Neighborhood Externality Risk
and
The Homeownership Status of Properties

by

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Abstract

In contrast to corporate and institutional investors, single owner-occupiers cannot adequately diversify housing investment risk. Consequently, homeownership should be relatively less likely in places with higher housing investment risk. Using the American Housing Survey, it is documented that neighborhood externality risk, a major component of housing investment risk, substantially reduces the probability that a housing unit is owner-occupied, even when controlling for housing type and numerous location and household specific characteristics. The effects are quantitatively meaningful and change-in-change estimates suggest that the effects are causal.

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1 Introduction

Changes in neighborhood amenities can have considerable effects on house prices. Moreover, the likelihood of such changes can vary significantly between neighborhoods. Neighborhood uncertainty is therefore associated with substantial neighborhood specific housing investment risk. This simple observation raises important questions. Do potential homebuyers take into account the risk of changes in neighborhood amenities when they decide in which neighborhood to invest? Does neighborhood specific risk thereby affect the probability that a property is owner-occupied? This paper addresses these questions. Specifically, it examines whether neighborhood externality risk variables, directly measured as the standard deviations of four types of neighborhood externalities—junk and litter in the neighborhood, street noise, neighborhood noise, and neighborhood crime—between 1985 and 1999, negatively affect the likelihood that a specific housing unit is owner-occupied. Moreover, the paper investigates whether *changes* in the risk measures over time affect the likelihood of a *change* in the homeownership status of properties.[1]

The paper also examines the importance of neighborhood uncertainty for the low homeownership rates in inner cities. Inner cities typically have greater neighborhood uncertainty compared to suburban and rural places.[2] Inner cities also generally have a more poorly maintained housing stock, lack of social capital, substantial juvenile crime problems, and low quality schools. Interestingly enough, recent research links these inner city problems to low homeownership rates. For example, Galster [12] suggests that due to moral hazard problems tenants treat their units less carefully than homeowners. Rossi and Weber [41] and DiPasquale and Glaeser [4] suggest that homeownership benefits social capital. Green and White [14] show that homeownership provides a better environment for the upbringing of children. Hilber and Mayer [23] show that the positive correlation between land scarcity and school spending persists only in places with high homeownership rates. Finally, Fischel [8] suggests that places with high homeownership rates may also have better control over local government. Because of these findings, a better understanding of the causes of the low homeownership rates of inner cities should be developed.[3]

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[1] Homeownership status is defined as the tenure status of a property, which is either 1 for owner-occupied units or 0 for renter-occupied units.

[2] An analysis of the American Housing Survey for 1985 and 1999 indicates that center city locations and neighborhood externality risk measures are positively related. A similar link between inner cities and housing investment risk was suggested by Rachlis and Yezer [37]. They estimate real estate investment risk as the variance of the errors in an appraisal equation and show that such appraisal risk is related to inner city locations.

[3] The phenomenon of particularly low homeownership rates in inner cities can be partially explained by segregation of households with different characteristics. Segregated groups may have different income or wealth and may be differently affected by federal tax laws, borrowing constraints, or racial discrimination in capital markets.

The previous housing literature has mainly focused on household specific characteristics as determinants of the individual tenure choice.[4] Yet, research about the role of location specific factors as determinants of the homeownership status of *properties* is a widely underdeveloped area. The user cost literature (e.g., Rosen [39], Hendershott [20], Hendershott and Slemrod [21], Poterba [36]) argues that lower user cost of housing is expected to increase the probability of owning and the quantity of housing consumed. At any point in time, some factors driving user costs (e.g., maintenance costs) may vary between regions and metropolitan statistical areas (MSAs) but barely between nearby neighborhoods. Thus, user costs fail to explain cross-sectional differences in homeownership rates between neighborhoods. Linneman [29] points out that apartment buildings have a higher relative landlord production efficiency compared to single-family homes. Consequently, housing units are less likely to be owner-occupied in densely populated neighborhoods compared to sparsely populated ones.

Risk variables that are related to housing, in particular, neighborhood externality risk measures, are other potentially important but frequently overlooked factors that may determine the homeownership status of properties.

The main proposition of this paper—which is founded on the literature that followed Henderson and Ioannides [22]—is that typically owner-occupiers have to 'overinvest' in housing due to an investment constraint induced by owner-occupied housing. Thus, in contrast to corporate and institutional investors[5], the constrained owner-occupier households cannot adequately diversify their portfolios. The extent of the housing-related portfolio distortion depends on the extent of the involved housing risk. A decrease in housing risk (e.g., neighborhood externality risk) reduces the housing-related portfolio distortion, holding the level of housing consumption constant. The lower distortion then leads to two effects: an increase in housing consumption conditional on homeownership, and an increase in the attractiveness of homeownership relative to renting.

Furthermore, the households of different segregated groups may differ in their life-cycle attributes and in their uncertainty about future income. However, all these determinants fail to fully explain why homeownership rates are so extremely low in inner cities and thus the literature often has to rely on the argument that households that prefer center city places also have some intrinsic preferences for renter-occupation.

[4] It is now widely recognized that factors such as basic demographic variables (e.g., Eilbott and Binkowski [6], Gyourko and Linneman [16]), borrowing constraints (Linneman and Wachter [30]), race (e.g., Kain and Quigley [27], Gyourko, Linneman, and Wachter [17], Painter, Gabriel, and Myers [35]), expected length of stay (e.g., Haurin and Gill [19]), and taxes (e.g., Rosen [39]) are major determinants of the individual housing tenure choice (i.e., the decision of households whether to own or rent the home).

[5] Shareholders of public investment companies can adequately diversify their portfolio by holding shares of companies with differing risk-return compositions. Similarly, private corporate and institutional investors can adequately diversify the unsystematic portion of the involved investment risk if they hold larger asset portfolios.

Section 2 summarizes the theoretical literature that rationalizes the main proposition of this paper and discusses the results of related empirical work that links risk variables to housing tenure. Section 3 describes the data and some basic features of the neighborhood externality level and risk measures. Section 4 tests the main proposition using housing unit specific data from the American Housing Survey (AHS). The empirical analysis provides strong evidence that neighborhood externality risk variables are negatively related to the probability that a unit is owner-occupied, even when controlling for housing type and location specific characteristics, which are likely picking up some of the same variation as the neighborhood externality risk measures. The parameter estimates are not only highly statistically significant but—as the marginal analysis reveals—are also economically meaningful. For example, comparative statics of the cross-sectional estimates suggest that an increase in the uncertainty about junk and litter in the neighborhood by one standard deviation reduces the probability that a housing unit is owner-occupied by about 5 to 8 percent, depending on the model specification. Moreover, a change-in-change specification, which controls for persistent unobservables, confirms that *changes* in the neighborhood externality risk measures explain *changes* in the homeownership status of properties. Again, the quantitative effects are not trivial. Overall, the results provide strong support for the hypothesis that single owner-occupiers—in contrast to other investors—avoid neighborhoods with high externality risk. Moreover, the results of the empirical analysis suggest that neighborhood externality risk provides an alternative explanation for why homeownership rates are so low in many inner city neighborhoods. Finally, the empirical analysis discusses the sensitivity of the results with regard to arbitrary rescaling of the neighborhood externality level variables. The paper concludes with a discussion of the results and with policy implications in Section 5.

2 Uncertainty, Investment Decisions, and Homeownership Status

Several theoretical models imply that neighborhood uncertainty—a major component of house price uncertainty—affects the homeownership status of properties. In a seminal paper, Henderson and Ioannides [22] develop a housing investment-consumption model that provides a basis for analyzing housing demand and tenure choice. Their model acknowledges that owner-occupied housing involves both a consumption choice and a portfolio decision. The key element of their model is an investment constraint that requires that homeowners must own at least as much housing

as they consume.[6] Fu [10] further develops the Henderson and Ioannides framework and concludes that an increase of the investment risk (variation in house prices) reduces the optimal housing investment. Consequently, an increase in investment risk enlarges the distortion associated with owner-occupied housing.[7] This makes homeownership relatively more costly and reduces the probability that households own their home. While Henderson and Ioannides [22] and Fu [10] omit risky assets other than housing, Brueckner [2] provides a formal analysis of the 'overinvestment' issue of owner-occupied housing in a framework with several risky assets including owner-occupied housing. Using a combination of the housing investment-consumption model of Henderson and Ioannides [22] and the standard mean-variance portfolio framework, as presented by Fama and Miller [7], Brueckner demonstrates that when the investment constraint induced by owner-occupied housing is binding, homeowners cannot adequately diversify their portfolio.[8] Consequently, since the housing-related portfolio distortion is greater in places with higher housing risk (holding the level of housing consumption constant) and since a larger distortion leads to a decrease in the attractiveness of homeownership relative to renting, it follows that housing units in risky neighborhoods should be less likely to be owner-occupied.[9]

On the empirical side, a few studies link measures of uncertainty to housing tenure. For example, Haurin [18] and Robst, Deitz, and McGoldrick [38] focus on income uncertainty as a determinant of housing tenure. The results of both studies indicate that income uncertainty reduces the likelihood of households owning their homes. Sinai and Souleles [45] consider the trade off between the uncertainty of renting and house price uncertainty. They argue that with renting, the long-term cost of obtaining housing is unknown. Their empirical results indicate that the rent hedging benefit associated with owner-occupied housing significantly increases the homeownership rate. Rent hedging benefits may be small, however, for neighborhood specific rent uncertainty. Tenants are expected to be less sensitive towards neighborhood specific uncertainty of rents because—in contrast to owner-occupiers—they are typically compensated for shocks to neighborhoods with corresponding adjustments in rents. A few empirical studies focus specifically

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6 This is due to the absence of partial-ownership arrangements that are typically considered to be unfeasible.

7 This distortion potentially increases due to the fact that most homeowners strongly leverage their investments in owner-occupied housing.

8 Goetzmann [13] provides empirical evidence that there are substantial gains to creating large portfolios of residential properties compared to an investment in one single home. Analyzing the risk and return to investments in residential properties in four urban U.S. markets over the period from 1971 to 1985, Goetzmann shows that, for a given return, large portfolios of residential properties are much less risky than an investment in one single home.

9 The same conclusion can also be derived from a model that analyzes the tenure choice of households in a dynamic framework and under uncertainty of income and housing costs (e.g., Ortalo-Magné and Rady [34]).

on the link between housing investment risk and the tenure choice. Rosen, Rosen, and Holtz-Eakin [40] use national time series data from 1956 to 1979 and provide evidence that volatility in the relative price of housing services has a negative effect on the aggregate proportion of homeowners. Fishback [9] provides historical evidence in favor of the main proposition of this paper. In the early 1900s companies of the risky coal mining industry created their own company towns and provided housing for their employees. One main reason for these exclusively renter-occupied company towns was the involved housing investment risk. Finally, Turner [46] uses individual housing data from the AHS and a home price index at the MSA level to construct a price volatility measure. She finds evidence that families are less likely to own during periods of relatively high, anticipated house price volatility. One limitation of her approach is that the house price volatility variable is measured only at a fairly aggregated level, that is, at the MSA level. However, house price volatility varies also strongly within MSAs and, thus, the aggregated measure fails to explain neighborhood specific differences in the likelihood that a housing unit is owner-occupied.

In order to empirically test the prediction that neighborhood specific housing investment risk affects the homeownership status of properties, house price variation data at a much less aggregated level is needed. Unfortunately, such data—that is, the variation of true individual house prices over time or neighborhood specific repeat sales price indexes—hardly exists.[10] However, the same theoretical considerations and predictions that apply for housing investment risk also apply for neighborhood externality risk—a measure that can be derived from the AHS—as long as neighborhood characteristics are capitalized into house values.

