The Impact of Housing Market Conditions on Residential Property Upkeep

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Keywords: Public Goods, Neighborhoods, Default Risk, Home Equity

JEL Codes: H41, R23, D12

Abstract

This paper assesses the impact of housing market conditions on the theoretically motivated and empirically observed negative relationship between loan to value ratios and home maintenance expenditures. If the relationship is causal, then a down housing market will result in significantly decreased upkeep in the housing stock. The large rise and fall in home prices during the 2001-2009 period allows a unique opportunity to analyze the response of homeowners to changing housing market conditions. Data from the American Housing Survey is analyzed to confirm previous work that a negative relationship exists between loan to value ratios and routine maintenance expenditures; however, this relationship does not move in the expected direction when examined along with temporal variations in market conditions. Panel analysis reveals a more complex story. Households most likely to be at risk for default do decrease maintenance expenditures when default risk increases, but other households actually increased maintenance expenditures when the housing market conditions became less favorable.
**Introduction**

Many neighborhood-level attributes are provided largely through unmonitored voluntary contributions on the part of the neighborhood residents. Examples include the aesthetic appearance of the neighborhood, the supervision of neighborhood children, the care with which residents drive through the streets and participation in neighborhood social activities. These local public goods together create varying levels of neighborhood quality, which in turn impacts the well-being of neighborhood residents and is capitalized into neighborhood home prices. When neighborhoods improve many improved outcomes are possible—property values increase (Dubin, 1992), neighborhoods become more aesthetically pleasing (Leonard et al, 2010), socializing among residents is more likely (Sampson, 2003), neighborhood children often benefit from improved stability (Shaefer-McDaniel 2009), physical activity is more likely as the neighborhood is more “walkable” (Saelens et al 2003; Sallis & Glanz, 2006), and communities benefit from increased tax revenue. Likewise, the opposite can be said of neighborhoods in decay.

The purpose of this paper is to better understand the housing market determinants of local public good provision by analyzing the relationship between default risk—in both up and down housing markets—and routine maintenance expenditures. While the real-estate and housing economics literature has largely focused on the private benefits of home maintenance due to its large consumptive component (Harding, Rosenthal et al. 2007), property upkeep may also be thought of as an impure public good because it produces neighborhood externalities. Reduced exterior maintenance detracts from neighborhood aesthetics and any type of reduce maintenance may indirectly reduce neighborhood home prices because homes that are not maintained properly generally sell at a discount. These discounted sell prices then become part of the neighborhood
comparables upon which future sell prices are assessed (Vandell 1991). Economic theory suggests that defaulted home mortgage loans present a market failure whereby owners who default (or are at great risk of default) have reduced incentive to maintain their property. Therefore, there is likely a close link between housing market conditions and the provision of property upkeep. This linkage is particularly concerning when considering the externalities associated with home maintenance. While much of the cost of decreased maintenance is private, even a small proportion that generates negative neighborhood externalities could produce detrimental pro-cyclical influences on neighborhoods if a declining market reduces public good contributions that then cause further market price declines.

While evidence suggests high LTV loans and/or high default risk lead to decreased property upkeep (Harding, Miceli et al. 2000), the response of homeowners to changes in housing market conditions is unknown. In a depreciating market, low-equity homeowners are exposed to much greater default risk than in an appreciating market. However, it is unknown if this variation in default risk caused by market depreciation translates into behavioral changes on the part of neighborhood residents. The rapid rise and subsequent decline in home prices from 2001 through 2009 provides a natural experiment for the testing of this relationship.

The next section begins by developing a conceptual model to explain the influence of default risk on local public good contributions. The empirical investigation (Section 4) utilizes American Housing Survey (AHS) data that is described in Section 3 to estimate both cross sectional and panel models of routine maintenance expenditures. Finally, Section 5 concludes.
1. **Background**

   Neighborhood residents provide local neighborhood public goods through activities such as property upkeep and residents that are homeowners often have significant wealth invested in neighborhood housing. Household budgets matter for provision decisions because they determine the stock of resources available to invest in local public goods, and they are themselves influenced by public good provision through property values. Therefore, household behavior with regards to the provision of local neighborhood public goods is likely related to the role of housing in the household’s budget.

