Qualified Residential Mortgage: Background Data Analysis on Credit Risk Retention

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ABSTRACT

In 2011, the Commission, OCC, FRB, FDIC, FHFA, and HUD jointly proposed the criteria for a qualified residential mortgage (QRM). The Commission received comments[2] on the 2011 proposing release that questioned both the relevance of the data used in the proposing release and the underlying analysis. For example, Genworth suggested that the Agencies' analysis is flawed because (1) it reflects only loans purchased by GSEs and thus excludes mortgage originations held in non-GSE portfolios, and (2) multivariate analysis was not conducted and some QRM proposed parameters might not significantly impact default risk once the primary factors are held constant. Commentators were also concerned that (3) private mortgage insurance (PMI) was not examined in the proposing release. For example, Mortgage Guaranty Insurance Corporation (MGIC) cited studies by Milliman, Inc. and Promontory Financial Group that show a negative association between PMI and default risk, and pointed to the emphasis of the Dodd-Frank Act on mortgage insurance "to the extent such insurance or credit enhancement reduces the risk of default."

This document provides an analysis of serious delinquencies among non-GSE securitized mortgages ("private label mortgages") to address these comments, and to further understand the potential economic effects related to the definition of the term QRM. This analysis also considers the impact of the qualified mortgage (QM) definition on serious delinquency, including the effect of setting QRM guidelines narrower than those for QM.

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[1] This correction was performed for Mark Flannery, Director of DERA and Chief Economist of the Commission, and rectifies a misclassification of certain mortgage loans that have missing data on FICO scores, LTV ratios, or missing remittance data for some remittance periods, and addresses other minor errors. Taken together, these errors affected only a small number of records and do not qualitatively change the conclusions of the August 2013 paper. This paper supersedes that earlier paper authored by Joshua White and Scott Bauguess (with significant contribution by Ioannis Floros) that was prepared for Craig Lewis, then-Director of DERA and Chief Economist of the Commission, and was intended to provide background information on the potential economic effects from the definition of Qualified Residential Mortgage. The U.S. Securities and Exchange Commission, as a matter of policy, disclaims responsibility for any private publication or statement of any of its employees. The views expressed herein are those of the authors and do not necessarily reflect the views of the Commission or of the authors' colleagues on the staff of the Commission.

[2] Submitted comments on the 2011 proposed rule are available at: http://www.sec.gov/comments/s7-14-11/s71411.shtml

I.   MAIN FINDINGS

- Private label loans have a much higher serious delinquency (SDQ) rate than GSE purchased loans.

- Among historical loans that meet the 2011 proposed QRM definition, the SDQ rate for securitized private label loans is 4.3 times higher than GSE purchased loans.

- Historical loans meeting the 2011 proposed QRM definition have significantly lower SDQ rates than historical loans meeting the QM definition, but applying this definition results in significantly lower loan volume than QM.

- FICO and combined loan-to-value (CLTV)[3] are strong determinants of historical loan performance, while the effect of debt-to-income (DTI) is much lower.

- Adding FICO or CLTV restrictions to the QM definition reduces SDQ rates faster than the loss of loan volume: max ratios achieved at 795 FICO and 55% CLTV.

- PMI is not associated with a significantly lower SDQ rate in a multivariate analysis that controls for other loan terms and borrower characteristics.

The effect on loan performance and total dollar volume of eligible loans by further restricting the QM definition through higher credit quality standards (using FICO as a proxy) and lower CLTV requirements is illustrated in the following charts, which are based on 2.7 million private label loans originated from 1997 to 2009.

Serious Delinquency Rate of QM-Eligible Loans

* = Does not include other QRM proposed factors

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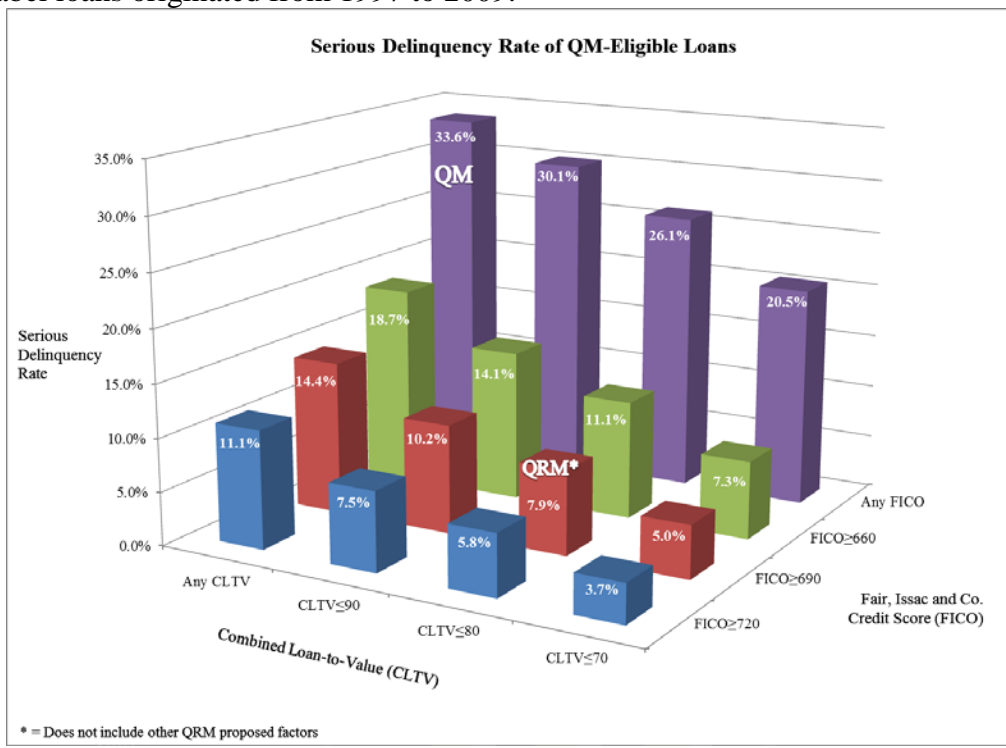
[3] Throughout the analysis, combined loan-to-value (CLTV) considers both first and second liens.

Dollar Volume of QM-Eligible Loans

* = Does not include other QRM proposed factors
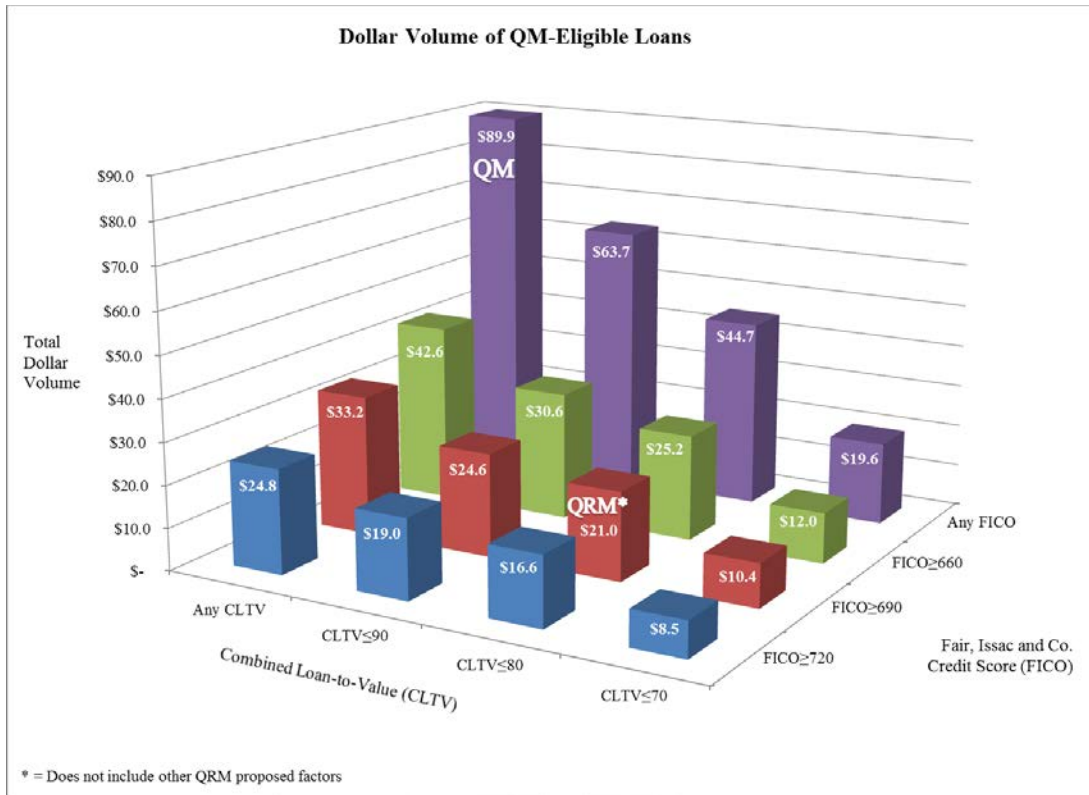
The marginal effects of CLTV, FICO, and other loan and borrower characteristics on SDQ estimated using a Logit regression model (described in Section VI) is reported below. For FICO, CLTV, Interest Rate, and DTI (continuous variables), the percentages reflect the impact on SDQ rate for a one standard deviation change in the corresponding borrower characteristic or loan term. All other percentages reflect the impact on SDQ rate from the presence or absence of the loan feature. The direction of the impact (i.e., positive or negative), can be determined from the coefficient estimates reported in Table 4. For example, a one standard deviation change in FICO score, from 660 to 730, corresponds to an 11.2% decrease in SDQ.

