House Price Shocks and Individual Divorce Risk in the United States

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Preliminary

April 1, 2014

Original Version: October 19, 2012

Abstract

Households in the United States hold a significant portion of their total wealth in owner-occupied housing. Thus, changes in housing prices may have an important impact on the marital surplus the household enjoys. What happens to marriages of homeowners when there is a shock to housing prices? This question is addressed using household data from the Panel Study of Income Dynamics and a quarterly MSA level house price index from the Federal Housing Finance Agency, controlling for local labor market conditions. House price shocks are calculated as the cumulative sum of residuals of a second order autoregressive model from the previous four years. Results show that positive house price shocks stabilize marriage for all couples. A one S.D. increase in the house price shock decreases the risk of divorce in the following year by about 13-18 percent. The results are driven by the younger cohort of households in the PSID, those with lower educational attainment, and those with relatively low family income. The findings are discussed in the context of theories on changes in marital surplus, and changes in the transaction costs surrounding divorce.

JEL Nos. D1, J12, R21

*Address: 2127 North Hall, University of California, Santa Barbara, CA 93106-9210. I am grateful to Shelly Lundberg, Peter Kuhn, Olivier Deschênes, Kelly Bedard, Maya Rossin-Slater, Kellie Forrester, and seminar participants at UCSB and the All-California Labor Economics Conference for helpful comments and suggestions.

1 Introduction

Do economic conditions affect marital stability? This question has seen renewed interest since the recession in 2007 both in the press and academia. Several recent articles in The New York Times have suggested a connection between the recession and the ability of a couple to afford a divorce: Leland (2008), Douthat (2009), and Parker-Pope (2011). A large portion of the population will experience a divorce in their lifetime: Kreider and Ellis (2011) estimates that 20% of all adults has ever been divorced as of 2011. In addition, divorce is potentially very detrimental for both the spouses and their children. Adults who have divorced have a lower standard of living and less wealth compared to married adults and report higher rates of depression (Amato (2000)). Children whose parents have divorced grow up to have less education, lower earnings, and higher rates of teen pregnancies and dropping out of high school (Gruber (2004), McLanahan and Sandefur (1994)).

Changing economic conditions affect household wealth and other household characteristics that in turn change the gains to marriage or ease with which a couple can separate. This paper examines one component of household wealth: owner-occupied housing. Specifically, how does a shock to housing prices affect the divorce hazard for married couples? Housing has been the largest component of household wealth for the past several decades, and about 33% of household wealth was held in residential housing as of 2007 (Wolff (2010)). In addition, house price shocks are useful shocks to study as they are likely exogenous to any actions of the individual households, as compared to other types of economic shocks such as job loss.

This paper uses restricted household level data to analyze the effect of house price shocks on the divorce hazard and I link this to a quarterly house price index by Metropolitan Statistical Area (MSA). To my knowledge this is the first paper to examine the effect of house price shocks on divorce using micro level data from the U.S. In order to measure unexpected changes in housing prices I take the residuals from a second order autoregressive process. The calculation of house price shocks is improved over the literature which does not consider moving behavior of households. The effect on the divorce hazard is identified using variability across MSAs, controlling for local economic conditions. I find that positive house price shocks decrease the divorce hazard, however there is no significant effect of negative house price shocks. In particular for the average couple, a one standard deviation increase in the positive house price shock reduces the risk of divorce by about 13 to 18 percent. The results are strongest in the later part of the sample, and for younger cohorts and households with lower income and education.

The economic literature on divorce, beginning with Becker et al. (1977), emphasizes surprises, and in particular economic shocks, as a principal driver of marital instability. In this seminal paper, Becker et. al. posit that it will only be surprises that matter for the decision to divorce as anything known to the couple will have already been considered in the decision to marry in the first place. A few papers have used longitudinal data to attempt to measure changes in expectations of each spouse's income such as Weiss and Willis (1997) and Böheim and Ermisch (2001). The literature generally find that only negative shocks to income increase the divorce hazard, and positive shocks do not have a significant effect.

Also related is the recent literature regarding the link between business cycles and divorce. Hellerstein and Morrill (2011) finds that an increase in the state-level unemployment rate leads to a decrease in the number of divorces per thousand people for the time period 1976-2009. Also using state-level vital statistics, Schaller (2013) confirms these results on divorce and shows marriage rates also decline with higher unemployment rates. Additionally, the author finds that these effects on marriage and divorce rates are permanent, not just changes in timing. Chowdhury (2011) measures the transitory component of income for households and finds that divorce moves pro-cyclically with business cycles. In other words, when income is low in a recession, the cost of divorce is too high so couples that might have otherwise divorced stay together. Low income and minority groups in the Fragile Families and Child Wellbeing Study are found to delay marital dissolution in bad economic times, as measured by state-level mortgage delinquencies and local-level unemployment rates in Harknett and Schneider (2012). Other recent papers have looked for a link between wealth shocks on fertility decisions.[1]

Most closely related to this paper are Rainer and Smith (2010) and Farnham et al. (2011), two recent papers that attempt to determine how house price shocks affect partnership dissolution.

[1]Lovenheim and Mumford (2013) use house price data and restricted-use location data from the Panel Study of Income Dynamics (PSID), as in this paper. They find that increases in housing wealth increase fertility rates for homeowners. **?** also examines the relationship between MSA level housing prices and MSA level fertility rates and also finds an increase in fertility among homeowners.

Contrary to my findings, both papers find that it is only *negative* house price shocks that matter for marital stability, though the results show differing effects. The methodology used in this paper most closely fits with Rainer and Smith (2010) (hereafter RS), which analyzes respondents of the British Household Panel Survey. Using county level housing prices mapped to local authority districts in the UK, the authors calculate unanticipated house price shocks for households. Both legal marriages and cohabitations are studied, and the analysis finds that negative house price shocks increase the risk of partnership dissolution. Farnham et al. (2011) (hereafter FSS) uses Metropolitan Statistical Area level house prices to examine the effect of unanticipated changes on the *stock* of divorced people in the MSA. Using marital status of respondents of the Current Population Survey, the authors find that the fraction of divorced individuals decreases with negative house price shocks. This effect is observed only within groups that are likely to be homeowners (those with higher levels of education). The fraction of the population divorced is a combination of individuals who are getting divorced, those who have not yet remarried, and the net migration of divorced and non-divorced people. Thus the results in FSS have a slightly different interpretation than those for individual households in RS and this paper. To my knowledge, there are no papers that look at house price shocks and divorce in the U.S. using micro level data and this paper attempts to fill this gap.

2 Theoretical Discussion

2.1 Determinants of Divorce

In economic models of marriage and divorce, a couple will decide to marry if the (expected) value of marriage is higher than the value of staying single. So, the value of the marital surplus also determines whether or not a couple will stay together. The gains to marriage are the combination of a large number of factors including those cited in below. If these factors that affect the gains to marriage change, it could lead to a match no longer being acceptable to the couple.

The following two period model of marriage and divorce follows closely to the model presented in Peters (1986). In the first period, the couple must decide whether or not to get married.

Suppose that the joint value of marriage in period 1 for the husband, H, and wife, W, is M_1. We assume that this value of marriage is a composite of a variety of factors of both spouses that together determine the value of this couple being married in the following simple relationship: $M_1 = M_{H,1} + M_{W,1}$. Each individual also has an outside option to the marriage: their present value of staying single for the two periods, S_H and S_W, respectively. The couple does not have perfect information about the value of marriage or staying single in the second period. Instead, the true values are not realized until the second period. We assume that both individuals know the joint probability distribution of the value of marriage in the second period

$$f(M_2) \sim N(0, \sigma_M^2)$$

and the joint probability distribution of the value if they divorce in the second period

$$g(D_H, D_W) \sim N(0, \sigma_D^2)$$

where D_H is the outside option of the husband and D_W is the outside option of the wife in the second period and $M_2 = M_{H,2} + M_{W,2}$. Also known before the decision to marry is the discount factor, b, and the probability of divorce, p, which is a function of M_2, D_H, and D_W.

The couple must make the decision whether or not to marry in the first period based on their expectations of the value of marriage. Let V be the expected present value of marriage, given the information available in period 1:

$$V = M_1 + b\left[\mathbb{E}\left(M_2\right)(1-p) + \mathbb{E}\left(D_H + D_W | \text{divorce}\right) * p\right]$$

where the value of marriage in the second period is the expected joint value of the marriage in period 2 times the probability of staying married, plus the expected joint value of becoming single times the probability of divorcing. Given the information that is available in period 1, the couple decides to marry if the expected value of marriage is at least as large as the sum of their present value of staying single:

$$V \geq S_H + S_W$$

In period 2, the true values of M_2, D_H, and D_W are realized. If any of the various factors that determine the value of marriage or of becoming single change from what was expected, the couple may suddenly find it better to divorce in the second period. For example, if housing prices are unexpectedly high in the second period, this may affect both M_2 and D_i as discussed in the next section. In a model of transferable utility, each spouse can transfer some of his/her value of marriage to the other if it is beneficial. In this case, if that the joint value of marriage in the second period is less than the joint value of being single (the outside option), there is no arrangement they can make between themselves such that they want to continue the marriage:

$$D_H + D_W > M_2$$

$$D_H + D_W > M_{H,2} + M_{W,2}$$

If this is the case, it will be optimal for the couple to divorce. The next section will discuss house price shocks in the context of changing gains to marriage.

