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Harvard University

Impact of Changes in Household Composition on Home Improvement Decisions

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Abstract

Though total spending on residential renovation and repair activities is approaching $200 billion a year, spending by homeowners and rental property owners on improvements and repairs to the stock of existing housing units has received little attention in the academic literature. Historically, studies have focused heavily on the static characteristics of the housing unit (age, value, size, location) and of the occupants (age, income, household composition). This paper extends this inquiry by incorporating dynamic factors that influence home improvement decisions (changes in the composition of the household, prior period spending on home improvements), and relates these characteristics to the set of housing space-oriented improvements that might be expected to be influenced by these dynamic elements. The results of these enhancements are encouraging. Additions of household members are significantly related to home improvement activity, particularly for do-it-yourself projects undertaken by members of the household. Also, the overall performance of the model is enhanced with the inclusion of these variables. Additional refinements of this approach would further increase our understanding of the factors determining home improvement decisions.

Impact of Changes in Household Composition on Home Improvement Decisions

by

Kermit Baker and Bulbul Kaul

Introduction

Expenditures on improvements and repairs to the U.S. housing stock are a substantial component of economic activity. According to estimates from the Joint Center for Housing Studies at Harvard University based on the 1995 and 1997 American Housing Surveys, spending by homeowners on improvements to their homes (during 1994 to 1997) totaled in excess of $100 billion per year on average. Another $25 billion was spent on average by homeowners on routine maintenance and repairs. Spending by rental property owners, as well as spending on vacant and seasonal units for property maintenance and improvements, is estimated in a separate government survey[1] to have averaged $40 billion per year over these years. In total, therefore, spending on residential improvements and repairs probably averaged about $165 billion per year between 1994 and 1997, which is just 10% less than the $184 billion average annual spending on construction of new private housing units over this period, according to U.S. Commerce Department figures. Though rivaling new construction in terms of expenditure levels, the body of knowledge on home improvement activity pales in comparison.

There are several reasons why home improvement and repair decisions are understudied. Activities that are included in the home improvement and repair category typically encompass not only a broad range of activities, but also a broad range of motivations. Additionally, available data are generally inadequate to support a thorough analysis of the complexity of these decisions. For homeowners, a home improvement decision likely involves a complex set of decisions that are influenced by the characteristics (including location) and condition of the home, the characteristics of the occupants, available housing alternatives, and the likely impact of home improvement on the value of the house and its

resale potential. For rental property owners — who are not included in the analysis covered by this paper — cash flow considerations and investment returns are additional factors.

The goal of this paper is to improve the understanding of home improvement activities undertaken by homeowners by looking at the relationship between changes in household composition and the category of home improvement projects that deals with the use of space within the home. By testing the theory that certain home improvement projects help modify the home to the evolving preferences of their occupants, this paper contributes to the understanding of the motivation of homeowners in undertaking home improvements.

Changes made to the American Housing Survey (AHS) beginning in 1995 facilitate the task of identifying a relationship between changes in household composition and changes in housing consumption through home improvements. In previous surveys only nine categories of home improvement projects were identified in the AHS. Beginning with the 1995 survey, information on 70 categories of home improvement projects is collected. This additional detail allows considerably more insight into the nature and scope of the projects undertaken. When coupled with the ability to link multiple years of survey results together, the AHS allows researchers the ability to identify changes in household characteristics, and then look for adjustments in housing consumption that may arise from these changes.

Studies of Home Improvement Activity

Despite the importance of residential renovation and repair activities, empirical research on the determinants has only been recently developed. Mendelsohn (1977) provides the earliest household-focused research on factors associated with homeowner improvement activity. His analysis concentrated on total spending for all types of home improvements. Characteristics of the occupants were the principal variables used to explain improvements spending as well as the few housing characteristics and locational variables available in the dataset. Also, recognizing the importance of the distinction between hiring a contractor and doing it yourself (D-I-Y), the method of installation was a key part of the analysis. Mendelsohn finds that higher income households spend more and are also less likely to do the

[1] U.S. Department of Commerce. Current Construction Reports, Expenditures for Improvements and Repairs (C-50).

work themselves; that young owners do most of the work themselves; and that the elderly spend almost as much on improvements as do other age groups.

In an attempt to take into account the factors external to the dwelling unit and the owner, Boehm and Ihlanfeldt (1986) develop a more completely specified model of the improvement process by including variables that measure the relative cost of improvement as well as neighborhood quality. Though these variables are significantly related to improvement activity, the authors continue to be disappointed by the explanatory value of the models. The authors hypothesize that a possible reason for the low explanatory power of the models could be the "large intrinsically stochastic component" of these home improvement expenditures. They also cite a study by Arthur D. Little that concludes that "in many cases what homeowners decide to do in improving their properties has little to do with the measurable variables but rather reflects diverse preferences for alternative living arrangements."

Pollakowski (1988) estimates the determinants of nine types of improvement categories (bathroom remodeled or added, kitchen remodeled or added, new addition, all or part of the roof replaced, major equipment replaced or added, insulation, new siding, storm windows and doors, and other major activities) separately, and concludes that important differences exist. He uses a three-way discrete choice (multinomial logit) model for each of the nine renovation and repair categories. These three choices are (1) hiring a contractor for an improvement, (2) doing-it-yourself and (3) taking no significant action. As with previous research, he concluded that household determinants differ substantially between D-I-Y and contracted work. He also finds that household behavior differs within the renovation and repair categories. He finds income not to be very important in explaining D-I-Y activity but an important determinant of contractor activities, and even more so for discretionary activities such as room additions and bathroom work. Recent movers were found to be more likely to undertake certain remodeling activities. Age of household head and the age of structure were also found to be important factors.

