratio for both category is 89%, and average property size applying for the housing loan is 116 per square meter for default borrower and 115 per square meter for non-default borrower.

5.2 Results and discussion

The logistic regression model was estimated to determine factors contributing to loan default for residential mortgage loans in Malaysia and the results are shown in Table 5. Overall, the

Status	Frequency	%
Non-default	41,972	89.00
Default	5,186	11.00
Total	*47,158*	*100*

Table 2.
Loan default status

Borrower characteristic	Variable/item	Non-default (41,972)	Default (5,186)
Age	Age	35	34
		Percentage	Percentage
Gender	Male	70.87	75.56
	Female	29.13	24.44
	Total	*100*	*100*
Ethnicity	Malay	66.05	59.29
	Chinese	8.26	5.46
	Indian	11.11	13.79
	Other	14.58	21.46
	Total	*100*	*100*
Marstat	Married	81.96	81.04
	Single	16.59	17.40
	Other	1.45	1.56
	Total	*100*	*100*
Occupation	OCCGOVT	20.94	18.96
	OCCSS	17.20	19.02
	OCCMGMT	7.70	7.04
	OCCEXEC	34.35	35.39
	OCCNEXEC	6.72	5.67
	OCCSELFEMP	5.89	6.02
	OCCUNEMP	7.20	7.91
	Total	*100*	*100*

Table 3. Borrower characteristic factors

Loan characteristics	Non-default (41,972) mean	Default (5,186) mean
PTI	0.2584	0.3308
Installment amount (RM/Month)	853.11	910.29
Income (RM/month)	3,301	2,752
LOANAGE	3376.29 days	3558.22 days
GUARANTOR	0.5731	0.5384
ORIBAL (RM)	118,577	118,965
LOANTEN (Month)	309	324
INTRATE (%)	0.0754	0.0850
LTV	0.8898	0.8985

Table 4. Loan characteristic factors

estimated model is found to have a good fit with the sample, with a highly significant results for overall fit test (p-value of almost equal to zero), high values of pseudo R-squared (0.1858) and high percentage correctly predicted (89.28%). The influences of VIF should at its minimum (value of VIF ranges from 1.01 to 3.09). There is no evidence of model specification errors and the robust standard errors (White–Huber standard errors) are employed in the estimated model. Thus, the estimated model is fit and could be used for interpretations.

For borrower characteristic factors, the results indicate that GENDER, MALAY and OTHER are positively associated with the mortgage loan default. The positive coefficient of GENDER with the estimated odds ratio (loan default to no loan default) of 1.2636 indicates that the odds for men to default is 26.36% higher than the women. The finding is similar to Lin *et al.* (2011), Mokhtar *et al.* (2012) and D'espallier *et al.* (2011). As highlighted by Kabeer (2001), men are implicated for willful defaults and moral hazard more than women. This is due to women are more risk averse (Barsky *et al.*, 1997; Sunden and Surette, 1998; Agnew *et al.*, 2003; Charness and Gneezy, 2012) and tend to be less selfish and exhibit greater cooperative

Variable	Coefficient	Odds ratio	*p*-value
Borrower characteristics			
AGE	−0.0520	0.9493	0.1250
AGE^2	0.0007	1.0007	0.1180
GENDER	0.2340	1.2636	0.0000***
MARSTAT	0.0980	1.1030	0.1990
MALAY[2A]	0.2791	1.3219	0.0160**
INDIAN[2A]	0.2026	1.2245	0.1350
OTHER[2A]	0.6197	1.8584	0.0000***
OCCSS[2B]	0.1724	1.1882	0.2060
OCCMGMT [2B]	0.0807	1.0841	0.4970
OCCEXEC[2B]	0.1168	1.1239	0.1150
OCCNEXEC [2B]	−0.1594	0.8526	0.2110
OCCSELFEMP [2B]	−0.1228	0.8844	0.3180
OCCUEMP[2B]	0.0654	1.0676	0.5510
Loan characteristics			
PTI	0.0365	1.0372	0.8110
LOANAGE	−0.0019	0.9981	0.0000***
$LOANAGE^2$	0.0000	1.0000	0.0000***
GUARANTOR	−0.3421	0.7103	0.0000***
ORIBAL	0.0007	1.0007	0.0000***
LOANTEN	0.0034	1.0034	0.0000***
INTRATE	1.1968	3.3094	0.0000***
LTV	1.2065	3.3418	0.0030***
Other control variables			
D2010	−1.1752	0.3088	0.0040***
DCRISIS	−0.0395	0.9612	0.6550
KEDAH[2C]	0.6684	1.9511	0.0000***
JOHOR[2C]	0.3159	1.3714	0.0020***
PENANG[2C]	0.4662	1.5940	0.0000***
SARAWAK[2C]	0.9414	2.5636	0.0000***
PERAK[2C]	0.9593	2.6098	0.0000***
TERENGGANU[2C]	−0.3315	0.7178	0.4090
KELANTAN[2C]	0.9539	2.5957	0.1150
SABAH[2C]	0.0696	1.0721	0.7460
PAHANG[2C]	0.5646	1.7587	0.1440
MELAKA[2C]	0.2115	1.2355	0.5070
NSEMBILAN[2C]	0.9947	2.7039	0.0000***
PROPSIZE	−0.0352	0.9654	0.7860
CONS	−10.3571	0.0000	0.0000***