Numerous empirical studies strongly confirm that neighborhood characteristics (e.g., Grieson and White [15], Dubin [5])[11] and neighborhood uncertainty (e.g., Furman Speyrer [11])[12] are capitalized into house values. Moreover, recent studies reveal that neighborhood changes can have quite substantial effects on house prices. For example, Lynch and Rasmussen [31] provide empirical evidence for Jacksonville, FL that neighborhoods have a devastating loss in property

[10] Housing units are typically sold only rarely. Therefore house price variation of individual units is normally not directly observable. Moreover, due to the shortage of housing sales at the neighborhood level within each year, repeat sales price indexes at the neighborhood level are typically not reliable.

[11] Grieson and White [15] argue that the reason for the lack of empirical evidence in earlier studies is that vacant land subject to positive externalities may be rezoned in the future. The possibility of a zoning change increases the value of the parcel, obscuring the effect of the externality. Thus, they formulate a new specification of neighborhood externalities that takes into account their argument. Dubin [5] omits all neighborhood and accessibility measures from the set of explanatory variables and instead models the resulting autocorrelation in the error term. Both approaches provide strong evidence for capitalization of neighborhood amenities into house prices.

[12] Furman Speyrer [11] provides empirical evidence that single owner-occupiers in Houston are willing to pay house price premiums for zoning and restrictive covenants that reduce neighborhood uncertainty.

values if the neighborhood crosses a certain high crime threshold. Houses that are in the top two cost of crime deciles are discounted about 39 percent relative to a comparable house in the other areas. Bogart and Cromwell [1] find that disruption of neighborhood schools in an Ohio school district reduces house values by approximately 10 percent. All these findings suggest that neighborhood characteristics are related to house prices and that neighborhood externality risk is a major component of housing investment risk.[13] Consequently, one can predict that, all else equal, housing units should be more likely to be owner-occupied in neighborhoods with relatively low externality risk. The empirical analysis below tests this prediction. Section 3 describes the data and Section 4 provides the empirical evidence.

3 Description of Data and Neighborhood Externality Risk Measures

The data used in the empirical analysis is drawn from the AHS conducted by the Bureau of the Census for the Department of Housing and Urban Development (HUD). More specifically, the analysis is based on the national surveys collected every other year between 1985 and 1999. These surveys cover on average 55,000 repeatedly evaluated housing units and their occupants in the United States.

The AHS provides a large array of housing unit-, household-, and location-specific variables including information on four neighborhood externality variables: junk and litter in the immediate neighborhood, street noise, neighborhood noise, and neighborhood crime.[14] The measurement of these four neighborhood externality level variables, summary statistics, and the construction of the neighborhood externality risk measures are described in more detail below.

3.1 Measuring Neighborhood Externalities

The measure for junk and litter is obtained as follows. Until 1995, Census Field Representatives assessed the accumulation of junk and litter in the immediate neighborhood of the housing unit. The Representatives rated the housing unit's immediate neighborhood as having no accumulation (coding of variable = 0), minor accumulation (1), or major accumulation (2). In 1997 the survey method was changed and since then all respondents are asked directly about the level of junk and litter in their neighborhood.

[13] Results of simple hedonic house price regressions that use data from the AHS for 1985 and 1999 and control for characteristics of the housing unit, housing type, and various location characteristics are consistent with these findings. However, such hedonic regressions may be criticized because of omitted variable problems.

[14] The AHS does not disclose the exact location (street address or Census tract information) of the housing units. Due to this limitation average evaluations of all occupants in a neighborhood are not available.

The remaining three neighborhood externality level variables are obtained directly from the occupants of the units. The occupants are asked three questions, which are coded as follows: Street noise: 0 = does not exist, 1 = exists, 2 = objectionable, do not wish to move, 3 = objectionable, wish to move; neighborhood noise: 0 = does not bother, 1 = bothers; neighborhood crime: 0 = does not exist, 1 = exists, 2 = objectionable, do not wish to move, 3 = objectionable, wish to move.

3.2 Sample Size and Descriptive Statistics

The final regression samples exclude units that are mobile homes, vacant, or occupied by households that do not pay a market rent. The exclusion of these units and missing values reduces the regression samples to 25,971 observations for 1985 and to 29,322 observations for 1999. Table 1 describes the variables used in the logit estimates for 1985 and 1999 in detail. Most variables do not vary significantly between 1985 and 1999 and reflect national demographic changes and economic conditions. However, the means of certain neighborhood externality variables (described above) vary substantially between certain years. This is due to changes in economic conditions such as the economic boom in the 1990s and changes in the way the survey was conducted.[15]

Table 2 reports the percentage of units that had either no change in a specific neighborhood externality variable, had a change in both directions, or had a steady decrease or increase in the valuation of the neighborhood externality between 1985 and 1999. The results demonstrate that most units with neighborhood externality variation experience a random variation rather than a steady improvement or decline. See the end note of Table 2 for a detailed explanation.

3.3 Measuring Neighborhood Externality Risk

Each risk measure is based on the standard deviation of the corresponding neighborhood externality level variable calculated for each housing unit using data from 8 surveys from 1985 to 1999. Take junk and litter for example. Let *i* index housing units and *t* index calendar years. Then, because the AHS is a panel study on units, let $junk_{it}$ be the junk and litter variable. The risk measure for junk and litter for the *i*th unit is the standard deviation,

$$\hat{\sigma}_{junk_i}^{85-99} = \sqrt{\frac{\sum_{t=1985}^{1999} \left(junk_{it} - \overline{junk}_i \right)^2}{T-1}}, \qquad (1)$$

[15] See the 'Documentation of Changes in the 1997 American Housing Survey' for a detailed description of the changes and Section 3.3 for a further discussion of the issue.

where T = 8, and $\overline{junk}_i$ is the within-unit mean over time of the junk and litter variable. That is, for a given unit, the variation in $junk_{it}$ comes from time-series variation in how the Census Field Representative assessed the junk and litter in front of the property. The other three risk measures $\hat{\sigma}^{85\text{-}99}_{st\ noise_i}$, $\hat{\sigma}^{85\text{-}99}_{ne\ noise_i}$, and $\hat{\sigma}^{85\text{-}99}_{crime_i}$ are computed likewise.[16]

One important concern with regard to the four risk measures is that the variance over time in the four externality measures may be due to differences in the perceptions of the various occupants of a dwelling over the sample period. Because rental dwellings are likely to experience more occupant turnover than owner-occupied dwellings there might be greater variance of externality perceptions for rental than for owner-occupied units. If this were true, this would suggest that the causation could run in a direction opposite to that suggested by theory.

In order to evaluate this concern it is important to distinguish between the assessment method for the junk and litter measure and the assessment method for the other three externality measures. Until 1995 the junk and litter variable is assessed by Census Field Representatives. Thus, at least until 1995, the variance of the assessment is completely independent of occupant turnover. Between 1995 and 1997 the assessor changed for all properties (from the Census Field Representative to the occupant of the unit), independent of the homeownership status of the property. That is, the change affected rental dwellings and owner-occupied units in exactly the same manner. Only between 1997 and 1999 might there be variance due to occupant turnover as opposed to true changes in the junk and litter accumulation in the neighborhood. In order to test whether the last assessment period has any impact on the results, all regressions in Section 4 were reestimated using the standard deviation for junk and litter using data only from 1985 to 1997. Results are virtually unchanged. Even excluding the data from 1997 has little impact on the results and statistical significance levels remain unchanged in all cases.[17] Overall, these findings strongly suggest that the effects of the risk

[16] Standard deviations for the four neighborhood externality variables are also created for units with missing values, as long as not more than 4 observations are missing per unit and externality. The value of T is adjusted accordingly.

[17] In addition, the binary logit models presented in Section 4 were also reestimated using *adjusted* neighborhood externality risk measures that control for time fixed effects, such as the change in the assessment method in 1997. The adjusted measures were created as follows. Take junk and litter for example. The value of the junk and litter level variable for each *individual* unit in a particular year is divided by the mean of the junk and litter level variable for *all* units for that particular year, thereby adjusting for time fixed effects. The adjusted risk measure for junk and litter is then computed like in equation (1) using the *adjusted* unit and year specific externality level measure and the within-unit mean of the *adjusted* measure over time instead of the original measure. The results of the estimates are similar to the ones reported in Section 4, providing further support for the claim that the negative relation between the junk and litter risk measure and the tenure status of properties may be unaffected by the change in the assessment method in 1997.

measure for junk and litter on the homeownership status of properties was not significantly influenced by occupant turnover.[18]

One way to assess the validity of the remaining three risk measures is to examine to what extent the risk measures are related to the turnover frequency. Table 3 reports partial correlation coefficients between the risk measures on the one hand and the turnover frequency, measured as the number of turnovers between 1985 and 1999, and the tenure status of properties on the other. The partial correlation coefficients between the risk measures and the turnover frequency (column 1) are quite weak—with a mean of 0.048—which is only a quarter of that for the correlations between the risk measures and the tenure status (column 2). While this simple test cannot entirely eliminate the concern that there could be a degree of reversed causality for the three additional risk measures, the results do suggest that most of the measured variance is true variation in neighborhood externalities rather than measurement error. However, acknowledging the issue, Section 4 reports results for two separate sets of specifications. The first specification only includes the risk (and level) measure for junk and litter, which is clearly unaffected by occupancy turnover. The second specification then adds the risk (and level) measures for the remaining three neighborhood externalities. While the coefficients of all four risk measures are statistically highly significant, it is reassuring that not only is the risk measure for junk and litter the statistically most significant variable among the four risk measures but also the quantitatively most meaningful (see Section 4 for details).

4 Empirical Specification and Results

The probability that a housing unit is owner-occupied is estimated using a binary maximum-likelihood logit model. The next subsection describes the basic empirical specification in detail. Section 4.2 reports results for the base model. Section 4.3 discusses potential endogeneity concerns and presents a change-in-change specification to address the concerns. Section 4.4 presents results for the change-in-change models. Finally, Section 4.5 discusses some further issues and provides evidence for the robustness of the results.

[18] One might still be concerned about interpersonal utility comparisons among Census Field Representatives, which assess the junk and litter accumulation based on questionnaire definitions. In this context it is important to note that while changes in the assessment due to changes in the Census Field Representatives may cause variation, such variation is random and is not related to the homeownership status of properties.

4.1 Empirical Specification

The main theoretical prediction of this paper is that, all else equal, housing units are more likely to be owner-occupied in neighborhoods with lower neighborhood externality risk. Hence, the empirical model must include housing unit specific measures of neighborhood externality risk along with other housing unit specific control variables that are expected to explain the homeownership status of a particular housing unit *i*.

As discussed above, while the risk measure for junk and litter can be considered to be unaffected by occupant turnover, one might be concerned about the exogeneity of the other three risk measures. Thus, results are reported separately for (a) a specification that only includes 'junk and litter' and (b) a specification that includes risk measures for all four neighborhood externalities.

When potential homebuyers assess different neighborhoods in order to decide where to invest, it is not a priori clear whether their expectations of neighborhood uncertainty are formed from past observations, whether they build informed expectations of future neighborhood uncertainty, or whether it is a mix of the two assessment methods. Thus, results are reported for two different time periods, 1985 and 1999, using the same risk variables, which are standard deviations measured between 1985 and 1999. Consequently, the logit models for 1985 assume that households have reasonable foresight about neighborhood externality variation, while the models for 1999 assume that expectations are built on past experience.[19]

The logit models include a number of controls that are expected to affect the homeownership status of properties. The reasoning for the inclusion of these control variables is outlined below.