Stevenson and Wolfers (2007) provide an excellent overview of what specific factors can lead to divorce, and how these factors have changed over time. The discussion about what influences marital dissolution can be divided into two categories: macrostructural factors (White (1990)) and individual or family characteristics. By macrostructural we mean those factors that affect the cost of divorce for the whole of society such as changes in laws, changes in social norms and stigma surrounding divorce, and gender roles. At the micro level there are a number of determinants of divorce. First, we know that there are differences in the propensity to divorce across race/ethnicity and socio-economic groups. Fertility decisions and fertility outcomes can make a couple more or less likely to divorce. In addition, data shows that couples who are older when they first marry have a higher chance of reaching any particular length of marriage. This is observed in SIPP data by Kreider and Ellis (2011) and is also true of respondents in the PSID, and Rotz (2011) shows that the increase at the age of marriage explains at least 60% of the decrease in the divorce rate since 1980. Another aspect that may affect divorce has been the rise in cohabitation. Stevenson and Wolfers (2007) report on data from various sources that show very little cohabitation existed before 1970, and then growing at a fairly steady rate thereafter. One rationale for cohabitation is learning about match quality before making the decision to marry. To the extent that couples only receive a noisy signal regarding the match quality, a couple may divorce if the realization of the value of marriage is lower than expected. On the other hand, a divorce may occur if the value of the marriage itself changes over time, even if the value of marriage was perfectly observed at the start (Marinescu (2012)).

2.2 House Price Shocks and Divorce

The definition of a "house price shock" in this paper is the portion of the change in local housing prices that is unexpected. I chose to use these *unexpected* changes in housing price for several reasons. First, if instead the analysis used just the change in the house price index from one year to the next, this would include both anticipated and unanticipated changes in housing prices. If some portion of the change in housing prices is anticipated, it is unclear when we would expect a household to respond to an anticipated change in wealth. On the other hand, using only the unexpected portion of the change in prices allows us to try to identify a direct response to a change in wealth after it has occurred. The second reason is drawn from the literature on the link between housing prices and consumption/saving decisions of households. In much of the recent literature the focus has changed to housing price shocks, or windfall gains in housing wealth. There has been conflicting empirical and theoretical findings on responses to changes in housing prices, and it has been suggested that this is because some changes in housing prices are anticipated by households. Stemming from the theoretical work of Skinner (1996), Disney et al. (2010), Attanasio et al. (2011) and others demonstrate how a household's consumption decisions might respond to house price shocks. If a household were to experience a rise in housing prices that they had expected, according to the standard life-cycle model of consumption there should be no response since agents are forward looking (ignoring the issue of credit constraints). That is, any expected increase in housing prices has already been incorporated into the consumption/savings path chosen by the households, ignoring any issues of credit constraints. If instead the household faces a shock to housing prices that was unexpected, we might see a change in their behavior.

As discussed in the above model of marriage, a couple will marry (and stay together) so long as the value of staying married is greater than the value of being single. Unexpected changes in housing prices can affect the gains to marriage in several ways and these effects are likely different for owners versus renters. Two main channels through which house price shocks may affect marital stability discussed here: gains of marriage and changes in transaction costs surrounding divorce.

The sociology and psychology literature has extensive research on the positive correlation of a household's financial situation and marital satisfaction as seen in Cutright (1971) and Conger et al. (1990). Increases in income or a better financial position is hypothesized to affect satisfaction in two ways: through the allowed increases in consumption and through the increased "constraints" to marital dissolution. By which we mean that a couple that has increased their income has more to lose in terms of its higher consumption/asset accumulation standing if a divorce were to occur. An increase in housing prices for homeowners is an increase in their wealth which may decrease their financial stress. This decreased stress would increase the value of marriage, which in turn decreases the probability of divorce. In the context of the marriage model, this would lead to an increase in M_2.

One of the gains to marriage in the theoretical literature is one of economies of scale within households. In short, there many consumption goods that must be purchased for each household, including the housing itself, dishwashers, washing machine, etc. These items are those that all members of the household can use, and so living together has its advantages. Renters will save on rent, owners must only purchase one home, and purchasing one dishwasher is better than needing to purchase two. Thus, living together to benefit from these economies of scale provides one reason for cohabiting and/or marrying. For homeowners, an increase in the value of residential housing increases these economies of scale and thus the value to staying married. With higher housing costs, a couple would lose out on these larger economies of scale if they were to divorce and live apart. Put differently, an increase in housing prices would increase the cost of living apart since they couple would become *buyers* in the market. In the case of a shock to housing prices, the couple will not have taken this change into account when making their decision to marry, and thus it may affect their likelihood of staying married. This would be equivalent to a decrease in D_H or D_W. To the extent that increases in housing prices increases rents, this effect may be similar for owners and renters.

Changes in housing prices also affect the equity that homeowners hold in their houses. With a decrease in house prices, there is a decrease in the value of the home, and therefore the equity held in the home. This may not matter to homeowners who have paid off their homes, or who do not intend to sell the home soon. However, during the 2007-2009 recession many homeowners ended up with mortgages that were "under-water", or they owed more on the mortgage than the home was worth. For all homeowners, a decrease in the value of housing means that it must be sold for less money but the amount owed on the home through the mortgage stays constant. Through this channel, an unexpected decrease in housing prices can decrease the divorce hazard since the costs to divorce are higher, or some couples might be "locked" in their homes. This would suggest that negative house price shocks would decrease the divorce hazard.

Another consideration for married couples is their prospects for buying or selling a house. After a divorce occurs and the household's assets must be divided, and often the primary residence must be sold. Since housing is by far the largest asset for most households, there may not be enough wealth in other assets for one spouse to take over sole ownership of the home. In this data, 38% of heads of household switch to renting in the year of divorce. When housing prices are high, and the economy is experiencing a boom, there is an excess demand for housing so it would be relatively easy for a couple to sell their house in the case of a divorce (Case and Shiller (1988) and Genesove and Mayer (1997)). A housing boom would make it easier to sell the home, and leave the couple with a larger amount of money to buy separate residences. This suggests that positive house price shocks would increase the divorce hazard by reducing the transaction costs of divorce. In the context of the model of marriage, this would increase the values of D_H and D_W. Conversely, in a housing bust, there tends to be an excess supply of houses which would make it relatively difficult to sell the house upon divorce, but cheaper to buy a new home.

So, the theoretical predictions suggest that the effect of house price shocks on divorce could go in either direction. Increases in housing prices increase the gains to marriage, which would suggest they decrease the divorce hazard. On the other hand, it is easier to sell your home when prices increase which makes it easier to divorce. Given the theoretical direction of an effect on the probability of divorce is potentially in either direction we explore the question with micro level data on households.

3 Data and Methods

Two main data sets are linked in this paper to study the effect of house price shocks on marital stability. The house price index used is the All-Transactions Index for MSAs from the Federal Housing Finance Agency.[2] This index combines transactions from sales as well as appraisals. The All-Transactions Index provides the best-suited house price index for the analysis in this paper as it covers a long period of time and provides information for all currently defined MSAs.[3] As of 2010, there were 374 MSAs defined by the U.S. Office of Management and Budget. In addition, some of the largest of the metropolitan areas have been subdivided into smaller divisions. This gives us a total of 384 MSAs and/or MSA Divisions in the All-Transactions Index. The data contains a price index for some MSAs as far back as 1975, and continues quarterly through the end of 2011. By 1987, the index has data for 80% of the MSAs. The index is deflated using the Consumer Price Index, CPI, excluding housing. This means that the index used will reflect how housing prices have changed as compared to all other consumer goods.

As previously mentioned, I attempt to measure the unexpected portion of the change in housing prices. To calculate these shocks, I approximate the quarterly house price index with a second order autoregressive process with MSA and quarter fixed effects is used in this paper, as described in Equation 1.[4] Quarter fixed effects are included since the index is not seasonally adjusted.

[2]Data obtained through the Office of Policy Analysis and Research in Washington, DC: FHFA (2012)

[3]Other indexes exist, most notably the S&P/Case-Shiller Home Price Indexes, however they do not fit as well with the goals of this paper. The Case-Shiller index only covers 20 Metropolitan Statistical Areas in the U.S., and does not begin until the late 1980s or early 1990s, and so there would be too few observations to use for analysis.

[4]All of the analysis shown in the paper follow this methodology that is used in the rest of the literature. Changing to a longer autoregressive processes does not change the results.

$$HPI_{i,t} = \beta_1 + \beta_2 * HPI_{i,t\text{-}1} + \beta_3 * HPI_{i,t\text{-}2} + \gamma_i + \eta_q + u_{i,t} \tag{1}$$

where i is the MSA, t is time, indexed by the year and quarter. HPI is the quarterly house price index, deflated using the CPI, that is regressed on the index for each MSA from the previous two quarters. γ_i is a fixed effect for the the MSA, and η_q is a fixed effect for the quarter. The remaining variation in the residuals from this first stage regression are taken to be the unanticipated change in prices. At each point in time I use the cumulative sum of residuals from Equation 1 for the past four years, or past 16 quarters. This methodology ensures that for each MSA in each year we can compare a cumulative sum of residuals that has the same starting date. Thus, using the residuals from the previous regression, the house price shock, $Shock_{i,t}$ is calculated as:

$$Shock_{i,t} = \hat{u_{i,t}} + u_{i,\hat{t-1}} + ... + u_{i,\hat{t-16}} \tag{2}$$

where $\hat{u_{i,t}}$ is the residual from Equation 1 for MSA i in time t.[5] By using the residuals of the the AR(2) process, the house price shock variable attempts to measure unexpected changes in local housing prices, rather than changes that are anticipated. As the shock is calculated as the sum of the past four years of residuals, the earliest date for the house price shock is 1979. The average start date for the house price shock in the sample is 1988.[6] Since MSAs have different start date, calculating the shock as the sum of the past four years gives us a measure that can be easily compared across locations.

The shock from Equation 2 is quarterly and the household respondents used are surveyed annually. Because of this, the quarterly shocks are averaged across each year. Although this takes away some of the variation in the variable, it seems unlikely that a large house price shock that occurs in one quarter only would affect a marriage, instead it is likely persistent shocks that matter. In order to assign the correct house price shock to each household, we exclude those

[5]The index is measured quarterly, so adding the residuals from the past 16 quarters to the current quarter gives us the sum for 4 years. House price shocks of other lengths are tested in Section 4.

