The implications of loan maturity on the probability of default: evidence from Peruvian long-term loans

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XXXV Encuentro de Economistas del Banco Central de Reserva del Perú

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Motivation

- Long-term lending tends to be associated with higher productivity of firms. Therefore, its scarcity is recognized as an obstacle to economic growth (Caprio & Dermigüc-Kunt, 1997; Diamond, 2004).

- Empirical studies involving large datasets have mostly been conducted for firms in developed countries (Jimenez & Saurina, 2004 and 2006; Johnston et al., 2015), excluding families and emerging economies.

- Identifying the impact of certain loan characteristics considering different maturities might help understand credit risk for Peruvian loans.

Literature review

Table: Literature review

Author(s)	Methodology	Dependent variable	Main signs
Aver (2008)	OLS	Probability of default	Real interest rate for short-term consumer loans (+), Slovenian stock exchange index (+), employment rate (-), reference interest rate (+), interbank interest rate (-), real interest rate on home loans (+)
Bonfim (2009)	Discrete choice model, duration model	Corporate credit default	Credit growth (+), interest rate (+), bond yields (+), stock market index (-), solvency ratio (-), ROA (-), sales growth(-)
Fiordelisi et al (2013)	Probit model	Probability of default	Concentration of lenders (-), length of credit relationship (-), size of the firm (-), collateral (+), HHI (+)
Jappelli and Pagano (1999)	OLS	Loan-loss provision, index of credit risk	Level of information (-), GDP growth rate (-), lender rights (-)
Jimenez et al. (2006)	Random effect logit	Probability of default	Credit growth rate of bank (+), maturity (-), collateral (+), size (-)
Jimenez et al. (2004)	Binomial logit model	Probability of default	Collateral (+), maturity (-), relationship banking (-), saving banks versus commercial banks (+), size (-)
Johnston et al. (2015)	Logit	Loss-given-default	Loan size (-), "age" of loan at default (-), maturity (+), interest rate premium (-), judicial foreclose (+), bank size (-)
Li (2014)	OLS, Logistic model, survival analysis	Probability of default of individual mortgages	Unemployment rate (+), house price volatility (+), personal loan interest rate (+), house price (-), GDP growth (-), loan-to-value ratio (+), loan size (-), income (-), volatility of income (+), leverage and indebtedness (+), non-housing wealth (-)
Quagliariello (2007)	Panel	Loan-loss provision, "new" bad debts	Growth of performing loans (-), bank cost-to-income ratio (+), non-performing loans to total loans ratio (+), GDP growth rate (-), interest rate of long-term debt (+), stock exchange index (-), interest rate spread (-)

Source: compiled by the authors

Hypotheses

1. Loans with longer maturities exhibit a higher PD.
   - Riskier debtors prefer long-term loans (Flannery, 1986 and Johnston et al., 2015).
   - Long-term debtors are assessed rigorously, so screening is important (Jimenez & Saurina, 2004 and 2006).
2. Collateralized loans exhibit a lower PD than uncollateralized ones.
   - Firms prefer to pledge collateral to pay lower interest rates, solving adverse selection problems (Stiglitz & Weiss, 1981; Bester, 1985).
   - Collateral is demanded for riskier borrowers (Jiménez & Saurina, 2004; Rajan & Winton, 1995).
3. The number of bank-debtor relationships is positively correlated with the PD.
   - Measure of over-indebtedness (Foglia et al., 1998).
   - If loans are spread across many institutions, the screening process is more thorough, decreasing the PD (Jiménez & Saurina, 2004).

Characteristics

- Three databases compiled by the SBS:
  - Credit Report of Debtors: monthly information of all loans granted by supervised credit institutions.
  - A database that reflects repayment ability compiled for over-indebtedness supervision (income variable).
  - A database compiled on in-situ supervisory processes which reflects detailed loan characteristics by operation (interest rate and maturity variables).
- Period of analysis: 2012 - 2016.
- More than 26 million observations.

