

THE DETERMINANTS OF MORTGAGE DELINQUENCY

by

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Abstract

The recent housing crisis has highlighted the need to better understand the determinants of mortgage default. Concerns about potential sizable differences in default rates by race and ethnicity as well as reports in the popular press regarding the propensity for rising numbers of homeowners to strategically default motivate a careful study of mortgage delinquency in America post-housing bubble. Using longitudinal data from the Panel Study of Income Dynamics (PSID), we examine borrowers in the years 2005, 2007 and 2009 and, controlling for a number of default-related variables, take a closer look at the characteristics of those delinquent on their mortgage by 2009. We find startling racial and ethnic gaps present as well as strong effects from children, education, and the presence of recourse/non-recourse laws in the state of residence on the likelihood of delinquency. In addition, we find evidence that strategic default plays a role in explaining the likelihood that a homeowner in 2005 will be delinquent on his or her mortgage by 2009.

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Dedication

For Paul for all your love and leaning.

Chapter 1 - Introduction

In the late 1990's and into the early 2000's the economy was booming and housing prices were rising. This trend continued until early 2007 when the housing bubble effectually "burst" and prices began to decline rapidly. With the state of the economy declining borrowers were finding it more difficult to make their mortgage payments and foreclosures swept across the country in record numbers. In 2009, foreclosures increased by 21% from 2008 and more than 120% from 2007 (Prior, 2010). Moreover, the median national house price was 25% lower than its peak in 2005 (Armour, 2009). By 2010, approximately 17 million homes were "underwater", in that the owners of these homes owned more on the bank loans than the homes were worth (Armour, 2009). In an attempt to stem the tide of foreclosures, as early as 2008, the Obama administration implemented the Making Home Affordable program to assist homeowners and stimulate the economy. However, the program, which was allotted \$75 billion, has been met with heavy criticism and so far has proven only mildly successful.

This housing crisis has led researchers to work double time, expanding their studies looking to hone in on the causes of default. Over the years two major fields of theory have developed explaining delinquency, default and subsequent foreclosure. The first being trigger events—those unforeseen events that drastically change one's financial status leaving them unable to make their mortgage payments. Such events include divorce, death of a family member, medical expenses, job loss, etc. The second theory is one of strategic behavior, where borrowers choose to abandon their mortgage obligations despite being able to pay. This behavior is induced without any trigger event, any financial loss other than that loss of equity. With house prices dropping drastically, often homeowners find themselves owing more on their mortgage than their house is actually valued, and borrowers are finding it more advantageous to take a credit hit and abandon their house, mortgage and all, rather than continuing to make payments on their loan.

While both theories deserve merit and have ample data and research to support them neither look at the demographics of those in default. The majority of the data used to derive these theories comes from loan data. These data provide detailed information on the characteristics of loans and how each reacts and develops in time based on payment history, refinancing options,

interest rates, credit history of owners, etc., but they offer little, if any information on the individual behind the loan.

Using rich data from the Panel Study of Income Dynamics (PSID) we are able to track individual households over the years and determine, based on their demographics, their likelihood of mortgage delinquency by the end of our study. Our sample is unique in that we have individual data on race, ethnicity, sex, age, education, employment, and other variables that are not captured in the loan data. Ours is the first to analyze the housing market using this type of data after the downturn in the market.

We use weighted data on race, ethnicity, sex, children, age, marital status, and education combined with biennial data from 2005-2009 on income, wealth, employment, and equity to determine the likelihood of an individual being delinquent on their mortgage by 2009. We use state dummies to control for variations in local housing markets, economies and laws on recourse. After constructing the model we add in a non-recourse¹ variable to determine whether or not living in a non-recourse state has any additional effect (Ghent 2010).

We first implement a Linear Probability Model (LPM) and study the coefficient estimates finding robust results across all models. Later we implement a probit model to gain more efficient results and compare the two in turn. The results of the probit estimation provide for several significant inferences. We find that education, equity, and wealth all act as significant deterrents of delinquency. Conversely, we find large racial and ethnic gaps in the probabilities, where being a black or Hispanic head of household both increase the probability of being delinquent substantially. There are some differences in age groups, where middle aged (35-64) heads of households are more likely to be delinquent than retirement aged (65+) heads of households. Lastly we discover that living in a non-recourse state significantly increases the likelihood of being delinquent, supporting previous literature on the subject.

¹ Some states have specific laws outlawing recourse action against borrowers who have foreclosed. These “non-recourse” states have put in place laws to protect the borrower from what they see as excessive damages. Conversely, lenders in “recourse” states are able to take recourse action against borrowers, which usually includes legally coming after the borrower to fulfill their debt obligations. One common cost lenders may come after is the difference between the remaining amount on the mortgage and the fair market value of the house, but other costs include lawyer fees and other associated court costs.

The rest of the paper follows thus. In section 2 we present and review previous literature and findings on the subject. Section 3 discusses the economic theory behind the study. Section 4 provides a description of the data used. Section 5 presents and explains the empirical models used. Section 6 reports the empirical findings. Section 7 concludes.