[6]This is somewhat different to the calculation of house price shocks in RS and FSS. Both of those papers use methodology presented in Disney et al. (2010) where the house price shocks are calculated as the cumulative residuals of an AR(2) process of the house price index with county fixed effects. Unlike the U.K. House Price data used by Disney et al. (2010) and Rainer and Smith (2010), the All-Transactions Index starts at different dates for different MSAs. Therefore, simply cumulating the residuals from Equation 1, as in RS, is not an ideal strategy since the shock could not be accurately compared across MSAs.

households who have lived in the MSA for less than four years, and so a sum of the shocks from the past four years would not be relevant to them. In comparison, the methodology used in RS gives a measure of the price shocks since the start of the housing data. For households that have just moved from one MSA to another, the entire past history might not be the relevant house price shock that matters for decision-making.

The second main data set used is the PSID[7], household panel survey that currently has data available annually from 1968-1997 and bi-annually from 1999-2009. The panel began with a nationally representative sample of 4,802 families, and has followed the initial sample and their children as they split off and formed new households. As of the latest release in 2009, there were 8,690 households being interviewed. The analysis is completed using the original households and their split-offs. In addition, the restricted Geocode Match data from the PSID is used to obtain finer location measures for the households. This data is then used to match households to a house price shock by Metropolitan Statistical Area.

Finally, we link to the county unemployment rate, in order to observe the effect of house price shocks on divorce independent of changes in local business cycles.[8] As expected, the county unemployment rate is negatively correlated with the house price shocks. However, the coefficient of correlation between the two series is relatively low at -0.27. Note that the sample in each model in Section 4 begins in 1982, rather than in 1979 at the start of the housing price shocks, due to the availability of the county unemployment rate data.

Table 1 explores summary statistics for the two different married homeowner groups in the data: married households who are in the baseline estimation sample in Section 4 and have a valid house price shock and all married homeowners, including those who are not in the estimation sample. The 'House Price Shock' variable listed in the table is calculated as mentioned in Equation 1. These two groups of couples are compared to see if there are any major differences between the estimation sample and the entire population of married home-owners. The couples who are not in the estimation sample either do not have a measured house price shock, or have missing data for another explanatory variable. There are several reasons why a couple might

[7]Data obtained through the University of Michigan: PSID (2012).

[8]Unemployment data by MSA is only available beginning in 1990, so county unemployment data was used. In many cases the MSA covers one county, however for some larger MSAs there may be several counties included.

Table 1: Summary Statistics of Married
PSID Households, 1975-2009 Means

	Estimation Sample		**All Homeowner Couples**	
	Husband	Wife	Husband	Wife
Demographics:				
< High School	0.155	0.114	0.196	0.151
High School	0.295	0.426	0.320	0.438
Some College	0.211	0.204	0.185	0.191
College	0.338	0.256	0.299	0.221
White	0.875	0.875	0.896	0.894
Black	0.063	0.064	0.056	0.056
Hispanic	0.051	0.053	0.040	0.045
Year of Birth	1943	1945	1941	1944
Number of Children	0.821	0.821	0.882	0.882
Marriage:				
Age First Married	23.62	21.65	23.25	21.32
Year First Married	1967	1967	1965	1965
# of Marriages	1.198	1.183	1.243	1.181
Length of Curr. Marriage	26.42	26.42	24.30	24.30
Frac. Divorcing this Yr	0.011	0.011	0.012	0.012
Employment:				
Employed	0.738	0.576	0.748	0.561
Unemployed	0.015	0.012	0.016	0.013
Labor Income	$57,331	$21,670	$50,815	$18,591
Housing:				
House Value	$210,320	$210,320	$179,555	$179,555
Remaining Principal	$69,448	$69,448	$59,997	$59,997
House Price Shock	0.111	0.111	0.102	0.102
County Unemployment Rate	0.059	0.059	0.062	0.062
Couples	3,893	3,893	9,675	9,675
N (Couple-years)	30,013	30,013	64,190	64,190

NOTE: Monetary variables are in 2009 dollars. The house values are self-reported yearly measures of the value of the current residence for home-owners. Estimation sample begins in 1982 when county unemployment data is available. Sample weights are used.

not have a house price shock matched to them: the couple does not live in an MSA, they do not live in an MSA during the period that the MSA has housing data available, or they do not have a location reported with in the PSID Geocode Match Data. This means that for those couples who do have observations in the Geocode Match data but have no house price shock, they live in towns of less than 50,000 people and/or rural areas, or they live in an MSA with fewer than four years worth of housing data.

Both men and women in marriages in the estimation sample have more education compared to the whole sample, and are more likely to be white. In addition, both the husbands and the wives earn more income than those in the whole sample. The average current duration for married couples is 26 years for couples in the sample and 19 for couples who are not in the sample. Those couples included in the sample have fewer children and are slight more likely to be divorcing in a given year. The baseline estimation sample is limited to couples who own a home and they live in more expensive homes compare to the entire sample of couples who are homeowners. These couples also have more principal remaining on their mortgages, which is unsurprising since their homes are more valuable. Looking at the number of couples in each category, we see that a significant number of couples are excluded from the sample mostly because there is no housing data for them. Some of these couples are addressed further in section 4.1, using a different house price index.

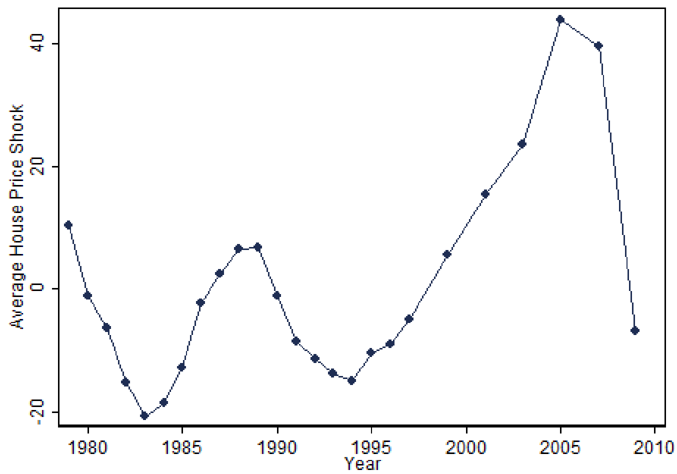
One potential complication to note is that from the beginning of the PSID data in 1968, until around 1985, there were important changes occurring in the legal environment surrounding divorce. During the 1970s, the majority of states changed these requirements to allow for "no-fault" divorce.[9] The reasons for requesting a divorce included incarceration, adultery, insanity, and willful neglect of of one's wife and children. Since the earliest date of the analysis is 1982, for virtually every observation in the regressions the state in question has already converted to no-fault terms of divorce. Despite this, there were still large changes in the prevalence and attitudes toward divorce, so all of the specifications of the divorce model have year fixed effects to take out any unobserved year-specific differences in the propensity to divorce.

3.1 Description of House Price Shocks

Figure 1 presents the yearly means of the house price shocks that the households of the PSID face. This is constructed using the house price shocks calculated in Equation 2 and combining them with the data on the PSID households based on the CBSA code of each metropolitan area (or FIPS State/County code for the largest metropolitan areas). The figure illustrates that on average households had positive house price shocks during the late 1990s and early 2000s, and on average negative house price shocks during 2007-2009. The weighted mean of the shock for all respondents is 2.59, with a standard deviation of 27.95. This is very close to the mean and standard deviation of the estimation sample. The size of the house price shocks range from -109

[9] Freed (1972), Freed and Henry H. Foster (1979), Jacob (1988), and Marvell (1989) contain information about when each state introduced some legal method for obtaining a divorce through no-fault to either spouse.

Figure 1: Yearly Mean of House Price Shock of Respondents



to 147. It should also be noted that this figure represents averages for all metropolitan areas, so although on average the house price shock variable is positive in the 1990s and 2000s, there was much variation across locations.

To see this is true, Table 2 shows the average value of the house price shock in different states in 1995 (the beginning of the housing boom) and 2005 (the peak of the housing boom). The last column shows the overall change in the house price shock during this time. The table illustrates that there were very large differences across states during this time period of rising house prices. The first few rows show the values for the states with the smallest change in house price shocks from 1995 to 2005. A few states even had prices falling unexpectedly or perhaps not rising as quickly as expected. If we compare these to the states that had the largest change in house price shocks during the housing boom we notice two facts. First, many but not all of the states with the largest shocks had large negative house price shocks at the start of the boom. Second, all of these states had much larger positive house price shocks in 2005, as compared to the small shock states. It is encouraging that the states that have been identified as having large shocks during the housing boom, Arizona, Florida, California, etc., are indeed the places that anecdotally we know had extreme increases in prices.