   Housing is generally one of the largest and most high-risk components of a household’s portfolio and significantly impacts household financial decisions. Empirical evidence suggests that households deal with the risk associated with housing investments by reducing stock-holdings (Cocco, 2005; Flavin and Yamashita, 2002) and sorting out of the housing market during times of increased volatility (Turner, 2003). Additionally, home equity is tapped to smooth consumption during times of financial stress (Hurst and Stafford, 2004). Finally, as previously mentioned housing also provides consumption benefits. Housing then has three key functions in the homeowner’s portfolio: it is a risky asset which pays dividends; it is a form of “forced savings” because equity is often costly to withdraw, but can be used to weather income shortfalls; and it is consumed. When home equity is high it can help smooth fluctuations in public good provision; but when equity is low, public good provision may be adversely affected.

   The current equity stake in a property may be measured by subtracting the current loan to value ratio (LTV) from 1. Thus a high LTV is indicative of a low equity stake in
the property. However, we should consider the degree to which equity stake is known by
the homeowner. The outstanding loan value is information that at least is easily
attainable—usually from the monthly mortgage bill. However, the value of the house is
often only estimable with a degree of error. Further, default risk—defined as the
probability that default or foreclosure will occur—is positively correlated with LTV, but
there are also other factors involved. The likelihood of default usually depends upon the
full household budget constraint, the term structure of interest rates, housing market
conditions and the likelihood of “trigger events” which cause a sudden change in a
household’s financial situation. LTV only provides insight into the housing component
of household budgets. Due to the complexity of assessing default risk (Kau and Keenan
1995; Vandell 1995; Avery, Bostic et al. 1996), it is likely that knowledge of default risk
exposure is unknown to many homeowners; or becomes known only when default risk is
very high or very low.

Harding et al (2000) finds loan to value ratios (LTV) to be negatively related to
home maintenance expenditures using AHS data from 1985 through 1995. However, it is
unknown if this observed relationship is caused by the increased default risk associated
with high LTV mortgages or is some other behavioral characteristic of low-equity
homeowners. While this distinction is subtle, it has important policy implications. If the
relationship is caused by default risk, then poor economic conditions and housing market
volatility will exacerbate the degree to which high-LTV homeowners “under maintain”
their homes. However, if most homeowners are unaware of their level of default risk
exposure, then it is unlikely that a causal relationship will be observed as default risk
exposure changes over time. Further, the results (or some portion of them) may be
attributed to an omitted variable problem whereby unobserved behavioral preferences or motivations shared by homeowners who also choose low-equity positions are what cause the observed empirical relationship. In this case the causal role of default risk in public good contributions will be less.

Previous empirical work generally supports the conclusion that default events lead to decreased neighborhood home prices (Harding, Rosenblatt & Yao, 2010; Lin et al., 2008; Leonard & Murdoch, 2009; Immergluck & Smith, 2005; and Cotterman, 2001). Leonard & Murdoch (2009) propose that these changes may occur through a decrease in local public good contributions and this mechanism is supported by the timing of the price impacts of foreclosure (Harding, Rosenblatt et al. 2009). This suggests that when default occurs maintenance decreases, but it is unknown if there is a smooth transition whereby maintenance decreases with increases in default risk.

2.1 A Model of Residential Property Upkeep

Harding et al (2000) extends the model of Henderson and Ioannides (1983), which results in a two-period expected utility maximization problem in which utility depends on housing utilization. The optimal utilization rate occurs when the marginal benefit of housing utilization equals the present value of marginal maintenance costs. The intuition gleamed from the model is that a market failure will occur when the full marginal costs of home utilization (e.g. maintenance costs) cannot be assessed to the occupant of the house. This occurs in the case of rental properties as well as properties at risk of default. This model suggests a negative relationship between household maintenance expenditures and default risk.