Chapter 2 - Literature

The racial and ethnic gaps in mortgage delinquency are staggering. While the rate of homeownership for black and Hispanic heads of households has been well documented to be lower than their counterparts it fails to be seen why those black or Hispanic heads who succeed in homeownership are so much more likely to be delinquent. Turner and Smith (2009) note an alarming difference in homeownership rates. Less than 50% of black and Hispanic households own, while white, non-Hispanic households own 75% of the time. This gap in homeownership wouldn't explain the increase in delinquency rates we find for these groups over their white, non-Hispanic counterparts. It could be argued that those black and Hispanic heads that do own would be a "filtered" group effectively "chosen" to succeed. Turner and Smith (2009) explore this phenomenon by taking a look at the exit rates from homeownership by race, ethnicity and income using data from the Panel Study of Income Dynamics (PSID). Due to the manner in which the PSID is constructed Turner and Smith (2009) break their analysis up into two separate groups: households from 1970-1997 and those same households 1999-2005. Controlling for a number of factors (including crisis/trigger events), they find that black households post-1997 are 4% more likely to exit from homeownership than non-black households. Before 1997, though, they find no gap between races. Boehm and Schlottmann (2004) support this latter finding using PSID data from 1984 to 1992 and report actually that black households are less likely to exit homeownership. Turner and Smith (2009) find higher exit rates for Hispanic households pre-1997, however, they find no significant difference between the exit rates of Hispanic and non-Hispanic households post-1999, concluding that "the low homeownership rates of Hispanic households in the U.S. post-1997 are due to low entry rates, not high exit rates."

Haurin and Rosenthal (2004) found results similar to Turner and Smith (2009). Using the National Longitudinal Survey of Youth (NLSY) they show that African-American and Hispanic households have shorter spells of homeownership than white and non-Hispanic households. On average they find that white, Non-Hispanic first-time homeowners maintain homeownership for just over 16 years while African-American and Hispanic first-time owners maintain shorter spells of 9.5 and 12.5 years, respectively. Their estimates control for a number of factors such as

region, family size, employment and education. They also note that for the age group of 21 to 34, higher education substantially lessens these race and ethnicity gaps.

Contrary to most publications, Quercia, McCarthy and Stegman (1995), using data on rural, low-income borrowers collected by the Housing Assistance Council, report that minority borrowers are less likely to default on their mortgage than non-minority borrowers.

Demographically, they also find that being married and having more children both have positive effects on the likelihood of default and that female borrowers are less likely to default.

The importance of crisis or trigger events has been well documented, often in conjunction with lower equity, but not always. The aforementioned Quercia, McCarthy and Stegman (1995), report that trigger events and “borrower-related events” are what significantly effect a borrower’s decision to default. They find that home equity has no significant effect on the borrower’s decision to default. Elmer and Seelig (1999) show that negative equity (a proponent of strategic default) is “neither a necessary nor a sufficient condition for default...” They conclude that trigger events effecting income (job loss, medical expenses, etc.) have a much larger impact on default. It is these events, they argue, that cause a borrower to become insolvent and therefore to be unable to pay their mortgage. With that in mind it is obvious that the more equity a borrower has the more “cushion” they have if an income trigger event should occur. If a borrower has negative equity they will be unable to borrow emergency funds against the value of their house, however, if their equity remains positive they will still have at least some financial cushion to fall back on. Their argument is that even with positive equity a trigger event may cost more than the remaining equity in the house and therefore cause the borrower to go insolvent and subsequently default.

Likewise, there has been a substantial amount of literature on the theory of defaulting strategically. There have been varying hypotheses on the severity of strategic behavior, however. Foster and Van Order (1984, 1985) were the first to apply the term “ruthless” to this type of behavior. They concluded that borrowers acted “ruthlessly” by abandoning their mortgage obligations immediately upon the advent of negative equity (Vandell 1995). However, a number of publications since have argued against the severity of this ruthless behavior (see Vandell 1995 for an extensive report against the idea of strict ruthlessness). Non-ruthlessness and the admittance of the importance of trigger events did not dissolve the theory of strategic behavior, though; but rather, they refined it. Kau, Keenan and Kim (1993, 1994) argue for the idea of

“near-ruthless” behavior, stating that in a realistic model the house value is likely to drop well below the value of the mortgage before someone will choose to default.

Bhutta, Dokko and Shan (2010) perform an extensive examination of the behavior of defaulters in the subprime mortgage market, taking a close look at the extent of the effects of negative equity and accounting for liquidity shocks. Using mortgage data and ZIP-code level housing price indices from First American CoreLogic they were able to produce a sample size of over 130,000 loans with no missing data on a number of different variables. Aside from individual loan characteristics the paper looks at location (Arizona, California, Florida or Nevada), unemployment rates and credit card delinquency rates (to account for economic shocks), house value, mortgage balance, equity, age of loan, interest rate, FICO scores, etc. They found the median borrower “walks away” from their mortgage when equity reaches -62%. Modeling the defaults accounted to liquidity shocks and comparing those to unconditional defaults, they found a number of defaulters choosing to do so strategically. Defaults that occur when a borrower is only slightly below zero equity, the authors argue, can almost certainly be attributed to liquidity shocks, stating that “...being slightly underwater is evidently not a sufficient condition for default.” As equity drops lower and lower more and more defaults are given the “strategic” title.

The authors attempt to quantify a “total cost” of default. In such that if this total cost to default drops below the borrower’s negative percent equity the borrower will default. This total cost includes a number of different costs including monetary and non-monetary costs of default as well as foregone expected capital gains. With this in mind they determined that once negative equity drops below -50%, half of defaults are strategic resulting in nearly 20% of total defaults being strategic. Discrepancy in FICO scores was also examined. The highest scores reflected the greatest value of negative equity (absolute value) displaying perhaps a sense of responsibility or obligation towards repaying their loan. However the lowest scores are not necessarily the quickest to walk away. They explain this phenomenon through the fact that the number of loans given to individuals with such low scores drops drastically and those few remaining are arduously screened. Therefore the lender, taking a perceived higher risk, attempts to lessen these risks by lending to only those they deem responsible. While those borrowers with a slightly higher score are screened less vigorously with the end result that they are willing to walk away from their loan at a higher equity level (median borrowers).