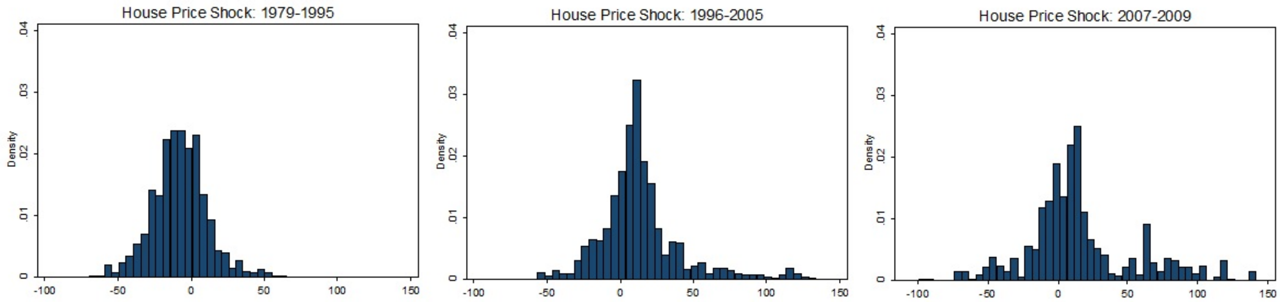
To further describe the distribution of the house price shocks, the next figure shows how the distribution of the house price shock has changed over time. Figure 2 divides the sample into three time periods: pre-housing boom (1979-1994), during the housing boom (1995-2005), and

Table 2: House Price Shock by State:
1995 and 2005

State	**Shock in 1995**	**Shock in 2005**	**Difference**
Smallest:			
Indiana	6.49	2.17	-4.32
Ohio	7.10	4.29	-2.81
Iowa	7.07	6.72	-0.35
Colorado	12.99	14.17	1.18
Nebraska	7.42	9.62	2.20
Kentucky	5.42	8.29	2.86
Michigan	4.11	7.57	3.46
Largest:			
Massachusetts	-32.42	46.84	79.26
New Hampshire	-37.27	44.83	82.10
Maryland	-16.90	68.18	85.07
Arizona	-1.47	92.96	94.42
Nevada	2.97	100.68	97.71
New Jersey	-26.48	74.19	100.67
Rhode Island	-29.92	73.24	103.16
Florida	-9.61	110.82	120.43
Washington D.C.	-24.51	100.10	124.60
California	-28.31	114.30	142.61

during the housing bust (2007 and 2009). The house price shock is measured in index units, and the width of each bin on the histograms is five index points. The figure shows that compared to the other two time periods, the distribution was much more concentrated during 1995 to 2005. The earliest time period had negative house price shocks on average, and the middle time period had positive house price shocks on average with a relatively large number of observations in the right tail of the distribution. The latest time period does not have a very smooth distribution, likely because it is only for two years and so has far fewer observations included than the other two sample periods. We can see that there were still many positive house price shocks calculated during the recession years of 2007-2009, which is a feature of the large positive shocks observed in the four years prior to these.

Figure 2: Histogram of House Price Shock over Time



The next four figures provide a visualization of the house price shocks for a select few years. The figures show the house price shock data overlaid on a map of MSAs using ArcGIS software.[10] The color gradient shows house price shocks of different sizes from -160 to +160. Thus MSAs that are more red to orange in color experienced negative house price shocks in the given year, and MSAs that are more green to yellow in color experienced positive house price shocks in the given year. Note that the shocks switch from negative between the fourth and fifth color category. As described above, there are only some of the MSAs that were collecting housing data early enough to appear in Figure 3. Figure 4 shows the house price shocks roughly at the start of the housing boom, where many places had experienced negative shocks. Moving to Figure 5, many more MSAs are appearing in yellow-green as many locations were experiencing positive shocks. A few places to note in bright green that had very large shocks are several MSAs in California, Nevada, Arizona, Washington D.C., and Florida as illustrated by Table 2. Once we get to 2009, we observe several places begin to experience housing "busts", the locations appearing in red in Figure 6.

[10]Note that in the analysis some larger population MSAs are divided into subregions for finer location measures. However, the GIS maps of metropolitan areas groups all of these subregions one area, so the house price shocks shown on the maps are the average for the year for the larger areas. The MSAs that are sub-divided in this way in the analysis are Boston, Chicago, Dallas/Ft. Worth, Detroit, Los Angeles, Miami, New York, Philadelphia, San Francisco, Seattle, and Washington, D.C.