CONTINUOUS VARIABLES

FICO Score	11.2%
Combined Loan-to-Value Ratio	10.6%
Interest Rate	4.6%
Debt-to-Income Ratio	2.3%

DUMMY VARIABLES

Negative Amortization	16.2%
Full Documentation	12.1%
Prepayment Penalty	11.8%
Interest Only	10.4%
Balloon	7.7%
Loan Term > 30 Years	6.8%
Owner Occupied	5.4%
First Lien	3.9%
Teaser Rate	1.6%
Private Mortgage Insurance	0.6%
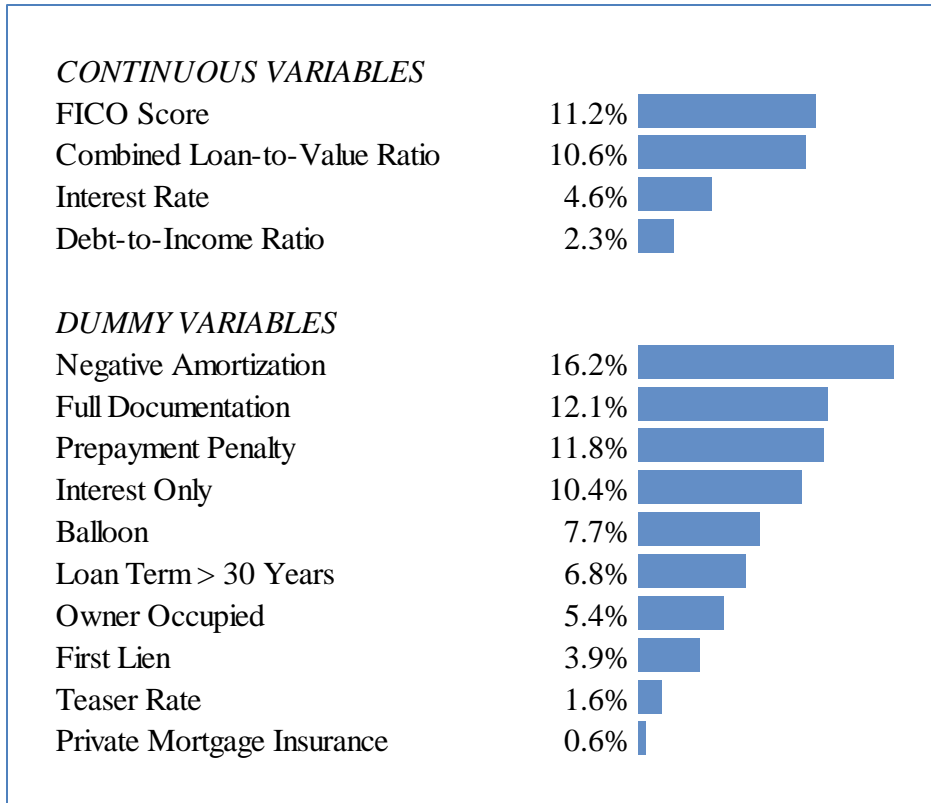
II.   DATA

This analysis uses historical loan performance data from MBSData LLC, which advertises coverage of loan level information on over 95% of non-GSE mortgage backed securities (i.e., private label loans). This data was not available to the Commission at the time of the 2011 risk retention proposing release, which relied on data from (1) Lender Processing Services[4] and (2) Enterprise databases housed at other Agencies.

While the MBSData database provides coverage for more than 20 million loans, not all have complete information on QM or QRM proposed terms and features. In particular, only 13% of the covered loans have DTI information. This restricts the analysis because the QM loans cannot have DTI levels above 43%, and QRM can be no broader than QM. Hence, our analysis relies on 2.7 million loan originations from 1997 to 2009 that resulted in public mortgage backed securities, most of which were originated during 2004, 2005 and 2006.

The MBSData coverage is significantly less than what was used in the 2011 proposing release analysis (e.g., Enterprise database) and by commenters in their analysis using other databases (e.g., CoreLogic). One concern is that the MBSData loans analyzed might be non-representative of the population of all loans, subjecting the analysis of these loans to a potential selection bias. This could affect the interpretation of the results if the exclusion of DTI is systematically related to loan performance (e.g., if the availability of DTI in the MBSData

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[4] These data are also referred to as "McDash" or LPS data.

database is conditioned on better or worse than average loans) or is related to other loan and term features that are related to loan performance.

The analysis in Appendix A shows that there is a 15% higher SDQ rate among the loans used for this analysis compared to the remaining MBSData loans with missing DTI information. The loans analyzed in this report have higher instances of fixed rate mortgages, full documentation loans, loans with a prepayment penalty, and loans with a balloon payment when compared to the remaining MBSData loans with missing DTI. We comment on the effect of the different SDQ rates for the samples with and without DTI coverage in Appendix A. Our preliminary tests show that the effect of most loan characteristics on SDQ are stronger in the missing DTI sample, indicating that for many factors, our analysis underestimates their impact on SDQ rates. We obtain similar results when using a representative sample from the CoreLogic database.

III.   IMPACT OF QM & QRM

In this section, we analyze the impact of the QM[5] and the 2011 proposed QRM[6] definition on historical loan performance and eligibility using the MBSData database. For the applied QM definition, we do not separately consider the set of eligible loans deemed subprime – first (subordinated) lien loans more than 150 (350) basis points above the average prime offer rate. We also consider the proposed alternative QRM definition (QRM_A[7]) with higher DTI and higher CLTV. In each instance, the definitions of QRM and QM would have had a significant impact on the eligibility of pre-crisis originations and the ultimate performance of those that were private label.

A.   Applying Definitions to Historical Loan Originations

Table 1 presents the fraction of loans meeting the definition of QM and the 2011 proposed definitions of QRM and QRM_A. Because the 2011 proposed thresholds for QRM and QRM_A differ by loan purpose (i.e., purchase vs. refinance), we present the statistics for each loan purpose separately.

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[5] We use the following QM loan criteria that correspond to the final QM definition: (1) the loan term is not greater than 30 years; (2) the loan has full documentation; (3) the loan does not have negative amortization, interest only, or balloon payments; and (4) back-end DTI is less than or equal to 43%. Due to data restrictions, we do not have data on points and fees.

[6] We use the following QRM loan criteria that correspond to the QRM definition in the 2011 risk retention proposing release: (1) the loan term is not greater than 30 years; (2) the owner is the primary occupant; (3) the loan has full documentation; (4) the loan does not have negative amortization, interest only, or balloon payments; (5) there is no prepayment penalty; (6) the back-end DTI is less than or equal to 36%; (7) the FICO is 690 or greater; (8) the CLTV is less than or equal to 80% (purchase), 75% (rate & term refinance), or 70% (cash out refinance); and (9) the loan is a first lien loan. Due to data restrictions, we do not have information on points and fees, front-end DTI, and some other QRM definition criteria.

[7] We use the following Alternative QRM (QRM_A) loan criteria that correspond to the Alternative QRM definition from the Agencies' 2011 risk retention proposing release request for comment. Alternative QRM loans include the following changes to QRM: the back-end DTI is less than or equal to 41% (Fixed) or 38% (ARM) and the CLTV is less than or equal to 90% (purchase), 90% (rate & term refinance), or 75% (cash out refinance). Due to data restrictions, we do not have information on points and fees, front-end DTI, and some other Alternative QRM definition criteria.

Less than a quarter of private label loans with non-missing DTI in the MBSData database qualify under the QM definition. Applying the 2011 proposed definitions of QRM and QRM_A yields less than 1% qualifying loans, indicating that substantially all non-GSE loans originated and securitized prior to the financial crisis would not meet the proposed standards. This implies that the potential market impact of a applying either proposed definition of QRM is substantial, as almost all securitized, privately labeled MBS loans in this analysis would not have qualified.

Table 1: Fraction of Loans Meeting QM, QRM and QRM_A Definitions by Loan Purpose

		% of loans qualifying as:		
Loan Purpose	N	QM	QRM_A	QRM
Purchase	1,289,101	18.99	0.83	0.51
Rate & Term Refinance	244,686	21.26	3.27	1.89
Cash Out Refinance	1,016,693	24.17	0.59	0.36
Purpose is Missing	152,473	40.86	--	--
All	2,702,953	22.38	0.91	0.55

B. Impact on Historical Loan Performance

As our measure of loan performance, we use serious delinquency (SDQ), defined as a loan having ever been 90 days late, foreclosed, or real estate owned. The SDQ rate for private label loans covered by the MBSData database is approximately 44% (Table 2). This is substantially higher than the 5.3% reported for all GSE loans in the 2011 proposing release analysis.[8] Serious delinquencies fall to 34% for QM-eligible loans, and 3% for QRM-eligible loans as defined in the 2011 proposing release. As subsequent analysis shows, these rates are substantially higher than similarly defined loan groups using GSE originated loans. Finally, loans taken for the purpose of rate and term refinancing had lower SDQ rate than loans taken for the purpose of purchase or cash out refinancing.

Table 2: Serious Delinquency for Loans Meeting Definition of QM, QRM and QRM_A

	% of loans seriously delinquent (SDQ)			
Loan Purpose	All	QM	QRM_A	QRM
Purchase	48.30	37.03	5.05	3.68
Rate & Term Refinance	42.49	30.58	2.99	1.36
Cash Out Refinance	43.21	35.01	5.14	3.75
Missing	22.37	16.81	n/a	n/a
All	44.40	33.57	4.40	2.98
Number of loans	2,702,953	604,876	24,729	14,950

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[8] This figure is also higher than the historical non-GSE delinquency rate. According to U.S. Census Bureau data, 30-day delinquency levels for conventional mortgages averaged 2.9% to 4.1% from 1983 to 1995.

IV.   ANALYSES IN 2011 PROPOSING RELEASE

In the 2011 proposing release, the Agencies relied upon two types of analyses. First, GSE data were analyzed using a "sensitivity analysis" to show the influence of not meeting each of the proposed QRM standards on SDQ and the total dollar volume of loans (TDV). Second, LPS data were used to analyze the threshold effects of various loan characteristics. In this section, we replicate the sensitivity analysis for the sample of private label loans and compare it to the 2011 proposing release results for GSE purchased loans.

A.   Sensitivity Analysis

Table 3 presents a sensitivity analysis similar to the analysis in the 2011 proposing release[9], comparing non-GSE securitized loan originations reported by the MBSData database to GSE purchased loans. This analysis shows the influence of not meeting each of the proposed QRM standards on SDQ and TDV. Similar to the analysis in the 2011 proposing release, we report SDQ and TDV for (1) all loans, (2) loans meeting the proposed QRM threshold, and (3) loans that meet all but one of the proposed QRM standards (i.e., product type, DTI, LTV, and FICO).

Table 3: Sensitivity Analysis
This table compares mean values of loans originated between 1997 and 2009 that were ultimately securitized. Data on the Government Sponsored Entity, or "GSE", loans are taken from the Appendix A of the 2011 Credit Risk Retention proposing release. The "private" loans include loans in the MBSData database with non-missing data on back-end DTI ratios. The serious delinquency rate (SDQ) is the percentage of loans that were ever 90 days late, foreclosed, or real estate owned. Total dollar volume (TDV) is the sum of the original loan balance. Product Type includes loans with low or no documentation, negative amortization, interest only, and balloon payments. All other variables are defined in Appendix B of this document.