A large degree of heterogeneity was discovered amongst the sample, as noted by the large (58%) estimated standard deviation of total cost. One explanation is given to location, where median borrowers in Florida and Nevada (recourse states) have higher costs of default and thus delay defaulting until they are “20 to 30 percentage points more underwater than the median borrower in the non-recourse states.”

It should be noted that aside from the quantifiable portions of the total cost—recourse penalties, relocation costs, to some extent expected capital gains, etc.—an almost crippling cost in some cases is the stigma associated with default and/or foreclosure. That is, the public tends to view defaulting in poor light. Guiso, Sapienza and Zingales (2009) summarize this stigma nicely. Using survey data taken from December 2008 to March 2010 the authors find that 81% of respondents think strategically defaulting is “morally wrong.” They also find a level of spatial homogeneity in that respondents who have known someone who has strategically defaulted were more willing to do so themselves. They estimate that “by March 2010 [the percentage of defaults performed strategically] rose to 35.6%.” They also found that black and Hispanic respondents are much more likely than white and non-Hispanic respondents to default strategically given the same adverse conditions.

Elmer and Seelig (1999) previously mentioned as proponents of trigger-event theory added in their findings that “strategic default remains a possibility, but only in antideficiency or other nonrecourse legal environments.” Ghent and Kudlyak (2010) look at the impact living in a recourse/non-recourse state has on a borrower’s decision to default. The threat of recourse implied by state law “decreases the probability of default when there is a substantial likelihood that a borrower has negative home equity.” In other words when a borrower is faced with the decision to stay or walk away from their under water mortgage they are much more likely to do so in a state whose laws will not allow for lenders to take recourse action.²

² See Ghent and Kudlyak (2010) for an extensive state-by-state breakdown of recourse laws.

Chapter 3 - Economic Theory

In this section we present the economic theory behind our model. For the purpose of this paper it stands that a head of household, by 2009, will be in one of two scenarios: either they are late on their mortgage payments and therefore delinquent or they are current on their mortgage payments and non-delinquent.

There are a number of different variables that affect whether or not a person is delinquent and these variables are often broken up into two categories: those that relate to trigger events and those that lead to strategic default. We look closely at these and control for them accordingly. A good deal of the literature out there supports the theory of trigger-event motivated delinquency (Quercia et al 1995, Elmer 1999, etc.). The specific trigger events we control for are job loss and a change in marital status. We would expect each of these to have a positive impact on the likelihood of delinquency as both tend to adversely affect a borrower both financially and psychologically. Similarly, especially with the recent housing crisis, there is ample literature suggesting that often delinquency occurs as a matter of financial strategy (Bhutta et al 2010, Guiso et al 2009, Kau et al 1993, 1994, Vandell 1995, etc.). Aside from asking an individual outright if they strategically defaulted there is no definitive way to know that was the case (Guiso et al 2009). However, it is known that equity plays a large roll in the decision to strategically default. While it is technically possible for someone to default on his or her loan in the presence of decent positive equity it makes no sense financially to do so. It is dwindling equity and more so negative equity that leads to borrowers choosing not to make their mortgage payments and becoming delinquent. Therefore we control for a household's equity with the underlying assumption that it will have a negative effect on the likelihood of delinquency. The more equity a homeowner has the less likely they should be to default on their mortgage obligations via delinquency and subsequent default (Vandell 1995, Bhutta et al 2010). The effect of living in a recourse or non-recourse state has also been shown to effect a borrower's decision to choose delinquency. We expect someone living in a non-recourse state to be more likely to choose delinquency, as the penalty for doing so would be less severe than those living in states that allow recourse.

We include a number of demographic variables controlling for age, sex, race, ethnicity, education, marital status and children. We expect younger heads of household to be more likely to be delinquent on their mortgage by 2009. Older heads of households typically tend to demonstrate a degree of stability and a stronger sense of responsibility not found in younger owners. While being female, black or Hispanic has been shown in the past to have adverse effects on an individual's income and homeownership the correlation between these traits and delinquency is still a fresh idea. Based on the trends of these traits we would expect that a female, black or Hispanic head of household would be more likely to be delinquent on their mortgage by 2009 and we construct our model with this in mind. We expect higher education and marriage to carry negative connotations with regards to delinquency. Marriage, similar to an increase in age, speaks to stability. The presence of children could go either way. On the one hand having children could be associated with an established family life, marriage, etc. that again, point to stability and would therefore decrease the likelihood of delinquency. Conversely, caring for children is expensive. Should a family in a tight financial situation experience a trigger event, having children would allow for less financial leeway. A homeowner only caring for themselves or perhaps a spouse will be more able to adapt to a financial crisis. We expect the presence of children to have a negative effect on the likelihood of delinquency but leave open the possibility of it doing the opposite based off the aforementioned scenarios.

Chapter 4 - Data and Empirical Model

Our data come from the Panel Study of Income Dynamics (PSID), a longitudinal survey of households collected yearly from 1968 to 1997. After 1997 the survey was adjusted, dropping some of the original core households and introducing others to the sample. After 1997 the survey was collected biennially and the sample weights were recalculated. The sample weights, when applied, make the PSID sample representative of the U.S. population (Turner 2009). For our analysis we weighted the data by their 2007 sample weights. Our data contain explanatory variables from 2005 and 2007, while the data for our dependent variable, delinquency, comes from 2009. In 2009, homeowners were asked directly, “Are you currently behind on your mortgage payments?” This is how we define delinquency: if a homeowner answered yes, they are delinquent, if no, they are not. We find in our weighted sample that 5% of homeowners are delinquent on their mortgage payments by 2009. The minimum amount of time a homeowner is delinquent in our sample is one month, ruling out the possibility that a homeowner may have just missed their payment by a couple days or weeks. This also allows for some of our delinquent homeowners to be in default, while others may not necessarily be³.