Note(s):
1. ***, **, * represent significance at 1%, 5% and 10% level, respectively
2. 2A. Comparison group: Chinese
2B. Comparison group: OCCGOVT (Government type of occupation)
2C. Comparison group: Selangor state (including Kuala Lumpur)
3. Goodness of fit and robustness tests
a. Overall fit test (Wald chi-squared): significant with *p*-value of almost zero
b. Pseudo R-squared = 0.1858; Percentage correctly predicted = 89.28%
c. VIF (excluded the squared independent variables): mean = 1.44, minimum = 1.01, maximum = 3.09
d. General specification test: no evidence of specification errors (*p*-value = 0.491)
e. The robust standard errors are used in the estimated logit model

Table 5.
Logistic regression

behavior driven by a sort of – morality of responsibility (Gilligan, 1982). From a real-world perspective, this study concludes that male borrowers are usually have higher financial commitments compared to female borrowers that may affect their ability to repay the mortgage loans.

As for ethnicity, the positive and significant coefficient of MALAY and OTHER indicates that Malay and other types of ethnicity (i.e. indigenous groups) have higher tendency to default compared to Chinese borrowers, which is used as the comparison group. Compared to the Chinese borrowers, the Malay and other indigenous groups have higher odds (to default) of 32.19 and 85.84% respectively. As put forward by Loke *et al.* (2013), Malays are more susceptible to fall into the credit card debt trap due to the lack of financial savviness. Thus, this study concludes that Malay and other indigenous groups have lower level of financial literacy compared to Chinese. This can also be associated with the ethnic economic involvement where historically, Malays largely engaged in farming, Chinese engaged in mining and commerce, while ethnic Indians worked on plantations (Thillainathan and Cheong, 2016). As a result, the Chinese communities are relatively better at financial knowledge because they are more exposed to business and commerce.

As for the loan characteristic factors, the LOANAGE is found to be significant with U-shaped relationship as shown by the negative coefficient of LOANAGE and positive coefficient of $LOANAGE^2$ [4]. This finding is consistent with Campbell and Dietrich (1983), Quercia and Stegman (1992), Hendershott and Schultz (1993) and Springer and Waller (1993) where there is exist a non-linear relationship between mortgage age and probability of default. In terms of the estimated odds ratio, at the initial loan age, the one-day increase in loan age will decrease the odds to default by 0.19%; whereas at the later stage, the one-day increase in loan age will increase the odds to default by 0.0000264%. This implies that the probability of default will be lower at the initial loan age, and then will be likely to increase after a certain duration. Similar to Green and Furstenberg (1975), the present study concludes that old loans are more likely to default as compared to the new loan. This study suggests that the lending institutions in Malaysia should closely monitor the loan performance in the later stage of life to lessen the probability of default.

As expected, loan with guarantor is less likely to default as compared to loan without guarantor, as shown by the negative and significant coefficient of GUARANTOR. The estimated odds ratio shows that loans with guarantor have 28.97% lower odds of getting default compared to loans without guarantor. This indicates that financial institutions should ensure the debt-to-service ratio (DSR) of the borrower fall within the accepted value before approving the housing loan. Otherwise, lenders should request for guarantor if the applicant does not meet the qualification range.

Other loan characteristic factors that found to be positively and significantly contributed to the loan default are ORIBAL, LOANTEN, INTRATE and LTV. This means that higher loan original balance, longer loan tenure, higher loan interest rate and higher loan-to-value (LTV) ratio will increase the probability of loan default. The finding of ORIBAL is similar to Kelly (2008), Soyer and Xu (2010), and Quercia *et al.* (2012) where their empirical findings show that a larger initial loan amount will increase the probability of default. Quantitatively, the increase of RM1000 in original balance will increase the odds to default by 0.07%. As for LOANTEN, the increase of one year in loan tenure will increase the odds to default by 0.34%.