	All Loans	QM	QRM_A	QRM	QRM Except the Following			
					Product Type	DTI	LTV	FICO
SDQ								
GSE	5.3%	--	--	0.7%	3.7%	2.1%	1.7%	4.4%
Private	44.4%	33.6%	4.4%	3.0%	10.9%	5.2%	6.8%	13.4%
TDV ($Billions)								
GSE	$11,926	--	--	19.8%	24.4%	37.2%	29.7%	23.7%
Private	$547	16.4%	2.0%	1.2%	4.3%	2.3%	2.1%	1.7%
Number and Fraction of Total								
GSE	--	--	--	--	--	--	--	--
Private	2,702,953	22.4%	0.9%	0.6%	1.8%	1.1%	1.4%	1.1%

Performance of the securitized non-GSE loans reported by MBSData is significantly worse than the performance of GSE purchased loans reported in the 2011 proposing release

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[9] See Appendix A of the 2011 proposing release for comparison: http://www.sec.gov/rules/proposed/2011/34-64148.pdf

using the Enterprise database. SDQ for all MBSData loans is 44.4% compared to 5.3% for GSE loans. This finding is similar to the results in a study by Elul (2011), who finds prime, private label loans have a 20% higher delinquency rate than non-private securitized loans (i.e., GSE loans).[10]

Restricting the analysis of securitized non-GSE loans to those that qualify according to the 2011 proposed QRM definition yields SDQ levels between 1.36% and 3.75% depending on loan type. While these are significantly lower SDQ rates compared to all non-GSE securitized loans in the MBSdata database, the SDQ rate for all securitized non-GSE QRM loans remains about four times higher than the 0.69% SDQ for QRM qualifying GSE loans. This suggests potential differences in the underwriting standards between non-GSE and GSE purchased loans that are not captured by the reported loan characteristics. Alternative explanations include misreported loan characteristics[11] that are systematically different between the two databases, or a potential bias in the selection of loans included in the MBSData database.[12]

In a separate (untabulated) analysis we consider how the Table 3 results change when restricted by loan type. Of each of the loans that meet all but one of the 2011 proposed QRM thresholds, those that do not meet the threshold FICO≥690 are associated with the highest marginal SDQ levels, as high as 18.08% for cash-out refinances. LTV with PMI is the next most important contributor to SDQ levels. Loans that do not meet the LTV (with PMI) levels, exhibit SDQ levels that reach 13.03% for cash-out refinances.

B.   Proposing Release Threshold Analysis

The 2011 proposing release analysis assesses the performance of securitized and non-securitized loan originations covered by McDash LPS and CoreLogic between 2005 and 2008 and concludes that LTV levels and FICO scores have a considerable influence on serious delinquency rates. The analysis shows, for example, that mortgage borrowers with a FICO score of 690 or lower were six times more likely to default as borrowers with FICO scores above 740. The analysis also shows default rates increase noticeably among loans with an LTV above 80%.

In the next section, we estimate logistic regression models to assess the relative statistical significance and marginal effects of the various loan and term characteristics considered. The estimation results reported in Table 4 corroborate the threshold analysis in the 2011 proposing release, and show that the marginal effects of CLTV levels and FICO scores on serious delinquency levels are the highest among all continuous independent variables.

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[10] Elul (2011) finds evidence that prime, privately securitized loans are subject to adverse selection problems, where lenders take advantage of information asymmetry by securitizing riskier loans based on private, non-observable information. These loans are riskier even when controlling for observable information available to residential mortgage backed securities (RMBS) investors.

[11] In a recent working paper, Piskorski et al. (2013) compare loan data with anonymously linked credit history and find about 10% of privately labeled RMBS loans misreport occupancy status and second liens. In their study, they find the misreported loans are associated with significantly higher delinquency rates.

[12] We discuss the potential likelihood of a data bias in Section VI-C.

V. LOGIT REGRESSION ANALYSIS

The analysis in this section examines the impact of loan characteristics on SDQ as the loan pools are restricted to QM and QRM definitions. The purpose is to assess the impact of loan characteristics on the likelihood of serious delinquency as the quality of the loan pool increases. For instance, does DTI, LTV, or FICO still predict the likelihood of serious delinquency when only QM-eligible loans are considered? The results are intended to inform on the merit of additional restrictions to the definition of QM, and to address commenter concerns that multivariate analysis could alter the interpretation of the results presented in the 2011 proposing release.

A. Research Design

We estimate binomial logistic models and report the marginal effects of various loan characteristics on the probability of serious delinquency in several panels of Table 4 at the end of the document.

The first four models of Table 4, Panel A, estimate the effects of loan characteristics that are often the focus of other studies – CLTV, FICO, and DTI (see e.g., Elul et al., 2010; Piskorski et al., 2010; Demyanyk and Van Hemert, 2011; and Demiroglu and James, 2012). For each of these models, we estimate the following equation:

$$Log(SDQ_i/(1-SDQ_i)) = a + \beta_1 DTI_i + \beta_2 CLTV_i + \beta_3 FICO_i \tag{1}$$

The remaining four models include additional loan characteristics, estimated according to the following equation:

$$\begin{aligned}
Log(SDQ_i/(1-SDQ_i)) = {} & a + \beta_1 DTI_i + \beta_2 CLTV_i + \beta_3 FICO_i + \beta_4 PMI_i + \beta_5 TEASER_i \\
& + \beta_6 INT\_RATE_i + \beta_7 LIEN\_FIRST_i + \beta_8 PREPAY_i + \beta_9 OCC\_OWN_i \\
& + \beta_{10} DOC\_FULL_i + \beta_{11} TERM\_LONG_i + \beta_{12} NEG\_AM_i \\
& + \beta_{13} INT\_ONLY_i + \beta_{14} BALLOON_i
\end{aligned} \tag{2}$$

where,

SDQ	= 1 if loan has ever been 90 days late, foreclosed, or real estate owned.
DTI	= the ratio of the total monthly debt / monthly gross income.
CLTV	= the combined loan to value including secondary liens.
FICO	= the Fair, Isaac and Company credit score of the borrower at origination.
INT_RATE	= the original interest rate of the loan.
PMI	= 1 if loan includes private mortgage insurance.
TEASER	= 1 if loan has a teaser rate.
LIEN_FIRST	= 1 if lien position is the first lien.
PREPAY	= 1 if loan has prepayment penalty.
OCC_OWN	= 1 if occupancy status is primary/owner-occupied.
DOC_FULL	= 1 if loan has full documentation.

TERM_LONG   = 1 if loan term exceeds 30 years at origination.

NEG_AM   = 1 if loan includes negative amortization.

INT_ONLY   = 1 if interest only loan.

BALLOON   = 1 if loan has a balloon payment.

For each model specification, we estimate the effects of the loan characteristics on SDQ for (1) loans with available DTI information, (2) QM-eligible loans, (3) QRM_A-eligible loans, and (4) QRM-eligible loans. Table 4 reports the coefficient estimates, with larger numbers corresponding to a greater impact on serious delinquency.[13] For continuous variables (FICO,CLTV, DTI, and INT_RATE), the numbers reported in parenthesis provide an economic interpretation, corresponding to the predicted percentage change in serious delinquency for a one standard deviation increase in the corresponding loan characteristic. For all other characteristics, the coefficient estimate represents the percent increase in SDQ associated with the presence of the loan or term feature. In each estimation, we control for the loan origination year.

B.   Results

1.   Primary Results

The estimation results of model (1) in Table 4 (Panel A) are consistent with prior literature on serious delinquency (e.g., Elul et al., 2010). Higher FICO scores are associated with statistically lower SDQ levels, while higher levels of CLTV, and to a lesser extent DTI, are associated with statistically significant increases in SDQ. For example, a one standard deviation increase in CLTV is associated with a 11.1% increase in SDQ, while a one standard deviation increase in DTI is only associated with a 1.9% increase in SDQ. Thus, the economic significance of DTI is about one-fifth of either FICO or CLTV.[14]
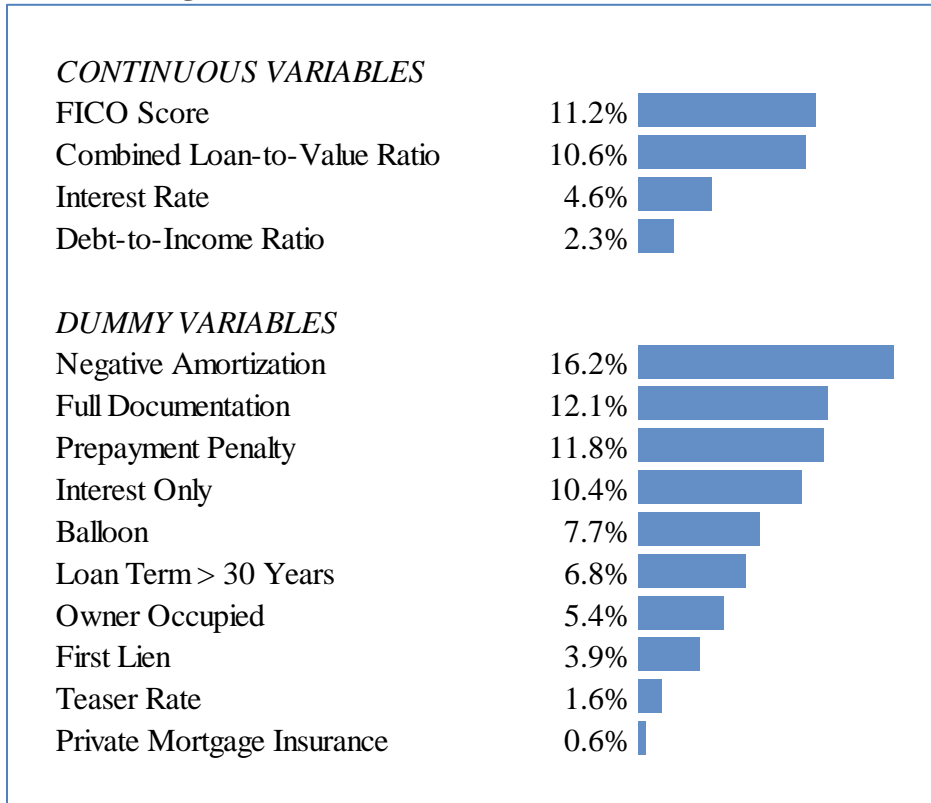
The relevance of FICO and CLTV on SDQ is not materially affected when controlling for the simultaneous effects of other observable loan characteristics (model 5). However, many of the other loan characteristics are also economically significant. Figure 1 charts the factor ranking from the estimates in model (5). Each ranking is the absolute value of the marginal effect from the regression. For the continuous variables (FICO, CLTV, DTI, and INT_RATE), this is the change in SDQ for a one standard deviation increase in the loan characteristic; for all other (dummy) variables, this is the change in SDQ associated with the presence of the loan term or feature. Figure 1 shows FICO and CLTV have the largest absolute effect on serious delinquency for all continuous variables, while PMI has the smallest effect among dummy variables.

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[13] The interpretation of marginal effects for continuous and dummy variables must be analyzed separately.

[14] As we show in later analysis (Appendix A), missing DTI information severely restricts the sample of loans available for the analysis, and this restriction is associated with a significant selection bias. We are unable to assess how this bias affects the estimates on the DTI variable in this analysis.