Using only data from the post-1997 era creates gaps from the off years for certain variables. Unemployment for instance captures only unemployment in the year prior to the survey. To adjust for this and to create our job loss and job instability variables we look instead at the respondent’s number of weeks employed at their current position. Job instability is a dummy variable which equals 1 if the respondent’s number of weeks employed in 2007 is less than the number of weeks employed in 2005, thus showing the respondent has spent at least some amount of time unemployed. Job loss is a dummy variable, which equals 1 if the respondent’s number of weeks employed in 2005 is positive while the number of weeks employed in 2007 is zero. This shows that the respondent had a job previously but is unemployed by 2007.

³ The term default is subjective and the length of time a homeowner is delinquent before default status is reached varies by lender and law. Typically a borrower is in default if they are 1, 2 or 3 months delinquent. The term delinquent as we use it includes those homeowners behind on their mortgage at least one month, in default according to the terms of their loan and those whose foreclosure process has begun.

We define equity as the difference between reported house value and the remaining principle on their first and second (if applicable) mortgages, divided by the house value. The PSID collects some data on subsequent mortgages, however only the remaining principle is reported for the first two mortgages on a single house.

Because total net-non housing wealth can often take on negative values we employed the common practice of shifting the scale of our values by adding the minimum plus 1 to all observations, thus making our former minimum one on our new scale (Osborne 2002). This shift allows us to perform the log transformation of wealth for our model without losing any observations. The same tactic was used to transform income as well.

Change in marital status is a dummy variable constructed to equal 1 if marital status equals 1 for 2005 and 0 for 2007, implying the respondent was married in 2005 but no longer is in 2007. This change could be due to a number of things including death or divorce. It does not equal 1 if the respondent gets married between the years. It only captures the dissolution of a marriage for any reason. Children equals 1 if they have at least one child, 0 otherwise. Non-recourse equals 1 if the respondent lives in a non-recourse state as defined by Ghent and Kudlyak (2010)⁴.

Table 4.1 reports our weighted sample means⁵. We find there are important differences across groups. Referring to Table 4.1, households that are delinquent by 2009 are on average less likely to have a college degree and more likely to be female headed, Hispanic and black than non-delinquent households. Delinquent heads of households are also slightly more likely to be middle aged and have children. Delinquent heads of households on average are less likely to be married but more likely to experience a change in marital status (death, divorce, separation, etc.).

⁴ Ghent and Kudlyak (2010) break up North Carolina by type of loan because recourse is not allowed on Purchase loans but is allowed on all others. We classify North Carolina as non-recourse because first mortgages are often purchase mortgages and very few in our sample have second mortgages that may in turn be susceptible to recourse.

⁵ A note on sample sizes: While great care was taken to accurately impute true values for missing values in the data, it still stands that in some cases it was impossible to completely rid the sample of missing values without making substantial assumptions about the data. We were unwilling to compromise the integrity of the data with such large assumptions and therefore opted to drop those observations from the model when necessary (Models (4), (5) and (6)). We've provided summary statistics specific to these models and their slightly truncated samples in Appendix A.1 through A.4.

Table 4.1 Weighted Sample Means

Variable Definition	All Homeowners	Delinquent	Current
Mortgage Delinquency	0.05	1	0
College Degree	0.42	0.15	0.44
Children	0.43	0.58	0.42
Income	101,912	71,248	103,553
Female	0.19	0.30	0.19
Married	0.67	0.61	0.67
Change in Marital Status	0.03	0.05	0.03
Hispanic	0.08	0.25	0.07
Black	0.09	0.21	0.09
AGE			
18 to 34	0.19	0.17	0.19
35 to 64	0.71	0.79	0.70
65 or older	0.11	0.04	0.11
Non-Recourse State	0.27	0.28	0.27
Total Net Non-Housing Wealth	260,324	78,035	270,074
Equity	43%	26%	44%
Job Loss			
2005 to 2007	0.08	0.10	0.08

Note: All dollar amounts are adjusted to 2009 dollars. Data are weighted using 2007 weights. Sample size is 3396 homeowners observed from 2005 to 2009 biennially.

With regards to income and wealth, we see that on average heads of households that are delinquent by 2009 have substantially lower incomes and total net non-housing wealth than non-delinquent heads of households, and, referring to Table 4.2, that income and wealth are skewed. The median income and wealth are much lower than the average for both groups. Looking again at Table 4.2 we find that delinquent heads of households experience a bigger drop in equity and are more likely to have become owners after 2005. Also delinquent heads of households tend to have lower house values than non-delinquent heads of households.

Table 4.2 Medians of Note and Additional Variable Means

Variable Definition	All Homeowners	Delinquent	Current
Income (median)	77,088	60,464	78,791
Total Net Non-Housing Wealth (median)	42,857	6,374	46,374
Equity (median)	42%	26%	43%
CHG IN EQUITY (median)			
2005 to 2007	3.7%	0.99%	3.8%
2007 to 2009	-3.5%	-12%	-3.4%
HOUSE VALUE (median)			
2005	203,297	161,538	208,779
2007	223,901	186,335	227,743
2009	200,000	150,000	200,000
HOME OWNERSHIP			
Owned in 2005	0.87	0.81	0.87
Owned After 2005	0.13	0.19	0.13
Job Instability			
2005 to 2007	0.20	0.24	0.20

Note: All dollar amounts are adjusted to 2009 dollars. Data are weighted using 2007 weights. Sample size is 3396 homeowners observed from 2005 to 2009 biennially.