First, the base specification includes a dummy variable for two or more unit buildings and another for single detached houses. These variables control for the type of housing unit. As pointed out by Linneman [29], apartment buildings have a higher relative landlord production efficiency compared to single-family homes.[20] All else equal, an apartment building should therefore be less likely to be owner-occupied compared to a single attached house—the omitted housing type in the logit estimates—or a single detached house.[21]

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[19] The findings in Section 4, that the risk measures have statistically and economically significant effects on the probability that a housing unit is owner-occupied in both specifications for 1985 and 1999, are also consistent with the observation that past variance is highly correlated with future.

[20] Relative landlord production efficiency may derive, for example, from maintenance cost efficiency, superior credit ratings, or the ability to solve free-rider problems. Landlord production costs in multi unit buildings are typically substantially lower compared to single detached or attached houses.

[21] One might be concerned that the housing type is endogenous (i.e. detached houses will not be built in seedy neighborhoods). However, while the housing type may indeed be considered endogenous in newly developing neighborhoods, the vast majority of housing units in the regression samples were built long ago. Their types can

Second, the base specification includes a number of location controls including a dummy variable for the center city status of the unit and dummy variables for all MSAs that are represented in the two samples for 1985 and 1999. These location controls capture center city and MSA-level unobservable characteristics (such as user cost differences across MSAs), which may affect the homeownership status of properties. A final group of location controls includes category dummy variables for the neighborhood externality level measures that correspond to the risk measures. That is, the specification that includes only the risk measure for junk and litter also only includes the category dummy variables for the junk and litter measure, while the specification with all four risk measures includes category dummy variables for all four corresponding level measures. The externality measures are included as category dummies in the model because of their nature as ordinal variables.[22] This final group of controls is included because for certain types of households (e.g., households with a longer expected duration in their property) owner-occupation is relatively more attractive compared to renting, and, at the same time, these potential homebuyers may have preferences for certain types of neighborhood amenities (e.g., low crime levels).[23] To the extent that the neighborhood externality risk and corresponding level measures are related, omitting the neighborhood externality level controls could bias the parameter estimates of the risk measures.

Third, the homeownership status of a property may also be partly inferred from characteristics of the households that occupy it. Each housing unit is located in a neighborhood with certain

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therefore be considered exogenous. The sample for 1999 only includes units that were already built in 1985 and the fraction of recently redeveloped units is tiny (only 0.5 percent of units in the regression sample for 1999 were redeveloped between 1995 and 1999). The sample for 1985 includes a larger fraction of units (7.9 percent) that were built within five years prior to 1985. In order to test whether newly built units in the regression samples have any impact on the results, housing units that were built (or redeveloped) within the last 5 years were dropped and the logit models for 1985 and 1999 were reestimated. Results are virtually unchanged. Even when all units are dropped that were built within the last 15 (instead of 5) years, results are very similar. Finally, the housing type dummies (for apartment buildings and single detached units) were dropped from the model altogether. While the effect on the coefficient and statistical significance level of the risk measure for junk and litter is negligible, the coefficients and significance levels of the other three risk measures increase significantly. Thus, to the extent that housing type is endogenous, the inclusion of the housing structure variables will bias against finding any effect of neighborhood externality risk on the homeownership status of properties.

[22] The distinction between ordinal and cardinal measures is important and is discussed in more detail in Section 4.5.

[23] Because of fixed costs related to owner-occupation, duration in the property may affect the tenure choice of *households*. That is, households often decide to become homeowners when they anticipate that they will stay at a particular location for a longer period of time, for example, when couples get married or when children reach pre-school age. These potential homebuyers likely also have preferences for certain neighborhood characteristics (e.g., good schools, lack of neighborhood crime). In other words, in equilibrium, locations with certain amenities attract households with different expected durations in their properties (and other characteristics that may differ and may affect a household's benefit from and costs of homeownership). Thus, although neighborhood amenities are likely priced into properties, locations with certain neighborhood externality levels may still be relatively more attractive for households with a longer expected duration in the property (e.g., married couples with pre-school children), affecting the overall demand for owner-occupation in the area.

amenities (distance to central city, crime rate, etc.). To the extent that households sort across locations according to their preferences and income, locations may consist of relatively homogeneous groups of households. For example, consider a community with poor public services but inexpensive housing. Such a location may attract liquidity constrained low-income families, increasing the local demand for renter-occupied housing. Because the vast majority of local residents will not be able to qualify for loans (in contrast to corporate and institutional investors), it is quite intuitive that, all else equal, housing units will be less likely to be owner-occupied in this location compared to a suburb with excellent public facilities and a large fraction of high-income residents. Because the AHS only reveals the demographic characteristics of the housing unit's occupant rather than the demographic composition of the neighborhood and does not record the neighborhood location, the individual characteristics are included in the empirical model to proxy for the demographic composition of the neighborhood. The following household specific covariates are included in order to capture other factors—that are potentially omitted in the empirical model—that affect the location specific demand for owner-occupied housing: household income, household income squared, household income interacted with average age of adult household members, category dummies for the average age of adult household members, family status, marital status, a dummy for whether the ethnicity of the household head is black, and immigration status.[24]

Consequently, the two base models for the homeownership status of property i in time period t= {1985, 1999} can be expressed as

$$\Pr\left(own_i^t = 1\right) = f\left(\hat{\sigma}_{junk_i}^{85\text{-}99},\ D_{junk_i^t},\ other\ location\ controls_i^t,\ housing\ type_i^t,\ demographics_i^t\right), \quad (2)$$

$$\Pr\left(own_i^t = 1\right) = f\left(\begin{array}{l}\hat{\sigma}_{junk_i}^{85\text{-}99},\ \hat{\sigma}_{st\ noise_i}^{85\text{-}99},\ \hat{\sigma}_{ne\ noise_i}^{85\text{-}99},\ \hat{\sigma}_{crime_i}^{85\text{-}99},\ D_{junk_i^t},\ D_{st\ noise_i^t},\ D_{ne\ noise_i^t},\ D_{crime_i^t},\\ other\ location\ controls_i^t,\ housing\ type_i^t,\ demographics_i^t\end{array}\right), \quad (3)$$

where $D_{junk_i^t}$, $D_{st\ noise_i^t}$, $D_{ne\ noise_i^t}$, and $D_{crime_i^t}$ are vectors of category dummy variables for the four neighborhood externality level measures.[25]

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[24] The AHS does not provide a measure of household wealth. In order to pick up as much of the omitted wealth variable as possible, household income is added non-linearly and is also interacted with the average age of the adult household members. See Appendix Table A1 for detailed results. In addition, the author imputed several measures of household wealth (based on alternative specifications) using the Survey of Consumer Finances for 1998. The overall fits are reasonably good but the imputed wealth variables are not particularly well identified. With this caveat, several additional logit estimates for 1999 were carried out using the imputed wealth variables. While the coefficient on imputed wealth is always positive and strongly significant, the coefficients and statistical significance levels of the four neighborhood externality risk measures remain virtually unchanged.

[25] Model specifications that include level measures instead of category dummy variables generate qualitatively very similar results. These results were reported in an earlier working paper version of this article.

4.2 Results for Base Specifications

Table 4 reports results for the two base models and for the two years 1985 and 1999. Column (1) reports coefficients and standard errors for the base equation that only includes the risk measure for junk and litter (equation 2) for 1985.[26] The neighborhood externality risk measure for junk and litter—the most visible among the four externalities—is strongly and negatively related to the homeownership status of properties, even when controlling for housing type and location. The coefficient of the risk measure is statistically highly significant, at the 1 percent level, as well as quantitatively meaningful. Quantitative effects along with marginal effects and elasticities are reported in Table 5.[27] The quantitative effect for the junk and litter risk measure reported in row 1 of Table 5 (based on the parameter estimates from column (1) of Table 4) suggests that an increase of the risk measure for junk and litter by one standard deviation reduces the likelihood that a unit is owner-occupied by 6.6 percent. Overall, the other control variables have the expected effect on the homeownership status of properties. Specifically, multi-unit buildings are much less likely to be owner-occupied compared to single attached or detached houses, with the latter group having the highest likelihood of being owner-occupied. Center city units are less likely to be owner-occupied, although the coefficient is only significant at the 5 percent level. Finally, the category dummies for minor and major accumulation of junk and litter are statistically completely insignificant, suggesting that it is the variation of the junk and litter measure rather than the level that has the most substantial negative impact on the homeownership status of properties.

The parameter estimates in column (2) of Table 4 indicate that all four neighborhood externality risk measures are negatively related to the homeownership status of properties. Three of the four risk measures are statistically significant at the 1 percent level, with the risk measure for neighborhood noise being significant at the 5 percent level. The coefficient on the risk measure for junk and litter in column (2) is somewhat smaller compared to the one reported in column (1) (-0.47 versus -0.60) and the corresponding quantitative effect is -5.2 percent, somewhat smaller as well.

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[26] White [47] suggests comparing the usual and robust estimates of the covariance matrix of maximum likelihood estimators as a test of model specification. Robust estimates of standard errors for maximum likelihood estimates are insensitive to model misspecification. White's [47] suggested comparison (i.e., test of model specification) was carried out for all reported logit estimates in Section 4, with no indication of model misspecification. That is, usual and robust standard errors are very similar in all cases. Consequently, usual standard errors are reported.

[27] Quantitative effects are calculated as the standard deviation of the risk measure divided by the mean and multiplied with the elasticity. These calculated values are only correct for marginal changes in the explanatory variable. For larger changes, the calculated values can only be considered as approximations. Furthermore, for discrete variables the values are difficult to interpret. However, these percentage numbers allow a direct comparison of quantitative effects for different explanatory variables.

The quantitative effects for the remaining three measures are somewhat smaller compared to the one for the risk measure for junk and litter; -4.4 percent for street noise, -1.7 percent for neighborhood noise, and -2.6 percent for neighborhood crime. Interestingly, the parameter estimate for the center city dummy and the parameter estimates for most of the neighborhood externality category dummies are statistically completely insignificant when controlling for all four risk measures. The other control variables—including demographics—have the expected effects on the homeownership status of properties. The full set of results is reported in the Appendix Table A1.

Results for 1999 are reported in columns (3) and (4). Overall, results look very similar, with the model estimates for 1999 having a slightly greater predictive power compared to those for 1985. The parameter estimates of all risk measures are statistically significant at the 1 percent level for both specifications. The quantitative effects for 1999, also reported in Table 5, are somewhat larger compared to those for 1985. For example, an increase of the risk measure for junk and litter, measured between 1985 and 1999, by one standard deviation reduces the likelihood that a housing unit is owner-occupied in 1999 by between 6.1 and 7.7 percent, depending on the model specification. The quantitative effects for the other three risk measures are -4.7 percent for street noise, -1.9 percent for neighborhood noise, and -2.6 percent for neighborhood crime. Overall, the results strongly confirm that neighborhood uncertainty has a negative impact on the homeownership status of properties and that the negative impact is fairly important economically, at least for the more visible externalities, junk and litter and street noise.[28] Moreover, the findings are consistent with households being forward as well as backward looking in assessing neighborhood risks.

