

Federal Reserve Bank of New York
Staff Reports

Using Home Maintenance and Repairs
to Smooth Variable Earnings

Joseph Gyourko
Joseph Tracy

Staff Report no. 168
May 2003

This paper presents preliminary findings and is being distributed to economists and other interested readers solely to stimulate discussion and elicit comments. The views expressed in the paper are those of the authors and are not necessarily reflective of views at the Federal Reserve Bank of New York or the Federal Reserve System. Any errors or omissions are the responsibility of the authors.

Using Home Maintenance and Repairs to Smooth Variable Earnings

Joseph Gyourko and Joseph Tracy

Federal Reserve Bank of New York Staff Reports, no. 168

May 2003

JEL classification: D12, E21, R21

Abstract

Recent research indicates that the marked increase in U.S. income inequality over the last twenty-five years has not been matched by a similar increase in consumption inequality. This paper examines the role of saving/dissaving in a house as a vehicle for consumption smoothing. Data from the *American Housing Survey* show that expenditures on home maintenance and repairs are economically significant, amounting to roughly \$1,750 per household each year. This figure is comparable to the labor literature estimates that put households' average annual transitory income variance at about \$2,200. Our calculations show a significant elasticity of maintenance and repair expenditures to transitory income shocks. The elasticities are higher for less well educated households, which are more likely to be liquidity constrained than their better educated counterparts.

Gyourko: Real Estate and Finance Departments, Wharton School, University of Pennsylvania (e-mail: gyourko@wharton.upenn.edu); Tracy: Research and Market Analysis Group, Federal Reserve Bank of New York (e-mail: joseph.tracy@ny.frb.org). The authors thank Alisdair McKay and Richard Thompkins for their research assistance and Albert Saiz and Peter Linneman for helpful comments on an earlier draft. The views expressed in the paper are those of the authors and do not necessarily represent the position of the Federal Reserve Bank of New York or the Federal Reserve System.

Among the many challenges households face in managing their daily lives, one that has received increased emphasis from economists is how to cope with year-to-year fluctuations in family income. These fluctuations can be quite large, have increased substantially over time, and would impose hardships on the family if consumption had to move in sync with income. Moffitt and Gottschalk (1994, 1995) use *Panel Study of Income Dynamics (PSID)* data to document that transitory income variance increased 42 percent between 1970-78 and 1979-87—from just over 12 percent to just over 22 percent of annual income. More recently, Cameron and Tracy (1998) report using *Current Population Survey (CPS)* data that transitory income variance increased by two-thirds between 1967-71 and 1992-96.¹

In positing the permanent income hypothesis, Friedman (1957) reasoned that families would attempt to smooth transitory income fluctuations through savings and dissavings. A large literature has developed which tests for consumption smoothing in general and the permanent income hypothesis in particular.² Dynarski and Gruber (1997) [hereafter D&G] provide the most exhaustive recent assessment of the completeness and sources of consumption smoothing, concluding that the impacts of transfer payments and self-insurance via saving play similarly large roles in the smoothing of income shocks.

Our focus in this paper is on the use of housing as a buffer. That housing could play an important role in consumption smoothing is suggested by the fact that it is the dominant asset in most households' portfolios. Figure 1 shows the average asset allocation share for households based on the 1998 *Survey of Consumer Finance* data. Weighting each household equally, the

¹Cameron and Tracy (1998) report that transitory income variances decline sharply with education. However, over time transitory income variance has increased for all education levels.

²There are a number of good surveys of empirical work on consumption. See, for example, Browning and Lusardi (1996) and Deaton (1992).

average household in 1998 had over 40 percent of its assets tied up in a house and less than 15 percent invested in stocks and bonds. For homeowners, the average real estate share is even higher. Figure 2 reports median real estate and equity shares by wealth percentile in 1998. For households in the 40th to 80th percentiles of the wealth distribution, real estate accounts for roughly one-half to two-thirds of wealth. Only for the top five percent of the wealth distribution did the equity share equal or exceed the real estate share.³

Given the dominant role of housing in a homeowner's portfolio, it is natural to ask how important housing is as a vehicle for smoothing variable income flows. In a broader sense, homeownership undoubtedly helps smooth variation in "full" income—defined as measured income plus the imputed rental value of the house. The consumption flow of housing services almost certainly is quite stable compared to measured income. Essentially, how much a home would rent for on the market is only weakly correlated with the transitory income shocks to the owner's income. Thus, the proportionate change in an owner's full income from a transitory income shock will be less than the proportionate change in measured income.

Conditional on being an owner, saving or dissaving in one's home can occur in different ways. One avenue is to adjust the investment position in the unit by allowing maintenance and repair expenditures to fluctuate in response to income shocks. Another is to build or reduce equity via mortgage financing or refinancing. We analyze the first method of smoothing because of its relatively low fixed costs and because it is an economically feasible option for owners in virtually all market conditions. While refinancing involves larger fixed costs and may become

³In contrast, in the Flow of Funds Accounts data for 1998, the aggregate equity share in the household sector exceeded the aggregate real estate share. See Tracy, Schneider, and Chan (1999).

prohibitively expensive in rising interest rate environments, this method of smoothing has received substantial attention in the popular press over the past few years as interest rates as fallen to levels not seen in many decades. And, Hurst and Stafford (2002) provide a careful analysis of consumption smoothing via refinancing.

Hurst & Stafford conclude that homeowners do, indeed, smooth consumption via ‘cash out’ refinancings.⁴ Figure 3 plots the Mortgage Bankers Association index of refinancing activity, documenting that the volume of refinancing has increased dramatically over the past few years as mortgage rates have fallen to historic lows.⁵ Hurst and Stafford’s results indicate that liquidity constrained households were 19 percent more likely to have refinanced during the early 1990s. In addition, liquidity constrained households converted over 60 percent of the equity they removed while refinancing into current consumption. They find no evidence of similar behavior by unconstrained households who also refinanced.⁶

The potential for home maintenance and repair expenditures to be an important tool for smoothing idiosyncratic earnings variation is indicated by the fact that these expenses averaged 3.1% of annual household income in a panel of houses tracked by the *American Housing Survey*

⁴A ‘cash out’ refinancing occurs when a homeowner refinances mortgage debt and borrows more than is necessary to repay the outstanding balance plus closing costs.

⁵This rise in refinance activity may also reflect declines in the costs of refinancing as the mortgage lending market has become more competitive (see Bennet, Peach and Peristiani (2001)), as well as homeowners being more informed about refinancing options today than in the past. Moreover, a recent Federal Reserve Bank survey (see Canner, Dynan, and Passmore (2002)) found that 45 percent of homeowners who refinanced in 2001 and the first half of 2002 used the opportunity to take cash out of their home, with the mean (median) amounts of cash taken out being \$26,723 (\$18,500).