Ziegert (1988) also distinguishes between different types of improvement and repair activity, and elects to focus his analysis exclusively on additions to the home. Relevant to our current research, Ziegert concludes that unmet consumption demand (rather than investment potential) is the primary influence on the household's decision to add onto their home.

Bogdon (1996) focuses her research on the homeowner's choice to hire a contractor for the home improvement as opposed to doing the project themselves. Also, like Pollakowski, Bogdon hypothesizes that different types of improvements may have different determinants and therefore estimates the determinants of improvements separately for each of the nine improvement categories covered by the AHS. She concludes that household characteristics are important determinants of the choice between doing the job oneself and hiring someone else to do the work. She also finds that married couple households or households with multiple adults are more likely to do the job themselves. Higher household income and more years of education were found to have a positive correlation with the probability of hiring outside help.

The past 25 years of research into the home improvement process have provided improved understanding of the characteristics of households that are likely to undertake projects. However, current models continue to have low explanatory power, no doubt reflecting that the household decision-making process regarding home improvements is complex. Any cross-sectional analysis of household and housing unit characteristics will provide only part of the answer. The household's decision is much more dynamic, and will no doubt be greatly influenced by previous home improvement activity, recent and planned changes in household composition, future mobility plans and so forth. While this research will attempt to deal with only a portion of these additional factors, the hope is to underscore the merits of expanding the factors considered in the empirical analysis of home improvements.

Incorporating Dynamic Elements into Home Improvement Decisions

Home improvement encompasses many diverse types of activities, for each of which there are likely to be different motivations. Replacement projects — such as roofing, siding, heating, plumbing and electrical systems, and exterior windows and doors — are likely to be determined primarily by the age, condition and other characteristics of the home. They often are analyzed simultaneously with more discretionary projects such as room additions, kitchen and bathroom remodels, and structural alterations; projects that are likely to be greatly influenced by the characteristics of the occupying households. We use the term "discretionary" home improvement project in this analysis to distinguish between projects that

are motivated by a desire to enhance the use of the home, versus replacement projects that help maintain the structural integrity or basic functioning of the home.

Most analysis of home improvement activities does not fully incorporate the dynamic elements of homeowner decisions. Many improvement projects, we hypothesize, can be thought of as mechanisms for a homeowner to adapt a home to their evolving needs. As household composition changes, a homeowner's use of the home may change. Improvements are one of the mechanisms to adjust the home to current needs. A focus of this paper will be to analyze the extent to which changes in household composition trigger major home improvement projects that impact the way the home is used.

There are other dynamic elements of the homeowner's improvement decisions that are unable to be adequately incorporated into this analysis. If a household wants to adjust its housing consumption, undertaking a home improvement is but one of the alternatives. Another common strategy is to move to a different home that more closely matches one’s housing preferences. Even then, homeowners may undertake improvements to tailor their new homes to their evolving tastes and needs. Data limitations hinder our ability to measure this behavior. The American Housing Survey, the principal database used for this analysis, is a panel of dwelling units, and once a household moves, that household is no longer tracked by the survey.

Finally, the low explanatory power of most models of home improvement behavior may be largely due to limited information on the current condition of the unit, the previous home improvement activities undertaken by the owner on that unit, and the owner's plans for future housing choices and home improvements. For example, if a household has recently remodeled the bathrooms in their home, the likelihood of undertaking a bathroom remodeling project is no doubt less than another household with similar characteristics living in a home where the bathrooms haven't been updated for decades. Likewise, if a household is planning on moving soon, the likelihood of undertaking a home improvement project is probably less (ignoring resale considerations) than a comparable household that is not planning on moving for some time, and therefore could enjoy the benefits of a home improvement for many years. This is especially true for significant structural modifications such as room additions.

Data Description

The database used in this analysis is a linked public use file of the 1993, 1995 and the 1997 American Housing Surveys. The three surveys were longitudinally linked to look at the effect of changes in household composition over 1995-97 period on the modification of space within the house. The reason for linking the 1993 AHS to this file was to incorporate recent spending on home improvements into the analysis as well as to obtain baseline information on household composition. The 1995 and 1997 surveys offer the same level of job detail. There is also a great level of job detail available for both of these survey years. (See Appendix Table I for survey questions on home improvement spending.) This detail was particularly useful in developing more precise aggregations of project categories. (See Appendix Table II for listing of detailed remodeling categories listed in the source database).

Homeowners that lived in their homes continually over the 1992-1997 period were included in the analysis. The database contained 31,449 (61.2 million weighted) owner-occupied homes in 1993, 29,384 (63.5 million weighted) in 1995 and 26,309 (65.4 million weighted) in 1997. Of these, only single-family attached and detached units were retained; mobile homes and condos were dropped from the analysis because the remodeling behavior in these structures is believed to be sufficiently different from that in single family homes. This left 52.2 million units in 1993, 54.0 million units in 1995 and 55.2 million units in 1997. Only units that were successfully interviewed in all three years were kept in the file. Units where all household members moved in after the 1993 survey were dropped. The final sample comprises of 14,850 (36.1 million weighted)[2] owners who live in single-family attached and detached homes and continually occupied their homes between 1993 and 1997.

Overall, as shown in Table 1, 80% of homeowners report a job over the 1994-1997 period. Over 80% of the homeowners reported no expenditures for projects in the discretionary category but did report expenditures for projects in other categories: replacements; improvements to the property, or disaster-related repairs. Almost half of the households reported one or more do-it-yourself (D-I-Y) home improvement projects.

