Internet Appendix for "Moving to a Job: The Role of Home Equity, Debt, and Access to Credit," published in *American Economic Journal: Macroeconomics.*

Yuliya Demyanyk, Dmytro Hryshko,

María José Luengo-Prado and Bent E. Sørensen

July 25, 2016

Abstract

This internet appendix has six sections with supplementary material. Section A provides more details on the data. Section B discusses econometric identification. Section C supplies the results from a number of empirical regressions which demonstrate the robustness of our results. Section D supplies the results from a number of regressions on simulated data which analyze the robustness of our results to the regression specification and certain modeling choices. Section E presents the household problem in recursive form and describes our computational procedure. Section F gives more details about the welfare analysis.

A More Details on the Data and Data Cleaning

The TU-LP dataset was created by TransUnion who merged credit report data with mortgage information from the LoanPerformance Securities Database from CoreLogic.[1]

We start with a TU-LP merged sample for the years 2005–2007 with approximately 47.3 million observations (11.8 million first-lien loans and 13.1 million borrowers). We drop loans for which the loan-to-value ratio is missing (less than 1 percent of loans), and we drop borrowers that do not have matching ZIP code-level HPI in the CoreLogic dataset (11 million observations).[2] We further drop all borrowers who had more than one active first lien reported within a year (9 million observations).

After calculating lagged variables, we keep data for the years 2007–2009, which leaves us with 17 million observations (including 4.8 million loans and 6.6 million borrowers). The main cleaning restrictions applied to this sample are the following: (1) we drop 4.3 million observations for which an individual's property ZIP code differs from the mailing (residence) ZIP code at time $t-1$, when the individual's moving decision is made. A discrepancy may

[1] The exact matching algorithm is proprietary, but it incorporates numerous fields that are available from both databases, such as loan number, loan origination date, loan origination amount, property ZIP code, and servicer. Actual borrower names and addresses are used within the algorithm to minimize false positive matches, but the database itself contains only anonymized borrower credit data. The match rate is exceptionally high in comparison to other matched databases studied in the literature (93 percent with less than 1 percent false-positive for open loans, and 73 percent for closed loans).

[2] The CoreLogic HPI dataset covers 19.25 percent of the ZIP codes in the U.S.; these ZIP codes cover about 62 percent of the U.S. population.

indicate either an error, that the owner receives mail elsewhere, or that the property is not owner-occupied. (2) We drop 800,000 observations for which the balance-to-limit ratio on all mortgages is either zero or missing. This eliminates borrowers who terminated their loan at time $t-1$, as those are either renters at time $t-1$ or homeowners who have paid off their mortgages. (3) We drop 81,000 individuals who default on their mortgage despite having more than 20 percent equity in their homes—this eliminates individuals for whom measurement error in equity is likely to be substantial. These restrictions leave us with approximately 12 million observations (4 million loans and 5.6 million borrowers). In our regressions, we do not utilize 1.6 million individuals that appear in our data only once (singletons). Dropping observations for which any variable used in the main regression is missing, leaves us with about 9 million observations. This sample contains loans with single borrowers or with multiple co-borrowers. We drop loans with more than two co-borrowers (0.18 percent of the sample). For all empirical tables reported in the paper and appendices we keep loans with one or two co-borrowers (about 2 million loans have single borrowers and about one million loans have two co-borrowers). For robustness (not reported in a table), we re-estimate Table 2 using a sample that includes all single borrowers and only one co-borrower (selected randomly) from each pair; the results are not affected by this selection.

Most of the mortgages in our sample are classified as subprime or Alt-A.[3]

[3]LoanPerformance classifies non-agency mortgage-backed securities pools into subprime, Alt-A, and jumbo/prime in the following way: *subprime* mortgages usually have balances lower than the Freddie/Fannie Mae conforming limit. Loans are originated under expanded credit guidelines. The following characteristics are typical of a subprime pool: more than 75 percent are full-doc loans, very low share of non-owner-occupied properties (less than 6 percent), low average FICO credit scores (usually below 650), more than 50 percent have

Also, as Demyanyk and Van Hemert (2011) show, more than half of the sample consists of so-called hybrid loans, for which the interest rate is fixed for two or three years and then starts adjusting. (Loans that reset so quickly are non-existent in the prime market). These hybrid mortgages were short-lived, with almost all of them being in default or prepaid within three years of origination (see, for example, Demyanyk, 2009), and they were more likely than prime mortgages to generate negative equity because they typically were originated with very low down payments.

B Discussion of Identification with Individual and ZIP×Year Fixed Effects

Because we include individual fixed effects, our results are not driven by constant individual-specific characteristics (for example, high impatience, which may simultaneously result in high mobility and low home equity). Inclusion of an individual-specific fixed effect is equivalent to removing the individual-specific average. Consider, for example, the dummy for very negative equity in year t and refer to the dummy as D_{it}^{N}, where individual i is in the

prepayment penalties, and loans are often originated to borrowers with impaired credit history. *Prime* loans in the dataset are mainly jumbo mortgages. The pools of these usually contain loans that have balances greater than the Freddie/Fannie Mae conforming loan limit. Mortgages are made under a traditional set of underwriting guidelines to borrowers that have good credit history. *Alt-A* mortgages, generally speaking, are originated to borrowers with good credit histories and scores but under expanded underwriting standards. A typical Alt-A loan would be made for non-owner-occupied homes, loans with LTV ratios exceeding 80 percent and no mortgage insurance (or having a "piggy back" second loan at origination), loans made to those who are self-employed, and loans that have high debt-to-income ratios but are not subprime. Many loans in an Alt-A pool would be no-doc, non-owner-occupied, with FICO score higher than the 620 average.