⁶This distinction between types of owners is potentially important because some of the consumption being funded through cash out refinancings may be ‘lumpy consumption’ such as college education, weddings, and purchases of durables like cars and trucks. This type of spending need not occur to buffer income shocks. That Hurst and Stafford find differential effects for credit constrained households seems to provide strong evidence of consumption smoothing.

(*AHS*). Conditional on a household making positive maintenance expenditures in a year, the average annual amount was just over \$1,750 in current dollars. Cameron and Tracy (1998) report that for the period 1992-96 the average transitory income variance was 8.5 percent, or \$2,200. Even with reductions in the fixed costs associated with mortgage refinancings, maintenance and improvements spending still should be less costly than housing debt to alter in response to income shocks. Moreover, most maintenance can be deferred equally well in rising and falling interest rate environments.

While not focusing on the role of housing, the D&G study cited above reports some intriguing results regarding this type of spending. Using *Consumer Expenditure Survey (CEX)* data, they estimate that “home services”, which consists of various repair and maintenance activities, has an elasticity of 0.60 with respect to income changes. The only larger elasticity was for durable goods which has an elasticity of 0.89.⁷ The *CEX* data, then, indicate that homeowners do save/dissave in their house in responding to income fluctuations.

We build on D&G’s approach by examining this question using an alternative data source, the *AHS*. The *AHS* data is particularly well suited to an analysis of the role of housing in consumption smoothing, as it allows us to look at income changes over wider time intervals and to control for characteristics of the household, the neighborhood, and the local housing market which could influence the estimated elasticities. In addition, we employ a friction regression model that captures the propensity for zero changes in maintenance expenditures (which are prevalent in the data) by assuming that small changes in desired expenditures (whether positive or

⁷These elasticities are taken from Table 4 of D&G and are based on their IV estimates. D&G also examined the *PSID* data which tracks consumption of food and housing expenditures. Housing expenditures in the *PSID* data consist of rent and mortgage payments. They find that the elasticity of housing expenditures in the *PSID* is significantly lower, ranging from 0.16 to 0.18 (see Table 3).

negative) do not result in changes in actual spending.⁸

Our results confirm that homeowners do engage in saving/dissaving in their home in order to offset income fluctuations. However, the magnitude of the offset appears to be substantially lower than D&G's instrumental variables (IV) estimate. That said, we do find a stronger effect for less-well educated households (i.e., household heads with no more than a high school degree). This is consistent with Hurst and Stafford in that these households are likely to be more liquidity constrained on average. Finally, we show that the use of one's house as a buffer via deferred (or accelerated) maintenance shows up in reported house values. That this behavior is internalized by homeowners is interesting in its own right, and it has potentially important implications for the accuracy of local area repeat sale house price indices.

Data and econometric issues

To estimate the elasticity of home maintenance decisions to transitory income fluctuations, we must observe both income changes and changes in household expenditures on home repair, maintenance and improvements. In addition, enough demographic and household composition variables must be available to permit measurement of transitory income variations about a life-cycle income path, as well as to control for any changes in a household's preferences for housing services.

The *AHS* is well suited to this task. Since 1985, this survey has been conducted every two

⁸See Rosett (1959). This approach also is consistent with an implication of the empirical work on maintenance which concludes that a Tobit model can be rejected in favor of a more flexible specification that breaks the link between the impact of a variable on the probability of a positive expenditure and on the magnitude of the expenditure given that it is positive (see Boehm and Ihlanfeldt (1986), Mendelsohn (1977), and Reschovsky (1992)).

years on a continuous panel of houses. The *AHS* data contain a unique identifier for each house, an indicator for whether the house is owned or rented, and the year in which it was purchased if the unit is owned. We restrict our attention to owned homes. For this subsample, the house identifier and the purchase year allow us to track households across surveys. The *AHS* data also provide detailed household demographic information which allow us to estimate a simple model of transitory income shocks, as well as to control for likely household preference changes for housing services. In addition, the *AHS* panel covers much of the 1980-1993 period examined by D&G, thereby allowing us to compare results over a similar time period using different data.

Following D&G, we restrict our sample to households where the head is between twenty and fifty-nine years old. In contrast to D&G, we include households headed by a male or a female. We drop observations if they contain allocated values for either income or house values. We further restrict the sample to houses located in SMSAs for which we can merge in repeat-sale house price data.⁹ We then select all observations where the same household owns the home across adjacent *AHS* surveys. For this subsample, we measure the two-year change in household income.¹⁰ This provides us with a wider window to measure income changes than is available in the *CEX* data.¹¹

⁹We match repeat-sale house price data for 115 SMSAs. We use the SMSA house price data to control for possible “equity” effects in the maintenance decision. By this, we mean the potential impact of recent changes in local housing prices on maintenance decisions. See below for more on this.

¹⁰D&G measure the change in income only for the household head. They chose to focus on the head’s income changes since they were interested in measuring the extent to which a spouse’s income is used to offset income swings for the head. Our goal is to measure the extent to which fluctuations in household income are offset through savings decisions regarding the home.

¹¹Using the *CEX* data, D&G measured the nine month difference in annualized income. We also experimented with wider, 4-year windows. Results based on a 4-year window are not significantly different from those reported below.

For the years 1985 - 1993, the *AHS* asked a series of questions on home maintenance/repair/improvement activities (hereafter referred to as maintenance activities) undertaken by the household over the prior two years. More specifically, the survey reports on how much households spent over the past two years on each of ten maintenance activities.¹² Table 1 lists these maintenance categories along with summary statistics for the real expenditures in each category for our sample of households.¹³ Summing across the various categories, homeowners on average make positive maintenance expenditures in 90 percent of the 2-year periods. Conditional on a positive maintenance expenditure, the average household expenditure over a 2-year period is \$3,967. The average 2-year unconditional maintenance expenditure is \$3,556. The average ratio of annualized unconditional maintenance expenditure to reported house value is 1.6%. Similarly, the average ratio of annualized unconditional maintenance expenditure to household income is 3.1%. In the analysis below, we treat these expenditures as expenses rather amortizing them over time.¹⁴

The basic empirical question we address is to what extent homeowners offset transitory income shocks through changes in home maintenance activities. We can begin with a simple

¹²We combine the two maintenance categories: new insulation and storm doors/windows. Routine maintenance expenditures are reported for the prior year. We double these expenditures to make them comparable to the other expenditure categories.

¹³In each year, these nominal expenditures are right-censored at \$9,997. For many of these expenditure categories the *AHS* records a missing response. For households that indicate they did not engage in a particular maintenance activity, we treat a missing expenditure as a zero. However, we exclude from the estimation any household that indicated it did engage in a particular maintenance activity, but reports a missing dollar expenditure. Were we more interested in the level of maintenance activity, we would have tried to impute maintenance values for these households. Because we are interested in identifying the effects of changes in income on changes in maintenance behavior, we do not impute so as to minimize any effects from measurement error.