2.2 A Conceptual Model of Default Risk
Kau, Keenan and Kim (1994) present the theory for determining default risk by examining default as the realization of a homeowner’s intertemporal optimization decision. While much of the literature is concerned with the solution of the mortgage valuation problem (Kau and Keenan 1995), this, though necessary for determining the space over which default probabilities are positive, provides the dollar value of default and not the \textit{probability} of default—the primary concern for this analysis. The probability of “optimal” default for a given house price, interest rate and LTV is a function of values of the interest rate ($r$) and house price ($Q$) in the future (Kau, Keenan et al. 1994) and occurs only when the mortgage valuation is sufficiently low, or in the default region ($D$).

$$\Pr\{\alpha = 1 \mid r, Q, s\} = \alpha(r(\tau(i)),Q(\tau(i)),\tau(i)) \in D$$

for some $\tau(i) > s$ where $s$ is the current time. \hfill (1)

The time path of interest rate and house prices necessary to solve the Kolmogorov backward partial differential equation (see Kau, Keenan et al. 1994 for more details) that defines the probability are given by

$$dr = \gamma(\theta - r)dt + \sqrt{\sigma_r}dz_r$$ \hfill (2)

and

$$\frac{dQ}{Q} = (\alpha - \phi)dt + \sigma_H dz_H$$ \hfill (3)

The term structure of the interest rate ($r$) is described by a stochastic, mean reverting process where $\gamma$ is the rate of reversion to the steady-state value, $\theta$, and $\sigma_r$ provides the volatility of the stochastic Wiener process, $z_r$. House values are a function of the expected rate of return on the housing asset, $\alpha$; the service or rental flow from the house, $\phi$; housing volatility, $\sigma_H$; and a stochastic disturbance, $z_H$. The term $(\alpha - \phi)$ represents the
expected rate of appreciation. While home price appreciation does not impact the valuation of the default option (Kau and Keenan 1995), it does play a role in determining default risk. Additionally, I re-emphasize that default risk remains zero unless, the cost of the mortgage exceeds the house price; thus the equity stake in the house must be sufficiently low before default is an option considered by the homeowner. Default risk then varies with changes in LTV, the rate of appreciation, the term structure of interest rates and structural changes that affect interest rate and home price volatility.

2.3 Reduced form Model

Together the conceptual models for home maintenance and default risk suggest a reduced form empirical model for maintenance expenditures:

\[ q_{it} = f(Y_{it}, Q_{it}, N_{jt}, LTV, r_t, HPI) \]  

(4)

The empirical model will estimate this reduced form equation. Income \((Y)\) represents available resources to invest in maintenance expenditures. House value \((Q)\) and neighborhood condition \((N)\) are included to control for factors which likely impact the amount of routine maintenance required for upkeep. Increases in \(LTV\), decreases in interest rates \((r)\), and decreases in \(HPI\) all increase default risk. Interest rate and home price volatility also affect default risk, but they are structural characteristics which are difficult to measure on a year-by-year basis. Regardless, during the sample period, the change in volatility would have increased default risk and be correlated with the effects of \(r\) and \(HPI\).

Empirical Estimation Strategy

Following Harding et al. (2000), I first take a cross-sectional approach and estimate the relationship between high LTV mortgages and maintenance expenditures.
The empirical analysis will assess the impact of default risk on household’s maintenance expenditures by estimating (4). Current period equity, $Q_t$, is proxied by the inclusion of LTV threshold variables that indicate mortgages who’s LTV exceeds 90%, 80%, 70% or 60%. Current period income ($Y_t$) and neighborhood quality are measured by the variables $INCOME$ and $QUALITY$, respectively. Further, several individual level characteristics are used to control for variations in preferences for maintenance expenditures. Home price appreciation ($HPI$) and interest rates ($r$) cannot be included in the cross sectional model, but we can compare the estimated models across AHS sample years to begin to understand the impact of housing market conditions. The large variations of HPI and interest rates during the sample period will facilitate an insightful comparison of the relationship between maintenance expenditures and LTV as the associated level of default risk changes.

A log-linear model\(^1\) is specified and estimated using tobit since 10-15 percent of the observations for maintenance expenditures are zero each sample year\(^2\). According to the AHS codebook maintenance expenditures are also top coded at $9998, but in the final dataset used for analysis, no top coded observations were observed.