LPM Model

Using the PSID data and selecting only those who are homeowners in at least one of 2005, 2007 or 2009, we examine the likelihood of mortgage delinquency by 2009. Our data is weighted using the 2007 sample weights and after cleaning and imputing missing data our weighted sample includes 3,396 households. We adjust for possible clustering by state within the data.

The likelihood for head of household, n , to be delinquent on their mortgage is estimated based on our weighted sample to be

$$(1) \quad delinquent_n = \alpha + \beta_i demographic + \delta_j trigger + \gamma_k strategic + \eta_m financial + \pi_s state + \varepsilon_n,$$

where $delinquent_n$ equals 1 if the head of household is delinquent on their mortgage by 2009 and zero otherwise. *Demographic* is an n by 8 matrix containing the demographic variables on education, children, sex, marital status, ethnicity, race, and age (young and middle-aged). *Trigger* is an n by 2 matrix containing those variables related to trigger events: change in marital status and job loss. *Strategic* is an n by 2 matrix containing those variables pertaining to strategic defaulting: non-recourse and equity. *Financial* is also an n by 2 matrix containing individual n 's log-income and log-wealth. *State* is an unreported dummy variable that controls for the state of residence of the respondent. This should help control for varying economic effects across the country.

Probit Model

Using the same weighted data as in equation (1) we apply a probit estimation and find that the likelihood a head of household will be delinquent on their mortgage by 2009 is

$$(2) \quad \text{prob}(delinquent_n) = \Phi(\alpha + \beta_i demographic + \delta_j trigger + \gamma_k strategic + \eta_m financial + \pi_s state),$$

where $\text{prob}(delinquent_n)$ equals 1 if the head of household is delinquent on their mortgage by 2009 and zero otherwise. $\Phi(\cdot)$ is the standard normal cumulative distribution function. All variables in equation (2) are the same as those included in equation (1).

Due to the initial drawbacks of the LPM (incorrectly estimating values outside our possible range of 0 or 1) we estimate both an LPM model and a probit model to insure accuracy within our results. The probit model is better suited for a binary dependent variable; however, its assumption that the error term follows a standard normal distribution is a strong one that may not hold true. Keeping this in mind we run both models and compare results accordingly.

Chapter 5 - Empirical Results

Table 5.1 presents the Linear Probability coefficient estimates with robust standard errors.⁶ Across models, the coefficient estimates consistently indicate that black and Hispanic homeowners as well as homeowners with children are more likely to be delinquent on their mortgage than other groups. Looking at our final model, Model (6), a black homeowner is 6.1 percentage points more likely to be delinquent and a Hispanic homeowner is 10.3 percentage points more likely to be delinquent. These increased percentage points are large and correspond to increases in the likelihood of delinquency of 122% and 206%, respectively. While having children increases this likelihood by 32% with an increase in percentage points of 1.6. Conversely having a college degree significantly reduces the likelihood of delinquency. A decrease of 4.0 percentage points due to the homeowner having a college degree corresponds to an 80% decrease in the likelihood of delinquency. These results remain significant throughout all models and the percentage points only vary slightly.

State dummy variables are included in Models (2) through (6). Model (3) includes the variable job loss. With this inclusion in the model, surprisingly, we see that controlling for other factors, neither trigger event—job loss or change in marital status—has any significant result. This insignificance maintains throughout all models. Models (4), (5) and (6) build off of (3) by including equity, total net non-housing wealth and whether or not the homeowner lives in a non-recourse state, respectively. Equity has strong negative effects on the likelihood of delinquency. Increasing a homeowner's equity by 10 percentage point will decrease the likelihood of delinquency by .71 percentage points thus leading to a 14.2% decrease in the likelihood of delinquency according to our initial equity inclusion model, Model (4). Subsequent models yield similar results with only a slight decrease in the overall effect of equity (13.8% vs. 14.2%).

⁶As R^2 values are often misrepresentative of longitudinal data (Hill 2001), to deter confusion these values are not reported with the coefficient estimates in Table 5.1. However, for consistency we have included them in a separate index, which can be found in Appendix A.5.

Table 5.1 Linear Probability Model Estimates of Mortgage Delinquency

	(1)	(2)	(3)	(4)	(5)	(6)
	Base	States	Job Loss	Equity	Wealth	Recourse
Intercept	.160** (.071)	.109* (.063)	.108* (.064)	.119* (.064)	.178** (.068)	.178** (.068)
College Degree	-.042*** (.008)	-.041*** (.008)	-.041*** (.008)	-.040*** (.007)	-.040*** (.007)	-.040*** (.007)
Children	.017* (.009)	.018** (.009)	.018** (.009)	.016* (.009)	.016* (.009)	.016* (.009)
Log Income	-.013** (.006)	-.013** (.006)	-.013** (.006)	-.010* (.006)	-.007 (.006)	-.007 (.006)
Female	.037** (.018)	.033* (.018)	.033* (.018)	.028 (.017)	.027 (.017)	.027 (.017)
Married	.009 (.011)	.007 (.011)	.007 (.011)	.007 (.011)	.007 (.011)	.007 (.011)
Change in Marital Status	.012 (.028)	.018 (.028)	.018 (.028)	.025 (.029)	.027 (.029)	.027 (.029)
Hispanic	.101*** (.017)	.106*** (.018)	.105*** (.018)	.104*** (.018)	.103*** (.018)	.103*** (.018)
Black	.060*** (.020)	.063*** (.021)	.063*** (.021)	.062*** (.020)	.061*** (.020)	.061*** (.020)
AGE						
18 to 34	.028** (.014)	.027* (.015)	.028* (.015)	.003 (.019)	-.001 (.018)	-.001 (.018)
35 to 64	.037*** (.013)	.034** (.013)	.034** (.014)	.022 (.015)	.020 (.014)	.020 (.014)
Non-Recourse State						.146*** (.006)
Log Total Net Non-Housing Wealth					-.007* (.004)	-.007* (.004)
Equity				-.071*** (.023)	-.069*** (.023)	-.069*** (.023)
Job Loss			.013 (.015)	.012 (.016)	.012 (.016)	.012 (.016)
Sample Size	3396	3396	3396	3384	3380	3380