[2] 1997 weights

Table 1
Home Improvement Projects

	Number of homeowners (millions)	Percent of total
Total	**36.1**	
Any Do-It-Yourself Project (1994-1997)	16.5	45.7%
Discretionary	6.6	18.3%
Replacement/other	14.8	40.9%
Any Professional Project (1994-1997)	23.3	64.5%
Discretionary	6.6	18.3%
Replacement/other	22.2	61.5%
Any Project (1994-1997)	29.7	82.2%
Discretionary	11.8	32.6%
Replacement/other	28.6	79.1%

Do-It-Yourself Jobs - Someone in the household completed the job
Professional Jobs - Someone outside the household completed the job

Note : Categories sum to more than total because a household may undertake projects in more than one category
Source : Joint Center Tabulations of the 1993-1997 American Housing Survey

Between 1993 and 1997 10.2% of all owner households reported adding at least one minor child (household member less than 18 years of age) to their household. Additionally, 7.0% of owner households reported adding a household member other than a child. Of the people who have lived in their homes over the 1993-97 period, 15.2% experienced some increase in their overall composition.

Table 2
Homeowners with Additions to Household

Changes in household composition	Number of households (in 000s)	Percent
Added a child	3,684	10.2%
Added other than a child	2,547	7.0%
Any increase in the household composition	5,491	15.2%
All Homeowners	36,147	100.0%

Source : Joint Center Tabulations of the 1993-1997 American Housing Survey

A change in the composition of the owner households appears to strongly impact the likelihood of undertaking a home improvement project, especially discretionary jobs. Overall, 33% of all owners reported expenditures for a discretionary project, compared with 46% of owners who added one or more children to their household during 1993-1997. (See Table 3.)

Without controlling for household or housing characteristics, the impact of a change in household composition appears to be more substantial for D-I-Y activities than it does for professionally installed projects. Just over 18% percent of all owners reported D-I-Y discretionary expenditures over this period, compared with 31.6% of owners who added a child, and 26.2% who added another household member. While almost the same proportion of all owners reported professionally installed discretionary projects as reported D-I-Y projects (18.3%), 21.5% of owners that added a child reported expenditures in this category.

Table 3
Changes in Household Composition and Home Improvement Projects

	Added a child	Added other	All Homeowners
Total (in 000s)	3,684	2,547	36,147
Any Do-It-Yourself Project (1994-1997)	64.9%	54.6%	45.7%
Discretionary	31.6%	26.2%	18.3%
Replacement/other	58.5%	48.2%	40.9%
Any Professional Project (1994-1997)	67.3%	63.4%	64.5%
Discretionary	21.5%	20.0%	18.3%
Replacement/other	64.0%	61.1%	61.5%
Any Project (1994-1997)	90.7%	84.8%	82.2%
Discretionary	46.3%	40.2%	32.6%
Replacement/other	87.4%	81.1%	79.1%

Source : Joint Center Tabulations of the 1993-1997 American Housing Survey

Changes in household composition, therefore, appear to be strongly associated with undertaking home improvement projects, particularly those types of projects that impact the use of space within the home. We also looked at the uncontrolled expenditures for these categories. Those who added a child spend about $500 more on discretionary jobs than the

average homeowner. This difference is even more substantial for professionally installed jobs. Households that added a child spend $3000 on average more than the average homeowner does even though about an equal proportion of each group undertakes a professionally-installed project. Expenditures for replacements do not vary a lot.

Table 4
Household Composition Change and Average Expenditures

	Number of households reporting jobs (000s)	Mean Expenditure
D-I-Y Expenditures		
All Homeowners		
Discretionary	6,618	$3,526
Replacement/other	14,787	$1,541
Added a child		
Discretionary	1,166	$4,070
Replacement/other	2,156	$1,770
Added other than a child		
Discretionary	668	$4,533
Replacement/other	1,228	$1,497
PRO Expenditures		
All Homeowners		
Discretionary	6,619	$8,015
Replacement/other	22,216	$4,604
Added a child		
Discretionary	792	$11,042
Replacement/other	2,359	$5,093
Added other than a child		
Discretionary	510	$11,195
Replacement/other	1,555	$5,058
Source : Joint Center Tabulations of the 1993-1997 American Housing Survey		

However, it is possible that owners who experience changes in their household composition also have other characteristics that are associated with higher levels of home improvement activity, such as higher incomes, larger homes, higher-valued homes, and so forth. In our model we control for these standard demographic, socioeconomic and housing stock variables that are traditionally used to explain home improvement activity.

Model and Hypothesized Outcomes

A multinomial logit model is used to identify the impact of change in household composition on home improvement activities. The dependent variable relates to the choice between a D-I-Y discretionary project, a professionally installed discretionary project, and not doing any home improvements. This variable captures projects undertaken over the four-year period 1994-97, and thus is able to measure home improvement activity that might have been undertaken in anticipation of or after a change in household composition. Although a household could have reported both a D-I-Y and a pro job, we only retain those households where there is no overlap between these categories.[3] The explanatory variables include recent remodeling spending, age of reference person, household composition, race/ethnicity, region, metro area, year unit was built, years in the unit, years of education, income, value of the house, number of adults in the household and number of rooms in the house in 1993 and increases in household composition in 1993-1995 or 1995-1997. The reference group contains 35-44 year olds, married couples with children, with no increases in household composition in 1993-1995 or 1995-1997, white, living in the northeast, and that have lived in the unit for less than 2 years in 1993. They also live in a home built between 1980 and 1993, with an average of 2.1 adults in 6.6 rooms, with income of about $50,000 in a house worth about $113,000. (Appendix Table III provides the average characteristics for these variables).

[3] Since we have aggregated some job categories, there is obviously some overlap between households that report a D-I-Y discretionary and those that report a pro discretionary job. These categories should be independent, and therefore we eliminate all the households where both job types were reported (677 households, 1.7 million weighted). We still have 2,031 households (5 million weighted) reporting only a pro discretionary job and 1,988 households (5 million weighted) reporting only a D-I-Y discretionary job. If a household reported both a discretionary job and a replacement job within either the D-I-Y or the pro category, then we regard it as having completed a discretionary job, since we are not interested in modeling replacement jobs for the purpose of this paper.