Figure 3: Map of House Price Shocks: 1981

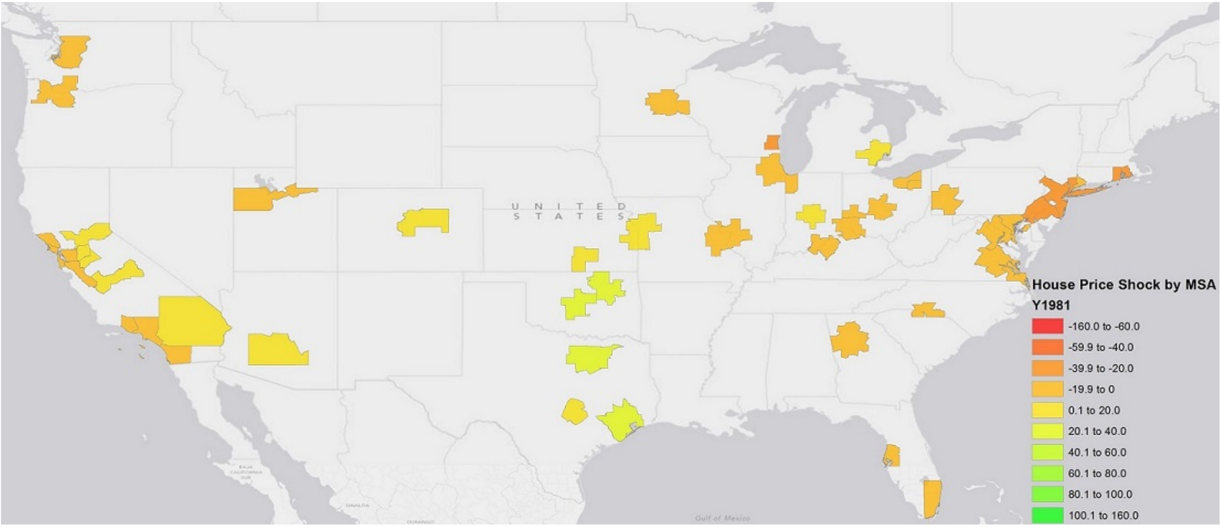


Figure 4: Map of House Price Shocks: 1995

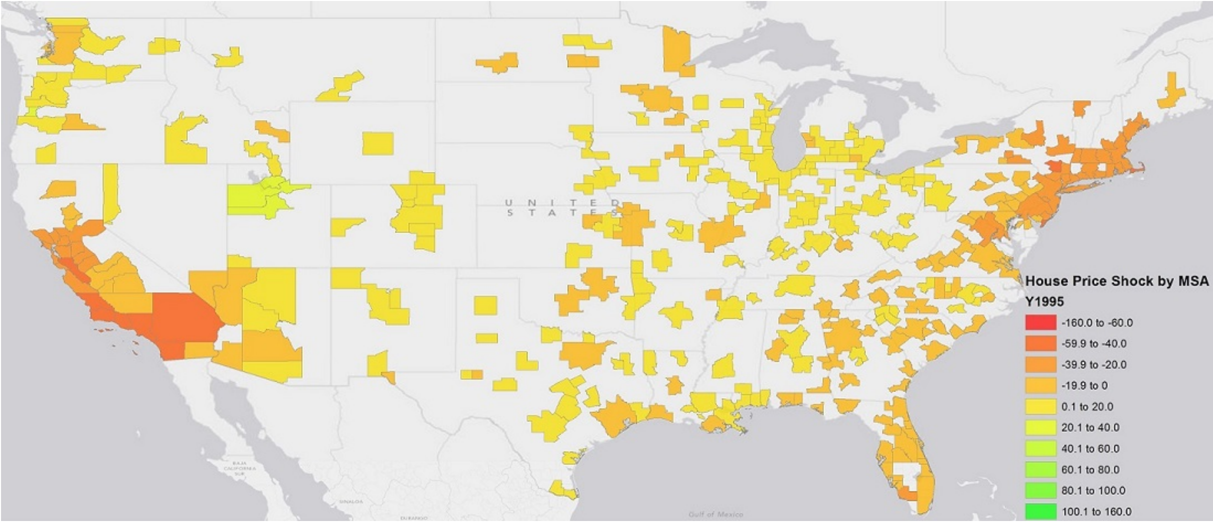


Figure 5: Map of House Price Shocks: 2005

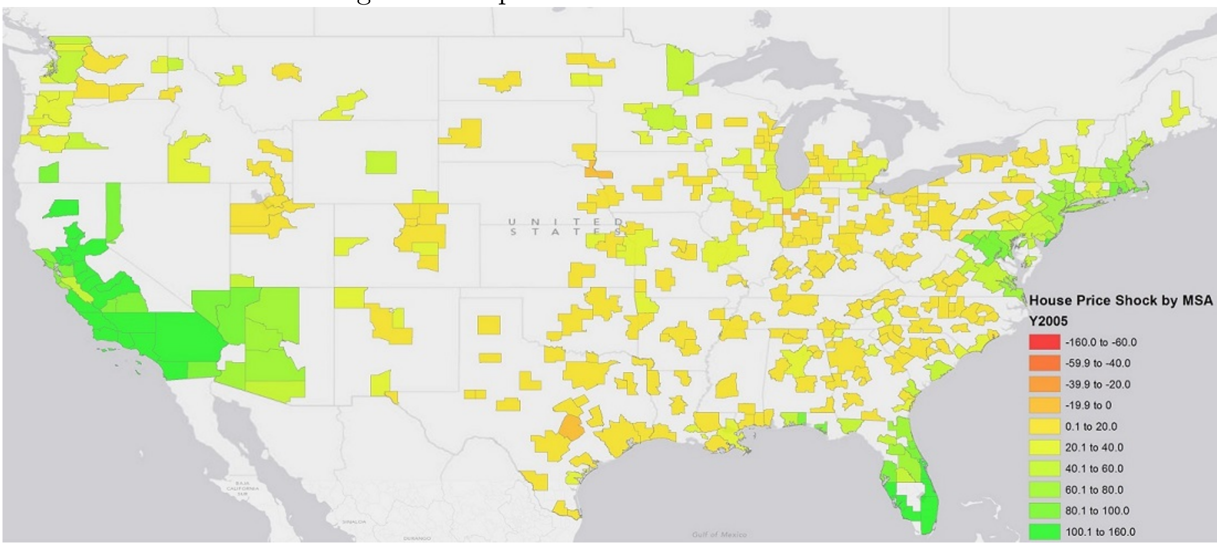
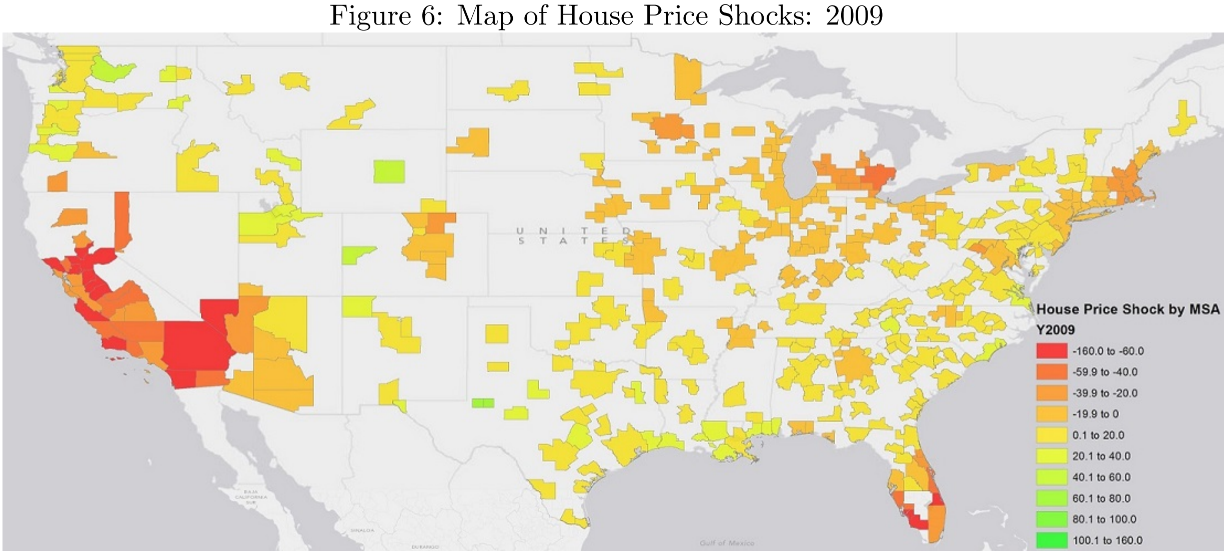


Figure 6: Map of House Price Shocks: 2009



4 Results

Discrete time duration analysis is used to analyze the effect of house price shocks on the probability of divorce. Since I want to estimate the effect of house price shocks on the probability of divorce for individual couples, duration analysis provides the ideal estimation strategy. The interpretation of the results of a duration model would be how house price shocks affect the instantaneous probability of divorce for the couple, conditional on the couple having stayed together for this long. These types of models control for the length of time the couple has survived, as we know that the likelihood of divorce occurring changes with the current length of the marriage. The date of divorce is set as the date of separation. In the PSID, the reported separation date is the date at which the couple stopped living together and so it is a good measure of the end of the relationship. The legal process of divorce can often take a long time and so if the couple does not report a separation date, we use one year prior to the date of divorce as a proxy for the date of separation. This method allows us to most accurately capture the true end date of the relationship. As noted in Kreider and Ellis (2011), using data from the Survey of Income and Program Participation, the median length of time between a separation and divorce is one year. The shock variable is scaled by dividing by the standard deviation of the variable. Therefore, the interpretation of the coefficients in the regressions is for a one standard deviation change in the variable.

The divorce model used in the regressions is similar to the specification in RS, Böheim and Ermisch (2001), and Weiss and Willis (1997). I estimate the effects of house price shocks while controlling for various observable factors about the couples that may affect the divorce hazard. This includes things that would change the gains to marriage, the value of being single, and the direct or indirect costs of divorce. The model includes demographic controls, such as race, education, and age at marriage, as the baseline divorce hazard may vary across these dimensions. Year fixed effects are included in the regression as there may be legal or social factors that affect the divorce hazards differently across the years of the sample. In addition, the PSID was a nationally representative sample of households in 1968, so the respondents come from very different birth cohorts. To address this, each of the regressions include dummy variables for birth cohort groups. Finally, the county unemployment rate for each year is included to isolate the effects of house price shocks on the divorce from local area business cycles.

A probit model is used for analysis, controlling for the current duration of the marriage. Given that a household is observed many times in the data, the interpretation of the marginal effects from a probit regression is the effect on the probability of divorce in the current year, conditional on the marriage having reached the current duration. Jenkins (1995) shows that by including controls for the elapsed duration of the marriage, as well as other controls at time $t-1$, then the maximum likelihood estimation of the parameters from a probit analysis are consistent.[11] Thus, a probit model in this form provides a framework for discrete time duration analysis. To control for the length of the marriage, the log of the current duration of the marriage is included in the divorce regression. This choice of the log of the marriage duration specifies a particular parametric form for the baseline hazard. We see that the baseline probability of divorce in the data is decreasing at a decreasing rate over time, thus the choice of the log of the duration of the marriage.

Since positive and negative shocks to house prices may have different effects on the divorce hazard, the variable $Shock_{i,t-1}$ is divided into its positive and negative components. The variables of interest reported in Table 3 are "Positive House Price Shock" and "Negative House Price Shock", which are equal to zero when a shock of the opposite sign occurs. To make the negative shock coefficients easier to interpret, the absolute value of the shock is used. The results in Table 3 are for those couples who are homeowners, and allows for respondents who have multiple marriages in the sample. In each probit model, the marginal effects are reported for the explanatory variables. The divorce regression to be estimated is:

$$div_{i,t} = \alpha_0 + \alpha_1 * \text{Pos. House Price Shock}_{t-1} + \alpha_2 * \text{Neg. House Price Shock}_{t-1} + \beta_1' * X_{i,t-1} + \beta_2' * Z_i + \gamma_t + u_{i,t}$$

where $div_{i,t}$ is 0 while married and 1 at the date of separation; Pos. House Price Shock_{t-1} and Neg. House Price Shock_{t-1} are the calculated positive and negative house price shocks; $X_{i,t-1}$ are a set of time-varying controls such as education, marriage duration, and the county unemployment rate; Z_i are time-invariant controls such as race, age at marriage, birth cohort, and number of previous marriages; and γ_t are year fixed effects.

Each column in Table 3 represents a different regression model, sequentially adding in more and more explanatory variables. I find that positive shocks are statistically significant at the 5% in each column of Table 3, except for Column (1) which contains only the varibles of interest and the county unemployment rate.[12] In each of the models, there is a negative sign on the positive house price shock variable which indicates that larger, positive house price shocks stabilize marriage. The standard errors are clustered by household, however the results are also robust

[11] Ideally we want the value of each variable at the date of divorce. A divorce occurs between the previous and current interview so the closest date, without going past the divorce, is the date of the previous interview. Thus, the analysis does not include information that occurred AFTER the date of divorce.

[12] Positive house price shocks also have a significant and negative effect using a logit model or a linear probability model.

Table 3: Probit Model of Divorce Hazard:Homeowners

Variable	(1) Marg. Eff. (S.E.)	(2) Marg. Eff. (S.E.)	(3) Marg. Eff. (S.E.)	(4) Marg. Eff. (S.E.)	(5) Marg. Eff. (S.E.)
Pos. House Price Shock$_{t-1}$	-0.0013	-0.0034***	-0.0014**	-0.0014**	-0.0014**
	(0.0011)	(0.0012)	(0.0007)	(0.0007)	(0.0007)
Neg. House Price Shock$_{t-1}$	-0.0032*	-0.0014	-0.0003	-0.0003	-0.0003
	(0.0019)	(0.0019)	(0.0011)	(0.0011)	(0.0011)
Year Effects	No	Yes	Yes	Yes	Yes
Demographic Ctrls	No	No	Yes	Yes	Yes
Fertility Ctrls	No	No	No	Yes	Yes
Income Ctrls	No	No	No	No	Yes
# of Couples	4,243	4,243	3,894	3,894	3,893
N (couple-years)	32,091	32,091	30,016	30,016	29,960
Pseudo-R^2	0.0018	0.0188	0.1138	0.1152	0.1150

Sample weights are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.

to two-way clustering on household and MSA since the house price shocks only vary at the MSA level. In most models, the marginal effects suggest that negative house price shock also stabilize marriage but it is only significant at the 10% level with no other controls.

Column (2) shows regression results for a divorce model with only the house price shock variables, county unemployment rate, and year fixed effects. Including demographic control variables such as age, birth cohort, education, and race in Column (3) reduces the size of the marginal effect compared to Column (2) to -0.0014, however it is still significant at the 5% level. Next in Column (4), I add fertility controls for the age of the youngest child and number of children in the household.[13] This baseline estimation sample has 30,016 couple-year observations, for 3,894 couples. This covers 309 divorces experienced by the couples. The average number of times a couple is observed in the estimation sample is eight times, with a maximum of 22 times. Column (5) adds measures of income for the husband and wife. The full specification for the probit model is shown in Table 10 in the Appendix.

I find a marginal effect of -0.0014 in the baseline regression of Column (4) in Table 3 which means that for a one S.D. increase in the house price shock, the divorce hazard is decreased by 0.14 percentage points. The average value for the dependent variable, representing the fraction of the sample that is divorcing in a given year, is 0.0105 or 1.05%. This is a 13.3% decrease in

[13]The specification in Column (4) is used as the baseline specification for later tables, when other regressors are not specified.

the divorce hazard at the means of all variables.[14] In 1995 near the start of the housing price boom the average house price shock was 5.5 and in 2005 near the peak of the housing prices average house price shock was 43.9 for a change in the positive house price shock of about 38.4 index units. The standard deviation of the house price shock variable is 26.6 so this was a 1.44 standard deviation increase in housing prices. This would suggest that the housing boom of the late 1990s and early 2000s decreased the divorce hazard for the average couple by 19.2%.