Note: Our dependent variable is delinquency, where delinquency equals 1 if the borrower is late on their mortgage and 0 otherwise. Standard errors are reported in parentheses.

Our base model shows a minimal yet significant negative effect of income on the probability of delinquency that carries through the inclusion of state dummies, job loss and

equity. In our base model we see that a \$10,000 increase in income yields a .13 percentage point decrease in the probability of delinquency; this corresponds to a 2.6% decrease in the likelihood of mortgage delinquency. However, the inclusion of wealth essentially “swallows up” the income effect. We find that between the two measures of financial status it is the more encompassing wealth variable that significantly (albeit minimally) affects a homeowner’s likelihood of delinquency.

With the inclusion of further variables in subsequent models we find a refinement effect. Many significant variables remain intact while others lose significance with the addition of new variables. Female head and age, like income before, are both significant in the earlier models but lose such significance as the model becomes more refined. In the base model we find that female-headed households are 74% more likely to be delinquent than their male counterparts. We also find that young and middle-age homeowners are 56% and 74%, respectively, more likely to be delinquent than those homeowners of retirement age. All of these effects fade out, however, with the inclusion of such variables as equity, wealth and non-recourse. Where the argument could be made that there is some correlation between female-headed households and equity or wealth due to underlying sexual discrimination, it could be argued it is more the case of model refinement. Earlier models were probably leaving out key variables and consequently insignificant variables were given more significance than they merit. The same could be said for age with the idea that older borrowers have more time to accrue wealth and more time to pay down their mortgage principle resulting in higher equity. But again, we do not believe that is the case.

The inclusion of wealth, while significant, has very little effect on the outcome of the model. A \$10,000 increase in wealth correlates to a decrease of .03 percentage points and thus a decrease of only .54% in the likelihood of delinquency. Its lack of magnitude is peculiar though as now, with income being insignificant, the only substantial measure of a homeowner’s financial health comes from our equity variable. Considering the wealth measure does not include home equity there should be no direct correlation between the two. The argument could be made here for a correlation between wealth and equity; the more wealth an individual has the more likely they are to have a higher-valued home (which would be an indirect correlation with equity). While this isn’t necessarily the case it could possibly explain the weak effect of wealth.

Model (6) includes the variable for non-recourse. We find results congruent with previous literature (Ghent 2010). A homeowner residing in a non-recourse state is 14.6 percentage points more likely to be delinquent, corresponding to a 292% increase in the likelihood of delinquency versus a homeowner living in a recourse state. This is a substantial increase that along with the significant effects of equity points to a number of delinquent homeowners being of the strategic variety.

Marital status, change in marital status, and job loss all retain insignificant coefficients throughout the models. As mentioned before, this is especially alarming for the change in marital status and job loss variables. The insignificance of these two variables in particular leads to the argument that trigger events leading up to 2009 are less significant than those found in previous periods. Marital status is an institutional variable that carries with it the underlying belief that married couples tend to be more financially fit and thus more able to “weather the storm.” While this may be true in the case of trigger events not related to a change in marital status it would seem almost irrelevant in the case of homeowners applying a strategic method of defaulting. A spouse cannot prevent a sudden drop in house prices. With other variables hinting strongly at strategic behavior, it would make sense that marital status would be insignificant.

Table 5.2 presents the probit coefficient estimates with robust standard errors.⁷ Across models the coefficient estimates consistently indicate that black and Hispanic homeowners are more likely to be delinquent on their mortgage than other groups. Similar to our LPM estimates, across all models the probit coefficient estimates also show a strong negative effect of having a college degree. Table 5.3 reports the marginal effects from the probit estimation, computed using the normal probability distribution evaluated at the sample means of the control variables.

In Model (6) we find that black homeowners are 2.6 percentage points more likely to be delinquent, corresponding to a 53% increase in the likelihood of delinquency. Similarly Hispanic heads of households show an increase of 3.5 percentage points in the likelihood of delinquency; this corresponds to a 71% increase in the likelihood of delinquency. As in our LPM models we find that having children increases the likelihood of delinquency in our probit models, too. A homeowner with at least one child is 20% more likely to be delinquent than a homeowner with no children.

⁷ Likelihood Ratios are reported with corresponding models in Table 5.2.