Model Description:

Following Pollakowski (1988), we use a three way discrete choice (multinomial logit) model to estimate the choice between the following categories of home improvement projects undertaken by homeowners:

Choice:

1. Do-It-Yourself discretionary projects
2. Professional discretionary projects
3. No home improvement projects reported

Regressors:

Constant, recent spending, age, household composition, race/ethnicity, region, metro area, year built, years in the unit, years of education, household income, value of the house, adults in the household, number of rooms in the house, increases in household composition

The multinomial logit can also be thought of as a series of binary logits. However, we want to simultaneously compare the effects of our independent variables on the choice of these two remodeling categories, and not doing anything. The generalized model can be hypothesized to be a function of various socioeconomic and demographic factors, and can be expressed as:

Choice = *f* (recent spending, age, household composition, race/ethnicity, changes in household composition, etc.)

Let y be the dependent variable with J nominal outcomes. The categories are numbered 1 through J, and do not have to be in any particular order[4]. We assume **Pr (y = m | x_i)** to be the probability of observing outcome m given x, and a function of the linear combination of $x\beta_m$. To ensure nonnegative probabilities we take the exponent of $x\beta_m$. In order to make the probabilities sum to 1, we divide **exp($x\beta_m$)** by $\Sigma^J_{j=1}$ **exp ($x\beta_j$),** the sum of all probabilities**.** The predicted probability that y = m given x is

$$\Pr(y = m \mid x_i) = \exp(x_i\beta_m) \; / \; \Sigma^J_{j=1} \exp(x_i\beta_j)$$

[4] Long, J.Scott. 1997. *Regression Models for Categorical and Limited Dependent Variables.* Sage Publications.

In our model we have assumed the third outcome, no home improvement projects were reported between 1994-1997, to be the reference category, so $\beta_3 = 0$. Therefore, $\exp(x\beta_3) = 1$. Thus, the probability of each outcome can be expressed as

$$\Pr(y = 1 \mid x_i) = \exp(x_i\beta_1) \,/\, 1 + \Sigma^2_{j=1} \exp(x_i\beta_j)$$
$$\Pr(y = 2 \mid x_i) = \exp(x_2\beta_2) \,/\, 1 + \Sigma^2_{j=1} \exp(x_i\beta_j)$$
$$\Pr(y = 3 \mid x_i) = 1 \,/\, 1 + \Sigma^2_{j=1} \exp(x_i\beta_j)$$

All coefficients generated by the model are with respect to this reference or base category. The effects of various variables on the probability of doing a D-I-Y or a professional discretionary job are estimated against this choice of not doing anything. The effect of each independent variable is allowed to differ for each of the outcomes. Thus, the effect that adding a child could have on the probability of a D-I-Y discretionary job is allowed to differ from the effect of the same variable on the likelihood of undertaking a professional discretionary job.

Hypothesized Effects*:*

1) *Target Demographic Variables: Added Minor to Household; Added Other Than Minor to Household.*

The focus of this analysis is to determine the impact of household additions on home improvement decisions of homeowners. Even though the addition of household members puts added financial burdens on the household, we hypothesize that households which add members will be more likely to undertake home improvement projects to accommodate these new members, and modify the home to changing use patterns.

Home improvements may occur either in anticipation of a change in composition, about the same time as a change in composition, or after the fact when the household decides that an increase in household size necessitates a change in the use of the home. In an attempt to capture the home improvement responses, we measure home improvements over a four-year period, 1994 through 1997.

Some types of household additions may prompt a different response in home improvements than others. A young married couple having their first child may well spark modifications to the home to accommodate that child, as well as anticipated future children. A friend or relative that joins a household for what is expected to be a limited period of time probably won't prompt the same level of home improvement activity. We create a variable for the addition of one or more minor children, and another for the addition of one or more household members.

The other variables used in the estimation model are intended more as control variables to accurately measure the impact of changes in demographic composition on home improvement activity.

2) Socioeconomic Factors: Income, Value and Education.

The model includes several measures of current and potential future ability to pay for home improvements. Total household income for the 12 months preceding the interview is a standard measure of the household's ability to afford a home improvement. Higher income is expected to increase the likelihood of a professional discretionary job, although the impact of higher incomes on D-I-Y projects is more difficult to anticipate. We also include income in its quadratic form to estimate the expected diminishing returns of income on home improvement activity.

House value and years of education are included as proxies for wealth and future earning potential. Occupants of homes with greater value or that have higher levels of education would be expected to make more major discretionary improvements to their home. Such households would also be more likely to hire professionals to undertake projects. Presumably, higher quality work is desired in higher valued homes (Mendelsohn, 1977).

3) Duration of Tenure.

Duration of tenure is thought to be a very important determinant of remodeling expenditures. Recent movers, for example, would more likely make discretionary adjustments in the first couple of years after moving in order to customize the home to their preferences, and get maximum use out of any improvement that they might make to the home. In previous research by the Joint Center (Improving America's Housing, 1999; McArdle, 1996) home improvement activity is shown to decline the longer the home has been owned. Thus, we

include the number of years in the current unit to account for the time that the household has had to make desired modifications to the home.

4) Demographic Factors: Age of Household Head, Household Size, and Composition.

Older homeowners would be expected to undertake fewer D-I-Y projects due to the physical demands of these projects, and therefore more likely to hire a professional contractor to undertake a home improvement. Since costs are greater for professional projects, older households might be expected to undertake fewer projects in general.

Larger households, where the living space is used more intensely, might be expected to undertake more home improvement projects. Smaller households, and households where the household composition is unlikely to change in the near future, are less likely to undertake home improvements since many of these projects are intended to adapt the home to changing needs and changing uses of the home.

5) Housing Characteristics: Age, Size, and Location of Home.