Figure 1. Factor Ranking for All Loans

CONTINUOUS VARIABLES
FICO Score	11.2%
Combined Loan-to-Value Ratio	10.6%
Interest Rate	4.6%
Debt-to-Income Ratio	2.3%

DUMMY VARIABLES
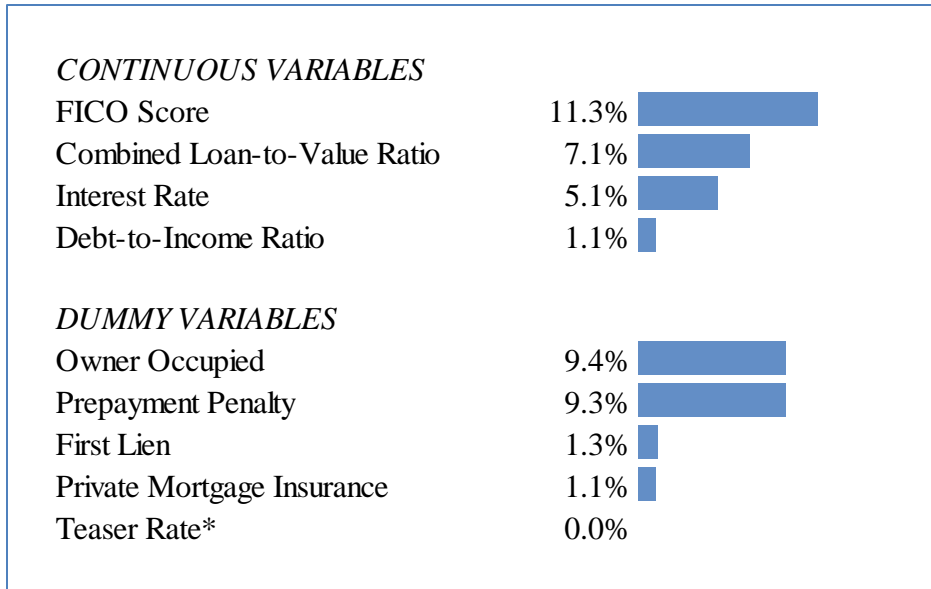|	
Negative Amortization	16.2%
Full Documentation	12.1%
Prepayment Penalty	11.8%
Interest Only	10.4%
Balloon	7.7%
Loan Term > 30 Years	6.8%
Owner Occupied	5.4%
First Lien	3.9%
Teaser Rate	1.6%
Private Mortgage Insurance	0.6%

The economic relevance of FICO and CLTV remain when we restrict the analysis to only QM-eligible loans. In fact, in model (2) FICO becomes a more important determinant of SDQ when the analysis considers only QM-eligible loans (a one standard deviation increase in FICO is associated with a 14.6% decline in SDQ among QM-eligible loans compared to an 11.1% decline among all loans). Similar results are obtained after including other loan characteristics (model 6). Figure 2 charts the factor rankings. Given that serious delinquencies remain above 30% in QM-eligible loans, and that these factors are significantly and economically significant, we might expect that delinquencies will benefit considerably from QRM restrictions.

Among QRM and QRM_A eligible loans (models 3, 4, 7, and 8), FICO, DTI. and CLTV remain statistically significant, but are less economically relevant. While these results indicate that the 2011 proposed QRM definitions absorb the explanatory power of these factors, the corresponding sample sizes are severely restricted; less than 1% of analyzed loans qualify.

Taken together, this analysis shows that there remains a high SDQ rate among QM-eligible loans, and the QM restriction does not lessen the economic relevance of FICO and CLTV in explaining SDQ. Hence, FICO and CLTV continue to be important "knobs" in determining historical loan performance. On the other hand, the QRM or QRM_A restrictions severely restrict the number of loans eligible in our sample of historical loan data.

Figure 2. Factor Ranking for QM-Eligible Loans (* not statistically significant)

CONTINUOUS VARIABLES	
FICO Score	11.3%
Combined Loan-to-Value Ratio	7.1%
Interest Rate	5.1%
Debt-to-Income Ratio	1.1%
DUMMY VARIABLES	
Owner Occupied	9.4%
Prepayment Penalty	9.3%
First Lien	1.3%
Private Mortgage Insurance	1.1%
Teaser Rate*	0.0%

Figure 3. Factor Ranking for QM-Eligible Loans with CLTV ≥ 80% (* not statistically significant)

CONTINUOUS VARIABLES	
FICO Score	12.9%
Interest Rate	3.9%
Combined Loan-to-Value Ratio	3.9%
Debt-to-Income Ratio	0.9%
DUMMY VARIABLES	
Owner Occupied	11.4%
Prepayment Penalty	9.8%
Teaser Rate	0.6%
Private Mortgage Insurance	0.8%
First Lien*	0.1%
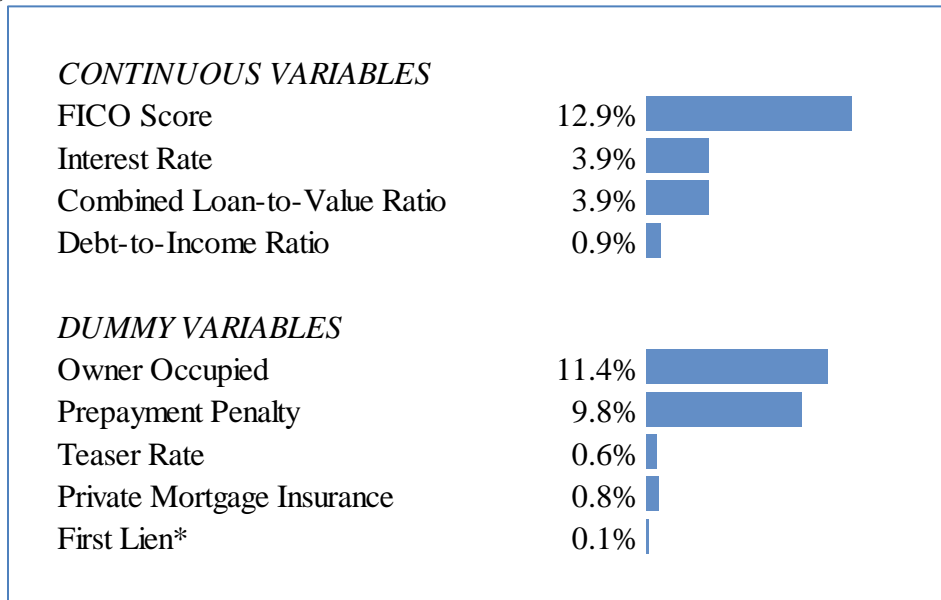
2. Additional PMI Analysis

In Panel B of Table 4, we repeat the analysis on QM-eligible loans in model (6) from Panel A for various stratifications of CLTV. In model (6b), we restrict our sample to the loans that exhibit CLTV levels greater than 80% to assess the effect of PMI on SDQ. As commenters note[15], these are the CLTV levels in which PMI is most frequently employed. Figure 3 presents the factor rankings for all QM-eligible loans with CLTV greater than or equal to 80%. The
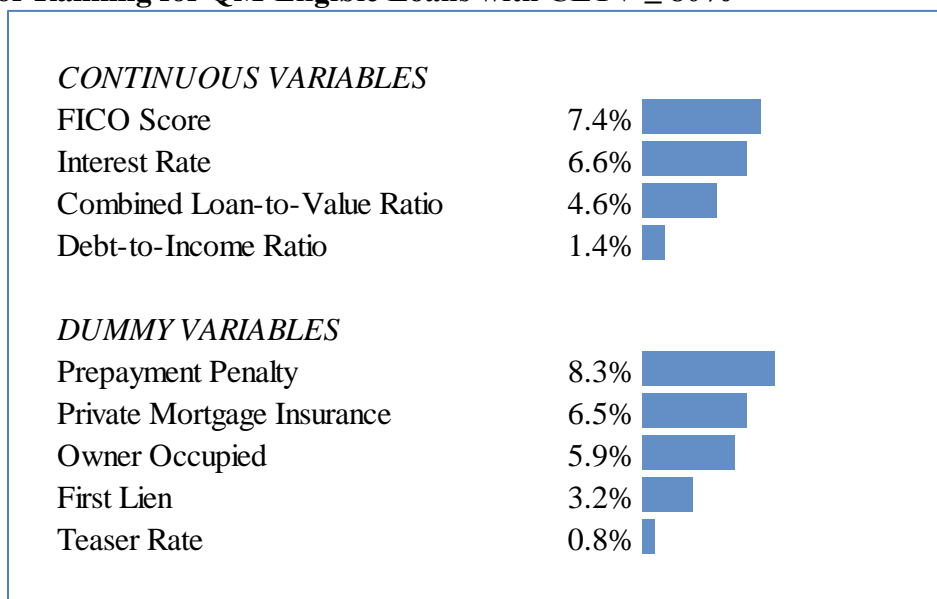
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[15] For example, see comments by MGIC, Genworth and MICA.

coefficient estimate on PMI is statistically, but not economically, significant, indicating that PMI does not have a material impact on SDQ among QM-eligible loans. While the marginal effect of CLTV is diminished (a mechanical effect from the stratification), the economic relevance of FICO remains unchanged.

3.   Additional CLTV Analysis

The remaining models in Panel B of Table 4 examine the effect of incremental CLTV restrictions of less than 70%, 80% and 90%, respectively. As expected, the economic relevance of CLTV diminishes with lower CLTV restrictions due to a mechanical effect. However, FICO remains economically relevant among all stratifications, with a one standard deviation increase associated with a 6.2% decrease in SDQ among the lowest CLTV stratification (≤70%). Figure 4 reports the factor rankings of all explanatory variables on SDQ.

Figure 4. Factor Ranking for QM-Eligible Loans with CLTV ≤ 80%

CONTINUOUS VARIABLES	
FICO Score	7.4%
Interest Rate	6.6%
Combined Loan-to-Value Ratio	4.6%
Debt-to-Income Ratio	1.4%
DUMMY VARIABLES	
Prepayment Penalty	8.3%
Private Mortgage Insurance	6.5%
Owner Occupied	5.9%
First Lien	3.2%
Teaser Rate	0.8%

This analysis shows that the effect of FICO is largely independent of CLTV requirements, and is therefore not a proxy or substitute for CLTV in the determination of SDQ. These results hold when we alter the stratification to include (non-overlapping) CLTV ranges in Panel C: 70%-79.99%, 80%-89.99%, and greater than or equal to 90%.

The explanatory power of each model is approximately the same, with the number of qualifying loans falling to 101,080 from 366,073 as CLTV is restricted from 90% to 70%. The average SDQ rate falls to 20.45% from 30.11% as CLTV is restricted from 90% to 70%. This compares to 604,876 QM-eligible loans with no CLTV restriction and corresponding 33.57% SDQ.

4.   Additional FICO Results

In Panel D of Table 4, we repeat the analysis on QM-eligible loans in model (6) from Panel A for various stratifications of FICO, starting with 680 minimum FICO. As expected, the economic relevance of FICO diminishes with higher minimum levels due to a mechanical effect.

While the marginal effects of CLTV do not materially change across the stratifications, they are less than half the estimate from the Panel A, model (6), without a FICO restriction. In particular, a one standard deviation increase in CLTV is associated with a 2.92% increase in SDQ for the 680 minimum FICO restriction compared to 7.12% for no FICO restriction. Figure 5 reports the factor rankings of all explanatory variables on SDQ for the 680 minimum FICO restriction.