Structure of loans

Table: Structure of loans by type, as of 2016

	Debtors		Size of portfolio		Average interest rate (%)	Average maturity (months)
	Number	%	US$ Million	%		
Firms	**2,228,189**	**35.9**	**53,859**	**65.3**	**46.2**	**17**
Corporates	654	0.01	17,522	21.3	5.2	21
Big-sized companies	2,781	0.05	11,800	14.3	7.7	22
Medium-sized companies	29,740	0.48	13,597	16.5	12.6	29
Small-sized companies	423,613	6.82	7,896	9.6	29.5	27
Micro-sized companies	1,784,387	28.73	3,044	3.7	49.5	14
Households	**4,613,542**	**74.2**	**28,590**	**34.7**	**63.8**	**42**
Revolving loans	2,878,864	46.36	5,723	6.9	68.7	-
Non-revolving loans	3,064,405	49.35	10,522	12.8	49.4	37
Mortgages loans	234,549	3.78	12,344	15.0	10.3	186
Total	**6,209,854**	**100.00**	**82,449**	**100.00**	**59.5**	**32**

Source: SBS

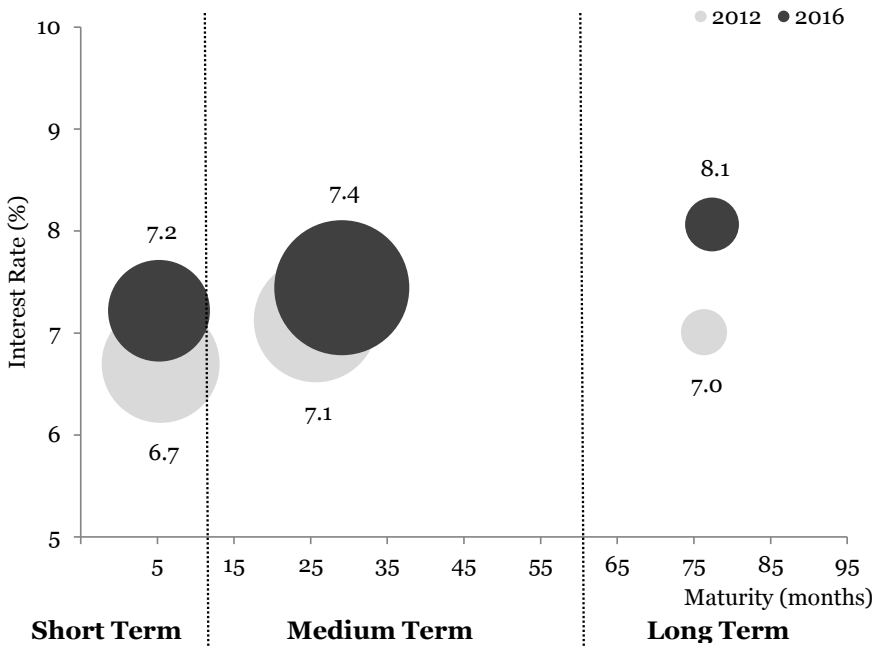
Structure of loans

Table: Structure of loans by type and maturity, as of 2016

	Share of the portfolio (%)			Average interest rate (%)			Average maturity (months)		
	ST	MT	LT	ST	MT	LT	ST	MT	LT
Firms	**26**	**62**	**12**	**61.2**	**40.1**	**21.3**	7	**19**	**74**
Corporates	38	54	7	5.1	5.2	5.8	5	28	75
Big-sized companies	26	62	12	7.6	7.8	8.4	5	29	78
Medium-sized companies	25	53	22	12.3	13.1	11.8	5	30	88
Small-sized companies	5	84	11	40.7	29.1	22.0	7	16	75
Micro-sized companies	11	88	1	66.6	45.5	32.4	7	26	73
Households	**36**	**18**	**46**	**68.6**	**55.6**	**15.1**	**8**	**28**	**116**
Revolving	100	-	-	68.7	-	-	-	-	-
Non-revolving	2	53	45	67.7	55.7	17.0	7	27	85
Mortgages	0	2	98	10.9	13.9	10.3	4	42	189
Total	**30**	**43**	**27**	**37.2**	**24.8**	**14.6**	7	**29**	**100**