The frequency of home improvements would be expected to be higher for older homes since they have experienced greater levels of depreciation and are more in need of updating. Larger homes contain more space that may need to be improved. U.S. regions are included to pick up generally unmeasurable locational influences such as climate or housing characteristics that vary by location. Central city, suburban, and non-metropolitan location may influence the owner's ability to make improvements (particularly additions) due to zoning, building code, and land use restrictions.

6) Previous Spending on Home Improvements.

Spending during the previous two years (1992-1993) on home improvements is thought to be an indication that the household is in the midst of a larger wave of home improvement activities, and therefore has an increased likelihood of undertaking projects during the period under analysis. However, there is the alternative possibility that home improvement spending during the previous period indicates that a household has recently completed some home improvements, indicating that the home has recently been adapted and therefore is less likely to require additional modifications.

7) Race / Ethnicity.

Race and ethnicity are included to pick up discrimination or other market inefficiencies in home improvement activity related to these household characteristics. Bogdon (1996) finds

that “black households have a significantly lower probability of performing their own renovations than white households with comparable characteristics and comparable housing units”.

Empirical results

The coefficients of the variables in the multinomial logit model measure the difference between the impact of that variable on the probability of choosing one type of job (D-I-Y or pro) and the impact of the same variable on the probability of not undertaking a home improvement. Interpreting coefficients in the polytomous models is not as simple as looking at the signs and telling the effects of the variables on the change of the associated probabilities.

The results can be interpreted in two ways:[5]

Discrete Change in the Probabilities

We can calculate a discrete change in the probabilities by changing the independent variable from 0 to 1 for dummies, and plus and minus one standard deviation from the mean for continuous variables. At the means, the probability of a homeowner undertaking a D-I-Y discretionary job over this period is 25.0%, and that of a pro discretionary job is 32.9%. The probability of doing a D-I-Y discretionary job falls from 25.0% to 24.3% for a household that did not add a child and goes up to 31.6% for one that added a child, keeping everything else at the means. Table 5 summarizes D-I-Y and professional probabilities for selected house types keeping all the other variables at their means. For example, a married couple previously without children who have lived in their home for between 3 and 10 years, and who added a child, the probability of doing a professionally installed discretionary job jumps from under 33% to 41.0%.

[5] Long, J.Scott. 1997. *Regression Models for Categorical and Limited Dependent Variables.* Sage Publications.

Table 5
Discrete change in probabilities

	Professional discretionary	Do-It-Yourself discretionary	No job
Actual	30.1%	29.5%	40.4%
At the means	32.9%	25.0%	42.1%
If all households added a child	39.3%	31.5%	29.2%
If no household added a child	32.1%	24.3%	43.6%
If all households added someone other than a child	29.3%	36.4%	34.4%
If no household added someone other than a child	33.1%	24.3%	42.7%
Married without children in 1993 and added a child	38.6%	31.8%	29.6%
Married without children in 1993 and added a child, lived in the unit for 3 to 10 years in 1993	41.0%	31.1%	27.9%

Factor Change in the Odds

We can't always rely on the signs on the coefficients, because it is possible that the probability of some category (other than the base category), despite having a positive sign, will fall relative to another outcome. A more reliable way to look at the effects of variables in this kind of model is to look at the odds ratios, which are the odds of doing one job relative to another. We can analyze these odds as our exogenous variable changes. *For a unit change in the exogenous variable, the log of odds of outcome 1 versus the base category is expected to change by the exponent of the coefficient (exp (β_1) units) of that variable with respect to the base category, holding all other variables constant.*[6]

This interpretation does not depend on the level of the variable under investigation or that of any other. These odds are basically the difference in the coefficients of the exogenous

variable associated with the two outcomes. If the difference in the coefficients is positive, then increases in that independent variable will increase the likelihood of observing choice 1 relative to the base category. The odds of falling into one category versus another will be in the same direction as the difference of the coefficients. This difference in the coefficients will also tell us how the log of odds is expected to change for a one-unit change in the explanatory variable. Thus, the exponentiated value of a coefficient is the relative risk ratio for a one-unit change in the corresponding variable. This is measured relative to the probability of the base category. For instance, the relative probability of alternative 1 (doing a pro job) to the base category (alternative 3, not doing anything) is:

$\Pr(y=1) / \Pr(y=3) = \exp(X\beta_2) / \exp(X\beta_3) = \exp(X\beta_2)$, because $\beta_3 = 0$

This is exp (.607), or 1.835, an increase in the odds by 83.5% (See Table 6.) for someone who added a child. This measures the effect of a change in the dummy "*added a child*" on the probability of undertaking a pro discretionary job. The one unit change in the independent dummy variable is change from 0 to 1.

For a household that adds a child, the odds of doing a D-I-Y discretionary job relative to the base category (not doing any job) increase by 94.1%, holding all other variables constant. For professionally installed jobs, the effects are also quite sizeable, with an increase in odds of 83.5% over the base category. For those who added someone other than a child, the odds of D-I-Y discretionary jobs go up by over 85% relative to not doing anything, and by 69.1% relative to a pro job.

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[6] Long, J.Scott. 1997. *Regression Models for Categorical and Limited Dependent Variables.* Sage Publications.