¹⁴This is the same treatment as in D&G.

regression framework for home maintenance expenditures as given in equation (1)

$$(1) \quad M_{irt} = \alpha + \beta Y_{it} + X_{it} \delta + Z_{rt} \gamma + \varepsilon_{irt} ,$$

where M_{irt} is the i^{th} household's 2-year maintenance expenditure, Y_{it} is the i^{th} household's income, X_{it} is a vector of education/demographic characteristics for the household head and household composition variables, and Z_{rt} is a vector of house, neighborhood and SMSA characteristics. Examples of this type of empirical specification can be found in Mendelsohn (1977) and Reschovsky (1992). The coefficient of interest is β .

Permanent and life-cycle differences in income can be partially captured by controlling for factors such as the education and job experience of the household head. However, there may be important permanent differences in incomes across households that are not captured in the variables contained in X . To the extent that these unobserved factors are constant over 2-year intervals, we can eliminate their effects by taking the first-difference of equation (1).

$$(2) \quad \Delta M_{irt} = \beta \Delta Y_{it} + \Delta X_{it} \delta + \Delta Z_{rt} \gamma + \mu_{irt}$$

In equation (2), we regress the 2-year change in maintenance expenditures on the 2-year change in household income, any changes in the household characteristics (i.e. changes in marital status or family size), and changes in house, neighborhood and SMSA characteristics. Since many of the controls used in equation (1) are constant over 2-year intervals, equation (2) involves fewer control variables. We control for the expected evolution of income over the life cycle by

regressing the change in family income on the typical demographic and human capital variables used in an earnings regression. We use the residual income growth as our measure of the income change in equation (2). We treat this residual income variation as reflecting transitory fluctuations in household income.¹⁵

While we follow D&G in estimating equation (2) in levels and not logs, we extend their basic specification to include controls for changing conditions in the neighborhood and the local housing market. We include indicators for whether the household felt that their neighborhood had significantly improved or worsened over the past two years. Household maintenance decisions may also depend on the degree of recent price appreciation in their local housing market – what we term an “equity effect.” We control for this by including the 2-year house price appreciation rate for the MSA based on the Freddie Mac repeat-sale price index. Finally, we include region and year fixed effects in order to capture any persistent aggregate maintenance differences across large geographic areas and across years.

Beyond the specification issues discussed above, an important issue in estimating β is dealing with measurement error in the reported income changes. In their comparison of matched CPS data with social security earnings records, Bound and Krueger (1991) estimate that 20-25 percent of the variation in reported income changes is due to measurement error. While we are unaware of any study of measurement error in the *AHS*, this survey likely suffers from similar problems to those found for the CPS. Left uncorrected, measurement error in the income changes will tend to bias downward estimates of β .

¹⁵Changes over time in the skill premia in the labor market which account for a significant component of the movements in the permanent income variance should have a minimal impact on our two-year income differences. See Katz and Autor (1999).

Altonji and Siow (1987) advocate using a set of income determinants to instrument for reported income in order to alleviate this problem.¹⁶ D&G construct an alternative measure of income using information on the hourly wage, usual weekly hours, and weeks worked. Unfortunately, the *AHS* data does not ask questions on wage rates or hours/weeks worked, so we can not duplicate the D&G instrument.¹⁷ As an alternative, we use a variant of the “grouping” method suggested by Wald (1940), Bartlett (1949), and Durbin (1954). For each year in our sample, we estimate where a household is in the income distribution for that year and census region. We track the household’s income decile in each of the two years and create a set of indicators for changes in deciles across the two year period. We then use these indicators for decile changes as instruments for the underlying income change. This choice of instruments will filter out measurement error that does not move the household between different deciles of the income distribution.

Another part of our strategy involves constructing the sample in an effort to minimize problems that might arise due to measurement error. As noted earlier, we drop all observations

¹⁶These determinants can include constructed income measures from information on wages, weeks and hours; as well as indicators for events that are associated with income changes such as unemployment spells, illness, quits and promotions.

¹⁷More specifically, the D&G instrument involves using data from the *PSID* and the *CEX* on the number of hours worked in the previous year and the current wage rate to impute earnings. The change in imputed earnings is used to instrument for the change in reported earnings. Essentially, variation in hours worked is presumed to be associated with transitory changes. In terms of using significant earnings events as instruments, the closest the *AHS* data come to allowing us to follow this approach is a series of questions pertaining to whether the worker received any income from unemployment insurance or workman’s compensation. Unfortunately, beginning in 1985 (the starting point of our data) these questions were aggregated into a general “other sources of income” question that also includes interest and dividend income. This obviously reduces the usefulness of the question for our purposes. The only income ‘distress’ questions that were continued after 1983 asked if the family received food stamps or general welfare. These events apply to a very small fraction of the sample, rendering the questions less useful for instrumenting purposes.

that include imputed values for household income. Including these observations would introduce imputation errors in our measure of the transitory income shocks. In addition, we symmetrically trim the top and bottom 1% of the measured income changes and aggregate maintenance changes, thereby eliminating the most extreme outliers.¹⁸

A third econometric issue becomes important when we look at changes in expenditures within the individual maintenance categories. As is evident from Table 1, for most of these maintenance categories there is a significant fraction of households that make no expenditures of that type over the 2-year period. For many of the maintenance categories, a sizeable fraction of households also make no expenditures over successive 2-year periods. This implies a significant fraction of the maintenance changes will be zero.

This feature of the data suggests using a “friction” estimator [see Rosett (1959)]. The basic idea behind this estimator is illustrated in Figure 4. Let ΔM^* denote an unobserved index of a household’s desired change in a particular maintenance expense, and let ΔM denote the household’s observed expenditure for that maintenance category. We model ΔM^* as a continuous latent variable. Friction models capture the propensity for zero changes in the data by assuming that small changes in desired expenditures (positive or negative) do not generate any actual changes in maintenance expenditures. The degree of censoring is captured by the parameters α_1 and α_2 .

The friction model is given by the following set of equations.

¹⁸We also generally do not use observations with imputed maintenance data. See footnote 13 for those details.

$$\Delta M_{irt}^* = \beta \Delta Y_{it} + \Delta X_{it} \delta + \Delta Z_{rt} \gamma + \mu_{irt}$$

$$(3) \quad \begin{aligned} & \Delta M_{irt}^* - \alpha_1 \text{ if } \Delta M_{irt}^* < \alpha_1 \\ \Delta M_{irt} &= 0 \text{ if } \alpha_1 < \Delta M_{irt}^* < \alpha_2 \\ & \Delta M_{irt}^* - \alpha_2 \text{ if } \Delta M_{irt}^* > \alpha_2 \end{aligned}$$

We estimate this friction model using both the actual change in income and instrumenting for the change in income.¹⁹

Before getting to the results themselves, it is useful to note that we report two different marginal effects. The first is the change in the desired expenditure (ΔM^*) level in response to a change in income. We call this the “conditional” marginal effect or ME_c . Second, we report the change in the actual expenditure level (ΔM) where we include the zeros in the calculation. We call this the “unconditional” marginal effect or ME_u . We evaluate the unconditional marginal effects as the average derivative across our estimation sample. This takes into account the nonlinearities in these marginal effects. The expressions for these two marginal effects are given below

$$(4) \quad \begin{aligned} ME_c &= \partial M^* / \partial Y = \beta \\ ME_u &= \partial M / \partial Y = \frac{1}{N} \sum_{i=1}^N [1 - (\Phi(Z_i | \alpha_2) - \Phi(Z_i | \alpha_1))] \beta, \end{aligned}$$

where $Z|\alpha$ represents the standardized control variables including the friction term α , and Φ is the standard normal cumulative density.