Finally, a few additional specifications were estimated in order to assess the importance of the inclusion of household specific covariates and whether neighborhood externality risk measures may be important in explaining the very low homeownership rates of central cities. Results are reported in the Appendix Tables. Appendix Table A2 reveals that the exclusion of household specific characteristics significantly increases the size of the coefficients and the quantitative effects of the four risk measures (see Appendix Table A2 and Table 5 for details). Appendix Table A3 indicates that the exclusion of the neighborhood externality risk measures considerably increases the size of the coefficients and the statistical significance levels of the category dummy variables of the neighborhood externality level measures and of the dummy variable for the center city status of the property. Interestingly enough, excluding neighborhood externality risk measures from the logit

[28] This suggests that the more visible externalities are either of more concern to the residents or can be better evaluated by them.

model implies non-trivial effects of unobservable center city specific characteristics on the homeownership status of properties. Parameter estimates in columns (2) and (4) in Appendix Table A3 imply that, all else equal, housing units in center city locations were in absolute terms 2.7 percent less likely to be owner-occupied in 1985 and 4.7 percent less likely in 1999. In contrast, logit estimates that properly control for measures of neighborhood externality risk (columns (2) and (4) in Table 4) find much smaller—and in the case of the estimates for 1985 statistically insignificant—quantitative effects; -1.2 percent for 1985 and -2.7 percent for 1999. Overall, these results provide an explanation for why traditional homeownership models—that omit direct measures of neighborhood externality risk—do not explain the phenomenon of low homeownership rates in center cities very well.

4.3 Discussion of Endogeneity Concerns and Specification of Change-in-Change Model

While these results suggest a strong negative impact of neighborhood risk measures on the homeownership status of properties, the cross-sectional specifications of equations (2) and (3) may cause concerns about the potential endogeneity of neighborhood externalities. Specifically, one might be concerned that—due to neighborhood interaction effects—the owner-occupancy rate of the neighborhood, which is omitted from the model, may have a positive effect on a housing unit's occupier status.[29] In the logit estimate, since the neighborhood owner-occupancy rate is omitted, it becomes part of the error term. Due to the omission of the neighborhood owner-occupancy rate, the error term may be negatively related to the neighborhood externality risk and level measures, such that the coefficients of these variables may be biased downwards. A second concern is related to the persistency of a housing unit's occupier status.[30] In the presence of uncontrolled persistency, one might only interpret the estimation results based on equations (2) and (3) as statistical correlations rather than causality.

In order to address the above two issues, a change-in-change specification is estimated. That is, if neighborhood externality risk measures have a causal effect on the homeownership status of properties one would predict that increases in the neighborhood externality risk measures should cause some owner-occupied units to become renter-occupied, while a decrease in the risk measures

[29] See Manski [32] for an exposition of the topic of 'neighborhood interaction effects' and Ioannides [25] and Ioannides and Zabel [26] for evidence of neighborhood interaction effects on housing demand. The neighborhood owner-occupancy rate is omitted because the AHS does not disclose the neighborhood location (i.e., Census tract information) of the housing units.

[30] For example, the physical characteristics and structures of rental units may be different from those of owner-occupied units (see Shlay [43] and [44]), such that the conversion of occupier status is not always feasible.

should cause some renter-occupied units to become owner-occupied. More specifically, previous changes in the neighborhood externality risk measures (calculated as the standard deviation for the period between 1993 and 1999 minus the standard deviation for the period between 1985 and 1991) should be able to explain changes in the tenure status of properties between 1993 and 1999, controlling for previous changes in the corresponding level measures and previous changes in other controls that vary over time. A change-in-change specification controls for inertial heterogeneity, such as the neighborhood owner-occupancy rate, and captures the persistency in occupier status. That is, unobservable persistency is controlled by simply being conditioned out.[31] The following change-in-change model specifications are estimated:[32]

$$\Pr\left(rent_i^{99} \mid own_i^{93}\right) = f\left(\Delta\,\hat{\sigma}_{junk_i},\ \Delta\,junk_i,\ \Delta\,other\ controls_i\right), \tag{4}$$

$$\Pr\left(rent_i^{99} \mid own_i^{93}\right) = f\left(\begin{array}{l}\Delta\,\hat{\sigma}_{junk_i},\ \Delta\,\hat{\sigma}_{st\ noise_i},\ \Delta\,\hat{\sigma}_{ne\ noise_i},\ \Delta\,\hat{\sigma}_{crime_i},\ \Delta\,junk_i,\\ \Delta\,st\ noise_i,\ \Delta\,ne\ noise_i,\ \Delta\,crime_i,\ \Delta\,other\ controls_i\end{array}\right), \tag{5}$$

$$\Pr\left(own_i^{99} \mid rent_i^{93}\right) = f\left(\Delta\,\hat{\sigma}_{junk_i},\ \Delta\,junk_i,\ \Delta\,other\ controls_i\right), \tag{6}$$

$$\Pr\left(own_i^{99} \mid rent_i^{93}\right) = f\left(\begin{array}{l}\Delta\,\hat{\sigma}_{junk_i},\ \Delta\,\hat{\sigma}_{st\ noise_i},\ \Delta\,\hat{\sigma}_{ne\ noise_i},\ \Delta\,\hat{\sigma}_{crime_i},\ \Delta\,junk_i,\\ \Delta\,st\ noise_i,\ \Delta\,ne\ noise_i,\ \Delta\,crime_i,\ \Delta\,other\ controls_i\end{array}\right), \tag{7}$$

where for example $\Delta\,\hat{\sigma}_{junk_i} = \hat{\sigma}_{junk_i}^{93-99} - \hat{\sigma}_{junk_i}^{85-91}$ (the other three change-in-risk measures are computed likewise) and where $\Delta\,junk_i = \overline{junk}_i^{93-99} - \overline{junk}_i^{85-91}$, with, for example, $\overline{junk}_i^{85-91}$ denoting the within-unit mean between 1985 and 1991 of the junk and litter variable. The vector $\Delta\,controls_i$ denotes a vector of changes in the time variant control variables (e.g., the average age of adult occupants or household income). Take household income for example. The change in the variable is calculated as $\Delta\,income_i = \overline{income}_i^{93-99} - \overline{income}_i^{85-91}$. Table 6 provides a list of change-in-controls variables used in the change-in-change models along with a more detailed description of the variables and summary statistics.

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[31] This specification is in the same spirit as the fixed effects logit model of Chamberlain [3]. The specification also addresses the concern of reversed causality in the sense that either homeowner-associations or dominant landlords affect the neighborhood quality and possibly the variation of neighborhood externalities. This is because the fact that current changes in the homeownership status of properties are related to previous changes in the neighborhood externality risk measures makes it hard to argue that (lack of) homeownership causes neighborhood externality risk.

[32] I am thankful to an anonymous referee who suggested these specifications.

4.4 Results for Change-in-Change Specifications

Table 7 presents results for the four change-in-change models outlined in equations (3) to (6). To begin with, the predictive power of the four models is remarkably high. For the sample of units owner-occupied in 1993, 92.7 percent of tenure status predictions for 1999 were correct. For the sample of units renter-occupied in 1993, the percent of correct predictions is 86.3 percent.

Column (1) of Table 7 reports results for equation (4). The parameter estimate for the change-in-risk measure for junk and litter is positive, as predicted, and statistically significant at the 1 percent level. That is, housing units owner-occupied in 1993 are more likely to become renter-occupied in 1999 if the uncertainty with regard to junk and litter increases between the two time periods 1985 to 1991 and 1993 to 1999. Table 8 reports quantitative effects for the parameter estimates presented in Table 7. Specifically, the quantitative effect for the change-in-risk measure for junk and litter is economically quite meaningful. As indicated by row 1 of Table 8, an increase of the risk measure for junk and litter, measured between 1985 and 1991, by one standard deviation, increases the likelihood (of 7.3 percent—see Table 6) that a unit that was owner-occupied in 1993 became renter-occupied in 1999 by 14.3 percent. This translates into 1 percent (=0.143*7.3 percent) in absolute terms, which is notable given that tenure status changes are relatively rare. Most of the other control variables have the anticipated sign. For example, increasing income is associated with a lower likelihood that a unit that was owner-occupied in 1993 became renter-occupied in 1999.

Column (2) of Table 7 reports results for equation (5), that is, for the specification with changes in all four risk measures. The parameter estimates for the four change-in-risk variables all have the anticipated positive sign and—with the exception of the change-in-risk measure for neighborhood noise—are statistically significant at the 1 percent level. Again, as Table 8 documents, the quantitative effects are important. For example, an increase of the risk measure for junk and litter by one standard deviation increases the likelihood that a unit that was owner-occupied in 1993 became renter occupied in 1999 by 13.1 percent (or 0.96 percent in absolute terms). The quantitative effects of the other two significant change-in-risk measures (street noise and neighborhood crime) are even slightly larger (15.9 percent and 13.4 percent). The other control variables are virtually unchanged compared to column (1).

Columns (3) and (4) report results for equations (6) and (7). As predicted, the coefficient on the change-in-risk measure for junk and litter is negative and statistically significant at the 1 percent level in both specifications. As Table 8 reveals, the quantitative effect is quite important as well. A one standard deviation increase in the risk measure for junk and litter, measured between 1985 and

1991 reduces the likelihood (of 13.7 percent) that a unit that was renter-occupied in 1993 became owner-occupied in 1999 by about 9.5 percent (1.3 percent in absolute terms). Column (4) also reports parameter estimates for the other three change-in-risk measures. While all three measures have the anticipated negative sign, only the risk measure for street noise is marginally significant. Again, most of the other control variables have the anticipated signs.

Overall, these results confirm the theoretical predictions and suggest that at least three of the four risk measures have a causal effect on the tenure status of properties. Moreover, it is reassuring that the risk measure for junk and litter, which is completely unaffected by occupancy turnover, is not only statistically significant at the 1 percent level in all estimated specifications but is also the quantitatively most important of the four risk measures.

The last subsection of the empirical analysis discusses some further concerns and provides evidence to mitigate these concerns.

4.5 Discussion of Further Issues and Sensitivity Analysis

To begin with, one might be concerned that virtually all housing units with high neighborhood externality variation are concentrated in distressed neighborhoods, while all housing units with no variation are concentrated in very good neighborhoods. In order to assess this concern, Table 9 reports the percentage of housing units in 1985 and 1999 that either have 'no variation', 'moderate variation', or 'high variation' in each of the four neighborhood externality measures.[33] Percentage numbers are reported separately for housing units located in 'top' neighborhoods (i.e., neighborhoods that are assessed by the AHS survey respondents as having a quality of 10, on a scale from 1 to 10) and for housing units located in 'distressed' neighborhoods (i.e., neighborhoods with a quality ranking below 6, on the same scale). As one might expect, distressed neighborhoods have a far higher percentage of units with high neighborhood externality risk and a far lower percentage of units with no neighborhood externality variation in the relevant time period between 1985 and 1999. However, Table 9 also documents that a rather high percentage of units in distressed neighborhoods have no neighborhood externality variation while a significant fraction of units in the top neighborhoods has a high variation.