Table 5.2 Probit Coefficient Estimates of Mortgage Delinquency

	(1)	(2)	(3)	(4)	(5)	(6)
	Base	States	Job Loss	Equity	Wealth	Recourse
Intercept	-.805 (.753)	-4.52*** (.495)	-4.51*** (.698)	-4.51*** (.756)	-3.15 (11.8)	-3.15*** (1.07)
College Degree	-.552*** (.116)	-.558*** (.122)	-.559*** (.122)	-.557*** (.121)	-.542*** (.123)	-.542*** (.123)
Children	.190** (.090)	.217** (.091)	.218** (.092)	.200** (.096)	.199** (.096)	.199** (.096)
Log Income	-.131** (.058)	-.149*** (.054)	-.151*** (.054)	-.129** (.056)	-.098* (.054)	-.098* (.054)
Female	.373** (.166)	.321* (.170)	.320* (.171)	.282* (.170)	.270 (.172)	.270 (.172)
Married	.104 (.130)	.085 (.136)	.080 (.134)	.093 (.142)	.091 (.143)	.091 (.143)
Change in Marital Status	.073 (.236)	.106 (.248)	.100 (.246)	.140 (.242)	.151 (.243)	.151 (.243)
Hispanic	.626*** (.106)	.720*** (.118)	.718*** (.118)	.713*** (.124)	.708*** (.126)	.708*** (.126)
Black	.460*** (.120)	.520*** (.132)	.520*** (.131)	.529*** (.129)	.529*** (.132)	.529*** (.132)
AGE						
18 to 34	.431* (.258)	.453* (.260)	.459* (.265)	.352 (.317)	.283 (.314)	.283 (.314)
35 to 64	.510** (.253)	.513** (.251)	.519** (.254)	.529* (.303)	.488 (.300)	.488 (.300)
Non-Recourse State						4.56*** (.189)
Log Total Net Non-Housing Wealth					-.132** (.061)	-.132** (.061)
Equity				-.644*** (.187)	-.629*** (.187)	-.629*** (.187)
Job Loss			.152 (.150)	.142 (.166)	.151 (.165)	.151 (.165)
Likelihood Ratio	152.9	218.3	219.4	249.1	252.3	252.3
Sample Size	3396	3396	3396	3384	3380	3380

Note: Our dependent variable is delinquency, where delinquency equals 1 if the borrower is late on their mortgage and 0 otherwise. Standard errors are reported in parentheses.

Table 5.3 Marginal Effects of Probit Estimation

	(1) Base	(2) States	(3) Job Loss	(4) Equity	(5) Wealth	(6) Recourse
Intercept	-.040	.109***	.108***	.119***	.178	.178***
College Degree	-.042***	-.041***	-.041***	-.040***	-.040***	-.040***
Children	.017**	.018**	.018***	.016**	.016**	.016**
Income	-.0006**	-.0007***	-.0007***	-.0006**	-.0005*	-.0005*
Female	.037**	.033*	.033*	.028*	.027	.027
Married	.009	.007	.007	.007	.007	.007
Change in Marital Status	.012	.018	.018	.025	.027	.027
Hispanic	.101***	.106***	.105***	.104***	.103***	.103***
Black	.060***	.063***	.063***	.062***	.061***	.061***
AGE						
18 to 34	.028*	.027*	.028*	.003	-.001	-.001
35 to 64	.037**	.034**	.034**	.022*	.020	.020
Non-Recourse State						.146
Total Net Non-Housing Wealth					-.0003**	-.0003**
Equity				-.003***	-.003***	-.003***
Job Loss			.013	.012	.012	.012
Sample Size	3396	3396	3396	3384	3380	3380

Note: Our dependent variable is delinquency, where delinquency equals 1 if the borrower is late on their mortgage and 0 otherwise. Income and Total Net Non-Housing Wealth are per \$10,000 increase. Equity is per %10 increase. Significance of marginal effects based on significance of corresponding coefficient estimates.

Having a college degree lowers the likelihood of delinquency by 2.7 percentage points causing a 54% decrease in the likelihood of delinquency. Total net non-housing wealth, income and equity all have a negative effect on the likelihood of delinquency, as well. We find that an increase in total net non-housing wealth of \$10,000 reduces the likelihood of delinquency by .03 percentage points, corresponding to a decrease in the likelihood of delinquency of .51%. An increase in income of \$10,000 reduces the likelihood of delinquency by .05 percentage points, which corresponds to a decrease in the likelihood of delinquency of .96%. While these figures are small they remain significant and it should be noted that with the inclusion of total net non-housing wealth in Models (5) and (6) the income effect remains significant (unlike our LPM results). Equity has a more substantial effect than both wealth and income. Increasing equity by

10 percentage points decreases the likelihood of delinquency by .31 percentage points, which corresponds to a 6.3% percent decrease in the likelihood of delinquency.

Referring again to Model (6) we find that non-recourse has, similar to the LPM model, the most profound effect on delinquency. Homeowners living in a non-recourse state are 23 percentage points more likely to be delinquent than those residing in a state with recourse; this corresponds to a 456% increase in the likelihood of delinquency. As likelihood ratios show (as well as other variables' identical coefficient estimates from Model (5) to Model (6)), adding the variable for non-recourse has little overall effect on the fit of the model. It appears the significance of living in a non-recourse state could have been dispersed across the actual state dummy variables for non-recourse states. Once the variable for non-recourse was included it would follow that those state dummy variables would lose significance. In other words, it is not the state a homeowner resides in that matters so much as the *type* of state—recourse or non-recourse.

Inspecting the coefficient estimates for both the LPM and probit models we find very few conflicting results. Similar to the LPM models we find in the probit models that sex and age lose significance with the inclusion of other significant variables (equity or wealth); also marital status, change in marital status, and job loss remain insignificant across all models. Unlike the LPM models, in the probit estimation income retains significance through our final model, Model (6). In both the LPM and probit models having a college degree, total net non-housing wealth and equity all have significant negative effects on the likelihood of delinquency, while having children, being Hispanic, being black and living in a non-recourse state all have significant positive effects on the likelihood of delinquency for a homeowner.