¹⁹We adapt the Nelson and Olson (1978) IV Tobit model to the friction model.

Empirical findings and discussion

Summary statistics on all of our control variables are given in Appendix Table A1. These data are readily comparable to the *CEX* sample used by D&G. Our household heads are slightly older than those in the *CEX* sample (i.e., 42.8 versus 40.5 year old heads on average). Although we restricted our sample to homeowners, the marriage rate in our sample is lower than the *CEX* sample (76 percent versus 84 percent). We did not restrict our sample to male headed households, though they make up 79 percent of our households. Our sample is better educated with only 7.6 percent high school dropouts (compared to 20 percent in the *CEX* sample) and with 37 percent college graduates (compared to 25 percent in the *CEX* sample)

The results for overall maintenance expenditures are given in Table 2. We find that a \$1,000 change in income results in an average change in 2-year maintenance expenditures of \$8.54 (OLS) and \$11.82 (IV). The implied elasticities are 0.16 (OLS) and 0.23 (IV). Our OLS elasticity estimate is higher than the D&G OLS elasticity estimate from the *CEX* data (0.08), but our IV elasticity estimate is significantly below their IV elasticity (0.60).²⁰ Thus, the *AHS* data do corroborate D&G's finding that homeowners directly save/dissave in their home to offset income fluctuations. We also tested for the presence of asymmetric income effects to see if the results are being driven primarily by positive (or only negative) income shocks. The results in columns 2 and 4 of Table 2 suggest that the maintenance response is symmetric to positive and negative transitory income shocks.

Given the paucity of research on the determinants of home maintenance expenditures, we

²⁰The increase in the D&G elasticity estimates using their IV strategy is greater than what one would expect based on the current estimates of the degree of measurement error in income changes. While we cannot be sure that our instrument is clean of all correlation with the measurement errors, our elasticity increase is more in line with the magnitude of the expected attenuation bias.

briefly summarize the other findings in Table 2 before turning to the disaggregated maintenance expenditure results. Changes in household size do not appear to generate any significant changes in maintenance activity by the household.²¹ Transitions into and out of marriage have imprecisely estimated maintenance effects. There is evidence of a positive “equity” effect on maintenance decisions. A ten percent appreciation in house prices in an SMSA is estimated to increase maintenance activity by \$130 (implied elasticity of 0.37). Controlling for average price appreciation in the SMSA, we find that homeowners tend to spend more on maintenance when they report that their neighborhood has significantly declined, though this effect is imprecisely estimated.

We then reestimate our specification on subsamples of households disaggregated by the household head’s degree of educational achievement. These results, which are reported in Table 3, compare the maintenance responses to income shocks of those with high school degrees or less (top panel) to those with at least some college training (bottom panel). Note that the implied IV elasticities are much higher for the less well-educated households (0.31 versus 0.17). This pattern of results is consistent with the view that the least well-educated homeowners have on average fewer liquid assets to help buffer transitory fluctuations in their income.²²

However, when we look separately at positive and negative transitory income shocks the story becomes more nuanced. Liquidity constraints facing low skilled homeowners would be

²¹This is consistent with households either anticipating future changes in household size when making their home purchase, or with accommodating changes in household size through a future change of residence.

²²It is difficult in the *AHS* to directly identify liquidity constrained/unconstrained households. The *AHS* does ask if the household has at least \$20 thousand in savings/investments. However, less than 1 percent of our estimation sample answered this question in the affirmative.

expected to result in a high elasticity with respect to negative transitory income shocks. The data suggest, though, that high and low skilled workers have similar responses to adverse income shocks. The larger overall maintenance elasticity for low skilled homeowners is driven by a larger response to positive transitory income shocks. One possible explanation is that low skilled workers may have few attractive avenues for saving, and investing in their house dominates other avenues. That said, it still is the case that better educated owners use their homes as buffers, too.²³ In sum, direct investment via maintenance appears to be a relatively cheap way of dealing with income shocks—as all types of households engage in this form of smoothing.

In Table 4, we examine the impact of income changes on individual maintenance expenditure categories. We focus primarily on the unconditional expenditure marginal effects which we use to construct our implied elasticities. The weighted average IV elasticity across all nine categories is 0.22, which is only slightly less than the IV estimate derived from the regression using the sum of the maintenance expenditures.

With the exception of siding and major equipment expenditures, each individual maintenance category exhibits a positive income elasticity, ranging from a low of 0.08 (for roofing) to a high of 0.50 (for new additions). The negative elasticities for major equipment and siding expenditures are very small in absolute value, indicating that households do not buffer transitory income shocks via spending on these features. It seems likely that these particular maintenance categories (possibly along with roofing, which has the smallest elasticity among those estimated to be positives) are not very discretionary in nature. That is, if your heating

²³This conclusion obviously applies to the aggregate results for this group (columns 1 and 3, bottom panel of Table 3).

system fails or if you have a leak in your roof or siding, you must spend something on repairs no matter what shocks to income you may be experiencing. It also seems sensible to us that routine and miscellaneous maintenance, insulation, and upgrades or additions of kitchens, bathrooms, and other rooms, would be more discretionary in nature. Hence, there is no indication that a single type of maintenance or repair item is being used to buffer income shocks; however, there does appear to be a small group of maintenance categories that are not used to buffer income shocks, probably because they are relatively non-discretionary in nature.

While we obviously have interpreted our estimated maintenance elasticities as responses to transitory income shocks, Moffitt (1997, pg 289) notes that "... period-to-period changes in income may contain a permanent shock arising from the presence of a random walk component in income." He cites the growing literature on micro-level earnings dynamics, including papers by MaCurdy (1982), Abowd and Card (1989) and Moffitt and Gottschalk (1995), and suggests including a lag change in income in the specification in order to ensure that the coefficient on the current change in income is picking up just the unexpected transitory income change. We can carry out this robustness check on the subsample of households that remain in their house for three consecutive surveys [1,258 observations]. This allows us to measure both their current 2-year change in income and their lagged 2-year change in income. When we estimate equation (2) on this subsample without including the lagged income change, the OLS coefficient (standard error) is \$6.70 (\$5.40). When we reestimate equation (2) on this subsample including both the current and lagged income change, the coefficients (standard errors) are \$6.55 (\$6.32) and -\$0.33 (\$6.31) respectively. So, we find neither a sizeable nor a significant effect of lagged income changes on current changes in maintenance activities. In addition, controlling for lagged income

changes does not have a qualitatively important impact on the coefficient estimate associated with the current income change. Hence, our interpretation of the maintenance and repair elasticities as capturing responses to transitory income shocks passes this robustness check.