A second concern is related to the nature of the neighborhood externality measures as ordinal variables. Specifically, the concern is that the measure of dispersion may be arbitrary, that is, the

[33] Further details on the classification of the risk measures into the three categories ('no variation', 'moderate variation', and 'high variation') and on the interpretation of the results are provided in the end note of Table 9.

standard deviation of an ordinal variable may be arbitrarily large or small and still maintain the preference ordering. Take the variable street noise for example. It is coded as 0 = 'does not exist', 1 = 'exists', 2 = 'objectionable, do not wish to move', and 3 = 'objectionable, wish to move'. Consequently, the difference between 'does not exist' and 'exists' is assumed to be the same as between 'objectionable, do not wish to move' and 'objectionable, wish to move'. However, this result is merely created by the arbitrary coding scheme. In reality, a resident may not care much, whether the condition street noise 'does not exist' or 'exists' but may care a lot, whether the condition is 'objectionable, do not wish to move' or 'objectionable, wish to move'. While one could also make a similar case for cardinal variables[34] and while the issue will likely bias against finding an effect, this is nevertheless an important concern that affects all four risk measures. The issue is addressed as follows. First, category dummies of the neighborhood externality measures are included in the empirical models rather than the externality level variables themselves. Take junk and litter for example. All logit models include two category dummy variables to separately capture the effects of 'minor accumulation' and 'major accumulation' on the homeownership status of properties (with 'no accumulation' being the omitted category). The two category dummy variables equal 1 if the accumulation of junk and litter is 'minor' or 'major', respectively, and 0 otherwise. Second, in an attempt to test whether the results are sensitive to an arbitrary rescaling of the neighborhood externality variables, all model specifications in Section 4 were reestimated using two alternative scaling schemes. The first rescaling uses the existing codes squared. The reasoning is that it is quite possible that potential homebuyers care more about differences at the 'bad end' of the scale than about differences at the 'good end' of the scale. Again, take junk and litter for example. The coding now becomes: 0 = 'no accumulation', 1 = 'minor accumulation', and 4 = 'major accumulation'. Hence, it is assumed that potential homebuyers care more about whether a neighborhood has 'major accumulation' versus 'minor accumulation' as opposed to whether a neighborhood has 'minor accumulation' versus 'no accumulation'. The statistical significance levels of the neighborhood externality risk measures are little affected in all (cross-sectional *and* change-in-change) specifications. The statistical significance levels remain unchanged in virtually all cases, with the z-values somewhat increasing in some cases and decreasing in others. See Table

[34] Consider for example noise that is measured in decibels. Noise may not matter to residents below a certain threshold level. Thus variation below the threshold level may not concern residents at all, while variation below *and* above the threshold level may strongly aversely affect the willingness of potential homebuyers to invest in the neighborhood. Thus, even if cardinal measures were available, this would not completely solve the problem unless one knew the true functional form of the relationship between the risk measures and the homeownership status of properties.

4 and the Appendix Table A4 for details. The second rescaling uses the square root of the existing codes (except for 0). This new scale assumes that potential homebuyers care more about differences at the 'good end' of the scale compared to differences at the 'bad end' of the scale. Specifically, take junk and litter for example. The coding now becomes: 0 = 'no accumulation', 1 = 'minor accumulation', and $\sqrt{2}$ = 'major accumulation'. Again, the statistical significance levels remain unchanged in virtually all cases. See Table 7 and the Appendix Table A5 for details. Overall, the findings of this sensitivity analysis are very reassuring in that they suggest that the main results presented in this paper are robust with regard to reasonable arbitrary rescalings of the neighborhood externality variables.

5 Conclusions

In this paper it is argued that owner-occupied housing typically causes a portfolio distortion for single owner-occupiers. This distortion increases with housing investment risk and, in particular, with the corresponding neighborhood externality risk. Thus, increasing neighborhood externality risk makes owner-occupied housing relatively less attractive and less likely compared to renter-occupied housing. Other things equal, neighborhood externality risk measures should negatively affect the probability that a housing unit is owner-occupied. The evidence presented here strongly supports this proposition and suggests that the relationship is causal.

The reported neighborhood externality risk measures are typically higher in center city locations and in distressed neighborhoods. The logit models suggest that the neighborhood externality risk measures explain up to half of the so far unexplained effect of unobservable center city specific characteristics on the homeownership status of properties. Interestingly, the dummy variable for units in center city places is no longer statistically significant in the specification for 1985 that controls for all four risk measures. This finding implies that the housing literature may no longer have to rely on peculiar intrinsic preferences of center city residents to explain the phenomenon of low homeownership rates in center cities. Moreover, if neighborhood externality risk partly explains low homeownership rates then, because of moral hazard problems of renter-occupiers, neighborhood uncertainty may also partially explain the decay of buildings in many inner city neighborhoods.

In fact, there have been attempts in the Chicago area to insure homeowners against property value reductions caused by neighborhood influences (e.g., Shiller and Weiss [42]). The most

prominent attempt is the Chicago 'home equity assurance program'. The main political goal of this program has been to avoid 'panic peddling' and thereby to avoid the further outflow of responsible residents. However, so far neither the Chicago 'home equity assurance program' nor other attempts by local governments in the Chicago area have been successful in dealing with the moral hazard and the selection bias problem. Shiller and Weiss [42] propose modifications involving a real estate price index that might deal better with the problem of moral hazard. However, until now none of the modifications proposed by Shiller and Weiss have been implemented. The findings in this paper suggest that the most crucial modification proposed by Shiller and Weiss—the real estate price index—ought to be neighborhood specific if it is to be successful.

There are a number of possible directions for future research. Given the fact that homeownership and the avoidance of neighborhood decay are considered politically desirable goals, one could further focus on institutional settings that may avoid neighborhood externality risk initially. Such institutional settings are deed restrictions and neighborhood covenants.[35] These settings may help to create stability in newly developing neighborhoods and may thereby encourage homeownership in these places. In established neighborhoods, one could focus on mechanisms that insure against the risk subsequently.

Finally, the methodology used in this paper can be used for other related research questions. For example, the Chicago experience shows that the 'home equity assurance program' has been most popular in predominantly white areas that face uncertain future ethnicity mixes. One might therefore expect that the neighborhood specific uncertainty about the future ethnicity mix is another significant determinant of the homeownership status of residential properties. Measures of ethnic uncertainty can be evaluated at the neighborhood-level and these measures can then be used to examine the influence of ethnic uncertainty on the tenure status of properties. Obviously, such a study will have to take into account the literature on discrimination in residential-mortgage lending (e.g., Munnell *et al.* [33] and Ladd [28]) and, in particular, the issue of 'geographic redlining', that is, the behavior of lenders to deny loans to an area because it has a large proportion of minority residents or because it is poor and rundown.

The research approach used here could help illuminate mortgage lending decisions and issues related to potential discrimination against minorities. Neighborhood specific risks are expected to affect the rate of return on loans. However, mortgage lenders may not be able to fully price neighborhood specific risks into mortgage interest rates. Hence, they may have incentives to avoid

[35] See for example Hughes and Turnbull [24] for an exposition of this topic.

locations with high neighborhood specific risks completely. The previous literature on discrimination in mortgage lending and redlining suggests by and large that lenders discriminate not on the basis of the location of the property but rather on the basis of the race of the applicant (e.g., Ladd [28]). However, previous studies only use rough proxies for neighborhood specific risks. In contrast, the neighborhood externality risk measures used in this paper are direct measures. Future work could, therefore, address whether mortgage originators take into account neighborhood specific housing investment risk when deciding whether to grant or deny credit. Better controls for neighborhood specific risks may also affect the statistical and quantitative significance of measures of discrimination against minorities. Finally, credit denial may affect different categories of investors (e.g., single owner-occupiers or private developers) in a different way. However, even if it were true that neighborhood specific risk measures affect the lending decision and thereby the homeownership status of properties, the fact remains that neighborhood externality risk is an important and so far overlooked determinant of the homeownership status of properties.

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Summary Statistics and Regression Tables

TABLE 1
Variable List and Summary Statistics for Base Regression Samples

Variable	# Obs.	Mean	Std. Dev.	Minimum	Maximum
Homeownership Status Variables					
Homeownership dummy, 1985	25971	.61	.49	0	1
Homeownership dummy, 1999	29322	.63	.48	0	1
Housing Structure Type, Overall Unit- and Neighborhood Quality, Probability of Turnover Within Unit					
One unit detached house dummy, 1985	25971	.58	.49	0	1
One unit detached house dummy, 1999	29322	.60	.49	0	1
Two or more unit building dummy, 1985	25971	.32	.47	0	1
Two or more unit building dummy, 1999	29322	.28	.45	0	1
Overall housing unit quality, 1985	25866	8.2	1.9	1	10
Overall housing unit quality, 1999	29017	8.0	1.8	1	10
Overall neighborhood quality, 1985	25807	8.0	2.2	1	10
Overall neighborhood quality, 1999	28901	7.9	1.9	1	10
Household Specific Information					
Household income, 1985	25971	27507.4	23527.7	0	264600
Household income, 1999	29322	49272.7	53320.9	0	996280
Average age of adults in unit, 1985	25971	45.4	17.7	18	91
Average age of adults in unit, 1999	29322	46.7	17.0	18	93
Family lives in unit, 1985	25971	.71	.45	0	1
Family lives in unit, 1999	29322	.63	.48	0	1
Married couple lives in unit, 1985	25971	.56	.50	0	1
Married couple lives in unit, 1999	29322	.52	.50	0	1
One or more children live in unit, 1985	25971	.37	.48	0	1
One or more children live in unit, 1999	29322	.37	.48	0	1
Ethnicity of household head is black, 1985	25971	.11	.31	0	1
Ethnicity of household head is black, 1999	29322	.13	.33	0	1
Previous residence outside USA, 1985	25971	.0082	.090	0	1
Previous residence outside USA, 1999	29322	.012	.11	0	1
General Location Specific Variables					
Center city dummy, 1985	25971	0.37	0.48	0	1
Center city dummy, 1999	29322	0.33	0.47	0	1
Unit is inside MSA, 1985	25971	0.80	0.40	0	1
Unit is inside MSA, 1999	29322	0.46	0.50	0	1
Neighborhood Externality Risk Variables (Standard Deviations)					
Std. dev. of junk and litter, 85-99 (1985 sample)	25971	.30	.29	0	1.2
Std. dev. of junk and litter, 85-99 (1999 sample)	29322	.27	.29	0	1.2
Std. dev. of street noise, 85-99 (1985 sample)	25971	.59	.45	0	1.7
Std. dev. of street noise, 85-99 (1999 sample)	29322	.56	.46	0	1.7
Std. dev. of neigh. noise, 85-99 (1985 sample)	25971	.14	.20	0	.58
Std. dev. of neigh. noise, 85-99 (1999 sample)	29322	.13	.20	0	.58
Std. dev. of neigh. crime, 85 (1985 sample)	25971	.57	.52	0	1.7
Std. dev. of neigh. crime, 85 (1999 sample)	29322	.54	.52	0	1.7

Note: The variable list and summary statistics are based on the base regression-samples for 1985 and 1999 (Table 4).