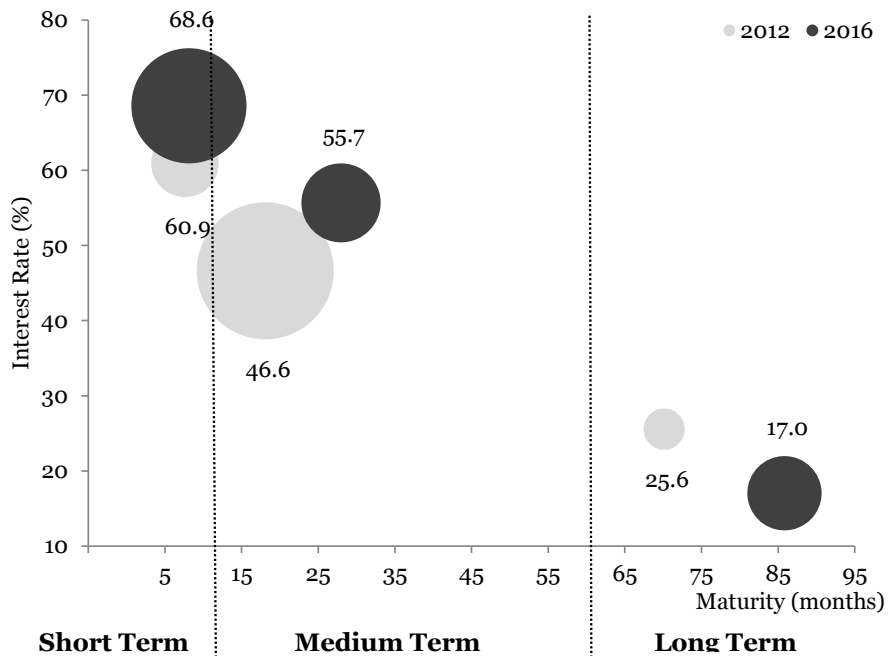
Composition by loan maturity: firms

Figure: Interest rate and average maturity for wholesale loans



*Wholesale: corporates and big-sized firms.

Figure: Interest rate and average maturity for MSME loans



*MSME: Micro, small and medium-sized firms.