Implications

If homeowners buffer income fluctuations by directly saving/dissaving in their house via maintenance and repair decisions, then this behavior should affect the value of the house. To identify this effect in the data, we need to be able to purge changes in house values of the effects arising from housing demand shifts. These demand shifts can reflect aggregate factors such as changes in mortgage interest rates, local labor market conditions, and community-specific factors. We use year effects to control for economy-wide shifts in aggregate demand for housing. Local housing market demand shifts are controlled for using the 2-year house price appreciation implied by the Freddie Mac repeat-sale house price index for the SMSA. Neighborhood demand shifts are captured through indicators for whether the homeowner feels that the neighborhood has significantly improved or worsened.

The impacts of homeowner income changes on changes in self-reported house values are reported in Table 5. We also check for asymmetries in the income change variable by estimating specifications which look separately at the effect of income gains and income losses. The coefficient on the SMSA house price appreciation rate is 0.91 with a standard error of 0.03. On average, homeowners in the *AHS* sample appear to be well informed of changes in the market value of their house. And, there is some evidence that reported deterioration in the neighborhood is associated with lower house value appreciation. Controlling for these factors, the results

indicate that homeowners in the *AHS* data internalize the impact of their maintenance decisions in response to income changes. The overall elasticity of house values with respect to the owner's income is 0.058. There is some evidence that the elasticity is slightly larger for income gains as compared to income losses.

A possible concern with these particular elasticity estimates is that the homeowner's income change may be proxying in part for demand shifts not captured elsewhere in the specification. In this case, the magnitude of the measured elasticity would be an overestimate of the impact on house values of the homeowner's maintenance decisions in response to income changes. As a robustness check, we computed for each SMSA the average residual income change for homeowners in the *AHS* sample in that SMSA. These residual income changes remove the impact of life-cycle effects, but leave any local labor market demand effects. When we add this SMSA average income change to the specification, we find that the coefficient on the average SMSA income change is insignificant and the coefficient on the household income change is unaffected. Controlling for the SMSA house price appreciation rate, then, appears to adequately capture local demand shocks.

These findings point out a potential weakness in the construction of repeat-sale house price indices. Repeat-sale price indices compare the change in the price of a house from its purchase to its subsequent sale.²⁴ By matching the "same" house over time, the aim is to purge the price changes of quality changes. However, to the extent that homeowners choose to maintain a house more or less than the underlying depreciation rate on the house, the same house will not

²⁴Some repeat-sale indices also mix in appraisals that typically are triggered by a mortgage refinancing.

display a constant quality over time. If unobserved maintenance activities by households are correlated within communities and vary over time, then this will impart a bias in transaction-based house price indices.

The labor market may be the mechanism for generating correlated maintenance activities in a community. Local labor market shocks (see Topel (1986)) generate correlated transitory income shocks for homeowners in a locality. The magnitudes of these correlated transitory income shocks are illustrated in Figure 5. This figure shows the distribution of average SMSA/year transitory income shocks for the 184 SMSA/year combinations in our AHS sample with at least ten households. Attempts by households to smooth these income shocks by saving/dissaving in their homes will generate correlated changes in the net depreciation of houses in the locality. Capitalization of this maintenance behavior into prices suggests local repeat sales indexes could be biased—both on the upside and downside of local market cycles.²⁵ That said, we leave examination of this issue to future research.

Conclusion

The last 25 years has witnessed a significant rise in income inequality in the United States. Using *CEX* data, Krueger and Perri (2002) do not find any parallel increases in consumption inequality. Specifically, Krueger and Perri find that while the standard deviation of the log of after-tax income increased by 20%, the standard deviation of log consumption increased by only 2%.

²⁵Goetzmann and Spiegel (1995) first hypothesized and confirmed that systematic home improvements made around the time of sale could bias repeat sales indexes. Knight, Miceli and Sirmans (2000) provide some evidence based on home sales in Stockton, CA that under-maintained homes tend to be brought up to a normal level of maintenance at the time of a sale. To the extent that their results generalize, then consumption smoothing through maintenance activities would generate a one-sided bias to repeat-sale price indices.

This suggests that households are quite successful in smoothing income fluctuations. D&G, also using *CEX* data, estimate that for every \$1 change in a household head's income, at least 76 cents is smoothed away in terms of its impact on consumption.

In this paper, we reexamined the role of saving/dissaving in a house as a vehicle for consumption smoothing. Using *AHS* data, we verify that the elasticity of homeowner maintenance decisions to transitory income shocks is quite high. Our estimated OLS elasticity is higher than D&G's (0.16 versus 0.08), while our IV estimated elasticity is below D&G's IV elasticity (0.23 versus 0.60). The *CEX* and *AHS* data both offer different advantages/disadvantages in terms of obtaining a clean estimate of this elasticity. The fact that both data sources confirm the presence of a large maintenance response to transitory income fluctuations raises our confidence that this is an important mechanism for homeowners in their efforts to smooth consumption. This mechanism complements the consumption smoothing homeowners can achieve by adjusting the debt position in their house as documented in Hurst and Stafford (2002). And, its use appears to be widespread across all types of households, which makes sense given that it has lower fixed costs than smoothing via refinancing.

We also find that homeowners internalize their own maintenance decisions when valuing their house. To the extent that transitory income shocks are correlated across a local labor market, this suggests a source of potential bias for repeat-sale price indices. The repeat-sale methodology assumes a constant rate of net depreciation in the housing stock over time. Spatially correlated maintenance decisions by homeowners can cause the net depreciation rates in a locality to vary over time. If this variation over time in net depreciation rates is reflected in sales prices, then this will induce a bias to the repeat-sale price index for that locality.