Table 4: Length of House Price Shocks: Probit Models

Variable	(6) Shock Sum of Past 1 Year Marg. Eff.(S.E.)	(7) Shock Sum of Past 2 Years Marg. Eff.(S.E.)	(8) Shock Sum of Past 3 Years Marg. Eff.(S.E.)	(9) Shock Sum of Past 6 Years Marg. Eff.(S.E.)
Pos. House Price Shock$_{t-1}$	0.0001 (0.0007)	-0.0005 (0.0007)	-0.0012 (0.0007)	-0.0035*** (0.0012)
Neg. House Price Shock$_{t-1}$	-0.0005 (0.0010)	0.0000 (0.0014)	-0.0004 (0.0011)	-0.0025 (0.0020)
Year Effects	Yes	Yes	Yes	Yes
# of couples	4,490	4,354	4,008	3,488
N (couple-years)	36,225	34,578	31,910	27,089
Pseudo-R^2	0.1062	0.1135	0.1160	0.1219

Sample weights are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.

Table 4 shows the long-lasting effects of unexpected changes in housing prices by modifying the way house price shocks are calculated compared to the previous table. Recall from Equation 2, that the house price shock is the sum of residuals from Equation 1 for the past four years. Table 4 explores sums of other lengths for the shocks. Looking at the one-year sum and two-year sum in Columns (6) and (7) we see the same sign as the baseline regression, though not significant. In Columns (8) and (9), however, we use longer measures for the house price shocks by taking the sum of residuals from Equation 1 for three and six years respectively. In Column (8) the marginal effect is about the same magnitude as the baseline results, though it's p-value falls just short of significance at 0.107. Column (8) exhibits an even larger and more significant effect than the baseline at -0.0035.[15] As before, in each of these regressions households who

[14] This is comparable in magnitude to the effect of a 1 S.D. negative income shock which decreases the divorce hazard by about 15% as estimated from my previous work in Milosch (2012). The effect on the divorce hazard of 13.3% is much larger than what RS found, but smaller than the effect of job loss as studied by Charles and Stephens (2004).

[15] The results look almost identical if we limit the sample to only the couples that would be included in every one of the four models in Table 4.

have moved into the MSA in the past one, two, three, and six years respectively are excluded from the analysis. This indicates that short-term fluctuations in housing prices, even if they are unexpected, do not affect the divorce hazard. Instead, it is only the longer lasting shocks to housing prices that affect this household decision.

I find that positive house price shocks stabilize marriage. Couples who have positive house price shock essentially experience a positive wealth shock, but also an increased cost to living apart. One interpretation of these results is that an increase in housing prices increases the gains to marriage. A positive house price shock means that it would be even more costly than before for a couple to maintain separate residences in the event of a divorce. This makes marriage a more attractive option than before. The results are unchanged when a control for the amount of remaining principal on the mortgage is included, or when controls for other lump sum payments (such as an inheritance) are received. Another possible explanation, as cited by the psychology and sociology literature (i.e. Cutright (1971), Conger et al. (1990)), is that the positive wealth shock decreases the financial stress in the relationship, thus decreasing the risk of divorce. Much of the economic literature finds that only negative financial shocks have a significant effect on divorce hazards. It may be that this paper finds an effect from positive shocks since it covers the time period of the U.S. housing boom where we saw large, positive shocks. Also, the fact that the data ends in 2009 and is bi-annual means that there are only two observation for each household during years with large decreases in housing prices, so there may just not be enough observations with large negative shocks to observe an effect.

Table 5: Combined Positive and Negative Shocks, All Couples, Renters

	(10) Owners		(11) All Couples		(12) Renters	
Variable	Marg. Eff.	S.E.	Marg. Eff.	S.E.	Marg. Eff.	S.E.
House Price Shock$_{t-1}$	-0.0009*	(0.0005)				
Pos. House Price Shock$_{t-1}$			-0.0016**	(0.0007)	-0.0024	(0.0025)
Neg. House Price Shock$_{t-1}$			0.0001	(0.0011)	0.0038	(0.0036)
Year Effects	Yes		Yes		Yes	
# of couples	3,893		4,618		1,515	
N (couple-years)	30,013		35,714		5,701	
Pseudo-R^2	0.1146		0.1252		0.1478	

Sample weights are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.

Table 5 shows a few additional findings. First, Column (10) does not separate the positive from the negative shocks, and the result from the previous tables still holds: increases in the house price shock decrease the risk of divorce. In Column (11), all couples are included in the analysis, regardless of whether they rent or own. Column (12) looks exclusively at the couples who are renters. The direction of the effect is the same for renters so unsurprisingly the marginal effect for all couples is similar.

The result that is consistent across all of these specifications is that positive local area house price shocks reduce the divorce hazard. This is suggestive of the scenario in Section 2 where homeowners face a sudden increase in cost of living apart which in turn increases the costs of divorce or that the better financial position of the household decreases stress in the marriage and makes divorce less likely. The only evidence that negative house price shocks stabilize marriage, as found by Farnham et al. (2011) is when year fixed effects are not included in the regressions though the sign of the coefficient in most models is consistent with their findings.

4.1 Who is Affected By House Price Shocks?

Table 6: Alternative Samples-Probit Models

Variable	(13) Younger Cohort Marg. Eff.(S.E.)	(14) Older Cohort Marg. Eff.(S.E.)	(15) 1982-1994 Marg. Eff.(S.E.)	(16) 1995-2009 Marg. Eff.(S.E.)
Pos. House Price Shock$_{t-1}$	-0.0034* (0.0020)	-0.0006 (0.0005)	-0.0017 (0.0016)	-0.0014* (0.0008)
Neg. House Price Shock$_{t-1}$	0.0006 (0.0036)	-0.0004 (0.0006)	0.0005 (0.0010)	-0.0008 (0.0018)
Year Effects	Yes	Yes	Yes	Yes
# of couples	2,456	1,437	2,352	3,229
N (couple-years)	15,067	14,946	15,349	14,664
Pseudo-R^2	0.0629	0.1344	0.1409	0.1104

Sample weights are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.

In this section we identify groups/time periods where the respondents are most affected by the house price shocks. Column (13) of Table 6 restricts the sample to the younger cohorts of heads of households in the PSID. Included are only households where the head was born in 1949 or later. The sample size is smaller, but as in the previous models positive house price shocks appear to stabilize marriage. It may be that young households have less wealth from sources other than their homes, and so do not have as much to use in the purchase of future homes if they divorce. Or, we could be seeing this effect simply from the young cohort being in a different stage of their marriage. In addition, the younger cohort is much more likely to experience a divorce. There is no significant effect of house price shocks on households from the older birth cohort. Of course, this may not necessarily be indicative of no effect for the older cohort, since there is considerable selection bias among the older married couples. The older cohort contains many couples that are much further along in their marriages that the younger birth cohort. Given this, the only couples included are those whose marriages have actually survived to this point. Thus, those who have divorced are already gone from the sample if they have not remarried. Next, we examine the beginning and ending periods of the data separately, as there was much greater variation in the house price shocks across MSAs later in the sample and different divorce rates across the country over time. The results from Columns (15) and (16) show that the results are driven by the time period with the greater volatility in house price shocks. In addition, since the housing data used by RS is from 1991-2009, their paper only contains couples in the BHPS during this time. The years in Column (16) are close to the years used in RS, providing a check that there was not just something different about the particular years used in their sample, rather than the full specification in Table 3 of 1982-2009.

Table 7: By Education and Income Levels

Variable	(17) Husband: HS or less Marg. Eff. (S.E.)	(18) Husband: Some Coll. or more Marg. Eff. (S.E.)	(19) Low: Family Income Marg. Eff. (S.E.)	(20) High: Family Income Marg. Eff. (S.E.)
Pos. House Price Shock$_{t-1}$	-0.0021** (0.0010)	-0.0007 (0.0007)	-0.0021** (0.0010)	-0.0009 (0.0008)
Neg. House Price Shock$_{t-1}$	-0.0010 (0.0010)	0.0007 (0.0015)	-0.0002 (0.0013)	0.0001 (0.0016)
Year Effects	Yes	Yes	Yes	Yes
# of couples	1,965	2,025	2,900	2,595
N (couple-years)	14,552	15,461	15,010	14,977
Pseudo-R^2	0.1706	0.0980	0.1595	0.1050

Sample weights are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.

Next the sample is divided by the education of the husband and the income level of the family in Table 7. The table shows results for respondents with education levels of *high school or less* and for *some college or more*. Comparing these two samples we see that the house price shock appears to only affect those respondents with lower education. A wealth shock like a house price shock might affect couples with different levels of household income differently. The sample is divided at the 50th percentile for age-adjusted family income at the time of marriage. From the marginal effects reported in Columns (19) and (20), we see that it is the lower income families that are affected by house price shocks. It may be the case that a shock to housing wealth has more of an impact on low income families if a greater fraction of their total wealth is held is housing.

Table 8: Including State Non-Metro. House Price Shocks: Homeowners

Variable	(21) Shock Sum of Past 4 Year Marg. Eff.(S.E.)	(22) Shock Sum of Past 6 Years Marg. Eff.(S.E.)	(23) Shock Sum of Past 4 Years Haz. Rat. (S.E.)	(24) Shock Sum of Past 6 Years Haz. Rat.(S.E.)
Pos. House Price Shock$_{t-1}$	-0.0012* (0.0007)	-0.0013** (0.0007)	0.839* (0.086)	0.791** (0.092)
Neg. House Price Shock$_{t-1}$	-0.0003 (0.0011)	-0.0013 (0.0011)	0.911 (0.172)	0.785 (0.171)
Year Effects	Yes	Yes	Yes	Yes
# of couples	4,068	3,639	4,399	3,650
N (couple-years)	30,599	27,584	30,978	27,636
Log-Psuedolikelihood	-1594.2	-1308.5	-1763.2	-1376.0
Psuedo-R^2	0.1142	0.1200	-	-

Sample weights are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.