Figure 5. Factor Ranking for QM-Eligible Loans with FICO ≥ 680

CONTINUOUS VARIABLES

FICO Score	4.4%
Combined Loan-to-Value Ratio	2.9%
Interest Rate	2.5%
Debt-to-Income Ratio	0.9%

DUMMY VARIABLES

Prepayment Penalty	8.5%
Owner Occupied	3.2%
Teaser Rate	1.3%
Private Mortgage Insurance	2.0%
First Lien	0.5%
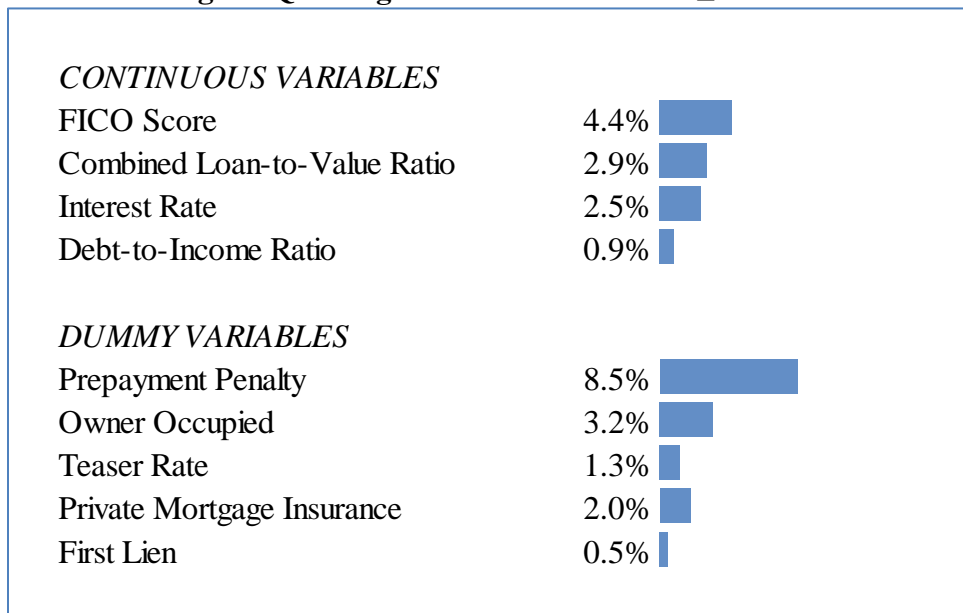
This analysis shows that the economic relevance of CLTV is materially lowered with even a minimum FICO restriction. This is in contrast to the earlier result that CLTV restrictions do not materially impact the effect of FICO. This evidence suggests that FICO is a partial proxy for CLTV in the determination of SDQ. These results hold when we alter the stratification to include (non-overlapping) FICO ranges in Panel E.

The explanatory power of the estimation model falls monotonically as FICO is restricted, with the number of qualifying loans falling from 195,248 to 91,190 as minimum FICO is increased from 680 to 740. The corresponding average SDQ rate falls from 15.88% to 9.28%. This compares to 604,876 QM-eligible loans with no FICO restriction and corresponding 33.57% SDQ. Finally, as in prior analysis, the marginal effects of CLTV are positive and range between 4.17 and 2.19 and the marginal effects of DTI and PMI have low economic relevance.

VI. TRADEOFF ANALYSIS OF SDQ AND TDV

The results of the parametric analysis in Section V indicate that among product and underwriting features associated with lower levels of SDQ, FICO, and CLTV are statistically and economically significant.

In this section, we examine how the rate of change in SDQ rates compare to the rate of change in the total dollar volume of loans as additional restrictions are applied to QM-eligible

loans. The premise behind this analysis as outlined by one commenter[16] is that additional restrictions to the QM definition will lower the incidence of default (a benefit), but at a cost of reducing borrowers' access to capital.

As we discuss below, we caution on the interpretability of this ratio. Although the metric is intuitive and simple, there is no clear economic interpretation. Unlike a measure of elasticity that allows for understanding of how the rate of change of one economic factor influences the rate of change of another (e.g., how the price of a good affects the quantity sold), there is not an identified functional relation between SDQ and TDV. Both are outcomes of a set of qualifying loan definitions, and one outcome is not necessarily the consequence of the other. Furthermore, delinquency rates and access to capital are not directly comparable; they have different units of measure that prohibit a one-to-one comparison implied by a ratio.

A.   Reduced Defaults (Benefit)

The intended benefit of additional product or underwriting restrictions is a decrease in the incidence of default. The three-dimensional (3-D) chart of SDQ rates of QM-eligible loans for various FICO and CLTV thresholds presented in Section II of this report shows that QM-eligible loans with any FICO or CLTV have a historical SDQ rate of 33.57%, which is a 24% decline from the SDQ rate of 44.4% for all loans[17], which could include sub-prime FICO scores and CLTV ratios above 100%. Limiting QM-eligible loans to FICO scores above 660 reduces the SDQ rate 18.7%, a 58% decline from the overall SDQ rate. Limiting QM-eligible loans to CLTV levels no greater than 90% reduces the SDQ rate to 30.1%, a 32% decline from the overall SDQ rate. Looking at the combination of FICO scores and CLTV ratios associated with the 2011 proposed QRM definition, a minimum 690 FICO and a CLTV no greater than 80% results in an SDQ rate of 8.8%, a 80% decline from the overall SDQ rate. Similarly, the combination of FICO scores and CLTV ratios that corresponds to the alternative QRM definition (QRM_A), a minimum 690 FICO score and CLTV ratios no greater than 90%, is associated with an SDQ rate of 11.1%.

B.   Reduced Loan Levels (Cost)

As earlier analysis shows, applying additional restrictions to the QM definition can significantly reduce SDQ rates, but can also severely restrict the number of eligible loans. For example, applying the 2011 proposed QRM and QRM Alternative definitions to our sample of private label loans eliminates more than 99% of the sample. Fewer qualifying loans could impact borrower access to capital if the inability to securitize them without risk retention reduces the likelihood that they will be originated.

The three-dimensional (3-D) chart of total dollar volume of QM-eligible loans for various FICO and CLTV thresholds presented in Section II of this report shows that QM-eligible loans

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[16] See comment from Center for Responsible Lending and referenced study sponsored by the Center for Responsible Lending:http://www.responsiblelending.org/mortgage-lending/research-analysis/Underwriting-Standards-for-Qualified-Residential-Mortgages.pdf. The authors of that study find a higher ratio for loans with some additional restrictions beyond QM on either FICO scores or CLTV ratios.

[17] Percentage decline is calculated as [(new SDQ% – original SDQ%) / original SDQ%].

had a TDV of just under $90 billion for our sample with DTI coverage. This is an 84% decline from the $547 billion TDV for the full sample. Restricting QM-eligible loans to FICO scores no less than 690 results in a TDV of $33.2 billion, a 94% decline from the full sample TDV. Restricting CLTV to 80% or less results in a TDV of $44.7 billion, which is an 88% decline from the full sample TDV. The combination of 80% CLTV and 690 FICO limitations results in a TDV of $21.0 billion, excluding 96% of all privately labeled, securitized loans during our sample period.

From one perspective, eligibility restrictions beyond QM that decrease the number of loans qualifying for the exemption from the requirements of risk retention by the securitizer impose a (social) cost to the system. Some borrowers that could otherwise support repayment of a residential loan might not be able to secure one. The alternative perspective is that the moral hazard from allowing higher risk loans into securitizations without any retained risk could lead to a recurrence of systemic risk concerns observed during the financial crisis. Regardless of perspective, there is no clear econometric method of identifying the point at which additional access to capital is a cost or a benefit.

C.   Ratio Analysis

The analysis below compares the change in the SDQ rates to the change in the TDV of loans as additional restrictions are applied to QM-eligible loans. From the perspective that restricting access to capital is strictly a cost (setting aside systemic or other risk concerns), the percentage decline in serious delinquency divided by the percentage decline in loan volume can be viewed as a benefit-cost ratio, with the simple intuition is that a higher ratio is preferred.

However, even with the assumption that restricting access to capital is strictly a cost, there is no economic interpretation that can be applied to the ratio because the benefits and costs are not measured in the same units. In particular, it is not clear how the benefit of a 1% decrease in SDQ should compare to the cost of a 1% loss in borrower access to capital. Moreover, it is possible that the cost – particularly the unobserved (social) cost – of restricting capital is non-linear. For instance, as additional restrictions/thresholds are added to the QM definition, there could be a shift in the marginal non-qualifying loan or borrower. Hence, comparing the ratio across different qualifying loan definitions may not be relevant.

Figures 6, 7, and 8 present a graphic of comparing this tradeoff across various additional restrictions to QM. Given that QRM can be no broader than QM, we use the ratio from QM-eligible loans as a lower-bound for comparison. QM loans have an SDQ rate of 33.57%, which is a 24.38% decline from the overall sample. QM loans have a TDV of $89.9 billion, which is an 83.58% decline in TDV. Thus, the ratio for QM-eligible loans is -24.38% / -83.58% = 29.17%.

1.   Effect of FICO Restrictions

Figure 6 shows the SDQ-TDV tradeoff for a range of FICO scores. Adding a FICO restriction above the definition of QM results in an increase in the ratio (above the QM ratio), reaching a peak at 795 FICO (ratio = 87.41%). At this level, which is the peak of the graph, each percentage decline in the loan volume is associated with a 0.87% decline in serious delinquency. As FICO scores are tightened beyond 795, we see the ratio begins to decline.

2. Effect of CLTV Restrictions

Figure 7 shows the SDQ-TDV tradeoff for a range of CLTV ratios. Adding a CLTV restriction above the definition of QM results in an increase in the ratio (above the QM ratio) reaching a peak 55% CLTV (ratio = 64.0%). However, consistent with the Section V analysis, the maximum ratio for FICO scores at 795 is greater than the maximum ratio for CLTV ratios no higher than 55%.

3. Effect of DTI Restrictions

Finally, Figure 8 shows the SDQ-TDV tradeoff for a range of DTI ratios is not materially different from the QM trade-off, which already has a DTI restriction.