References

- Abowd, John, and David Card. "On the Covariance Structure of Earnings and Hours Changes." *Econometrica* 57 (March 1989): 411-445.
- Altonji, Joseph G., and Aloysius Siow. "Testing the Response of Consumption to Income Changes with (Noisy) Panel Data." *Quarterly Journal of Economics* 102 (May 1987): 293-328.
- Bartlett, M. S. "Fitting of Straight Lines When Both Variables are Subject to Error." *Biometrics* (1949).
- Bennett, Paul, Richard Peach, and Stavros Peristiani. "Structural Change in the Mortgage Market and the Propensity to Refinance." *Journal of Money, Credit and Banking* 33 (November 2001): 954-976.
- Boehm, Thomas P., and Keith R. Ihlanfeldt. "The Improvement Expenditures of Urban Homeowners: An Empirical Analysis." *AREUEA Journal* 14 (Spring 1986): 48-60.
- Bound, John, and Alan B. Krueger. "The Extent of Measurement Error in Longitudinal Labor Market Data: Do Two Wrongs Make a Right?" *Journal of Labor Economics* 9 (January 1991): 1-24.
- Browning, Martin, and Annamaria Lusardi. "Household Saving: Micro Theories and Micro Facts." *Journal of Economic Literature* 34 (December 1996): 1797-1855.
- Cameron, Stephen, and Joseph Tracy. "Earnings Variability in the United States: An Examination Using Matched-CPS Data." Working Paper. Columbia University, April, 1998.
- Canner, Glenn, Karen Dynan, and Wayne Passmore. "Mortgage Refinancing in 2001 and Early 2002." *Federal Reserve Bulletin* 88 (December 2002): 469-481.
- Deaton, Angus. *Understanding Consumption*. Oxford, Clarendon Press, 1992.
- Durbin, J. "Errors in Variables." *Review of International Statistical Institute* (1954).
- Dynarski, Susan, and Jonathan Gruber. "Can Families Smooth Variable Earnings?" *Brookings Papers on Economic Activity* (1997).
- Friedman, Milton. *A Theory of the Consumption Function*. Princeton, Princeton University Press, 1957.
- Goetzmann, William N., and Matthew Spiegel. "Non-temporal Components of Residential Real Estate Appreciation." *Review of Economics & Statistics* (1995).
- Gottschalk, Peter, and Robert Moffitt. "The Growth of Earnings Instability in the U.S. Labor Market." *Brookings Papers on Economic Activity* 2 (1994): 217-272.
- Hurst, Erik, and Frank Stafford. "Home is Where the Equity Is: Mortgage Refinancing and Household Consumption." Working Paper. University of Chicago, Graduate School of Business, August, 2002.
- Katz, Lawrence F., and David H. Autor. "Changes in the Wage Structure and Earnings Inequality." In *Handbook in Labor Economics*, edited by Orley C. Ashenfelter and David Card, 1463-1555. Amsterdam, Elsevier, 1999.
- Knight, John R., Thomas Miceli, and C.F. Sirmans. "Repair Expenses, Selling Contracts and House Prices." *Journal of Real Estate Research* 20 (Nov.-Dec. 2000): 323-336.

- Krueger, Dirk, and Fabrizio Perri. "Does Income Inequality Lead to Consumption Inequality? Evidence and Theory." Working Paper No. 9202. National Bureau of Economic Research, September, 2002.
- MaCurdy, Thomas. "The Use of Time Series Processes to Model the Error Structure of Earnings in a Longitudinal Data Analysis." *Journal of Econometrics* 18 (January 1982): 83-114.
- Mendelsohn, Robert. "Empirical Evidence on Home Improvements." *Journal of Urban Economics* 4 (October 1977): 459-468.
- Moffitt, Robert A. "Can Families Smooth Variable Earnings? Comments and Discussion." *Brookings Papers on Economic Activity* 1997, no. 1 (1997): 285-292.
- , and Peter Gottschalk. "Trends in the Autocovariance Structure of Earnings in the U.S.: 1969-1987." Working Paper. The Johns Hopkins University, July, 1995.
- Nelson, Forest, and Lawrence Olson. "Specification and Estimation of a Simultaneous-Equation Model with Limited Dependent Variables." *International Economic Review* 19 (October 1978): 695-709.
- Reschovsky, James D. "An Empirical Investigation into Homeowner Demand for Home Upkeep and Improvement." *Journal of Real Estate Finance and Economics* 5 (1992): 55-72.
- Rosett, Richard N. "A Statistical Model of Friction." *Econometrica* 27 (April 1959): 263-267.
- Topel, Robert H. "Local Labor Markets." *Journal of Political Economy* 94, no. 3, pt. 2 (1986): S111-S144.
- Tracy, Joseph, Henry Schneider, and Sewin Chan. "Are Stocks Overtaking Real Estate in Household Portfolios?" *Current Issues in Economics and Finance* 5 (April 1999).
- Wald, A. "The Fitting of Straight Lines if Both Variables are Subject to Errors." *Annals of Mathematical Statistics* (1940).

Table 1. Repair / maintenance / improvement expenditures

Category	Probability of positive expenditure, Pr($\$ > 0$)	Conditional expenditure, E($\$ \$ > 0$)	Unconditional expenditure, E($\$$)
Routine maintenance	0.78	1,337	1,038
New addition	0.04	5,275	206
New/remodeled kitchen	0.09	3,350	315
New/remodeled bath	0.12	1,946	231
Roof	0.14	2,477	359
Siding	0.04	3,261	145
New insulation; storm doors/windows	0.20	1,416	281
Major equipment	0.12	2,286	279
Other, > \$500 each	0.25	2,802	702
Aggregate	0.90	3,967	3,556

Notes: AHS data, 1985-1993, real 1998 expenditures

Table 2. Aggregate maintenance / improvement expenditures

	OLS		IV	
	(1)	(2)	(3)	(4)
Change in income (2-year, \$1,000)	8.54** (2.31)		11.82** (2.58)	
Positive change in income (2-year, \$1,000)		8.55** (3.78)		12.65** (4.94)
Negative change in income (2-year, \$1,000)		-8.53** (3.45)		-11.11** (4.63)
Change in household size	-66.18 (78.63)	-66.17 (78.78)	-84.31 (79.20)	-83.76 (79.36)
Become married	164.46 (319.06)	164.34 (322.75)	120.98 (316.98)	112.44 (323.79)
Become single	-454.62 (292.63)	-454.74 (294.33)	-393.55 (295.62)	-400.38 (298.21)
SMSA house price appreciation (2-year rate)	13.24** (5.82)	13.24** (5.82)	12.97** (5.79)	12.95** (5.78)
Neighborhood improved	36.91 (184.74)	36.93 (184.49)	36.75 (184.65)	38.32 (185.94)
Neighborhood declined	198.34 (174.52)	198.34 (174.58)	197.00 (174.19)	197.18 (174.16)

Notes: AHS data 1985-1993. Sample size 8,320. Standard errors given in parentheses and have been adjusted for any dependence between households in the same SMSA and year. Specification includes year and region (4) effects. Instruments for the change in income are indicators for 2-year changes in the deciles of the income distribution in the household's major census region.