Chapter 6 - Conclusion

Many homeowners have suffered from weaker financial security because of decreasing house values, rising unemployment and a number of economic hardships. The ability to make a mortgage payment is not always an option and even when it is some borrowers are choosing not to make it given their adverse conditions. Mortgage delinquency has become more common due to people's inability to pay in this harsh economic climate coupled with people's unwillingness to pay given the status of their situation. Our research supports the validity of strategic default but lacks any contribution to the theory of trigger events. While we hesitate to refute the importance of trigger events we are obliged to point out their insignificance within our study.

Controlling for both a homeowner's newfound inability to pay (trigger events) and a homeowner's unwillingness to pay (strategic) we run six versions of two different models and find glaring incongruities in the demographics of borrowers. Even while controlling for these outside influences we find large racial and ethnic gaps in the likelihood of delinquency. The results imply that all else equal there are still certain unobservable characteristics or events that are affecting the rate of delinquency among black and Hispanic households specifically. The degree of these differences merits further research on the topic. To gain further insight on this, further research could take into account the urban/rural dynamic. A look at recent policy is also merited as recently programs have been installed to increase homeownership among minorities. While these programs have good intentions it might be that they are setting people up for failure. Regardless of policy it remains that the underlying threat lies in the unobservable effects of being black or Hispanic and further research specifically in this area is necessary.

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Appendix A - Additional Tables

Table A.1 Weighted Sample Means, $n = 3384$

Variable Definition	All Homeowners	Delinquent	Current
Mortgage Delinquency	0.05	1	0
College Degree	0.42	0.15	0.44
Children	0.43	0.58	0.42
Income	102,061	71,694	103,677
Female	0.19	0.29	0.19
Married	0.66	0.61	0.67
Change in Marital Status	0.03	0.05	0.03
Hispanic	0.08	0.26	0.07
Black	0.09	0.21	0.09
AGE			
18 to 34	0.19	0.16	0.19
35 to 64	0.71	0.80	0.70
65 or older	0.11	0.04	0.11
Non-Recourse State	0.27	0.28	0.27
Total Net Non-Housing Wealth (TNW)	260,824	78,730	270,512
Equity	43%	26%	44%
Job Loss			
2005 to 2007	0.08	0.10	0.08

Note: All dollar amounts are adjusted to 2009 dollars. Data are weighted using 2007 weights. Sample size is 3384 homeowners observed from 2005 to 2009 biennially.

Table A.2 Medians of Note and Additional Variable Means, $n = 3384$

Variable Definition	All Homeowners	Delinquent	Current
Income (median)	77,198	60,464	78,849
TNW (median)	42,857	6,374	46,484
Equity (median)	42%	26%	43%
CHG IN EQUITY (median)			
2005 to 2007	3.7%	0.99%	3.8%
2007 to 2009	-3.5%	-12%	-3.4%
HOUSE VALUE (median)			
2005	203,297	161,538	208,779
2007	223,901	186,335	227,743
2009	200,000	150,000	200,000
HOME OWNERSHIP			
Owned in 2005	0.87	0.82	0.87
Owned After 2005	0.13	0.18	0.13
Job Instability			
2005 to 2007	0.20	0.24	0.20

Note: All dollar amounts are adjusted to 2009 dollars. Data are weighted using 2007 weights. Sample size is 3384 homeowners observed from 2005 to 2009 biennially.

Table A.3 Weighted Sample Means, $n = 3380$

Variable Definition	All Homeowners	Delinquent	Current
Mortgage Delinquency	0.05	1	0
College Degree	0.42	0.15	0.44
Children	0.43	0.58	0.42
Income	102,093	71,723	103,708
Female	0.19	0.29	0.19
Married	0.66	0.62	0.67
Change in Marital Status	0.03	0.05	0.03
Hispanic	0.08	0.26	0.07
Black	0.09	0.21	0.09
AGE			
18 to 34	0.19	0.16	0.19
35 to 64	0.71	0.80	0.70
65 or older	0.11	0.04	0.11
Non-Recourse State	0.27	0.28	0.27
Total Net Non-Housing Wealth (TNW)	260,824	78,730	270,512
Equity	43%	27%	44%
Job Loss			
2005 to 2007	0.08	0.10	0.08

Note: All dollar amounts are adjusted to 2009 dollars. Data are weighted using 2007 weights. Sample size is 3380 homeowners observed from 2005 to 2009 biennially.

Table A.4 Medians of Note and Additional Variable Means, *n* = 3380

Variable Definition	All Homeowners	Delinquent	Current
Income (median)	77,305	60,464	78,849
TNW (median)	42,857	6,374	46,484
Equity (median)	42%	26%	43%
CHG IN EQUITY (median)			
2005 to 2007	3.7%	0.99%	3.8%
2007 to 2009	-3.5%	-12%	-3.4%
HOUSE VALUE (median)			
2005	203,297	161,538	208,779
2007	223,901	186,335	227,743
2009	200,000	150,000	200,000
HOME OWNERSHIP			
Owned in 2005	0.87	0.82	0.87
Owned After 2005	0.13	0.18	0.13
Job Instability			
2005 to 2007	0.20	0.24	0.20

Note: All dollar amounts are adjusted to 2009 dollars. Data are weighted using 2007 weights. Sample size is 3380 homeowners observed from 2005 to 2009 biennially.

Table A.5 R² Values for Linear Probability Models

	(1)	(2)	(3)	(4)	(5)	(6)
	Base	States	Job Loss	Equity	Wealth	Recourse
Adjusted R ²	4.66%	5.03%	5.03%	6.03%	6.04%	6.04%
R ²	4.94%	6.69%	6.71%	7.72%	7.76%	7.76%
Sample Size	3396	3396	3396	3384	3380	3380