VII. SUMMARY

Our parametric analysis of historical loan data associated with private label residential mortgages indicates that SDQ rates among private label residential mortgages are significantly different than GSE loans. We also show that there remains a high SDQ rate (33.6%) among the loans in our analysis that meet the QM eligibility definition. By contrast, loans in our analysis that meet the 2011 proposed definition of QRM are associated with a significantly lower historical loan performance (approximately 3% SDQ rate), but less than 1% of the loans analyzed would have qualified under the QRM definitions. Regarding particular underwriting or loan features, we find that PMI has little to no relation to historical loan performance controlling for other loan characteristics. We also find that the impact of DTI on SDQ is small, approximately one-fifth the impact of FICO or CLTV, although this might be subject to potential selection bias because of missing DTI information for the majority of loans in our database. We find, consistent with the threshold analysis in the 2011 proposing release, that higher FICO scores and lower CLTV ratios are associated with significantly lower levels of serious delinquency, both statistically and economically. Even modest restrictions on FICO scores or CLTV ratios for QM-eligible loans are associated with significant reductions in SDQ rates. As we describe in Appendix A, all of these results are subject to potential biases due to restricted data on loan features, and there is indication that this bias leads us to overestimate the effect of CLTV while underestimating the true impact of FICO, and most other loan factors.

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IX. FIGURES

A. Figure 6 – FICO Benefit-Cost Ratio

Figure 6. FICO Benefit-Cost Ratio

This figure presents the benefit-cost ratio for a range of FICO scores among QM-eligible loans. The solid line shows the benefit-cost ratio for each loan with a FICO score greater than or equal to the value on the horizontal axis, while the dotted line shows the benefit-cost ratio for all QM loans regardless of FICO score.
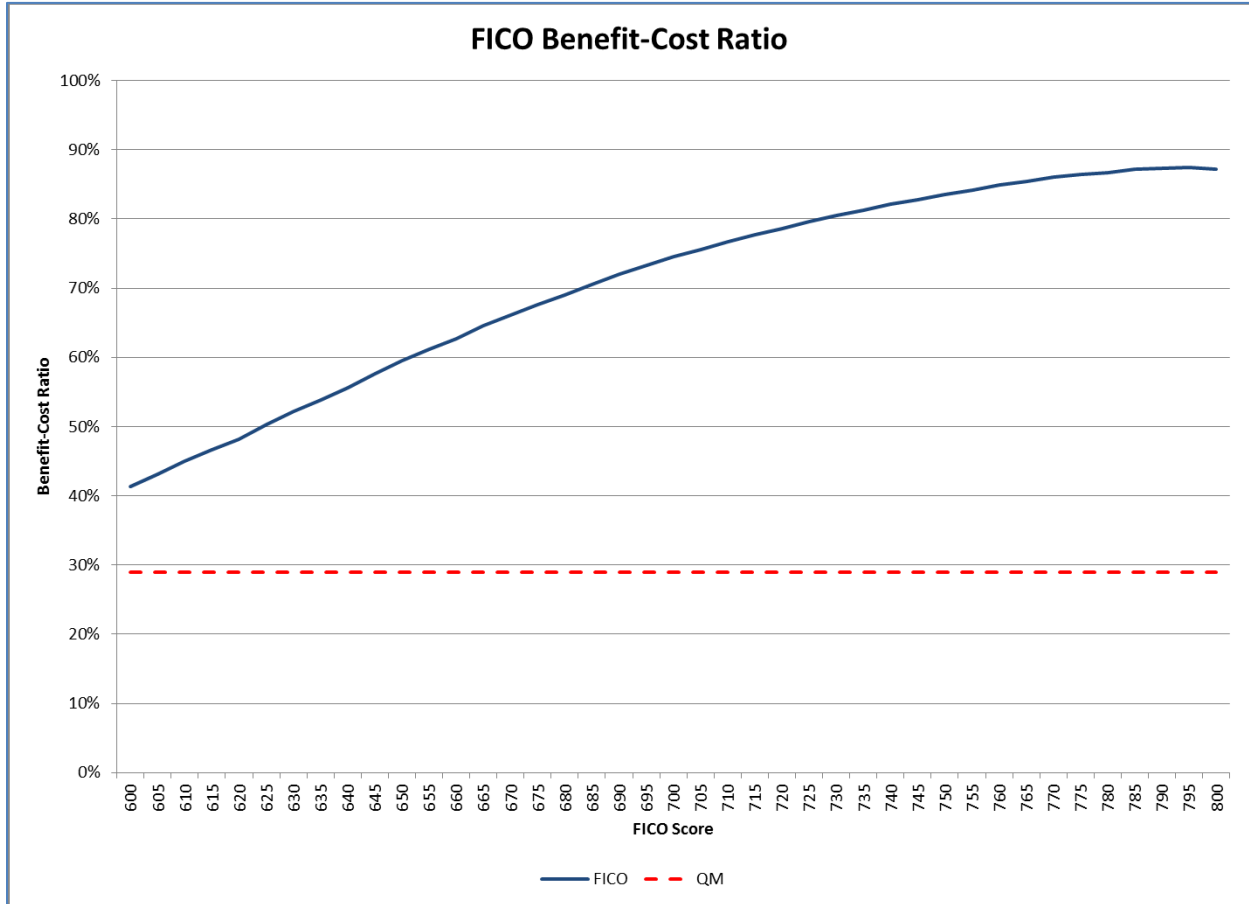
B. Figure 7 – CLTV Benefit-Cost Ratio

Figure 7. CLTV Benefit-Cost Ratio

This figure presents the benefit-cost ratio for a range of CLTV ratios among QM-eligible loans. The solid line shows the benefit-cost ratio for each loan with a CLTV ratio less than or equal to the value on the horizontal axis, while the dotted line shows the benefit-cost ratio for all QM loans regardless of CLTV ratio.
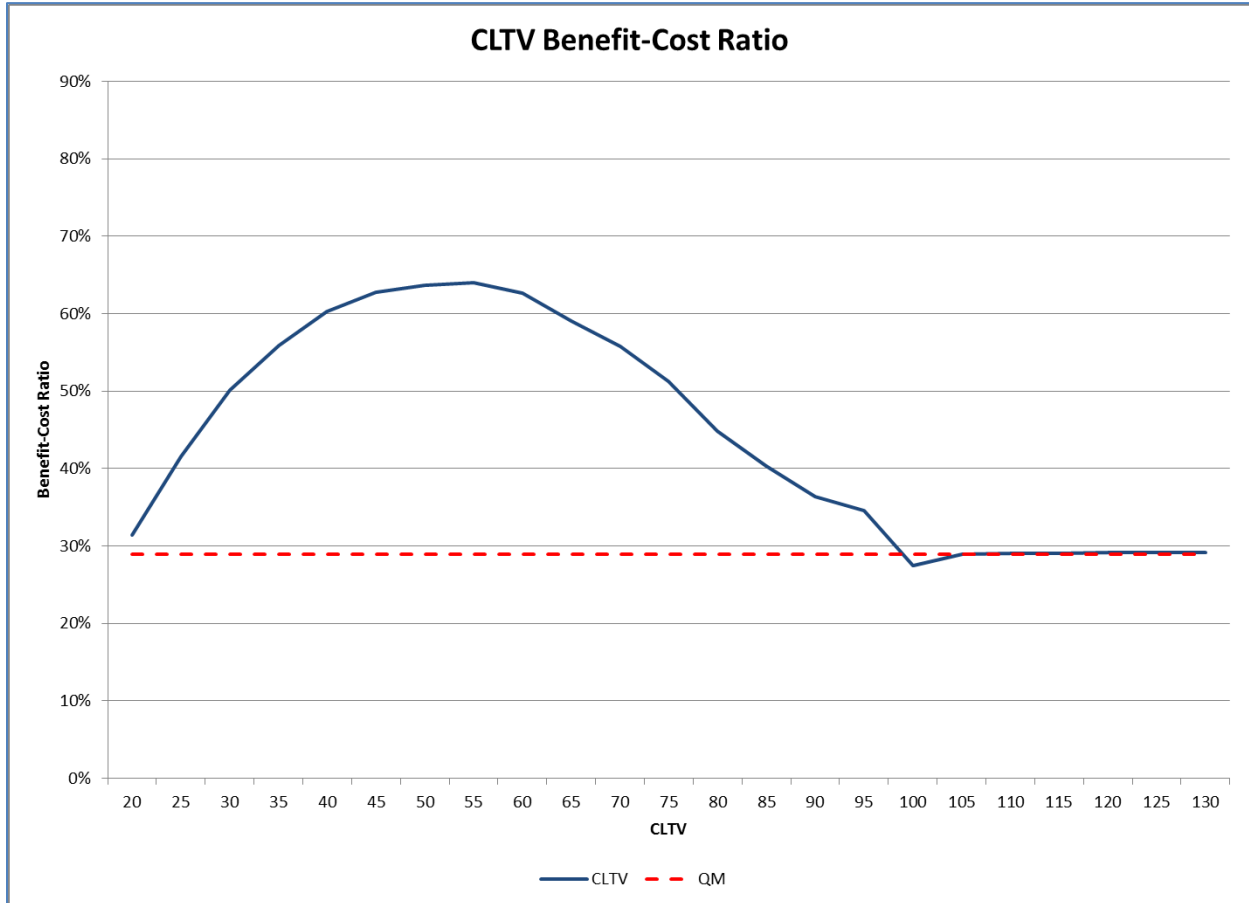
Figure 8. DTI Benefit-Cost Ratio
This figure presents the benefit-cost ratio for a range of DTI ratios among QM-eligible loans. The solid line shows the benefit-cost ratio for each loan with a DTI ratio less than or equal to the value on the horizontal axis, while the dotted line shows the benefit-cost ratio for all QM loans regardless of DTI ratio.

Table 4. Determinants of Serious Delinquency Rates (SDQ)