** significant at the 5% level, * significant at the 10% level

Table 3. Aggregate maintenance / improvement expenditures, by education of head

	OLS			IV		
	(1)	(2)	Implied Elasticity	(3)	(4)	Implied Elasticity
a) High school graduates and dropouts [3,250]						
Change in income (2-year, \$1,000)	14.31** (3.35)		0.26	16.93** (4.26)		0.31
Positive change in income (2-year, \$1,000)		19.86** (5.09)	0.36		21.92** (7.92)	0.40
Negative change in income (2-year, \$1,000)		-8.95 (5.64)	-0.16		-12.51* (7.17)	-0.23
b) Some college plus [5,070]						
Change in income (2-year, \$1,000)	5.81** (3.09)		0.12	8.58** (3.21)		0.17
Positive change in income (2-year, \$1,000)		2.78 (5.39)	0.05		6.19 (6.77)	0.12
Negative change in income (2-year, \$1,000)		-8.72* (4.66)	-0.17		-10.55* (6.01)	-0.21

Notes: AHS data 1985-1993. Size of each sample given in square brackets. Standard errors given in parentheses and have been adjusted for any dependence between households in the same SMSA and year. Specification includes year and region (4) effects. Instruments for the change in income are indicators for 2-year changes in the deciles of the income distribution in the household's major census region.

** significant at the 5% level, * significant at the 10% level

Table 4. Income effects by specific maintenance / repair categories

Category	Friction		IV Friction		Implied Elasticity	
	Conditional	Unconditional	Conditional	Unconditional		IV
Misc maintenance	2.85** (1.08)	2.52	3.68** (1.18)	3.25	0.17	0.22
New addition	19.05** (7.65)	1.34	21.41** (9.93)	1.51	0.45	0.50
New/remodeled kitchen	5.57* (3.15)	0.89	11.32** (4.08)	1.81	0.19	0.40
New/remodeled bath	2.30 (2.41)	0.44	4.46 (2.85)	0.86	0.13	0.26
Roof	4.07* (2.35)	0.91	1.79 (2.90)	0.40	0.17	0.08
Siding	-0.69 (4.55)	-0.05	-2.10 (4.85)	-0.16	-0.02	-0.08
New insulation; storm doors/windows	2.15* (1.19)	0.66	3.66** (1.62)	1.13	0.16	0.28
Major equipment	1.42 (2.05)	0.28	-0.24 (2.60)	-0.05	0.07	-0.01
Other > \$500	3.71** (2.25)	1.49	6.26** (2.70)	2.52	0.15	0.25
Weighted average elasticity					0.16	0.22

Notes: AHS data 1985-1993. Unconditional marginal effects based on average derivatives. IV estimates use indicators for 2-year changes in the deciles of the income distribution in the household's major census region to instrument the income change. Standard errors are given in parentheses and have been adjusted for any dependence across households in the same SMSA and year. Implied elasticities are based on unconditional expenditure effects. Weighted average elasticity use unconditional expenditure share weights.

** significant at the 5% level, * significant at the 10% level

Table 5. House Value Appreciation

Variable	OLS		IV	
	(1)	(2)	(3)	(4)
2-yr metro house price appreciation	0.906** (0.035)	0.906** (0.035)	0.906** (0.035)	0.906** (0.035)
2-yr % change in income	0.058** (0.005)		0.059** (0.005)	
2-yr % change in income - positive		0.075** (0.010)		0.075** (0.011)
2-yr % change in income - negative		-0.043** (0.007)		-0.046** (0.009)
Neighborhood improved	0.003 (0.006)	0.002 (0.006)	0.003 (0.006)	0.002 (0.006)
Neighborhood declined	-0.005 (0.005)	-0.006 (0.005)	-0.005 (0.005)	-0.006 (0.005)
R-square	0.129	0.129	0.129	0.129

Notes: AHS data 1985-2001. Sample size 22,991. IV estimates use indicators for 2-year changes in the deciles of the income distribution in the household's major census region to instrument the income change. Standard errors are given in parentheses and have been adjusted for any dependence across households in the same SMSA and year. Year*region(4) effects are included in each specification.

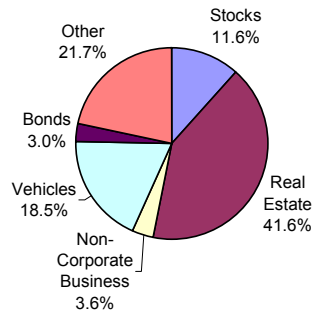
** significant at the 5% level, * significant at the 10% level

Appendix Table A1. Data Sources and Summary Statistics

Variable	Source	Mean	Standard Deviation	Min	Max
Change in household income, 2-year (\$1,000)	AHS: ZINC (# 0621, pg. 112)	1.03	32.08	-255.52	237.35
Age of head	AHS: AGE (# 0490, pg. 98)	42.85	8.73	21	59
White	AHS: RACE (# 0521, pg. 100)	0.81	0.39	0	1
Male	AHS: SEX (# 0553, pg. 101)	0.79	0.41	0	1
High school graduate	AHS: GRADE1 (# 0568, pg. 102)	0.31	0.46	0	1
Some college	AHS: GRADE1 (# 0568, pg. 102)	0.23	0.42	0	1
College graduate	AHS: GRADE1 (# 0568, pg. 102)	0.20	0.40	0	1
Graduate school	AHS: GRADE1 (# 0568, pg. 102)	0.17	0.38	0	1
Change in household size	AHS: PER (# 0586, pg. 104)	-0.02	0.43	-7	7
Married	AHS: MAR (# 0506, pg. 100)	0.76	0.43	0	1
Become married	AHS: MAR (# 0506, pg. 100)	0.03	0.18	0	1
Become single	AHS: MAR (# 0506, pg. 100)	0.03	0.18	0	1
House price appreciation, 2-year	AHS: VALUE (# 1068, pg. 148)	0.003	0.23	-1.37	1.73
SMSA house price appreciation, 2-year	Freddie Mac: http://www.freddiemac.com/finance/cmhpi/	0.10	0.13	-0.17	0.69
Neighborhood improved	AHS: HOWN (# 0291, pg. 78)	0.12	0.33	0	1
Neighborhood declined	AHS: HOWN (# 0291, pg. 78)	0.15	0.36	0	1
New house	AHS: BUILT (# 0044, pg. 16)	0.16	0.36	0	1