Table 6
Factor Changes in the Odds

For added a child					
Contrast	Coef.	z	P>|z|	Relative Risk Ratio	Percent change in odds
Projob -Diyjob	-0.056	-0.514	61%	0.946	-5.4%
Projob -Nojob*	**0.607**	**4.828**	**0%**	**1.835**	**83.5%**
Diyjob -Projob	0.056	0.514	61%	1.058	5.8%
Diyjob -Nojob*	**0.663**	**5.574**	**0%**	**1.941**	**94.1%**
Nojob -Projob*	**-0.607**	**-4.828**	**0%**	**0.545**	**-45.5%**
Nojob -Diyjob*	**-0.663**	**-5.574**	**0%**	**0.515**	**-48.5%**
For added someone other than a child					
Contrast	Coef.	z	P>|z|	Relative Risk Ratio	Percent change in odds
Projob -Diyjob*	**-0.525**	**-4.144**	**0%**	**0.591**	**-40.9%**
Projob -Nojob	0.094	0.726	47%	1.098	9.8%
Diyjob -Projob*	**0.525**	**4.144**	**0%**	**1.691**	**69.1%**
Diyjob -Nojob*	**0.619**	**4.897**	**0%**	**1.857**	**85.7%**
Nojob -Projob	-0.094	-0.726	47%	0.911	-8.9%
Nojob -Diyjob*	**-0.619**	**-4.897**	**0%**	**0.539**	**-46.1%**
* - Significant at the 99% confidence level					

The effects of the control variables are as expected. Higher income homeowners are more likely to undertake discretionary home improvement projects—both D-I-Y and pro—although there are diminishing returns to income for very high-income households. Owners with higher levels of education, i.e., those who can anticipate increased future earnings, are more likely to undertake pro projects, whereas owners of expensive homes are less likely to undertake D-I-Y projects. Owners that have lived in their homes longer are more likely to hire pros than to undertake improvements themselves.

Older households and households other than married couples are less likely to undertake D-I-Y projects. Occupants of older homes and larger homes are both more likely to undertake D-I-Y projects and to undertake pro projects as compared to doing no projects. Location of the home is not significantly related to undertaking pro projects, but owners in the Midwest and West, as well as those in suburban locations, are more likely to undertake D-I-Y projects.

Having completed a home improvement in the previous two years is associated with an increased probability of undertaking a job, both for D-I-Y and pro jobs. This may indicate that major improvements often are undertaken over a longer period of time. Blacks are significantly more likely to undertake jobs with professionals, and less likely to undertake D-I-Y jobs.

Significance Tests and Model Fit

We ran simple Wald tests on the significance of independent variables, both across alternatives and for a particular alternative (See Appendix Table V). Since these tests are based on a covariance matrix of the coefficients, they only give us an approximation. A likelihood ratio test is more reliable in such cases. This involves running two models, the unconstrained model which include the variables whose impact we are interested in assessing, and a constrained model in which we set the coefficients of that variable to zero.

$-2 \log ([L_R - L_{UR}])$, where $\mathbf{L_R}$ is the likelihood ratio for the restricted equation when the null hypothesis is used and $\mathbf{L_{UR}}$ is the likelihood ratio for the unrestricted equation.
This statistic follows a chi-square distribution. The likelihood ratio tests also yield significant results for all household change categories.

Table 7
Likelihood Ratio Tests

	for adding a child
chi2(2)	36.5
Prob > chi2	**0.0000***
	for adding other than a child
chi2(2)	27.7
Prob > chi2	**0.0000***
	Both
chi2(2)	74.1
Prob > chi2	**0.0000***

* - Significant at the 95% confidence level

There are several other ways to interpret the overall fit in these models. We could use the pseudo R^2 **,** which is **pseudo R^2 = 1- (L_R /L_{UR}),** where **L_R** is the likelihood ratio for the restricted equation (with just the intercept), and **L_{UR}** is the likelihood ratio for the unrestricted equation (model including the regressors). For this model the value of the pseudo R^2 is .134. Without the household change variables the pseudo R^2 drops to .128. Therefore, the household change variables add to the explanatory power of the model but only marginally so. Using a table for actual versus predicted values we arrive at the **count R-squared**[7] which is a measure of the percentage of correct predictions. Using this statistic we get 54.6% of the cases predicted correctly.

Table 8
Frequencies of Actual and Predicted Outcomes

	Actual				
Predicted*	**No Action**	**Professional**	**Do-It-Yourself**	**Total**	**correctly predicted**
No Action	**1,854**	843	550	3,247	
Professional	371	**678**	288	1,337	
Do-It-Yourself	494	510	**1,150**	2,154	
Total	2,719	2,031	1,988	6,738	54.6%

*Predicted outcome has maximum probability determined from the model results
Bold - Correct Predictions

Summary and Conclusions

In spite of being a large and dynamic industry, very little research has been conducted on the determinants of home improvement activity. The research that has been undertaken has looked at this activity from a static perspective, namely that home improvements are determined by owner characteristics and the current characteristics of the home (including its location). The purpose of this research is to add a dynamic element to the analysis, consequently that the addition of members to a household acts as an additional determinant of

[7] Maddala (1992, p. 334)

home improvement activity and that this factor impacts on homeowner improvement decisions in a variety of ways.

The results of this approach are very encouraging: by including the types of variables in previous models of homeowner improvement activity, variables which measure the addition of household members turn out to be highly significant determinants of space oriented (discretionary) homeowner improvements, particularly for homeowner installed (D-I-Y) projects. Furthermore, the overall performance of the model is enhanced with the inclusion of these variables as supported by the likelihood ratio tests. A three-way discrete choice model yielded estimates that correctly predicted the outcome (no action; D-I-Y project; professionally installed project) in almost 55% of the cases.

In spite of these results, however, the overall performance of the model remains somewhat disappointing, indicating that other factors influence home improvement decisions. Further enhancements to this approach would no doubt improve the results. In particular, since our approach included only owners that had occupied their home at least two years prior to the home improvement, we missed the most active home improvers—recent movers. Secondly, in limiting the improvement categories analyzed to "discretionary" projects, we inevitably included some projects that would not be expected to directly result from changes in household composition. A database that included more specific information on the type of home improvement project would help identify appropriate projects. On the other hand, the low frequency of these more targeted projects might introduce new methodological problems.