The finding of INTRATE is parallel with Vandell *et al.* (1993) and Goodman and Smith (2010), while the result of LTV is parallel with the findings by Hendershott and Schultz (1993), Springer and Waller (1993), Quigley and Van Order (1995), Deng *et al.* (1996), Hakim and Haddad (1999), Deng *et al.* (2000), Elul *et al.* (2010), Quercia *et al.* (2012), Campbell and Cocco (2015), and Gerardi *et al.* (2018). Quantitatively, the increase of one unit in interest rate and loan-to-value ratio will increase the odds by 230.94 and 234.18% respectively [5].

As for control variables, they are not the focus variables and thus, no interpretations are provided. Briefly, the 2010 lending policy dummy (D2010), and borrower's location dummy (KEDAH, JOHOR, PENANG, SARAWAK, PERAK and NSEMBILAN), are found to be significant. This indicates that it is important to include the control variables in the regression analysis.

5.3 Robustness test

One might argue the bias findings of the higher probability of default among male borrowers because they constitute approximately 70% of the sample. Hence, to gain further insight, the logistic regression model was re-estimated by gender, enabling this study to identify the sources of the gender differential effect in terms of the probability of loan default. Table 6 presents the estimated models in which the first model is the estimated model using male sample; and the second uses female sample. The odds ratio was used since the magnitude of the estimated coefficient of logit model is not directly interpretable. The last column of Table 6 shows the differences of the estimate odds ratio between male and female model. Since the insignificant variable has odds ratio that not significant different from one, i.e. the variable is not able to give an impact on the probability of loan default, thus the insignificant variables are ignored. Only the estimated odds ratio of the significant variables is compared.

Table 6 indicates that, male from Malay ethnicity is more likely to default (0.3585, in odds ratio) than the female Malay. Similar to other ethnicity, the male is more likely to default, however with substantially lower differences (0.1572). There are more significant variables in the loan characteristic factors. Compared to male, female has slightly lower negative impact (to loan default) of loan age (0.0026), and substantially lower for availability of guarantor (0.2078); whereas, female has slightly lower positive impact (to loan default) of original loan balance (0.0006), substantially lower for loan-to-value (LTV) ratio (1.7230), and moderately lower for loan interest rate (0.1410).

6. Conclusion and policy implications

This study aims to investigate factors contributing to mortgage loan default in Malaysia by analyzing 47,158 housing loan borrowers' data using the logistic regression analysis. The findings conclude that gender, ethnicity, guarantor availability, loan original balance, loan tenure, loan interest rate and loan-to-value (LTV) ratio are the significant factors that influence mortgage loans default in Malaysia. The results offer important implications for the housing finance policy in Malaysia.

It is suggested that a simple test on the basic money management skills can be executed during the loan evaluation process as a way to reduce the probability of mortgage loan default. Moreover, since women are more responsible in their loan repayment, Malaysian lenders may create a new mortgage loan product specifically for female borrowers, following the strategy of Grameen Bank in Bangladesh, that targets more women in its loan allocation, as 97% of its borrowers are women. Although this potentially triggers criticism of gender discrimination, the efforts of Grameen Bank, have however, received various awards and recognition worldwide. Among the awards is the MCCI Award – for their pioneering role in poverty alleviation and social development in Bangladesh.

Lenders may also request for guarantor if the borrower's debt-to-income ratio beyond the accepted value. In addition, lower interest rate can be charged to the low-income borrowers so that they can service the loan as the greater financial burden associated with high loan cost will lead to a higher loan commitment which will increase the risk of loan default. To further reduce the probability of default, the loan tenure can be shortened from 35 years to 30 years. As a final point, the maximum loan-to-value (LTV) ratio should be capped at 70% for the