TABLE 1—*Continued*
Variable List and Summary Statistics for Base Regression Samples

Variable	Based on Base Regression Sample for 1985			Based on Base Regression Sample for 1999				
	# Obs.	Mean	Std. Dev.	# Obs.	Mean	Std. Dev.	Minimum	Maximum
Neighborhood Externality Level-Variables								
Junk and litter in neighborhood, 85	25971	.32	.53	24715	.30	.52	0	2
Junk and litter in neighborhood, 87	17574	.31	.52	18777	.29	.51	0	2
Junk and litter in neighborhood, 89	13947	.32	.53	14994	.29	.51	0	2
Junk and litter in neighborhood, 91	15391	.29	.51	16670	.26	.49	0	2
Junk and litter in neighborhood, 93	15010	.31	.53	18448	.25	.49	0	2
Junk and litter in neighborhood, 95	15475	.30	.52	18850	.24	.48	0	2
Junk and litter in neighborhood, 97	23453	.14	.43	27389	.13	.42	0	2
Junk and litter in neighborhood, 99	23294	.14	.43	29322	.13	.41	0	2
Street noise in neighborhood, 85	25971	.63	.93	21452	.61	.92	0	3
Street noise in neighborhood, 87	23802	.62	.92	23824	.59	.91	0	3
Street noise in neighborhood, 89	23500	.61	.93	24677	.58	.91	0	3
Street noise in neighborhood, 91	23352	.60	.93	25685	.56	.91	0	3
Street noise in neighborhood, 93	23126	.61	.94	26591	.58	.92	0	3
Street noise in neighborhood, 95	22149	.59	.93	26069	.55	.90	0	3
Street noise in neighborhood, 97	21648	.51	.84	25986	.48	.83	0	3
Street noise in neighborhood, 99	21568	.50	.84	29322	.48	.83	0	3
Neighborhood noise, 85	25971	.084	.28	22126	.080	.27	0	1
Neighborhood noise, 87	23751	.077	.27	23674	.075	.26	0	1
Neighborhood noise, 89	23344	.078	.27	24462	.077	.27	0	1
Neighborhood noise, 91	23160	.083	.28	25425	.080	.27	0	1
Neighborhood noise, 93	22899	.089	.29	26308	.085	.28	0	1
Neighborhood noise, 95	21948	.086	.28	25844	.081	.27	0	1
Neighborhood noise, 97	21686	.028	.16	26014	.027	.16	0	1
Neighborhood noise, 99	21538	.030	.17	29322	.029	.17	0	1
Neighborhood crime, 85	25971	.41	.88	21426	.39	.86	0	3
Neighborhood crime, 87	23744	.41	.86	23762	.38	.84	0	3
Neighborhood crime, 89	23451	.47	.92	24635	.45	.90	0	3
Neighborhood crime, 91	23275	.51	.95	25609	.48	.93	0	3
Neighborhood crime, 93	23074	.51	.96	26533	.48	.93	0	3
Neighborhood crime, 95	22074	.49	.94	25987	.45	.91	0	3
Neighborhood crime, 97	21537	.36	.82	25892	.34	.79	0	3
Neighborhood crime, 99	21420	.30	.76	29322	.29	.75	0	3

Note: The variable list and summary statistics are based on the base regression-samples for 1985 and 1999 (Table 4).

TABLE 2

Changes of Neighborhood Externality Variables between 1985 and 1999

Neighborhood Externality	Percentage of Units, 1985-1999			
	Stable	Changes in both directions	Only decreasing or stable	Only increasing or stable
	(1)	(2)	(3)	(4)
Junk and litter (N=3,334)	24.2%	65.2%	8.7%	1.9%
Street noise (N=12,700)	28.5%	63.2%	4.7%	3.6%
Neighborhood noise (N=12,454)	68.1%	26.4%	4.1%	1.4%
Neighborhood crime (N=12,517)	39.3%	53.7%	4.0%	3.0%

Notes: Housing units are only included in the four samples if the specific neighborhood externality information is available for all 8 calendar years (1985, 1987, 1989, 1991, 1993, 1995, 1997, and 1999). In addition, the four samples include only housing units that are included in both base regressions for 1985 (Table 4) and 1999 (Table 5). However, percentage numbers are very similar if the sample sizes are not limited to the combined regression sample. The percentage numbers should be interpreted as follows. Take the variable junk and litter for example. 3,334 housing units that are included in both base regression samples have information on junk and litter for all 8 AHS years. Column (1) indicates that 24.2% of all units in the sample did not observe any change in the measure for junk and litter over the 8 AHS years. That is, there is either no accumulation of junk and litter for all 8 years, there is minor accumulation for all 8 years, or there is major accumulation for all 8 years. That is, the variance is zero. Column (2) indicates that 65.2% of all housing units in the sample observed changes of the neighborhood externality level variable in both directions. For example, the accumulation of junk and litter is first considered to be minor, then the assessment changes to major accumulation, and then back again to minor or no accumulation. Column (3) indicates that 8.7% of all housing units in the sample only observe decreasing or stable accumulations of junk and litter. That is, the accumulation of junk and litter never increases over the 8 AHS years but decreases at least during one period. Column (4) indicates that 1.9% of all sample units observe only increasing or stable accumulations of junk and litter over the 8 years. That is, the accumulation of junk and litter never decreases over the 8 years and increases at least during one time period. The remaining three rows for street noise, neighborhood noise, and neighborhood crime have to be interpreted likewise.

TABLE 3

Partial Correlations for Risk Measures with Self-Assessment, 1985-1999

Correlation Matrix	Turnover Frequency (1985-1999)	Constant Homeownership Status of Property (1985-1999)
	(1)	(2)
Std. dev. of street noise, 1985-1999	.067	-.18
Std. dev. of neighborhood noise, 1985-1999	.039	-.16
Std. dev. of neighborhood crime, 1985-1999	039	-.19

Notes: The sample includes all housing units that did not change their homeownership status between 1985 and 1999 and have no missing mover information, that is, information on whether a housing unit had occupant turnover or not is available for all 8 calendar years. The sample size is 9,282 observations.

TABLE 4

Binary Logit Estimate of the Homeownership Status (Base Regression), 1985 and 1999

Specification	Only Junk /Litter Risk Measure 1985	All Four Risk Measures 1985	Only Junk /Litter Risk Measure 1999	All Four Risk Measures 1999
Explanatory Variables	(1)	(2)	(3)	(4)
Std. dev. of junk/litter, 1985-1999	-.60 ** (.079)	-.47 ** (.081)	-.87 ** (.067)	-.69 ** (.069)
Std. dev. of street noise, 1985-1999		-.26 ** (.052)		-.34 ** (.048)
Std. dev. of neigh. noise, 1985-1999		-.23 * (.11)		-.31 ** (.10)
Std. dev. of neigh. crime, 1985-1999		-.14 ** (.046)		-.16 ** (.042)
Two or more unit building	-2.8 ** (.066)	-2.8 ** (.067)	-2.7 ** (.059)	-2.7 ** (.060)
Unit is a single detached house	.80 ** (.057)	.76 ** (.058)	1.0 ** (.048)	.98 ** (.049)
Unit is in center city	-.10 * (.048)	-.054 (.049)	-.19 ** (.046)	-.13 ** (.047)
Junk, litter and, trash: Dummy =1 if minor accumulation	-.018 (.050)	0.012 (.050)	-.16 * (.069)	-.10 (.071)
Junk, litter and, trash: Dummy = 1 if major accumulation	.086 (.11)	.11 (.11)	.14 (.11)	.15 (.11)
Category dummies for street noise in neighborhood	No	Yes	No	Yes
Category dummies for neighborhood noise	No	Yes	No	Yes
Category dummies for neighborhood crime	No	Yes	No	Yes
Demographic controls	Yes	Yes	Yes	Yes
MSA dummies	Yes	Yes	Yes	Yes
Constant	20.1 ** (.92)	20.2 ** (1.0)	1.2 (1.1)	1.5 (1.1)
Number of observations	25,971	25,971	29,322	29,322
Log-likelihood	-9,388.9	-9,325.5	-10,316.4	-10,230.0
Percent correct predictions	85.1	85.1	85.5	85.7

Notes: Dependent variable: 1 if unit is owner-occupied, 0 if unit is rented. ** Indicates significance at the 1 percent level, * indicates significance at the 5 percent level. Standard errors are in parenthesis. In column (1) 1,423 observations (5.2%) with non-missing values were dropped to make the sample size equal to the one in column (2). In column (3) 1,321 observations (4.3%) with non-missing values were dropped to make the sample size equal to the one in column (4). Due to space restrictions the coefficients and standards errors for the occupants' demographic characteristics and for the category dummy variables of the neighborhood externality levels are reported separately in Appendix Table A1. Results are reported for columns (2) and (4) only, though, the coefficients and statistical significance levels for the controls are very similar across specifications. The coefficients and standard errors of the 144 MSA dummies are not reported individually. A 0.5 threshold was used to compute the percent of correct predictions.

TABLE 5
Marginal Analysis for Risk Measures Using the Base Regressions for 1985 and 1999

Specification	Risk Measure (Std. Dev., 1985-1999)	Mean of Measure	Std. Dev. of Measure	Marginal Effect	Elasticity	Quantitative Effect
Table 4 (1)	Junk and litter	0.30	0.29	-0.14 **	-0.067 **	-6.6% **
Table 4 (2)	Junk and litter	0.30	0.29	-0.11 **	-0.053 **	-5.2% **
Table A2 (1)	Junk and litter	0.30	0.29	-0.25 **	-0.12 **	-12.2% **
Table A2 (2)	Junk and litter	0.30	0.29	-0.20 **	-0.099 **	-9.8% **
Table 4 (2)	Street noise	0.59	0.45	-0.059 **	-0.058 **	-4.4% **
Table A2 (2)	Street noise	0.59	0.45	-0.097 **	-0.094 **	-7.2% **
Table 4 (2)	Neighborhood noise	0.14	0.20	-0.051 *	-0.012 *	-1.7% *
Table A2 (2)	Neighborhood noise	0.14	0.20	-0.065 **	-0.015 **	-2.2% **
Table 4 (2)	Neighborhood crime	0.57	0.52	-0.031 **	-0.029 **	-2.6% **
Table A2 (2)	Neighborhood crime	0.57	0.52	-0.047 **	-0.045 **	-4.0% **
Table 4 (3)	Junk and litter	0.27	0.29	-0.18 **	-0.072 **	-7.7% **
Table 4 (4)	Junk and litter	0.27	0.29	-0.15 **	-0.057 **	-6.1% **
Table A2 (3)	Junk and litter	0.27	0.29	-0.30 **	-0.12 **	-12.8% **
Table A2 (4)	Junk and litter	0.27	0.29	-0.24 **	-0.093 **	-10.0% **
Table 4 (4)	Street noise	0.56	0.46	-0.072 **	-0.057 **	-4.7% **
Table A2 (4)	Street noise	0.56	0.46	-0.12 **	-0.094 **	-7.7% **
Table 4 (4)	Neighborhood noise	0.13	0.20	-0.066 **	-0.012 **	-1.9% **
Table A2 (4)	Neighborhood noise	0.13	0.20	-0.084 **	-0.016 **	-2.4% **
Table 4 (4)	Neighborhood crime	0.54	0.52	-0.035 **	-0.027 **	-2.6% **
Table A2 (4)	Neighborhood crime	0.54	0.52	-0.055 **	-0.042 **	-4.0% **

Notes: ** Indicates significance at the 1 percent level, * indicates significance at the 5 percent level. Marginal effects $\partial E\left[y|x\right]/\partial x$ are calculated as $\Pr(y=1)\cdot[1-\Pr(y=1)]\cdot\beta$. Marginal effects and elasticities reflect the changes in the probability of homeownership for an infinitesimal change in the neighborhood externality risk measures. Marginal effects, elasticities, and quantitative effects are calculated at the means of the dependent and independent variables. The sample homeownership rates are: 60.9% for 1985 and 70.2% for 1999. Quantitative effects are measured as the percentage change of the probability of homeownership as a reaction to the change of a specific risk variable by one standard deviation.