Third, since we restricted our analysis to owners that remained in their home during the entire six-year period, we omitted households that moved to a different home because of a change in the composition of their household. In doing so, we missed an important response in housing consumption from changes in household composition. Fourth, we have very little information on the condition of the home, or the range of improvements made by the owner prior to the period of analysis, both of which could be expected to influence the decision to improve their home. Finally, having more data on home improvement financing in the database would assist in the analysis of the owner's ability to afford home improvements, and willingness to undertake home modification projects.

Appendix Table I
Home Improvement Spending Questions on the American Housing Surveys

Questionaire - American Housing Survey, Home Improvement Spending - 1995 & 1997

Project Category - See Appendix Table II for complete list
1- 70 different tasks are covered

Total cost of replacements/additions reported

Someone in household did most of work for task
1 - Yes
2 - No
8 - Not reported
9 - Not applicable

Appendix Table II
Home Improvement Categories Included in the American Housing Survey

	Discretionary Jobs
1	Created finished bathroom from unfinished space
2	Created finished bedroom from unfinished space
3	Created finished kitchen from unfinished space
4	Created finished recreation room from unfinished space
5	Created other finished inside room from unfinished space
6	Add bathroom onto home
7	Add kitchen onto home
8	Add bedroom onto home
9	Add other inside room onto home
10	Add / Replace porch
11	Add / Replace deck
12	Moved walls in bathroom
13	Add / Replace cabinets in bathroom
14	Add / Replace flooring in bathroom
15	Add / Replace counter tops in bathroom
16	Add / Replace toilet in bathroom
17	Add / Replace tub / shower in bathroom
18	Add / Replace sink in bathroom
19	Add / Replace lighting fixtures in bathroom
20	Add / Replace other electrical items in bathroom
21	Painted / papered / wall tiled bathroom
22	Moved walls in kitchen
23	Add / Replace cabinets in kitchen
24	Add / Replace flooring in kitchen
25	Add / Replace counter tops in kitchen
26	Add / Replace other built-in appliances in kitchen
27	Add / Replace sink in kitchen
28	Add / Replace lighting fixtures in kitchen
29	Add / Replace other electrical items in kitchen
30	Painted / papered / wall tiled kitchen
31	Bedroom created through structural changes
32	Other room created through structural changes
33	Other major improvements / repairs inside home (up to three)
	Replacements and other jobs
1	Disaster required repairs
2	Add / Replace garage
3	Add / Replace carport
4	Add / Replace other outside structure
5	Add / Replace roof over entire house
6	Installed / Add siding to home
7	Replace / covered siding on home
8	Add internal water pipes to home
9	Replace internal water pipes in home
10	Add electrical wiring to home
11	Completely rewired the electrical wiring in home
12	Add / Replace fuse boxes or breaker switches
13	Add doors / windows to home
14	Replace doors / windows in home
15	Add plumbing fixtures to home
16	Replace plumbing fixtures in home
17	Add insulation to home
18	Replace insulation in home
19	Add wall-to-wall carpeting over bare sub flooring
20	Add wall-to-wall carpeting over a finished floor
21	Add other types of flooring over bare sub flooring
22	Replace finished flooring with same / different type of flooring
23	Installed new paneling / ceiling tiles
24	Replace existing paneling / ceiling tiles
25	Installed / Replace central air conditioning
26	Replace built in heating equipment
27	Installed new built in heating equipment
28	Add / Replace septic tank
29	Add / Replace water heater
30	Add / Replace dishwasher
31	Add / Replace garbage disposal
32	Add / Replace driveways / walkways
33	Add / Replace fencing or walls
34	Add / Replace patio, terrace, or detached deck
35	Add / Replace swimming pool, tennis court, or other rec. structure
36	Add / Replace shed, detached garage, or other building
37	Other major improvements or repairs to lot or yard (up to three)

Appendix Table III
Variable Definitions and Means of Independent Variables in 1993.

Variable	Mean	Std. Dev.
Prior Period Spending		
Completed a discretionary job in 1993	20%	0.40
Age of the reference person		
Age of the reference person	52.7	15.4
Age of the reference person squared	3,011	1,711
Household Composition		
Married Couples with children	31%	0.46
Married couple without children	39%	0.49
Other with children	5%	0.22
Single	14%	0.35
Other	10%	0.30
Race/Ethnicity		
White	86%	0.35
Black	7%	0.26
Hispanic	5%	0.21
Other	2%	0.15
Region		
Northeast	21%	0.41
North Central	27%	0.45
South	34%	0.47
West	18%	0.38
Metropolitan area		
Central City	22%	0.42
Suburb	51%	0.50
Non Metro	26%	0.44
Year Built		
Built between 1980 & 1993	17%	0.38
Built in the 1970s	19%	0.39
Built in the 50s and 60s	34%	0.47
Built in the 1940s	9%	0.28
Built before the 1930s	21%	0.40
Number of years in the unit		
Two years of less	10%	0.30
Between 3 and 10 years	34%	0.47
Between 10 and 15 years	11%	0.32
Between 15 and 20 years	11%	0.32
Over 20 years	33%	0.47
Years of education	13.0	3.1
Household Income (thousands)	46.8	35.0
Household Income squared (millions)	3,409.1	5,526.0
Value of the house (thousands)	112.9	80.0
Number of adults in the household	2.1	0.8
Number of rooms in the house	6.6	1.6
Changes in the household composition		
Added a child 1994-1997	10%	0.31
Added other than a child 1994-1997	8%	0.27