Variable	Male Odds ratio	*p*-value	Female Odds ratio	*p*-value	Differences
Borrower characteristics	(1)		(2)		(1)-(2)
AGE	0.9224	0.2110	0.9590	0.3030	−0.0366
AGE^2	1.0010	0.2590	1.0006	0.2660	0.0004
MARSTAT	1.0497	0.7050	1.1350	0.1930	−0.0854
MALAY	1.5968	0.0530	1.2383	0.1170	0.3585*
INDIAN	1.5559	0.1180	1.1283	0.4430	0.4277
OTHER	1.9839	0.0190	1.8268	0.0000	0.1572*
OCCSS	1.1326	0.6400	1.2300	0.1740	−0.0974
OCCMGMT	1.1517	0.5290	1.0426	0.7700	0.1091
OCCEXEC	1.1401	0.3400	1.1294	0.1740	0.0107
OCCNEXEC	0.8567	0.5360	0.8448	0.2540	0.0119
OCCSELFEMP	0.8561	0.5400	0.8960	0.4450	−0.0399
OCCUNEMP	1.0205	0.9370	1.0772	0.5480	−0.0567
Loan characteristics					
PTI	0.9388	0.8100	1.0401	0.8340	−0.1013
LOANAGE	0.9962	0.0000	0.9988	0.0270	−0.0026*
$LOANAGE^2$	1.0000	0.0000	1.0000	0.0360	0.0000*
GUARANTOR	0.8699	0.2770	0.6621	0.0000	0.2078*
ORIBAL	1.0012	0.0200	1.0006	0.0000	0.0006*
LOANTEN	1.0029	0.0040	1.0037	0.0000	−0.0008*
INTRATE	3.4161	0.0000	3.2751	0.0000	0.1410*
LTV	4.6245	0.0620	2.9015	0.0270	1.7230*
PROPSIZE	0.9401	0.8580	0.9593	0.8390	−0.0192
Other control variables					
D2010	0.0561	0.0000	0.5494	0.1140	−0.4933*
DCRISIS	0.8596	0.3410	1.0279	0.7870	−0.1683
KEDAH	2.0802	0.0000	1.9127	0.0000	0.1675*
JOHOR	1.1980	0.4190	1.4068	0.0030	−0.2088*
PENANG	1.8537	0.0020	1.5144	0.0010	0.3393*
SARAWAK	4.4145	0.0000	2.0034	0.0010	2.4112*
PERAK	3.6327	0.0040	2.3392	0.0020	1.2935*
TERENGGANU	0.3275	0.2890	0.9231	0.8710	−0.5956
KELANTAN	5.2456	0.0560	1.6312	0.5430	3.6144*
SABAH	0.6913	0.3880	1.3352	0.2640	−0.6439
PAHANG	1.0795	0.9220	2.0847	0.0500	−1.0052*
MELAKA	2.5830	0.0960	0.9632	0.9240	1.6198*
NSEMBILAN	1.6444	0.3060	3.0752	0.0000	−1.4308*
Cons	0.0007	0.0000	0.0000	0.0000	0.0007

Note(s): * Represents significance at least 10% level

Table 6. Sources of gender differential effects

borrowers to purchase their second home to minimize loan default as currently, the LTV is capped at 70% to buy third home and the rule does not apply to purchase first and second homes.

Future studies may expand the sample by employing data from other types of financial institutions that would give greater insights as findings might vary due to differences in objectives, functions and regulations. In addition, the findings are subjected to the censoring bias [6], where the no default borrowers are incomplete spells that censored on 31 October 2016 (date of obtaining the data). Once a panel data is available, future studies could perform the survival analysis to control for censoring bias and re-validating the findings of the present study.

Notes

1. Source: Bank Negara Malaysia Financial Stability Review–Second Half 2019 available at https://www.bnm.gov.my/ar2019/files/fsr2019h2_en_full.pdf. 2015 was the highest level of household indebtedness, reaching 89% of GDP.
2. Malaysia is a multi-racial country, with three major ethnic groups: Malay, Chinese, and Indian besides other ethnic groups in Sabah and Sarawak, called indigenous races. Malays and indigenous races are also known as "Bumiputra" forming the largest ethnic group in Malaysia. The ethnicity of indigenous group includes Eurasian, Iban, Kadazan, Punan and other Bumiputra in Malaysia.
3. In 2010, the Central Bank of Malaysia implemented a set of pre-emptive measures aimed at containing excessive household indebtedness and to reinforce responsible lending practices by loan providers.
4. The one-unit increases in interest rate refers to 1% point increase – which is huge as the interest rate ranges from 2% to 9.5% only. Thus, this leads to huge effect to the odds of default to no-default. Similar to the loan-to-value ratio that ranges from 0.5 to 1.
5. $LOANAGE^2$ was added in the regression analysis to test whether nonlinear relationship exists between the mortgage age and loan default. We interpret the coefficient of $LOANAGE^2$ as positive because the actual coefficient is 0.000000264 with the odds ratio of 1.000000264. The small value of coefficient is due to loan age was measured in number of days with the assumption of 365 days a year. For the power of two, the one-unit measurement of $LOANAGE^2$ refers to 133,225 days and this explains why the coefficient value is too small.
6. Thank you to the anonymous referee who has pointed out this potential censoring bias.

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