This table presents the marginal effects of a logistic regression with a dependent variable equal to 1 if the loan is ever 90 days delinquent, foreclosed, or real estate owned. For continuous v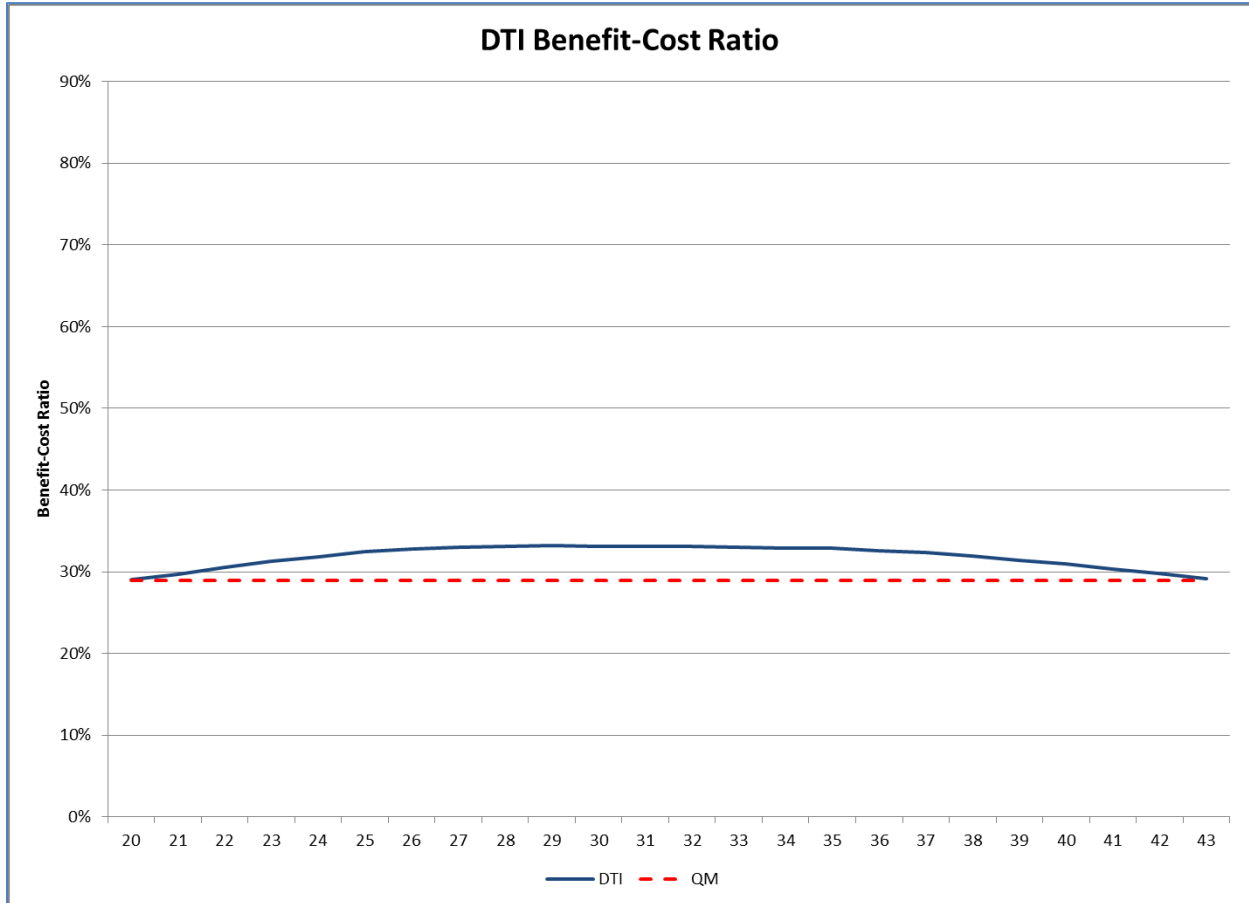ariables, the values in parentheses are the marginal effects multiplied by the standard deviation presented as a percentage. ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel A. QM vs. QRM

Dependent = SDQ		(1)	(1)	(1)	(1)	(2)	(2)	(2)	(2)
	Equation:	(1)	(1)	(1)	(1)	(2)	(2)	(2)	(2)
	Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample:	All	QM	QRM_A	QRM	All	QM	QRM_A	QRM
DTI		0.00199***	0.00088***	0.00074***	0.00047***	0.00245***	0.00140***	0.00078***	0.00045***
		(1.88)	(0.70)	(0.60)	(0.34)	(2.32)	(1.11)	(0.63)	(0.33)
CLTV		0.00706***	0.00519***	0.00073***	0.00048***	0.00677***	0.00421***	0.00066***	0.00048***
		(11.07)	(8.79)	(1.19)	(0.77)	(10.61)	(7.12)	(1.07)	(0.77)
FICO		-0.00159***	-0.00188***	-0.00044***	-0.00030***	-0.00161***	-0.00145***	-0.00038***	-0.00026***
		(-11.08)	(-14.64)	(-1.44)	(-0.99)	(-11.22)	(-11.34)	(-1.26)	(-0.83)
INT_RATE						0.01909***	0.02763***	0.01112***	0.00937***
						(4.64)	(5.10)	(0.80)	(0.07)
PMI						0.00554***	0.01136***	0.01255**	0.03237
TEASER						0.01551***	-0.00005	0.01072***	0.00646*
LIEN_FIRST						0.03905***	0.01310***		
PREPAY						0.11821***	0.09324***		
OCC_OWN						-0.05436***	-0.09376***		
DOC_FULL						-0.12051***			
TERM_LONG						0.06792***			
NEG_AM						0.16190***			
INT_ONLY						0.10424***			
BALLOON						0.07688***			
Average SDQ Rate		44.42%	33.54%	4.40%	2.98%	44.44%	33.57%	4.45%	3.01%
Year Controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations		2,690,480	600,046	24,729	14,950	2,689,738	599,488	24,344	14,699
Pseudo R²		0.1248	0.1220	0.1115	0.0896	0.1530	0.1357	0.1218	0.1027

Table 4. Determinants of Serious Delinquency Rates (SDQ) (continued)

This table presents the marginal effects of a logistic regression with a dependent variable equal to 1 if the loan is ever 90 days delinquent, foreclosed, or real estate owned. For the continuous variables, the values in parentheses are the marginal effects multiplied by the standard deviation presented as a percentage. ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel B. CLTV stratification

Dependent = SDQ Equation:	(2)	(2)	(2)	(2)
Model:	(6b)	(6c)	(6d)	(6e)
Sample:	QM with >=80% CLTV	QM with <=70% CLTV	QM with <=80% CLTV	QM with <=90% CLTV
DTI	0.00122***	0.00125***	0.00174***	0.00149***
	(0.94)	(1.06)	(1.45)	(1.23)
CLTV	0.00489***	0.00112***	0.00309***	0.00342***
	(3.87)	(1.63)	(4.64)	(5.26)
FICO	-0.00177***	-0.00068***	-0.00084***	-0.00103***
	(-12.92)	(-6.23)	(-7.41)	(-8.63)
INT_RATE	0.02175***	0.03286***	0.03723***	0.03680***
	(3.94)	(6.21)	(6.63)	(6.41)
PMI	0.00814**	0.07541***	0.06537***	0.03169***
TEASER	0.00625***	-0.01816***	-0.00768***	-0.00077
LIEN_FIRST	-0.00122	0.00688*	0.03190***	0.04064***
PREPAY	0.09765***	0.07922***	0.08346***	0.08706***
OCC_OWN	-0.11409***	-0.03625***	-0.05880***	-0.10028***
Average SDQ Rate	37.66%	20.45%	26.09%	30.11%
Year Controls	Yes	Yes	Yes	Yes
Observations	430,949	101,080	230,904	366,073
Pseudo R^2	0.1155	0.1595	0.1454	0.1374

Table 4. Determinants of Serious Delinquency Rates (SDQ) (continued)

This table presents the marginal effects of a logistic regression with a dependent variable equal to 1 if the loan is ever 90 days delinquent, foreclosed, or real estate owned. For the continuous variables, the values in parentheses are the marginal effects multiplied by the standard deviation presented as a percentage. ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel C. CLTV stratification continued

Dependent = SDQ Equation:	(2)	(2)	(2)
Model:	(6f)	(6g)	(6h)
Sample:	QM with 70-79.99% CLTV	QM with 80-89.99% CLTV	QM with >=90% CLTV
DTI	0.00155***	0.00173***	0.00097***
	(1.25)	(1.39)	(0.74)
CLTV	0.00496***	-0.00017	0.00548***
	(1.55)	(-0.05)	(2.65)
FICO	-0.00110***	-0.00120***	-0.00210***
	(-9.53)	(-9.70)	(-14.07)
INT_RATE	0.02775***	0.03241***	0.01614***
	(4.82)	(5.54)	(2.97)
PMI	0.06333***	0.03499***	0.01440***
TEASER	-0.01253***	0.00901***	0.00720***
LIEN_FIRST	0.04042***	0.05446***	-0.02877***
PREPAY	0.07012***	0.08567***	0.10254***
OCC_OWN	-0.07379***	-0.10414***	-0.12345***
Average SDQ Rate	27.70%	34.27%	39.23%
Year Controls	Yes	Yes	Yes
Observations	76,167	136,460	294,489
Pseudo R^2	0.1288	0.1051	0.1203

Table 4. Determinants of Serious Delinquency Rates (SDQ) (continued)

This table presents the marginal effects of a logistic regression with a dependent variable equal to 1 if the loan is ever 90 days delinquent, foreclosed, or real estate owned. For the continuous variables, the values in parentheses are the marginal effects multiplied by the standard deviation presented as a percentage. ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel D. FICO Stratification

Dependent = SDQ Equation:	(2)	(2)	(2)	(2)
Model:	(6i)	(6k)	(6l)	(6m)
Sample:	QM with >=680 FICO	QM with >=700 FICO	QM with >=720 FICO	QM with >=740 FICO
DTI	0.00113***	0.00104***	0.00096***	0.00076***
	(0.90)	(0.82)	(0.77)	(0.61)
CLTV	0.00153***	0.00132***	0.00117***	0.00108***
	(2.92)	(2.58)	(2.33)	(2.19)
FICO	-0.00122***	-0.00106***	-0.00093***	-0.00078***
	(-4.42)	(-3.22)	(-2.29)	(-1.50)
INT_RATE	0.01591***	0.01529***	0.01385***	0.01210***
	(2.49)	(2.29)	(2.01)	(1.72)
PMI	0.01958***	0.01651***	0.01424***	0.01367***
TEASER	0.01260***	0.01708***	0.01538***	0.01336***
LIEN_FIRST	0.00524***	0.00687***	0.00750***	0.00717***
PREPAY	0.08458***	0.07630***	0.06868***	0.06201***
OCC_OWN	-0.03245***	-0.02027***	-0.01259***	-0.00749***
Average SDQ Rate	15.88%	13.20%	11.12%	9.28%
Year Controls	Yes	Yes	Yes	Yes
Observations	195,248	157,006	122,935	91,190
Pseudo R^2	0.1425	0.1361	0.1330	0.1316

Table 4. Determinants of Serious Delinquency Rates (SDQ) (continued)

This table presents the marginal effects of a logistic regression with a dependent variable equal to 1 if the loan is ever 90 days delinquent, foreclosed, or real estate owned. For the continuous variables, the values in parentheses are the marginal effects multiplied by the standard deviation presented as a percentage. $***$, $**$, and $*$ indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel E. FICO Stratification continued				
Dependent = SDQ	Equation:	(2)	(2)	(2)
	Model:	(6n)	(6o)	(6p)
	Sample:	QM with 680-700 FICO	QM with 701-720 FICO	QM with 721+ FICO
DTI		0.00156***	0.00121***	0.00096***
		(1.24)	(0.93)	(0.77)
CLTV		0.00242***	0.00184***	0.00117***
		(4.17)	(3.23)	(2.33)
FICO		-0.00223***	-0.00155***	-0.00092***
		(-1.36)	(-0.90)	(-2.26)
INT_RATE		0.02148***	0.02242***	0.01388***
		(3.69)	(3.59)	(2.23)
PMI		0.02356**	0.02476***	0.01405***
TEASER		-0.00056	0.02514***	0.01544***
LIEN_FIRST		0.00204	0.00231	0.00769***
PREPAY		0.12351***	0.10691***	0.06830***
OCC_OWN		-0.08094***	-0.05094***	-0.01152***
Average SDQ Rate		26.66%	20.36%	11.03%
Year Controls		Yes	Yes	Yes
Observations		40,153	34,074	121,021
Pseudo R^2		0.0895	0.0979	0.1335

XI.   APPENDIX A

A.   MBSData Loan Characteristics

As discussed in Section III, only 13% of the loans in the MBSData database have information on DTI. This could lead to a selection bias in model estimates if the availability of DTI is systematically related to the SDQ or other loan and term features that are otherwise related to SDQ. We assess this likelihood in the following Tables by looking at the differences in loan characteristics between those with and without DTI information.