Composition by loan maturity: households

Figure: Interest rate and average maturity for consumer loans

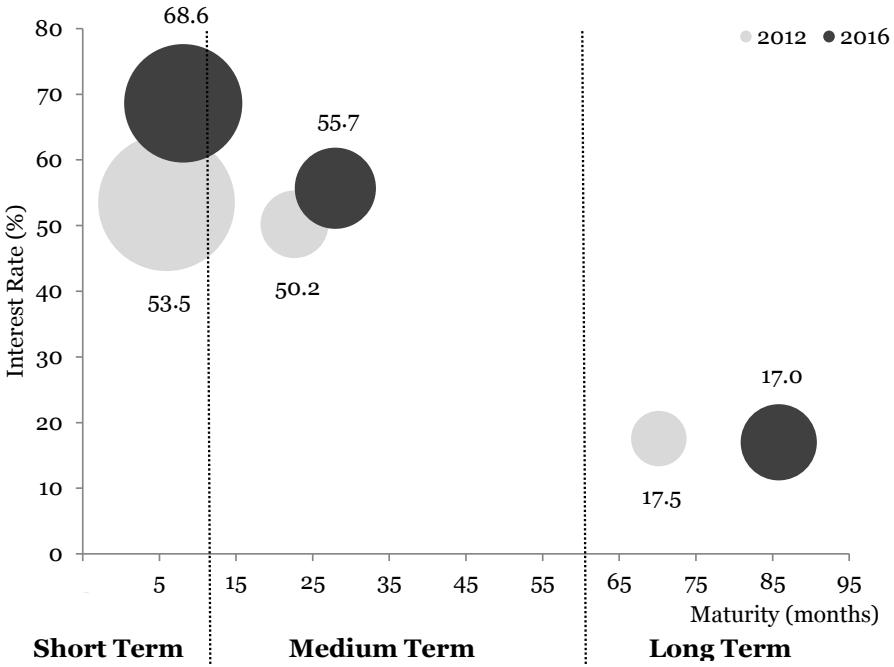
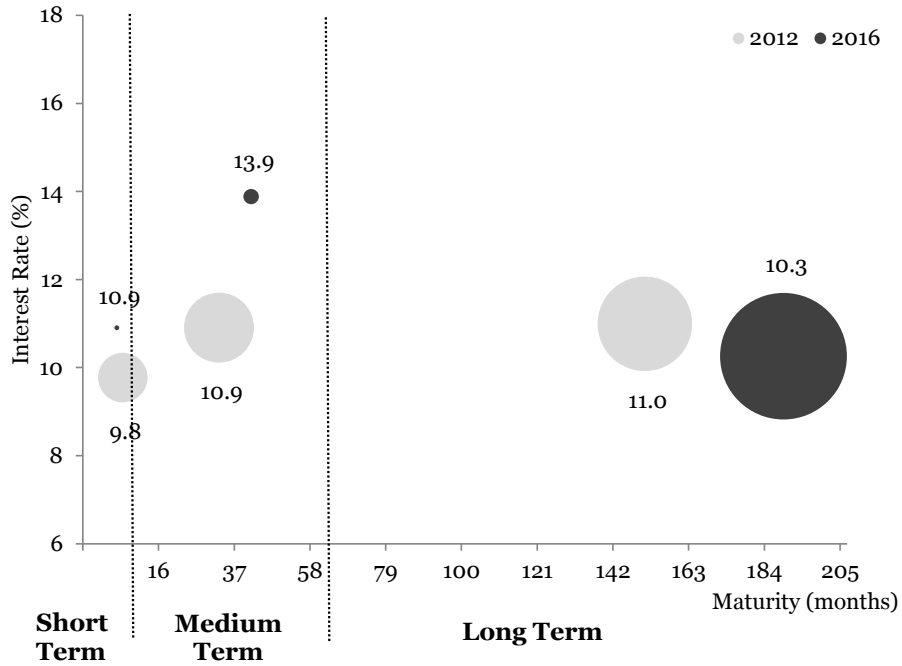
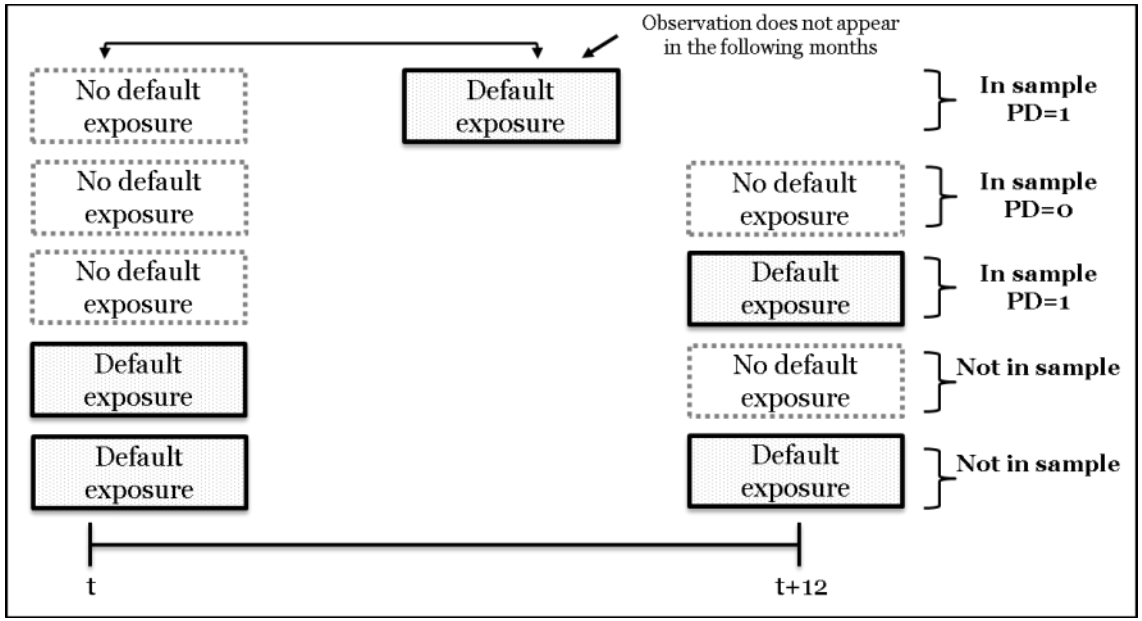


Figure: Interest rate and average maturity for mortgage loans



Estimation of the PD

Figure: Cohort method



- Two most common approaches (Schuermann & Hanson, 2004): cohort and duration.
- In the cohort method, the PD is based on proportions of individuals for each rating category from the beginning to the end a the time-window. This does not include possible changes in the risk categories in the estimation (duration approach).

Strategy

Two alternative models

- Binomial pooled logit model for each type of agent (firms and households). Maturity included as a dummy. (Jiménez & Saurina, 2004).
- Three models: each for a different term: short, medium and long-term. (Glennon & Nigro, 2005).