Table 8 provides results for an attempt to include some respondents who do not live in an MSA. The All-Transactions Index provides a house price index only for those respondents who reside in a Metropolitan Statistical Area, which is defined by the Office of Management and Budget as a geographical area with an urban area of more than 50,000 people. So in the baseline specification households located in areas with a population smaller than 50,000 are excluded. The FHFA provides another quarterly house price index for non-metropolitan areas at the state level beginning in 1995. The procedure from Section 3 is repeated for the Non-Metropolitan Index with quarter and state fixed effects. This index is used for households who are not located in an MSA but we know the state they live in. Since this only varies at the state level, and house prices can be vastly different across different areas of a state this is a much worse measure of house price shocks that what is measured using the All-Transactions Index. The results of probit models are presented in Column (21) and (22), and the results of the Proportional Hazards Model in Columns (23) and (24). The positive house price shocks are significant across all four specifications. The size of the marginal effects is very close to what was found in the baseline sample. This indicates that it is not something specific to couples who live in larger towns and cities, but applies to those in more rural areas as well.

4.2 Robustness Checks

A few robustness checks were performed to test the validity of the results presented above. First, an alternative type of duration analysis is performed using the Cox Proportional Hazards Model (Cox (1972)). This second type of model is used to check for consistency in the results found using a probit model. The Proportional Hazards model allows the researcher to use partial likelihood to estimate the coefficients of the model without specifying a particular functional form for the baseline hazard function.[16] As with the probit model, the analysis with the Proportional Hazards model allows for the respondents to have multiple marriage spells within the data. For each marriage at each point in time, the Proportional Hazards model estimates the effect of the explanatory variables on the divorce hazard. The results are presented in Table 9. For each of the variables, a hazard ratio greater than one indicates that an increase in the variable increases the divorce hazard, and a hazard ratio less than one indicates that an increase in the variable decreases the divorce hazard. For the same reasons as noted with the probit models, all of the regressions using the Cox Proportional Hazards Model include the time-varying variables measured at time $t-1$.

The direction of the effect for the positive house price shocks in Table 9 is the same as in Table 3.[17] The hazard ratio for the positive shocks is less than one in all models, suggesting that

[16] Discrete time duration models and continuous time duration models both provide estimates of the effect of the variables on the probability of divorce, but view the explanatory variables in slightly different ways. Jenkins (1995) states that for discrete time duration analysis, if the unit of time is a year, and the time-varying variables are measured at the end of each year, the model makes the assumption that the variables are constant over the year. This seems to be a reasonable assumption since most of the time-varying variables do not change very quickly (education, number of children, etc.). Evidence has shown that in general the time aggregation does not cause significant bias in the estimates for simple parametric approaches (Bergström and Edin (1992)).

[17] The difference in sample size between these regressions and those in Table 3 are partially because of the few households that are only observed once in the sample. A household must be observed at least twice to be included

Table 9: Cox Proportional Hazards Model of Divorce Hazard:Homeowners

Variable	(25) Haz. Ratio	Std. Err.	(26) Haz. Ratio	Std. Err.	(27) Haz. Ratio	Std. Err.
Pos. House Price Shock$_{t-1}$	0.820*	(0.088)	0.820*	(0.088)	0.821*	(0.088)
Neg. House Price Shock$_{t-1}$	0.984	(0.194)	0.980	(0.193)	0.984	(0.195)
County Unemp. Rate$_{t-1}$	0.145	(0.523)	0.143	(0.523)	0.147	(0.538)
Age at Marriage-Husb.	0.953	(0.100)	0.928	(0.098)	0.929	(0.100)
Age Diff.(H-W): -5 to -1	1.483	(0.375)	1.477	(0.374)	1.473	(0.373)
Age Diff.(H-W): 0 to 4	1.890***	(0.401)	1.907***	(0.405)	1.905***	(0.406)
Age Diff.(H-W): 5 to 10	2.384***	(0.602)	2.443***	(0.615)	2.437***	(0.618)
Age Diff.(H-W): > 10	5.139***	(2.286)	5.514***	(2.466)	5.496***	(2.472)
# Prior Marriages-Husb.$_{t-1}$	1.208	(0.201)	1.213	(0.203)	1.216	(0.205)
# Prior Marriages-Wife$_{t-1}$	1.091	(0.148)	1.095	(0.147)	1.093	(0.148)
High School-Husb.$_{t-1}$	1.207	(0.262)	1.200	(0.261)	1.202	(0.263)
Some College-Husb.$_{t-1}$	1.017	(0.234)	1.020	(0.236)	1.021	(0.242)
College-Husb.$_{t-1}$	0.969	(0.241)	0.979	(0.243)	0.984	(0.247)
High School-Wife$_{t-1}$	0.620**	(0.141)	0.604**	(0.137)	0.599**	(0.136)
Some College-Wife$_{t-1}$	0.600**	(0.152)	0.591**	(0.150)	0.584**	(0.149)
College-Wife$_{t-1}$	0.430***	(0.125)	0.426***	(0.124)	0.421***	(0.123)
Black-Husb.	1.399	(0.293)	1.449*	(0.304)	1.441*	(0.302)
Hispanic-Husb.	0.604	(0.211)	0.638	(0.225)	0.633	(0.227)
Wife Same Race	0.899	(0.244)	0.907	(0.245)	0.904	(0.248)
# of Children$_{t-1}$			0.877*	(0.064)	0.880*	(0.066)
Young Children$_{t-1}$			1.060	(0.188)	1.064	(0.190)
Log(Income)-Husb.$_{t-1}$					0.997	(0.022)
Log(Income)-Wife$_{t-1}$					1.004	(0.017)
Year Effects	Yes		Yes		Yes	
# of Couples	4,230		4,230		3,899	
N (couple-years)	30,402		30,402		30,016	
Log Pseudolikelihood	-1880.5		-1878.5		-1856.4	

Average of sample weights for each marriage are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.

larger positive shocks decrease the probability of divorce for the couple. The effect is significant at the 10% level for all specifications. The hazard ratio for the models in Table 9 is around 0.821. This would suggest that a one standard deviation larger positive house price shock would decrease the divorce hazard of the couple by 17.9% (compared to an estimate of 13.3% from the baseline estimation). Again thinking about the housing boom of the late 1990s to early 2000s, which had an average increase in house price shocks of about 38.4 index units. This corresponds to a 1.44 standard deviation increase in the house price shock. The results using the Cox Proportional Hazards model suggest that the housing boom decreased the probability of divorce for married couples by about 25.8% on average over the entire period.

Next, the estimation of the house price index as in Equation 1 includes lags from housing prices in the two previous quarters. This was chosen as to follow the methods used in the literature. However, the results hold if a longer lag structure is chosen (i.e. lags from the past three or four quarters). In addition to differences in the propensity to divorce across different years, there also may be regional differences over time. Including region-year interactions, the marginal effect on the positive house price shock is approximately the same at -0.0015 with a standard error of (0.0008) so the effect is significant at the 10% level. I also checked the robustness of the results using other levels of aggregation of the unemployment rate. The county unemployment rate begins in 1982, so a few years of data is cut off from the analysis. The results are unchanged when including the state unemployment rate, which covers the entire 1979-2009 time period of the available house price shock data, though this is clearly a much cruder measure of local business cycles. I also check the results using the unemployment rate at the MSA level, however these are only available from 1990 on. Though the sample size is reduced, the size of the significant marginal effect on the positive house price shock is about the same, though the standard error increases slightly to 0.0008 so it is now significant at the 10% level. The probability of divorce may also be influenced by the employment status of the husband and wife, however these are potentially endogenous variables if individuals change their labor market choices in anticipation of divorce. Including employment status of each spouse in

in a Cox Model. The other reason for the difference is the few observations with a zero weight. A Cox Model must have a constant weight for the duration of a marriage, so the average of the weight variable is used, which washes out a zero for one year in the weight variable.

the regressions does not change the results. To ensure that higher order marriages are not driving the results, I restrict the estimation sample to only first marriages of respondents. The marginal effect of the positive house price shock in that regression is slightly smaller (-0.0011) but is still marginally significant at the 10% level.

As an additional check we also examine the effect of a change in the level of the house price index. This would incorporate both the unexpected change in housing prices (as analyzed above) as well as the expected change in housing prices. Given that some portion of this variation may be expected by individuals, it is unclear when households would respond to anticipated changes in housing prices. One adjustment is made to the All-Transactions Index here. The effect of seasonality in housing prices is removed with a regression including quarter dummy variables. Then the percent change in the house price index is included in the divorce regression rather than the house price shock. The percent change variables are not significant. This is true for the change from one year to the next, or the change in prices over the past four years. The results are unchanged if the MSA-specific variation is also removed from the series.

5 Conclusion and Future Work

This paper has examined how wealth shocks affect marital stability. In particular, the paper asks how a wealth shock in the form of a house price shock affects the divorce hazard of individual households. Using household level data from the Panel Study of Income Dynamics and a MSA level house price index from the Federal Finance and Housing Administration, a measure of house price shocks are made for each household. Housing prices are approximated by a second order autoregressive process with MSA and quarter fixed effects. The residuals from the AR(2) process are cumulated for the past four years, and this cumulative sum serves at a measure of the house price shock. This calculation of house price shocks is an improvement over those previously used in the literature which did not consider the moving behavior of households. Consistent across different specifications is the result that positive house price shocks stabilize marriage. In addition, this result is robust to different econometric models of duration analysis, including probit models and Cox Proportional Hazard Models. Although the coefficient of negative house price shocks have the same sign as Farnham et al. (2011), the result is not significant in any specification with the house price shocks.