Table A1. Characteristics of Loans Originated between 1997 and 2009 by DTI Coverage.

	Selected sample Non-missing DTI		Full sample Non-missing remittance	
	Coverage	Average	Coverage	Average
Serious Delinquency Rate	100%	44%	100%	31%
Foreclosure	100%	28%	100%	20%
Front End DTI	--	--	1%	30%
Back End DTI	100%	39%	13%	39%
PMI	66%	3%	--	8.6%
LTV	99%	66%	98%	68%
CLTV	99%	86%	97%	79%
Down Payment	0%	--	0%	--
Primary Occupant	99%	87%	97%	84%
Lien Position	100%	--	97%	--
First	--	78%	--	83%
Second	--	23%	--	14%
Loan Type	32%	--	52%	--
Property Type	100%	--	99%	--
Points & Fees	0%	--	0%	--
Full Documentation Dummy	98%	55%	86%	45%
Teaser Rate Dummy	100%	43%	100%	40%
Prepayment Penalty	61%	54%	--	37%
Payment Type	100%	--	100%	--
ARM	--	40%	--	52%
Fixed	--	60%	--	48%
Product Type				
Negative Amortization	100%	6%	100%	5%
Interest Only Dummy	99%	18%	99%	18%
Balloon Dummy	100%	15%	100%	10%
Loan Purpose	94%	--	97%	--
Purchase	--	48%	--	43%
Refinance – Rate & Term	--	9%	--	15%
Refinance – Cash Out	--	38%	--	37%
FICO	99%	660	74%	669

Table A1 (above) reports the percent coverage and average for the 2.7 million loans with non-missing DTI, and also for the full set of loans with remittance data. The full sample of loans with remittance data has an SDQ rate of 31%, significantly lower than the 44% SDQ rate for the sample of loans with DTI data. We more formally assess the differences in Table A2 (below) by comparing selected characteristics from the non-missing DTI sample to a similar number of randomly-selected loans from the same MBSData database, but with missing DTI coverage. The SDQ rate is 15% higher for the non-missing DTI Sample, indicating the presence of a selection bias likely exists. Some of the loan characteristics are also substantially different, and may be the contributing factors to the differences in SDQ (e.g., balloon payments and prepayment penalties), although other differences seem counterintuitive (e.g., full documentation is higher among the higher SDQ sample).

Table A2. MBSData Loan Characteristics by DTI Coverage

	Means		Test of Difference	
	Non-missing DTI (N = 2,702,953)	**Random Sample (N=3,000,000)**	**Difference in means**	**Two-tail *p*-value**
SDQ	0.44	0.29	0.154***	0.000
CLTV	85.98	77.07	8.902***	0.000
FICO	660.22	672.46	-12.235***	0.000
PMI	0.03	0.07	-0.041***	0.000
DOC_FULL	0.55	0.43	0.128***	0.000
TERM_LONG	0.02	0.01	0.013***	0.000
LIEN_FIRST	0.78	0.83	-0.057***	0.000
NEG_AM	0.06	0.05	0.016***	0.000
INT_ONLY	0.18	0.18	-0.002***	0.000
BALLOON	0.15	0.09	0.058***	0.000
PREPAY	0.53	0.34	0.191***	0.000
TEASER	0.43	0.58	-0.148***	0.000
INT_RATE	7.86	7.50	0.356***	0.000

B. Effect of Selection Bias on Model Estimations

Although there is no formal test that can be run to assess the effect of the sample selection bias on DTI – because DTI is not observable and we do not have a valid instrument to control for the bias – we can assess the bias in the estimated coefficients on other loan characteristic (QRM-related factors) in the Logit regression models. Table A3 (below) presents Logit estimation results of the base model (equation 2 in Section VI) after dropping DTI as an explanatory variable. The first set of coefficient estimates are for the non-missing DTI sample; the second is for the random sample of missing DTI loans. The third column is the difference in coefficient estimates between the two samples. With the exception of CLTV and DOC_FULL, the effect of the QRM-related loan characteristics are stronger in the missing DTI sample, indicating that for these factors, our earlier analysis underestimates their impact on lowering SDQ. This assumes that the exclusion of DTI in the model estimations does not have a material impact on the results.

Table A3. Multivariate Tests of Differences in QRM-Related Factors

This table presents results of a modified equation (2) using the sample of loans with DTI coverage and a random sample of loans without DTI coverage. The dependent variable is serious delinquency (SDQ). DTI is not included in all models. The last column reports the F-test of the difference in coefficient estimates between samples. ***, **, and * indicates significance at the 1%, 5%, and 10% levels.

	Selected Sample Non-missing DTI Coefficient	Random Sample Missing DTI Coefficient	Difference F-test
CLTV	0.028***	0.015***	-0.013***
FICO	-0.006***	-0.007***	-0.000***
PMI	0.029***	0.127***	0.097***
DOC_FULL	-0.487***	-0.404***	0.083***
TERM_LONG	0.289***	0.494***	0.205***
LIEN_FIRST	0.216***	0.269***	0.053***
NEG_AM	0.671***	1.076***	0.405***
INT_ONLY	0.426***	0.547***	0.120***
BALLOON	0.330***	0.407***	0.077***
PREPAY	0.493***	0.497***	0.004
TEASER	0.061***	0.077***	0.016***
INT_RATE	0.090***	0.176***	0.086***
Year Controls	Yes	Yes	
Observations	2,689,738	1,989,998	
Pseudo R^2	0.1513	0.1711	

XII. APPENDIX B

Variable Definitions

Variable	Label	Definition	Predicted Sign on SDQ	Cite
DEPENDENT				
Serious Delinquency Dummy	SDQ	Equals 1 if loan has ever been 90 days late, foreclosed, or real estate owned.	N/A	Piskorski et al. (2013)
PRIMARY VARIABLES OF INTEREST				
Qualified Mortgage Dummy	QM	Equals 1 if: (1) the loan term is not greater than 30 years; (2) the loan has full documentation; (3) the loan does not have negative amortization, interest only, or balloon payments; and (4) back-end DTI is no greater than 43%.	–	Quercia et al. (2012)
Qualified Residential Mortgage Dummy	QRM	Equals 1 if: (1) the loan term is not greater than 30 years; (2) the owner is the primary occupant; (3) the loan has full documentation; (4) the loan does not have negative amortization, interest only, or balloon payments; (5) there is no prepayment penalty; (6) the back-end DTI is less than or equal to 36%; (7) the FICO is 690 or greater; (8) the CLTV is less than or equal to 80% (purchase), 75% (rate and term refinance), or 70% (cash out refinance); and (9) the loan is a first lien loan.	–	
QRM Alternative Dummy	QRM_A	Equals 1 if: (1) the loan term is not greater than 30 years; (2) the owner is the primary occupant; (3) the loan has full documentation; (4) the loan does not have negative amortization, interest only, or balloon payments; (5) there is no prepayment penalty; (6) the back-end DTI is $\leq$41% (Fixed) or 38% (ARM); (7) the FICO$\geq$690; (8) the CLTV is $\leq$90% (purchase), 90% (rate and term refinance), or 75% (cash out refinance); and (9) the loan is a first lien loan.	–	
Back-end Debt-to-Income	DTI	The ratio of the total monthly debt / monthly gross income	+	Mian and Sufi (2009); Demyanyk and Van Hemert (2011)
Combined Loan-to-Value	CLTV	The combined loan to value including secondary liens	+	Elul et al. (2010); Demyanyk and Van Hemert (2011); Demiroglu and James (2012)
FICO Score	FICO	The Fair, Isaac and Company (FICO) credit score of the borrower at origination. FICO scores range from 300-850.	–	Piskorski et al. (2010); Demyanyk and Van Hemert (2011); Demiroglu and James (2012)

Variable Definitions (Continued)

Variable	Label	Definition	Predicted Sign	Cite
CONTROL VARIABLES				
PMI Dummy	PMI	Equals 1 if loan includes private mortgage insurance	–	(–): Elul et al. (2010); Elul (2011), Piskorski et al. 2010
Interest Rate	INT_RATE	The original interest rate of the loan	+	Elul et al. (2010); Elul (2011); Demyanyk and Van Hemert (2011)
Negative Amortization Dummy	NEG_AM	Equals 1 if loan includes negative amortization	+	Demiroglu and James (2012)
Interest Only Dummy	INT_ONLY	Equals 1 if interest only loan	+	Elul et al. (2010); Elul (2011)
Balloon Dummy	BALLOON	Equals 1 if loan has a balloon payment	+	Demyanyk and Van Hemert (2011)
Teaser Rate Dummy	TEASER	Equals 1 if loan has a teaser rate	+	Gorton (2009)
Prepay Penalty Dummy	PREPAY	Equals 1 if loan has prepayment penalty	+	Elul et al. (2010); Elul (2011); Demyanyk and Van Hemert (2011)
Purchase Dummy	PURCHASE	Equals 1 if loan purpose is purchase	–	
Rate & Term Refi Dummy	RT_REFI	Equals 1 if loan purpose is rate & term refinance	?	(–): Elul (2011);
Cash Out Refi Dummy	CASH_REFI	Equals 1 if loan purpose is cash out refinance	?	(+):Elul et al. (2010); Elul (2011) (–): Pennington-Cross and Chomsisengphet (2007); Demyanyk and Van Hemert (2011)
Long Term Dummy	TERM_LONG	Equals 1 if loan term exceeds 30 years at origination.	+	Elul et al. (2010)
Owner/Primary Occupancy Dummy	OCC_OWN	Equals 1 if occupancy status is primary/owner-occupied	–	Demyanyk and Van Hemert (2011)
Full Documentation Dummy	DOC_FULL	Equals 1 if loan has full documentation	–	Keys et al. (2010); Demyanyk and Van Hemert (2011); Demiroglu and James (2012)
First Lien Dummy	LIEN_FIRST	Equals 1 if lien position is first lien	–	(+): Jagtiani and Lang (2011) (no difference): Lee et al. (2012) (-): Goodman et al. (2010)
OTHER VARIABLES				
Fixed Rate Mortgage Dummy	FIXED	Equals 1 if loan has a fixed interest rate	–	Gorton (2009); Demiroglu and James (2012)
Adjustable Rate Mortgage Dummy	ARM	Equals 1 if loan has an adjustable interest rate	+	Gorton (2009); Demiroglu and James (2012)