TABLE 6
Variable List and Summary Statistics for Change-in-Change Regression Samples

Variable	Based on Sample of Owner-Occupied Units in 1993 (N=13,656)		Based on Sample of Renter-Occupied Units in 1993 (N=9,688)			
	Mean	Std. Dev.	Mean	Std. Dev.	Minimum	Maximum
Changes in Homeownership Status Variables						
Unit is owner-occupied in 1993 and renter-occupied in 1999	.073	.26			0	1
Unit is renter-occupied in 1993 and owner-occupied in 1999			.14	.34	0	1
Changes in Neighborhood Externality Risk Measures						
Δ Risk measure for junk/litter (from 85-91 to 93-99)	-.051	.39	-.016	.40	-1.4	1.4
Δ Risk measure for street noise (from 85-91 to 93-99)	-.021	.57	-.0087	.68	-2.1	2.1
Δ Risk measure for neigh. noise (from 85-91 to 93-99)	-.019	.24	-.031	.32	-.71	.71
Δ Risk measure for neigh. crime (from 85-91 to 93-99)	-.025	.62	-.0072	.78	-2.1	2.1
Changes in Neighborhood Externality Level Measures						
Δ Level measure for junk/litter (averages 85-91→93-99)	-.095	.37	-.096	.38	-2	2
Δ Level measure for street noise (averages 85-91→93-99)	-.046	.57	-.064	.72	-3	3
Δ Level measure for neigh. noise (averages 85-91→93-99)	-.016	.17	-.033	.23	-1	1
Δ Level measure for neigh. crime (averages 85-91→93-99)	-.031	.57	-.031	.77	-3	3
Changes in Household Specific Variables						
Δ Real household income (in '000) (averages 85-91→93-99)	-936.1	24679.4	-1577.5	17082.8	-176900.4	308893.4
Δ Average age of adults in household (averages 85-91→93-99)	2.7	11.3	.37	12.8	-64.3	61.1
Δ Household's family status (averages 85-91 93-99)	-.069	.33	-.025	.37	-1	1
Δ Household's marital status (averages 85-91→93-99)	-.039	.36	-.016	.38	-1	1
Δ Household has children (averages 85-91→93-99)	-.029	.39	.016	.37	-1	1
Δ Household's ethnicity (to/from black; averages 85-91→93-99)	.012	.12	.024	.23	-1	1
Δ Household's origin (to/from abroad; averages 85-91→93-99)	.00078	.045	.0033	.080	-1	.75

Notes: The variable list and summary statistics are based on the samples for the change-in-change estimates reported in Table 7.

TABLE 7

Binary Logit Estimate of Changes in Homeownership Status between 1993 and 1999

Specification	Own 93→Rent 99 Only Junk/Litter	Own 93→Rent 99 All Four Risk Measures	Rent 93→Own 99 Only Junk/Litter	Rent 93→Own 99 All Four Risk Measures
Explanatory Variables	(1)	(2)	(3)	(4)
Δ Risk measure for junk/litter (from 85-91 to 93-99)	.43 ** (.10)	.40 ** (.10)	-.28 ** (.090)	-.28 ** (.091)
Δ Risk measure for street noise (from 85-91 to 93-99)		.34 ** (.068)		-.087 (*) (.054)
Δ Risk measure for neighborhood noise (from 85-91 to 93-99)		.27 (.26)		-.10 (.18)
Δ Risk measure for neighborhood crime (from 85-91 to 93-99)		.26 ** (.068)		-.0088 (.048)
Δ Level measure for junk/litter (averages 85-91 → 93-99)	-.40 ** (.11)	-.38 ** (.11)	.23 * (.096)	.24 * (.096)
Δ Level measure for street noise (averages 85-91 → 93-99)		-.070 (.069)		-.14 (.053)
Δ Level measure for neighborhood noise (averages 85-91 → 93-99)		-.50 (.37)		.58 * (.25)
Δ Level measure for neighborhood crime (averages 85-91 → 93-99)		-.24 ** (.074)		.044 (.051)
Δ Real household income (in '000) (averages 85-91 → 93-99)	-.080 ** (.014)	-.076 ** (.014)	.078 ** (.017)	.079 ** (.018)
Δ Average age of adults in household (averages 85-91 → 93-99)	-.038 ** (.0029)	-.037 ** (.0029)	-.0032 (.0024)	-.0037 (.0024)
Δ Household's family status (averages 85-91 → 93-99)	.34 * (.15)	.31 * (.15)	-.072 (.12)	-.073 (.12)
Δ Household's marital status (averages 85-91 → 93-99)	-.63 ** (.13)	-.63 ** (.13)	.073 (.10)	.084 (.10)
Δ Household has children (averages 85-91 → 93-99)	.039 (.095)	.037 (.096)	-.052 (.10)	-.051 (.10)
Δ Household's ethnicity (to/from black; averages 85-91 → 93-99)	.55 * (.23)	.55 * (.23)	-.054 (.13)	-.051 (.13)
Δ Household's origin (to/from abroad; averages 85-91→ 93-99)	2.1 ** (.68)	2.0 ** (.68)	-.33 (.37)	-.37 (.37)
Constant	-2.6 ** (.037)	-2.6 ** (.037)	-1.8 ** (.031)	-1.8 ** (.031)
Number of observations	13,656	13,656	9,688	9,688
Log-likelihood	-3,431.1	-3,405.8	-3,859.7	-3,847.0
Percent correct predictions	92.7%	92.7%	86.3%	86.3%

Notes: Dependent variable for columns (1) and (2): 1 if unit changed ownership status from owner-occupied to renter-occupied, 0 otherwise. Dependent variable for columns (3) and (4): 1 if unit changed ownership status from renter-occupied to owner-occupied, 0 otherwise. ** Indicates significance at the 1 percent level, * indicates significance at the 5 percent level. (*) indicates significance at the 10 percent level. Standard errors are in parenthesis. In column (1) and column (3) observations with non-missing values were dropped to make results comparable with the specifications that estimate the effects of all four risk measures on the homeownership status of properties. The coefficients and statistical significance levels of the remaining variables are virtually unchanged if household related variables are omitted.

TABLE 8

Marginal Analysis of Effects of Changes in Risk Measures on Changes in Homeownership Status

Specification	Δ Risk Measure (85-91→93-99)	Mean of Risk Measure (85-91)	Std. Dev. of Change	Marginal Effect	Elasticity	Quantitative Effect
Table 7 (1)	Change in uncertainty about junk and litter	0.32	0.39	.027 **	0.12 **	+14.3% **
Table 7 (2)	Change in uncertainty about junk and litter	0.32	0.39	.024 **	0.11 **	+13.1% **
Table 7 (2)	Change in uncertainty about street noise	0.50	0.57	.020 **	0.14 **	+15.9% **
Table 7 (2)	Change in uncertainty about neighborhood noise	0.20	0.24	.017	0.046	+5.6%
Table 7 (2)	Change in uncertainty about neighborhood crime	0.54	0.62	.016 **	0.12 **	+13.4% **
Table 7 (3)	Change in uncertainty about junk and litter	0.32	0.40	-.033 **	-0.076 **	-9.6% **
Table 7 (4)	Change in uncertainty about junk and litter	0.32	0.40	-.033 **	-0.075 **	-9.4% **
Table 7 (4)	Change in uncertainty about street noise	0.61	0.68	-.010 (*)	-0.045 (*)	-5.0% (*)
Table 7 (4)	Change in uncertainty about neighborhood noise	0.16	0.32	-.012	-0.014	-2.8%
Table 7 (4)	Change in uncertainty about neighborhood crime	0.60	0.78	-.0010	-0.0045	-0.6%

Notes: ** Indicates significance at the 1 percent level, * indicates significance at the 5 percent level, (*) indicates significance at the 10 percent level. Marginal effects $\partial E\left[y|x\right]/\partial x$ are calculated as $\Pr(y=1)\cdot[1-\Pr(y=1)]\cdot\beta$. Marginal effects $\partial E\left[y|x\right]/\partial x$ are calculated as $\Pr(y=1)\cdot[1-\Pr(y=1)]\cdot\beta$. Marginal effects and elasticities reflect the changes in the probability of homeownership for an infinitesimal change in the neighborhood externality risk measures. Marginal effects, elasticities, and quantitative effects are calculated at the means of the dependent and independent variables. 7.3% of the sample of owner-occupied units in 1993 is renter-occupied in 1999. 13.7% of the sample of renter-occupied units in 1993 is owner-occupied in 1999. Quantitative effects are measured as the percentage change of the probability that a housing unit changes its homeownership status (from owner-occupied to renter-occupied and from renter-occupied to owner-occupied respectively) as a reaction to an increase of the risk variable (measured between 1985 and 1991) by one standard deviation. For example, row 1 has to be interpreted as follows: An increase of the risk measure for junk and litter (measured between 1985 and 1991) by one standard deviation between 1993 and 1999 (from 0.32 to 0.71) increases the probability that an owner-occupied unit in 1993 becomes renter-occupied in 1999 by 14.3% (or 1% percentage point in absolute terms; 0.143*7.3%=1.0%). Row 6 has to be interpreted as follows: An increase of the risk measure for junk and litter (measured between 1985 and 1991) by one standard deviation between 1993 and 1999 (from 0.32 to 0.72) reduces the probability that a renter-occupied unit in 1993 becomes owner-occupied in 1999 by 9.6% (or 1.3% percentage points in absolute terms; 0.096*13.7%=1.3%).

TABLE 9

Neighborhood Externality Variation in Top- and Distressed-Neighborhoods

Year	Type of Neighborhood	Degree of Variation in Neighborhood Externality Measure	Type of Externality			
			Junk and Litter	Street Noise	Neighborhood Noise	Neighborhood Crime
			(1)	(2)	(3)	(4)
1985	Top Neighborhood *(N=9,656)*	% Units with 'no variation'	55.3%	34.6%	78.2%	48.5%
		% Units with 'moderate variation'	37.0%	60.1%	15.4%	53.0%
		% Units with 'high variation'	7.7%	5.3%	6.4%	4.5%
	Distressed Neighborhood *(N=4,004)*	% Units with 'no variation'	20.5%	12.0%	48.8%	18.5%
		% Units with 'moderate variation'	60.7%	65.1%	27.5%	56.9%
		% Units with 'high variation'	18.8%	22.9%	23.7%	24.6%
1999	Top Neighborhood *(N=6,994)*	% Units with 'no variation'	60.5%	42.1%	79.9%	54.3%
		% Units with 'moderate variation'	32.7%	52.6%	14.1%	40.8%
		% Units with 'high variation'	6.8%	5.3%	6.0%	4.9%
	Distressed Neighborhood *(N=3,651)*	% Units with 'no variation'	22.4%	11.9%	51.7%	19.2%
		% Units with 'moderate variation'	53.9%	64.0%	26.9%	53.2%
		% Units with 'high variation'	23.7%	24.1%	21.4%	27.6%

Notes: 'No variation' means that the specific neighborhood externality variable did not vary between 1985 and 1999. 'Moderate' variation' is any variation greater than zero and below the top 10-percentile, and 'high variation' is defined as variation that is in the top 10-percentile of the full regression sample for the specific year (1985 or 1999). 'Top neighborhood' and 'distressed neighborhood' are defined as follows. AHS survey respondents assess the quality of their neighborhood from 1-10. A neighborhood is considered 'top' if the survey respondent's valuation of neighborhood quality is 10. A neighborhood is considered 'distressed' if the valuation of neighborhood quality is below 6. The percentage numbers in columns (1) to (4) have to be interpreted as follows. Consider column (1) and rows 1-4. The regression sample for 1985 consists of 25,971 housing units (see Table 3), 9,656 units among these are in 'top' neighborhoods, while 4,004 units are in 'distressed' neighborhoods. The variation of the junk and litter variable (measured as the standard deviation of the junk and litter level variable between 1985 and 1999) varies across housing units. 55.3% of housing units that are in the regression sample for 1985 and are in 'top neighborhoods' have 'no variation' of junk and litter between 1985 and 1999 (see row 1). 37% of housing units have 'moderate variation' (row 2), and 7.7% have 'high variation' (row 3). That is to say, about 10% (10-percentile) of all housing units in the full regression sample for 1985 (N=25,971) have a standard deviation of the junk and litter variable above 0.71. However, only 7.7% of housing units in 'top' neighborhoods (row 3) but 18.8% of housing units in 'distressed neighborhoods' (row 4) have a standard deviation of the junk and litter measure above 0.71.