Dependent variable: default

- 1 if the debtor defaults over a 12-month time-window.
- 0 is the debtor remains in a non-default category over a 12-month time-window.

Default definition

More than 60 days past due.

Strategy

The following model is used for estimations:

$$Pr(y=1|\pi) = c + \sum_{i=1}^{I} \alpha_i X_i + \alpha W + \sum_{j=1}^{n} \gamma_j Y_j + \sum_{k=1}^{m} \delta_k Z_k + \epsilon \times macrofactors$$

Where:

- X_i: variables of interest (includes maturity dummy variables).
- W: repayment ability variable.
- Y_j: loan conditions variable.
- Z_k: debtor characteristics.

Features of the debtor

Table: Variables included in the model

Variables of interest	Type
Collateral	Dummy
N of bank-debtor relationships	Numerical
Short-term loan	Dummy
Medium-term loan	Dummy

Controls	Type
Repayment ability	
Income	Numerical
Loan conditions	
Interest rate	Percentage
Amount of the loan	Numerical
Currency	Dummy
Non-banking loan	Dummy

Controls	Type
Debtor characteristics	
Woman	Dummy
Age	Numerical
Province	Dummy
MSME loan	Dummy
Credit card loan	Dummy
Consumer loan	Dummy
Mortgage loan	Dummy

Firms: marginal effects on the PD

Table: Marginal effects of the determinants of the PD to firms

	Short-term	Medium-term	Long-term	Pool
Variables of interest				
N of bank-debtor relationships	1.07	1.56	1.3	2.03
Collateral	-0.31	-0.62	-0.55	-0.71
Short-term loan				-5.85
Medium-term loan				-5.51
Controls				
Repayment ability				
Income	-0.16	*	-0.92	-0.12
Loan conditions				
Interest rate	0.04	0.1	0.03	0.1
Amount of the loan	-0.09	0.24	-2.38	0.12
Currency	0.06	2.22	*	1.08
Non-banking loan	1.46	2.33	9.44	2.96
Debtor characteristics				
Province	-0.83	-1.28	-4.02	-1.81
MSME loan	24.93	25.25	17.29	34.91
Observations	1,277,393	5,151,173	115,279	6,543,845
Predicted probabilities (threshold = 0.5)	70.64%	72.28%	66.68%	71.80%

Households: marginal effects on the PD

Table: Marginal effects of the determinants of the PD to households

	Short-term	Medium-term	Long-term	Pool
Variables of interest				
N of bank-debtor relationships	0.79	0.39	1.7	0.75
Collateral	-1.14	1.95	-1.27	1.78
Short-term loan				-8.05
Medium-term loan				-2.34
Controls				
Repayment ability				
Income	-6.96	-6.34	-4.54	-6.32
Loan conditions				
Interest rate	0.09	0.17	0.13	0.13
Amount of the loan	1.97	-0.87	-1.08	-0.5
Currency	-7.69	-3.2	0.25	-2.24
Non-banking loan	-1.64	-0.56	2.53	-1.21
Debtor characteristics				
Age	-0.32	-0.31	-0.18	-0.29
Woman	-2.34	-2.5	-2.49	-2.48
Province	-3.71	-2.7	-1.5	-2.31
MSME loan	-0.33	-0.97	2.41	-0.53
Credit card loan	6.78	11.36	5.92	9.81
Consumer loan	12.19	3.83	3.43	6.29
Mortgage loan	-5.42	-4.68	-3.9	-4.74
Observations	1,077,428	6,372,874	1,949,836	9,400,138
Predicted prob. (thres.=0.5)	65.13%	66.59%	71.45%	67.22%

Overall analysis

Table: Determinants of the probability of default

	Firms				Households			
	ST	MT	LT	Pool	ST	MT	LT	Pool
Variables of interest								
N of bank-debtor relationships	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
Collateral	(-)	(-)	(-)	(-)	**(-)**	(+)	**(-)**	(+)
Short-term loan				(-)				(-)
Medium-term loan				(-)				(-)
Controls								
Repayment ability								
Income	(-)	*	(-)	(-)	(-)	(-)	(-)	(-)
Loan conditions								
Interest rate	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
Amount of the loan	(+)	(+)	(+)	(+)	(-)	(-)	**(+)**	(-)
Squared amount of the loan	(-)	(-)	(-)	(-)	(+)	(+)	**(-)**	(+)
Currency	(+)	(+)	*	(+)	(-)	(-)	**(+)**	(-)
Non-banking loan	(+)	(+)	(+)	(+)	(-)	(-)	**(+)**	(-)

Closing remarks

1. Correlation between maturity and PD appears as positive for both firms and households.

2. Impact of some credit risk drivers varies when differentiating loans by maturity:
   - Number of bank-debtor relationships positively correlated to PD
   - Collateral: negative for firms but positive for households (except long-term loans -usually mortgages-).
   - Non-linear relationship between amount of loans and PD.