Next, I conduct a panel analysis, to better understand the roles of LTV, interest rates, HPI and income in maintenance expenditure decisions while controlling for fixed effects associated with different housing units. A fixed effect tobit model is the preferred estimation scheme since it will allow for control of unobserved heterogeneity across housing units. Unfortunately, consistent estimation of this model is difficult (Baltagi

\(^1\) The natural log of maintenance expenditures was calculated as log(CSTMNT+1) so that the variable could be defined when maintenance expenditures were $0$. A log-linear model was also used by Harding et al (2000).
\(^2\) 14.6%, 14.6%, 15.2%, 11.9% and 10.8% of reported maintenance expenditures are zero for 2001, 2003, 2005, 2007 and 2009, respectively.
2008). However, for cases when at least 5 time periods are observed, it is possible to estimate the model with almost no bias (Greene 2004). I use this approach, limiting our panel sample to only those housing units with 5 repeat observations. Since the AHS survey is a panel of housing units (and not necessarily households), the variables describing household characteristics are still important controls in the model. Time dummy variables are also included to control for any time varying fixed effects that would impact maintenance expenditures.

2. Data

American Housing Survey (AHS) data from 2001 through 2009 is used to test the relationship between default risk and property upkeep. The national AHS household survey, administered by the U.S. Bureau of the Census, collects data from approximately 50,000 housing units and the households that occupy them at a biannual frequency. The AHS seeks to re-interview the same sample of housing units each survey administration and has interviewed the current sample of housing units since 1985 with some replacement to account for changes in the housing stock. The AHS sample is constructed by selecting households from one of 394 primary sampling units (PSU’s). The PSU’s are comprised of counties, groups of counties or independent cities. PSU’s sampled by the AHS cover 878 US counties with representation from all 50 states and the District of Columbia.

Descriptions of variables used in the empirical study are presented in Tables 1 and 2. The data contain variables that describe characteristics of the housing unit, the household that occupies the unit, the mortgage on the housing unit and the neighborhood
in which the housing unit is located. In each survey year, the sample is limited to owner-occupied, detached, single-family residences for which the full set of housing unit, household and mortgage characteristics are available. Observations with top coded values for the home value, the mortgage amount, the housing unit size, or household income were dropped. Additionally, observations for which the purchase price or estimated home value was less than $10,000, the unit had less than 200 square feet, or the head of household was less than 18 years of age were not considered in the analysis.

Summary statistics for the data used in the cross sectional analysis are presented in Tables 3 and 4. Maintenance expenditures, income and home values were adjusted to 2000 constant dollars. When combining all sample years, the average household spends $671 (adjusted to 2000 constant dollars) annually on routine home maintenance. Routine home maintenance expenditures reported by AHS include only routine repairs and maintenance "such as painting, plumbing, roofing or other minor repairs." Larger expenditures such as major upgrades, remodels or non-routine home improvements are excluded\(^3\). The average home is valued at $258,503, has 2198 square feet of living space and is 36 years old. Average annual household income is $83,064 and the average household size is 3 people. 49% of the respondents have college degrees; 7.5% are African American; and 9.3% are Hispanic. For the empirical analysis, \textit{VALUE} and \textit{INCOME} were scaled by dividing by 100,000 and 10,000, respectively.

The empirical model will control for neighborhood quality measured by the existence of nuisances within ½ block of the housing unit. The presence of these nuisances was recorded by the interviewer freeing the observations from responder bias

\(^3\) We intentionally exclude major repairs because the sorts of major repairs for which expenditures are reported are less likely to produce externalities in the neighborhood.
that would cause endogeneity problems in the model. Less than 4% of the housing units were within \( \frac{1}{2} \) block of any particular neighborhood nuisance. The neighborhood nuisances analyzed were the presence of abandoned or vandalized buildings, trash or litter in the streets or on nearby properties, roads which were in need of repair, bars on windows and nearby industrial facilities. Each nuisance measure was converted into a binary variable where 1 indicates the presence of the nuisance to any extent (e.g. major or minor accumulations of trash; one or more abandoned buildings, etc.). For each housing unit, the number of these nuisances that existed within \( \frac{1}{2} \) block were summed and subtracted from 0 to create a measure of neighborhood quality. Thus, \textit{QUALITY} takes on a value of -5 for the worst case in which every nuisance was present within \( \frac{1}{2} \) block and a value of 0 when no nuisances are present.