The role of housing shocks is explored further, by the birth cohort of the head of household, education and income levels, and remaining mortgage debt. The findings in this paper show that the couples that are affected are those with the heads of households from the younger cohort in the PSID, though this may be because those couples in the older cohort who were meant to divorce already have by the time they are observed in the data. It is not surprising that the house price shocks affect households with low education and low family income the most, as they would have the most difficulty paying for two homes.

As expected, shocks to housing prices have an important effect on the stability of marriage, since such shocks would affect the marital surplus, and the value of the outside options. In this paper, I consider house price shocks faced by individual households as it is likely that such shocks are exogenous to any of the unobserved behaviors of the household. In addition, it is an ideal price shock to study as housing is the largest component of wealth for most households in the United states for the past few decades. Finally, by focusing on shocks to housing prices we are identifying something that was not anticipated by households and therefore is not something they may have already incorporated into their decision regarding whether this marriage was suitable.

The households in the PSID come from a wide range of birth cohorts, and include many older couples that may not be a relevant sample of individuals potentially affected by shocks to housing prices. Thus, this line of research would benefit from examining other data sources with younger birth cohorts. Other questions yet to be investigated are how house price shocks affect other household decisions. There has been some recent research on the effect of house price changes on fertility, notably in **?** (using MSA level fertility data) and Lovenheim and Mumford (2013) (using self-reported house prices). Further examination of the topic is in order as self-reported housing prices is likely endogenous with a couple's fertility decisions. Another household decision that a house price shock potentially may affect is the labor supply and labor participation choices of households. These questions are to be explored in future research.

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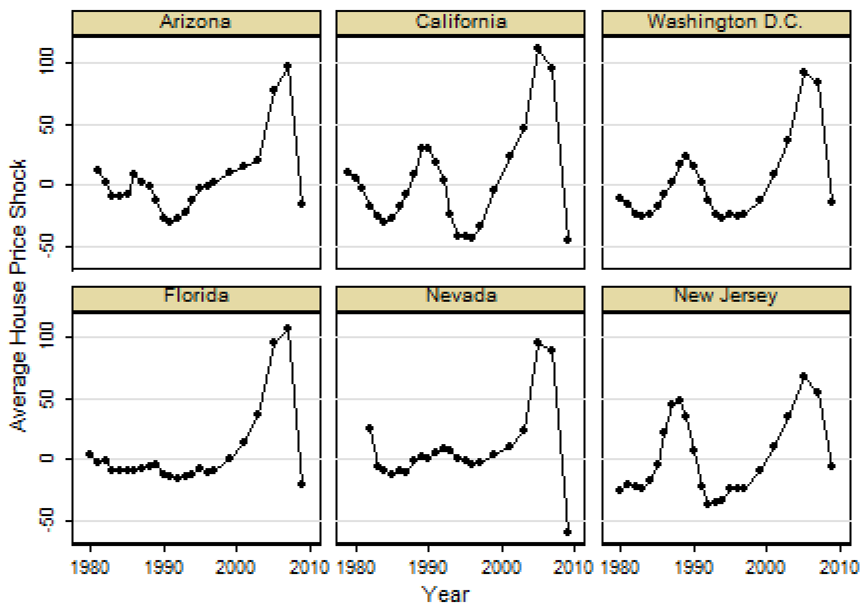
Appendices

A Further Description of House Price Shocks

The following two figures further explore the differences in the house price shock across locations discussed in the end of Section 3.1. Figure 7 shows panels for six selected states that were among those most affected during the housing boom. The figures show the average house price shock for each of the six states by year from 1979-2009. Even between these states we see there are differences in their experiences of house price shocks over the time period, especially in the earlier years. However, all of these states exhibit the same general pattern as observed in Figure 1 in the time period of 1995 to 2005.

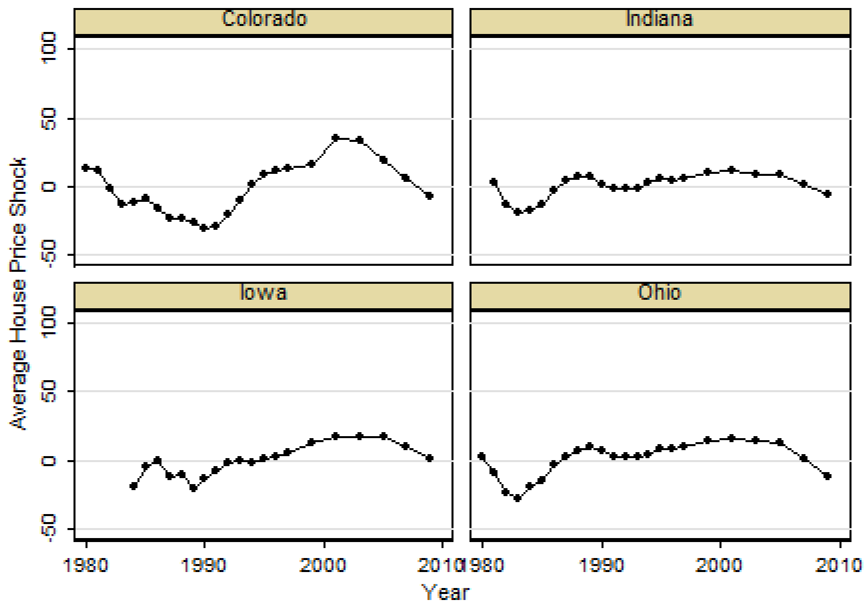
Figure 7: Large Shock States over Time



Next Figure 8 shows panels for four selected states that faced the smallest changes in the house price shock over the period 1995 to 2005. Again, the figure shows the average yearly house price shock for each of these four states in order to compare them to the states with large changes in the house price shock. All of these states have a relatively flat series for the house price shock over the time period, in stark contrast to what was experienced in California, Arizona, Florida, etc. Only Colorado has any semblance of the spike in the house price shock we see for the states in Figure 7. However, even this is dwarfed by the size of the house price shocks in the other states.

These two figures together make it clear that although prices were rising throughout the 1990s and

Figure 8: Small Shock States over Time



early 2000s, the experiences across different locations were not equal. Thus, the persistent increase observed in Figure 1 are due to the fact that some locations had very large increases in the variable during the housing boom years and some locations had no change in the variable during those years. So there is a substantial amount of variation across states and MSAs with which to identity an effect of the house price shock on the decision to divorce.

B Additional Tables

Table 10: Full Probit Model of Divorce Hazard:Homeowners

Variable	Marg. Effect	Std. Err.	Marg. Effect	Std. Err.	Marg. Effect	Std. Err.
Pos. House Price Shock$_{t-1}$	-0.0014**	(0.0007)	-0.0014**	(0.0007)	-0.0014**	(0.0007)
Neg. House Price Shock$_{t-1}$	-0.0003	(0.0011)	-0.0003	(0.0011)	-0.0003	(0.0011)
County Unemp. Rate$_{t-1}$	-0.0074	(0.0202)	-0.0071	(0.0203)	-0.0068	(0.0204)
Age at Marriage-Husb.	-0.0004	(0.0005)	-0.0004	(0.0005)	-0.0004	(0.0005)
Age Diff.(H-W): -5 to -1	0.0030*	(0.0021)	0.0030*	(0.0021)	0.0030***	(0.0021)
Age Diff.(H-W): 0 to 4	0.0044***	(0.0014)	0.0044***	(0.0014)	0.0044***	(0.0014)
Age Diff.(H-W): 5 to 10	0.0084***	(0.0030)	0.0085***	(0.0030)	0.0085***	(0.0030)
Age Diff.(H-W): > 10	0.0290***	(0.0140)	0.0298***	(0.0143)	0.0298***	(0.0143)
Log(Duration)$_{t-1}$	-0.0027***	(0.0006)	-0.0025***	(0.0006)	-0.0025***	(0.0006)
# Prior Marriages-Husb.$_{t-1}$	0.0011	(0.0010)	0.0011	(0.0010)	0.0011	(0.0010)
# Prior Marriages-Wife$_{t-1}$	0.0006	(0.0009)	0.0006	(0.0009)	0.0006	(0.0009)
High School-Husb.$_{t-1}$	0.0013	(0.0015)	0.0013	(0.0015)	0.0013	(0.0015)
Some College-Husb.$_{t-1}$	-0.0001	(0.0015)	0.0000	(0.0015)	-0.0001	(0.0015)
College-Husb.$_{t-1}$	-0.0003	(0.0016)	-0.0003	(0.0016)	-0.0003	(0.0016)
High School-Wife$_{t-1}$	-0.0015	(0.0014)	-0.0016	(0.0014)	-0.0016	(0.0014)
Some College-Wife$_{t-1}$	-0.0009	(0.0015)	-0.0009	(0.0015)	-0.0010	(0.0015)
College-Wife$_{t-1}$	-0.0025	(0.0014)	-0.0025	(0.0014)	-0.0026	(0.0014)
Black-Husb.	0.0027	(0.0020)	0.0029*	(0.0020)	0.0029*	(0.0020)
Hispanic-Husb.	-0.0022	(0.0012)	-0.0020	(0.0013)	-0.0020	(0.0013)
Wife Same Race	-0.0002	(0.0017)	-0.0001	(0.0017)	-0.0001	(0.0017)
# of Children$_{t-1}$			-0.0008*	(0.0004)	-0.0008*	(0.0004)
Young Children$_{t-1}$			0.0012	(0.0012)	0.0013	(0.0012)
Log(Income)-Husb.$_{t-1}$					0.0001	(0.0002)
Log(Income)-Wife$_{t-1}$					0.0001	(0.0002)
Year Effects	Yes		Yes		Yes	
# of Couples	3,893		3,893		3,893	
N (couple-years)	30,016		30,016		29,960	
Pseudo-R^2	0.1138		0.1152		0.1151	

Sample weights are used. Standard errors are clustered by person ID to account for each individual being present multiple times. *,**,*** indicate significance at the 10%,5%, and 1% level.