Appendix

APPENDIX TABLE A1

Binary Logit Estimate of the Homeownership Status (Base Regression), 1985 and 1999

	Table 4 (2) – *1985*			Table 4 (4) – *1999*		
	(1)			(2)		
Explanatory Variables	Parameter Estimates		Std. Err.	Parameter Estimates		Std. Err.
Std. dev. of junk/litter, 1985-1999	-.47	**	.081	-.69	**	.069
Std. dev. of street noise, 1985-1999	-.26	**	.052	-.34	**	.048
Std. dev. of neigh. noise, 1985-1999	-.23	*	.11	-.31	**	.10
Std. dev. of neigh. crime, 1985-1999	-.14	**	.046	-.16	**	.042
Two or more unit building	-2.8	**	.067	-2.7	**	.060
Unit is a single detached house	.76	**	.058	.98	**	.049
Unit is in center city	-.054		.049	-.13	**	.047
Junk, litter and, trash: Minor accumulation	.012		.050	-.10		.071
Junk, litter and, trash: Major accumulation	.11		.11	.15		.11
Street noise: Exists	-.17	**	.050	-.18	**	.048
Street noise: Objectionable, no wish to move	-.039		.063	.11		.071
Street noise: Objectionable, wish to move	-.054		.087	-.14		.093
Neighborhood noise: Bothers	-.12		.077	.078		.11
Neighborhood crime: Exists	-.027		.083	.013		.075
Neighborhood crime: Objectionable, no wish to move	.35	**	.071	.30	**	.084
Neighborhood crime: Objectionable, wish to move	.043		.089	.13		.10
Household income (in ‘000)	.0067	*	.0031	.0085	**	.0016
Household income squared (in ‘000,000)	-.00014	**	.000018	-.000019	**	.0000029
Household income (in ‘000) * Average age of adults	.00071	**	.000064	.00060	**	.000040
20 ≤ Average age of adults<25	-1.5	**	.087	-1.6	**	.10
25 ≤ Average age of adults<30	-.86	**	.060	-.93	**	.064
40 ≤ Average age of adults<45	.034		.073	-.16	**	.058
45 ≤ Average age of adults<55	.090		.067	-.16	**	.055
55 ≤ Average age of adults<65	.26	**	.069	.28	**	.068
Family	.12	*	.067	-.22	**	.079
Married couple	.46	**	.054	.72	**	.063
Children	-.57	**	.049	-.35	**	.057
Ethnicity is black	-.28	**	.063	-.37	**	.055
Previous residence outside USA	-1.2	**	.22	-1.1	**	.16
MSA dummies	Yes			Yes		
Constant	20.2	**	1.0	1.5		1.1
Number of observations	25,971			29,322		
Log-likelihood	-9,325.5			-10,230.0		

Notes: Dependent variable: 1 if unit is owner-occupied, 0 if unit is rented. ** Indicates significance at the 1 percent level, * indicates significance at the 5 percent level. The logit-models contain 144 MSA dummies that are not reported individually in the table. 85.1% (1985) and 85.7% (1999) are predicted correctly by the models.

APPENDIX TABLE A2

Binary Logit Estimate of the Homeownership Status (Excluding Demographics), 1985 and 1999

Specification	Only Junk /Litter Risk Measure 1985	All Four Risk Measures 1985	Only Junk /Litter Risk Measure 1999	All Four Risk Measures 1999
Explanatory Variables	(1)	(2)	(3)	(4)
Std. dev. of junk/litter, 1985-1999	-1.1 ** (.073)	-.88 ** (.075)	-1.4 ** (.061)	-1.1 ** (.064)
Std. dev. of street noise, 1985-1999		-.42 ** (.049)		-.53 ** (.044)
Std. dev. of neigh. noise, 1985-1999		-.28 ** (.10)		-.38 ** (.093)
Std. dev. of neigh. crime, 1985-1999		-.20 ** (.042)		-.25 ** (.040)
Two or more unit building	-2.7 ** (.060)	-2.7 ** (.061)	-2.6 ** (.054)	-2.6 ** (.054)
Unit is a single detached house	1.1 ** (.052)	1.0 ** (.053)	1.3 ** (.044)	1.2 ** (.045)
Unit is in center city	-.16 ** (.044)	-.084 (*) (.045)	-.33 ** (.042)	-.23 ** (.043)
Category dummies for junk/litter in neighborhood	Yes	Yes	Yes	Yes
Category dummies for street noise in neighborhood	No	Yes	No	Yes
Category dummies for neighborhood noise	No	Yes	No	Yes
Category dummies for neighborhood crime	No	Yes	No	Yes
Demographic controls	No	No	No	No
MSA dummies	Yes	Yes	Yes	Yes
Constant	21.2 ** (.86)	21.2 ** (.92)	2.0 * (.96)	2.4 * (.99)
Number of observations	25,971	25,971	29,322	29,322
Log-likelihood	-10,642.2	-10,509.8	-11,813.6	-11,617.6
Percent correct predictions	84.1	84.2	84.0	84.2

Notes: Dependent variable: 1 if unit is owner-occupied, 0 if unit is rented. ** Indicates significance at the 1 percent level, * indicates significance at the 5 percent level, (*) indicates significance at the 10 percent level. Standard errors are in parenthesis. In column (1) 2,925 observations (10.1%) with non-missing values were dropped to make the sample size equal to the corresponding logit estimates for 1985 in Table 4 (columns 1 and 2). In column (3) 1,423 observations (4.6%) were dropped and in column (4) 70 observations (0.24%) were dropped to make the sample sizes equal to the corresponding logit estimates for 1999 in Table 4 (columns 3 and 4). The coefficients and standard errors of the 144 MSA dummies are not reported individually. A 0.5 threshold was used to compute the percent of correct predictions.

APPENDIX TABLE A3

Binary Logit Estimate of the Homeownership Status (Excluding Risk Measures), 1985 and 1999

Specification	Only Junk /Litter Risk Measure 1985	All Four Risk Measures 1985	Only Junk /Litter Risk Measure 1999	All Four Risk Measures 1999
Explanatory Variables	(1)	(2)	(3)	(4)
Junk, litter and, trash: Minor accumulation	-.20 ** (.044)	-.16 ** (.045)	-.36 ** (.068)	-.29 ** (.070)
Junk, litter and, trash: Major accumulation	-.24 * (.10)	-.20 (*) (.10)	-.29 ** (.10)	-.20 (*) (.10)
Street noise: Exists		-.26 ** (.049)		-.30 ** (.047)
Street noise: Objectionable, no wish to move		-.18 ** (.060)		-.082 (.069)
Street noise: Objectionable, wish to move		-.25 ** (.083)		-.41 ** (.090)
Neighborhood noise: Bothers		-.21 ** (.070)		-.045 (.11)
Neighborhood crime: Exists		-.083 (.083)		-.059 (.074)
Neighborhood crime: Objectionable, no wish to move		.28 ** (.069)		.20 * (.082)
Neighborhood crime: Objectionable, wish to move		-.088 (.086)		-.024 (.099)
Two or more unit building	-2.8 ** (.066)	-2.8 ** (.066)	-2.7 ** (.059)	-2.7 ** (.059)
Unit is a single detached house	.81 ** (.057)	.80 ** (.057)	1.0 ** (.048)	1.0 ** (.048)
Unit is in center city	-.13 ** (.047)	-.12 * (.048)	-.24 ** (.046)	-.22 ** (.046)
Demographic Controls	Yes	Yes	Yes	Yes
MSA dummies	Yes	Yes	Yes	Yes
Constant	20.1 ** (1.0)	19.9 ** (1.0)	1.2 (1.1)	1.2 (1.1)
Number of observations	25,971	25,971	29,322	29,322
Log-likelihood	-9,417.7	-9,381.5	-10,400.7	-10,367.4
Percent correct predictions	85.2%	85.2%	85.6%	85.6%

Notes: Dependent variable: 1 if unit is owner-occupied, 0 if unit is rented. ** Indicates significance at the 1 percent level, * indicates significance at the 5 percent level. (*) indicates significance at the 10 percent level. Standard errors are in parenthesis. A 0.5 threshold was used to compute the percent of correct predictions. The sample sizes were restricted to those for the base specifications in order to make results comparable (see notes of Table 4 for details).

APPENDIX TABLE A4

Sensitivity Analysis for Base Model (Table 4), 1985 and 1999

Specification	Explanatory Variables	Only Junk /Litter Risk Measure 1985	All Four Risk Measures 1985	Only Junk /Litter Risk Measure 1999	All Four Risk Measures 1999
		(1)	(2)	(3)	(4)
Quadratic Rescaling	Std. dev. of junk/litter, 1985-1999	-.29 ** (.042)	-.22 ** (.045)	-.35 ** (.045)	-.27 ** (.047)
	Std. dev. of street noise, 1985-1999		-.078 ** (.018)		-.079 ** (.018)
	Std. dev. of neigh. noise, 1985-1999		-.21 (*) (.11)		-.36 ** (.12)
	Std. dev. of neigh. crime, 1985-1999		-.051 ** (.016)		-.063 ** (.017)
Square Roots Rescaling	Std. dev. of junk/litter, 1985-1999	-.69 ** (.087)	-.55 ** (.092)	-.93 ** (.088)	-.75 ** (.091)
	Std. dev. of street noise, 1985-1999		-.37 ** (.077)		-.43 ** (.082)
	Std. dev. of neigh. noise, 1985-1999		-.29 ** (.11)		-.41 ** (.11)
	Std. dev. of neigh. crime, 1985-1999		-.21 ** (.070)		-.19 ** (.075)

Note: Parameter estimates and significance levels of remaining explanatory variables remain virtually unchanged.

APPENDIX TABLE A5

Sensitivity Analysis for Change-in-Change Model (Table 7), 1985 and 1999

Specification	Explanatory Variables	Own 93→Rent 99 Only Junk/Litter	Own 93→Rent 99 All Four Risk Measures	Rent 93→Own 99 Only Junk/Litter	Rent 93→Own 99 All Four Risk Measures
		(1)	(2)	(3)	(4)
Quadratic Rescaling	Δ Risk measure for junk/litter	.31 ** (.071)	.30 ** (.074)	-.19 ** (.066)	-.18 ** (.068)
	Δ Risk measure for street noise		.15 ** (.027)		-.020 (.021)
	Δ Risk measure for neighborhood noise		.24 (.26)		-.12 (.18)
	Δ Risk measure for neighborhood crime		.11 ** (.028)		-.012 (.018)
Square Roots Rescaling	Δ Risk measure for junk/litter	.38 ** (.11)	.39 ** (.11)	-.33 ** (.090)	-.29 ** (.094)
	Δ Risk measure for street noise		.37 ** (.093)		-.15 * (.073)
	Δ Risk measure for neighborhood noise		.32 (.26)		-.10 (.18)
	Δ Risk measure for neighborhood crime		.35 ** (.096)		.0081 (.070)

Note: Parameter estimates and significance levels of remaining explanatory variables remain virtually unchanged.