The cross sectional data was combined and housing units not observed each period were dropped to create the panel dataset. This resulted in a balanced panel with 2596 housing units. Summary statistics for the panel dataset are presented in Tables 5 and 6. Overall, the panel data set is of slightly higher income than the combined cross-sectional samples and includes slightly fewer households with LTV ratios greater than 90%. However, the samples are very similar across most measures. Looking at the individual year averages in the panel data, some expected trends emerge. Household incomes were at their lowest in 2009 with a peak in 2001. Similarly estimated home values dropped to the lowest level in 2009, but they peaked in the 2007 sample indicating that a lag may exist between market conditions and the evaluations influencing homeowners’ estimates. Interestingly, maintenance expenditures were higher in 2005-2009 than during the appreciating market in 2001-2003.
3.1 Calculation of LTV

Assumptions must be made when making LTV calculations from data available in the AHS. I follow Harding et al. (2000) who use AHS data to estimate LTV by dividing the original loan amount by the current estimated home value\(^4\). There are some potential concerns with this method. First, the home value is self-report and assessed by the homeowner. While the self-report values are susceptible to large errors, they are highly relevant when considering the causal role of default risk with regards to homeowner behavior. LTV ratios calculated from self-report home values indicate the equity stake as perceived by the homeowner. According to economic theory it would be the perceived default risk that would cause homeowners to under-invest in their home. Second, using the original (rather than current) outstanding mortgage balance is usually an overestimate of the true LTV since the outstanding loan balance is almost always less than the original loan amount. This methodology provides an approximate upper bound to the true LTV. Since the empirical analysis is interested in determining the degree to which high-LTV homeowners differ from low-LTV homeowners, the bias introduced by using the upper bound for LTV will result in more conservative estimates of this difference. The continuous variable \(LTV\) is used to create dummy variables for various LTV thresholds. 14 percent and 11 percent of the mortgages sampled for the cross-sectional and panel analysis, respectively, have LTV’s greater than 0.9. Additionally, the empirical models include controls for various attributes of the mortgage: mortgage age (\(TIMERES\)) and loans in which other terms (such as the length of repayment) may vary (\(CANVAR\)).

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\(^4\) Harding et al. (2000) investigate alternative definitions of LTV, which have little impact on their results. Loan and home values used for calculating LTV were unadjusted for inflation.
3.2 HPI and Interest rate Data

The analysis is facilitated by the large rise and subsequent decline in home prices that occurred in the United States between 2001 and the end of 2009. Rapidly rising home prices ameliorate default risk since homes can easily be sold to cover the outstanding mortgage should a household’s financial resources become constrained. However, when home prices begin to fall, the opposite is true: default risk increases.

Quarterly HPI data was obtained from the Federal Housing Finance Authority (FHFA) for each of the US Census Divisions. The AHS data identifies the Census Division in which housing units are located allowing for the HPI data to be merged to the AHS data. The year over year percentage change in HPI is displayed graphically in Figure 1. Prior to 2006, the US housing market as a whole had experienced increasing HPI’s each quarter for the past 30 years. Beginning in 2003 HPI rose at the steepest rate seen since the late 1970’s in all regions except the Midwest. By 2006, the trajectory had shifted dramatically--falling from a national average high of 9.62% in the second quarter of 2005 to -8.29% by the end of 2008.

Annual average interest rate data for 10 year treasury market yields was obtained from the Federal Reserve Bank Board of Governors web site\(^5\). The mean interest rate over the period 1991 through 2009 was 5.3 with a standard deviation of 1.3. During our sample years, average annual interest rates were lower than this long-run average: 5.02 (2001), 4.01 (2003), 4.29 (2005), 4.63 (2007) and 3.26 (2009).

4. Results

The estimation strategy involves first performing a cross-sectional analysis of each AHS sample wave and comparing how the relationships between LTV and maintenance

\(^5\) http://www.federalreserve.gov/releases/h15/data.htm
expenditures vary during the housing market cycle. Next, a panel dataset is constructed and we directly estimate the impact of HPI and interest rates on maintenance expenditures.