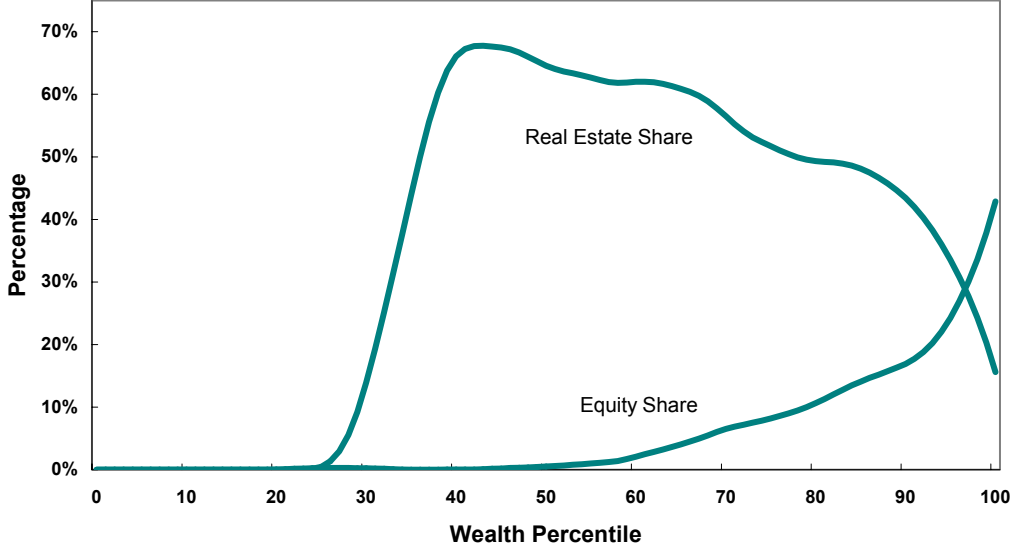
Notes: For AHS variables, the source column lists the AHS variable *name*, reference number, and code book page. The codebook refers to 1990 edition.

Figure 1. Average Household Asset Allocation



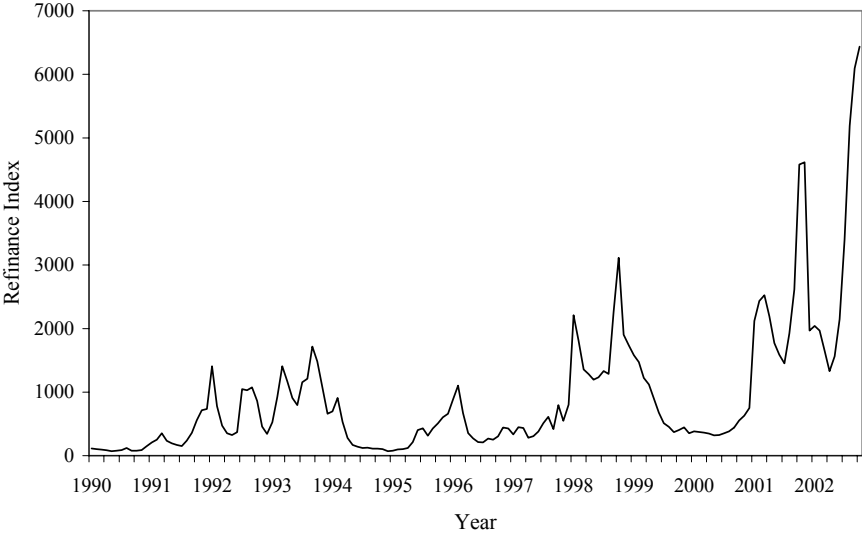
Source: Survey of Consumer Finance, 1998. Note “other assets” include transaction accounts, retirement and other managed accounts excluding those invested in stocks and bonds, and all remaining nonfinancial assets.

Figure 2. Portion of Household Assets in Corporate Equity and Real Estate by Wealth Percentile



Source: Survey of Consumer Finances, 1998.

Figure 3. Mortgage Refinance Index



Source: Mortgage Bankers Association

Figure 4: Friction Model Illustration

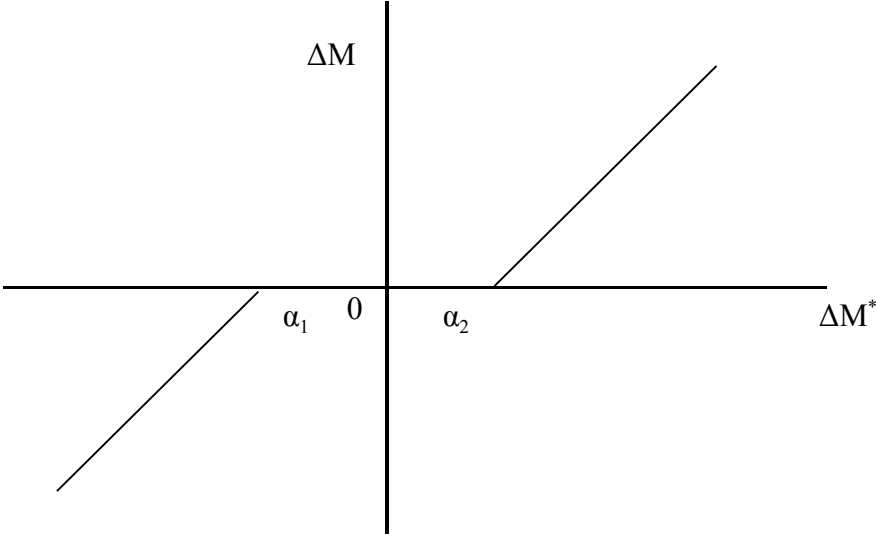
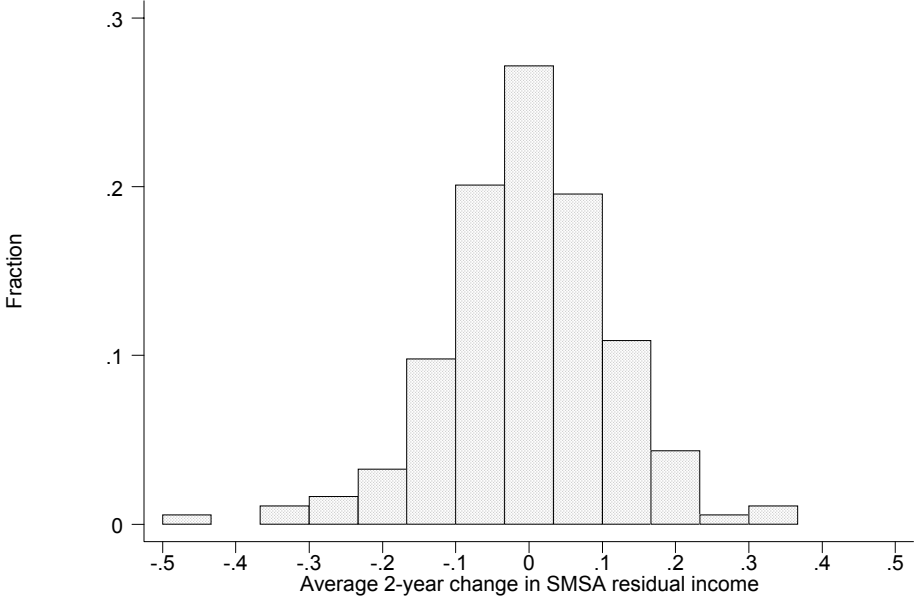


Figure 5. Distribution of SMSA Transitory Income Changes



Note: Each observation is the average 2-year residual income change in a specific SMSA and year.