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Annex: Determinants of the PD to firms

	Short-term	Medium-term	Long-term	Pool
Variables of interest				
N of bank-debtor relationships	0.1832***	0.1696***	0.1136***	0.1711***
Collateral	-0.0541***	-0.0690***	-0.0487***	-0.0614***
Short-term loan				-0.6209***
Medium-term loan				-0.5753***
Controls				
Repayment ability				
Income	-0.0274***	0.0004	-0.0807***	-0.0105***
Loan conditions				
Interest rate	0.0066***	0.0108***	0.0023***	0.0087***
Amount of the loan	0.1415***	0.4573***	0.4927***	0.3292***
Squared amount of the loan	-0.0069***	-0.0201***	-0.0260***	-0.0145***
Currency	0.0110***	0.2210***	-0.2129	0.0882***
Non-banking loan	0.2262***	0.2311***	0.6552***	0.2299***
Debtor characteristics				
Province	-0.1518***	-0.1478***	-0.4084***	-0.1621***
MSME loan	1.9192***	1.5715***	1.0599***	1.7837***
Year				
2012	-0.1113***	-0.0648***	-0.166	-0.0515***
2013	0.0392	0.0123***	-0.0133	0.0201***
2015	-0.2901***	-0.2827***	-0.1439***	-0.2859***
2016	-0.782	-0.8704	-0.2377	-0.8449
Observations	1,277,393	5,151,173	115,279	6,543,845
Log- likelihood	71,213	270,635	7,860	346,770
Predicted probabilities (threshold = 0.5)	70.64%	72.28%	66.68%	71.80%
Pseudo R-Squared (McFadden)	0.0463	0.0448	0.0516	0.0448

Annex: Determinants of the PD to households

	Short-term	Medium-term	Long-term	Pool
Variables of interest				
N of bank-debtor relationships	0.0407***	0.0179***	0.1022***	0.0362***
Collateral	-0.0593***	0.0876***	-0.0780***	0.0848***
Short-term loan				-0.4304***
Medium-term loan				-0.1161***
Controls				
Repayment ability				
Income	-0.3572***	-0.2893***	-0.2733***	-0.3058***
Loan conditions				
Interest rate	0.0047***	0.0077***	0.0081***	0.0065***
Amount of the loan	-0.3441***	-0.0268***	0.1528***	-0.1022***
Squared amount of the loan	0.0252***	-0.0002	-0.0091***	0.0042***
Currency	-0.4421***	-0.1503***	0.0149**	-0.1110***
Non-banking loan	-0.0861***	-0.0257***	0.1462***	-0.0595***
Debtor characteristics				
Age	-0.0165***	-0.0141***	-0.0110***	-0.141***
Woman	-0.1239***	0.1166***	-0.1571***	0.1235***
Province	-0.1997***	-0.1259***	-0.0925***	-0.1146***
MSME loan	-0.0170***	-0.0444***	0.1396***	-0.0256***
Credit card loan	0.3245***	0.4845***	0.3261***	0.4391***
Consumer loan	0.5594***	0.1701***	0.1957***	0.2884***
Mortgage loan	-0.2997***	-0.2228***	-0.2535***	-0.2419***
Year				
2012	0.3384***	0.1864***	0.0631***	0.2428***
2013	0.2091***	0.2102***	0.1369***	0.2128***
2015	-0.3342***	-0.2289***	-0.0383***	-0.2037***
2016	-0.6009	-0.6044	-0.1687	-0.5018
Observations	1,077,428	6,372,874	1,949,836	9,400,138
Log- likelihood	85,660	688,181	83,193	901,806
Predicted probabilities (threshold = 0.5)	65.13%	66.59%	71.45%	67.22%
Pseudo R-Squared	0.0595	0.0802	0.0358	0.0725