4.1 Cross Sectional Analysis

The cross-sectional model was estimated for each AHS sample year. Because the dependent variable (CSTMNT) has a large number of $0 responses, a tobit model was specified\(^6\). Independent variables include controls for housing unit, household, neighborhood and mortgage characteristics. To facilitate a comparison between model years that will provide insight into the change in the maintenance-LTV relationship as the default risk for a given LTV changes, three models were estimated in each sample year. Each model includes an LTV threshold variable indicating LTV ratios greater than a specified threshold: 0.7 (LTVGT7), 0.8 (LTVGT8) and 0.9 (LTVGT9). Table 7 displays the full set of coefficient estimates for the LTVGT9 models in each sample year. Only the coefficient estimates of the LTV threshold variables for the remaining models are reported in Table 8; all other coefficient estimates are similar to those of the LTVGT9 models.\(^7\)

Across samples, the estimated coefficients for housing and individual characteristics are stable. Maintenance expenditures are increasing with housing unit age and the tenure of the household. Residents in high quality neighborhoods, low income households, less educated heads and African Americans heads tend to spend less on maintenance. The location of the house matters differently depending on the AHS sample year. In all years except 2003, maintenance expenditures in the east census

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\(^6\) According to the AHS codebook CSTMNT is also top coded at $9998, but after the data reduction described above, no top coded observations were observed.

\(^7\) Full results are available from the author upon request.
region (the omitted category) were, ceteris paribus, greater than in other regions. In 2003, only Midwest households spent less on routine maintenance. 2003 was during the height of HPI growth, and there was significant divergence in HPI across regions.

The elasticity of maintenance expenditures with respect to LTV for each LTV category becomes more negative with increasing LTV (Table 8)—individuals tend to spend increasingly lower amounts on routine maintenance as the proportion of housing equity decreases. The results for 2007 deviate slightly from this trend. The variation in maintenance-LTV elasticity over the LTV categories in 2007 is very small. Nevertheless, they still indicate a statistically significant decrease in home maintenance expenditures for homeowners with LTV’s greater than 60%.

The next step is to assess the impact of HPI and interest rates on the observed LTV-maintenance relationship by comparing the results for each LTV threshold across sample years. To the extent that the LTV-maintenance relationship is explained by default risk, the gap in maintenance expenditures between high and low equity households, ceteris paribus, should increase when HPI or interest rates decrease because default risk for a given LTV is increased in such environments.

Figures 2 and 3 plot the maintenance-LTV elasticity against annual HPI growth. The horizontal axis is the HPI growth associated from the previous year to the sample year analyzed (Figure 2) or the HPI growth from the sample year to the next year (Figure 3). Movement to the left along the horizontal axis is associated with increased default risk. If the relationship between maintenance and LTV were caused by market failures due to increased risk of default, one would expect to see lower absolute values of maintenance-LTV elasticity as HPI growth increases. An upward sloping trend is
expected in Figures 2 and 3; however, this pattern is not observed. If anything it appears, that as HPI growth increases, the maintenance-LTV elasticity is becoming more negative, especially for the higher LTV categories ($LTVGT8$ and $LTVGT9$). The gap in maintenance expenditures between high and low equity homeowners is increasing with home price appreciation growth. Figure 4 plots a similar relationship, this time with the average 10 year treasury yield on the horizontal access. Default risk increases when interest rates decrease, thus an upward sloping trend is again expected. However, once again a downward sloping relationship is observed.

The analysis reveals that the relationship between LTV and maintenance expenditures cannot be explained by changes in default risk alone. The LTV-maintenance relationship does not move in the expected direction when default risk decreases. Next, I undertake a panel analysis to further assess the relative impact of the determinants of default risk on maintenance expenditures. The panel analysis allows me to control for changes in HPI and interest rates directly as well as fixed effects associated with individual housing units.

### 4.2 Panel Analysis

The panel data set was constructed from the AHS cross sections analyzed in section 4.1 and is estimated using fixed effect Tobit model. The estimation results for the panel analysis are displayed in Table 9. The time and housing unit fixed effect coefficient estimates are available from the author upon request.
specific fixed effects. Panel 1 also includes one additional variable NEWOWNER to indicate years in which housing units changed ownership. Both INTEREST and HPI have been standardized prior to inclusion in the model. New owners and Hispanic owners tend to spend less on maintenance while larger, wealthier households tend to spend more. HPI and LTVGT9 do not have a statistically significant relationship with maintenance expenditures, but interest rates are inversely related to maintenance expenditures. Thus, when interest rates are higher (and default risk is lower), individuals tend to spend less on maintenance—exactly the opposite relationship that economic theory would predict.