Appendix IV
Model Results – DIY Discretionary

Do-it-Yourself Discretionary Jobs	Coef.	Std. Err.	z	P>|z|
Completed a discretionary job in 1993**	**0.633**	**0.085**	**7.474**	**0%**
Age	-0.010	0.019	-0.506	61%
Age squared**	**-0.0004**	**0.000**	**-2.293**	**2%**
Married without kids	-0.012	0.094	-0.127	90%
Other with kids**	**-0.384**	**0.156**	**-2.465**	**1%**
Single**	**-1.063**	**0.154**	**-6.883**	**0%**
Other households**	**-0.419**	**0.134**	**-3.139**	**0%**
Black**	**-0.572**	**0.147**	**-3.899**	**0%**
Hispanic	-0.193	0.155	-1.246	21%
Other race**	**-0.691**	**0.240**	**-2.880**	**0%**
North Central*	**0.169**	**0.100**	**1.695**	**9%**
South	0.039	0.100	0.392	70%
West**	**0.374**	**0.114**	**3.294**	**0%**
Suburb*	**0.157**	**0.088**	**1.779**	**8%**
Non Metro	-0.087	0.100	-0.867	39%
Built in the 1970s*	**0.995**	**0.114**	**8.726**	**0%**
Built in the 50s and 60s**	**0.820**	**0.107**	**7.645**	**0%**
Built in the 1940s*	**0.877**	**0.148**	**5.906**	**0%**
Built before the 1930s**	**0.761**	**0.119**	**6.391**	**0%**
Between 3 and 10 years	0.057	0.113	0.506	61%
Between 10 and 15 years	0.034	0.143	0.240	81%
Between 15 and 20 years	-0.210	0.153	-1.375	17%
Over 20 years	-0.092	0.142	-0.651	52%
Years of education	-0.009	0.013	-0.674	50%
Household Income (thousands)**	**0.019**	**0.003**	**6.058**	**0%**
Household Income squared (millions)**	**-0.0001**	**0.000**	**-5.316**	**0%**
Value of the house (thousands)**	**-0.005**	**0.001**	**-8.479**	**0%**
Number of adults in the household	0.058	0.051	1.132	26%
Number of rooms in the house**	**0.086**	**0.024**	**3.524**	**0%**
Added a child 1994-1997**	**0.663**	**0.119**	**5.574**	**0%**
Added other than a child 1994-1997**	**0.619**	**0.126**	**4.897**	**0%**
Constant	-0.089	0.518	-0.173	86%
		Number of obs	6738	
* - Significant at the 90% confidence level		chi2(62)	1958.49	
** - Significant at the 95% confidence level		Prob > chi2	0	
		Pseudo R2	0.1336	

Appendix IV – continued
Model Results – Professional Discretionary

Professionally Installed Discretionary Jobs	Coef.	Std. Err.	z	P>|z|
Completed a discretionary job in 1993**	**0.530**	**0.082**	**6.430**	**0%**
Age	-0.016	0.017	-0.977	33%
Age squared	0.000	0.000	0.904	37%
Married without kids	-0.055	0.096	-0.580	56%
Other with kids	0.174	0.160	1.088	28%
Single*	**-0.221**	**0.133**	**-1.660**	**10%**
Other households	0.064	0.124	0.517	61%
Black**	**0.319**	**0.118**	**2.702**	**1%**
Hispanic	-0.161	0.165	-0.978	33%
Other race	-0.318	0.212	-1.502	13%
North Central	0.114	0.093	1.219	22%
South	0.067	0.092	0.727	47%
West	0.097	0.103	0.942	35%
Suburb	0.055	0.081	0.675	50%
Non Metro	-0.050	0.093	-0.532	60%
Built in the 1970s**	**1.005**	**0.114**	**8.797**	**0%**
Built in the 50s and 60s**	**0.921**	**0.107**	**8.616**	**0%**
Built in the 1940s**	**0.789**	**0.144**	**5.483**	**0%**
Built before the 1930s**	**0.729**	**0.119**	**6.143**	**0%**
Between 3 and 10 years	0.176	0.119	1.483	14%
Between 10 and 15 years	0.090	0.147	0.613	54%
Between 15 and 20 years**	**0.297**	**0.150**	**1.977**	**5%**
Over 20 years	0.164	0.138	1.181	24%
Years of education**	**0.092**	**0.012**	**7.391**	**0%**
Household Income (thousands)**	**0.019**	**0.003**	**7.358**	**0%**
Household Income squared (millions)**	**-0.0001**	**0.000**	**-4.506**	**0%**
Value of the house (thousands)	0.000	0.001	-0.546	59%
Number of adults in the household*	**-0.094**	**0.051**	**-1.862**	**6%**
Number of rooms in the house**	**0.091**	**0.023**	**4.034**	**0%**
Added a child 1994-1997**	**0.607**	**0.126**	**4.828**	**0%**
Added other than a child 1994-1997	0.094	0.129	0.726	47%
Constant	-3.124	0.493	-6.332	0%
		Number of obs	6738	
* - Significant at the 90% confidence level		chi2(62)	1958.49	
** - Significant at the 95% confidence level		Prob > chi2	0	
		Pseudo R2	0.1336	

Appendix V – Significance tests and Fit Statistics

Wald Tests

	D-I-Y Discretionary	**Professional Discretionary**	**Both**
for adding a child			
	chi2(1) = 31.1	chi2(1) = 23.3	chi2(2) = 34.4
	Prob > chi2 = 0.0000	**Prob > chi2 = 0.0000**	**Prob > chi2 = 0.0000**
for adding other than a child			
	chi2(1) = 23.9	chi2(1) = .5	chi2(2) = 28.2
	Prob > chi2 = 0.0000	Prob > chi2 = 0.4683	**Prob > chi2 = 0.0000**

Bold - Significant at the 95% confidence level

Fit Statistics

Log-Lik Intercept Only:	-7329.756	Log-Lik Full Model:	-6350.511
McFadden's R2:	0.134	McFadden's Adj R2:	0.125
Maximum Likelihood R2:	1	Cragg & Uhler's R2:	1
Count R2:	0.547	Adj Count R2:	0.24
D(6674):	12701.021	G2(31):	1958.491
AIC:	1.904	AIC*n:	12829.021
BIC:	-46133.749	BIC':	-1685.21

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