However, the model of default risk made note that interest rates and HPI are only relevant influences on default risk for individuals who are in the region over which default risk is possible. In other words, they might only matter for households with sufficiently low income and low equity stake so that default risk is a real possibility. To examine this possibility, I introduce the variable INCOME_RISK, an indicator variable for households whose annual income is less than their annual mortgage payments. The next model, Panel 2, includes INCOME_RISK and the interactions of INCOME_RISK and LTVGT9 with HPI and INTEREST. The results from Panel 1, remain unchanged, except now the interaction term shows a positive, statistically significant relationship with maintenance expenditures. Thus, individuals most likely to be in the default region did invest less in maintenance expenditures when interest rates decreased (and default risk increased). The panel analysis provides no indication that low-equity homeowners invest in maintenance differently from other homeowners, but households that are more likely to be in the region of positive default risk (i.e. low equity and low income) do respond to housing market conditions as theoretically hypothesized.
5 Conclusion

The purpose of this paper was to analyze the role of default risk on household routine maintenance expenditures. The large rise and fall in home prices during the 2001-2009 period allows a unique opportunity to analyze how homeowners vary their maintenance expenditures in response to changing housing market conditions. The resulting empirical estimates conform to existing theory, but only for households for whom positive (and perhaps substantive) levels of default risk are likely. Households with both low equity and reported annual income that is inadequate to cover their mortgage payments decreased maintenance expenditures when default risk was greatest. However, for all other households, maintenance expenditures did not decrease when default risk increased—in fact, they increased when interest rates dropped during the downturn in the housing market.

The results, of course, should be viewed in light of the study’s limitations. LTV ratios and home values are approximated, however, since the goal is to uncover the causal role of default risk in household behavior, estimated values provided by the household’s themselves are arguably relevant. In addition, maintenance expenditures are also self-reported and are not an exact measure of home upkeep. Further, due to the data requirements for estimating the panel model, the sample size for the panel analysis is reduced to include only those households observed in each sample year: 2001, 2003, 2005, 2007 and 2009. The lack of a significant relationship between $LTVGT9$ and maintenance expenditures in the Panel models is surprising since such a relationship was found in every sample year of the cross-sectional analysis and may be attributed to the
reduced sample size. Also, the data underlying the results is limited to one particular housing market cycle.

The empirical results strongly support the model of default risk put forth by Kau, Keenan, et al. (1994) whereby default risk is essentially zero unless the mortgage valuation is in the default region. Households do not decrease maintenance expenditures when default risk increases unless they are likely to be in this region (i.e. high LTV and low income). On the other hand, the empirical results provide no indication that other households (those unlikely to be in the default region) systematically decreased maintenance expenditures because default risk varies.

The explanation for the behavior of these “other” homeowners in response to changes in the interest rate is unknown—but it may be related to factors unassociated with default risk. For example, interest rates decreased during the economic recession triggered by the financial crisis in the mortgage market. Even though interest rates were very low, credit availability was also very low for many households—especially those with lower credit scores. Homeowners may have altered their expected tenure in the house since selling the property in a down market is undesirable and obtaining a new mortgage may have been difficult—longer expected tenure may induce more desire to maintain the property. Alternatively, they may invest more in maintenance in hopes of maintaining the home’s value despite the poor market conditions.

Regardless of the explanation for the behavior, the empirical results provide important policy insights. They suggest that many homeowners did not reduce maintenance expenditures because of the housing market declines in 2007 and 2009. Tax incentive programs for home maintenance or energy efficiency upgrades may have
increased take-up rates during housing market downturns. If such programs targeted home upgrades that impact neighborhood quality—such as improvements that improve the aesthetic quality of the housing unit—then these programs have the potential to counteract the neighborhood property value declines induced by high foreclosure rates (Harding, Rosenthal et al. 2007; Leonard and Murdoch 2009; Lin, Rosenblatt et al. 2009). Further, the panel analysis finds no evidence that the erosion of home equity alone reduces maintenance expenditures. Instead, it is only individuals at higher risk of default due to both a low-equity stake and income shortfalls that tend to respond to market level changes in default risk.
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Acknowledgements:
I wish to thank Jim Murdoch and anonymous reviewers for helpful comments.