sample for T_i periods, and label the CBSA-specific, positive-shock dummy $P_{rt} = \mathbb{1}(\text{Shock}^u_{rt} < 0)$ (relatively lower local unemployment shock). Keeping in mind that agents in our sample do not refinance until they drop out of the sample in the last period, the individual-level variation identifying this regressor, when individual fixed effects are included, is:

$$D^N_{it} P_{rt} - \frac{1}{T_i} \sum_{t=1}^{T_i} D^N_{it} P_{rt} = D^N_{it} - \frac{1}{T_i} \sum_{t=1}^{T_i} D^N_{it} \tag{A-1}$$

for the (majority of) cases where the CBSA labor market dummy does not change ($P_{rt} = 1$). This case illustrates the most important variation in the data (for individuals in weak labor markets the situation is similar). It is clear then that our results are mainly identified from individuals whose equity is not in the same category each year. Because the sample is constructed so that individuals do not refinance (except in the final year of their tenure in the sample which does not show up in the lagged regressors), the variation in the exogenous individual-specific equity dummy is driven only by ZIP code price variation, which affects individuals differently according to their initial LTV. Identification rests on the assumption that any component of the innovation term in the mobility equation is uncorrelated with this demeaned term.[4] We

[4]An individual-specific unobserved component will be removed by the demeaning. Consider again D^N_{it}, which is our main regressor of interest, although the following holds for any regressor. D^N_{it} can be approximated by components in the manner $D^N_{it} = w_i + v_{it}$, where w_i captures inherent individual-specific traits and v_{it} captures other variation that is not a function of inherent traits. The demeaning clearly removes the w_i component. (Age is an important time-varying individual-specific factor, but it is absorbed by the combination of the individual fixed effect with ZIP × year fixed effects.) It also removes the average of the v_{it}-term, which can be seen as "collateral damage," most obviously in the case where individuals are in the sample for only one period and all variation is removed. Simulated data, used in the model section, do not feature any w_i component by design; we, however,

consider this assumption reasonable because individuals drop out of the sample the year after they move (and right-hand-side variables are all measured in the year before the move), which rules out the possibility that individuals select themselves into appreciating (or depreciating) ZIP codes during the time they are observed. Changes in local labor market conditions will also provide some identification due to interactions with the individual fixed effects, but this is likely to be of second-order importance because consumers are in the sample for only a few years.

The inclusion of ZIP $\times$ year fixed effects implies, in addition, that each equity regressor is identified from variation relative to its average value across the N_{zt} individuals in the ZIP code where an individual lives in a given year. Consider

$$D_{it}^{N} P_{rt} - \frac{1}{N_{zt}} \sum_{i=1}^{N_{zt}} D_{it}^{N} P_{rt} = D_{it}^{N} - \frac{1}{N_{zt}} \sum_{i=1}^{N_{zt}} D_{it}^{N}, \tag{A-2}$$

where, again, we assume that P_{rt} equals one. The regressor (apart from controlling for individual-specific components) is identified from the difference between the negative equity dummy and the share of people with negative equity in the ZIP code in year t. Our results are therefore not driven by any average differences between ZIP codes. For example, some ZIP codes may be preferred by young people with high mobility and such ZIP codes might have lower than average appreciation, and in the absence of the ZIP code dummies we might spuriously assign differences between ZIP codes to equity effects on

also include individual fixed effects in the regressions on our simulated data so that the treatment of the v_{it}-term in the simulated data will be the same as in the empirical data.

individual mobility.[5]

C Supplementary Empirical Results

In this appendix, we display several supplementary results using the empirical data to further establish the robustness of our results.

Table C-1 shows that moving rates declined substantially from 2007 to 2009. We present statistics from TU-LP, from an Equifax sample similarly constructed (consumers with positive balances on their mortgages), and from the CPS.[6] As shown in the top two panels of Table C-1, the overall moving rate, computed as a change in ZIP code, declined from approximately 6.5 percent to 5.8 percent for TU-LP households, and from 4.3 percent to 3.6 percent for Equifax households. The moving rate across CBSAs declined from about 2.3 percent to 1.8 percent in TU-LP, and from 1.5 percent to 1.2 percent in Equifax. The moving rate from one state to another declined from 1.6 percent to 1.1 percent in TU-LP, and from 1.1 percent to 0.8 percent in Equifax. TU-LP households are predominantly subprime borrowers, which might explain why moving rates differ across the two datasets.[7] In the bottom panel, we

[5]In a balanced panel, the regressions can be performed literally by subtracting the individual and ZIP-year averages sequentially, but this no longer holds in unbalanced panels (see Wansbeek and Kapteyn, 1989). We ran the regressions using the REGHDFE module in Stata (`https://ideas.repec.org/c/boc/bocode/s457874.html`) after verifying that it handles multiple fixed effects correctly in our unbalanced sample.

[6]The Equifax Consumer Credit Panel dataset (Equifax), available to us from the Federal Reserve Bank of New York, is an anonymized 5 percent random sample of U.S. individuals who have a social security number and use credit in some form. For a more detailed description of the data, see Lee and van der Klaauw (2010). A previous version of this paper studied mobility in relationship to house-price appreciation using this dataset in addition to the TU-LP data. The results were consistent with the ones reported to the extent they can be compared, but for brevity we focus our regressions on TU-LP data only.

[7]The moving rates in Equifax are in line with the national moving rates for homeowners

tabulate moving rates for homeowners using the CPS, which has much broader coverage than the credit bureaus; for example, it includes very young, highly mobile people who may not yet have a credit history, military personnel, and owners with zero mortgage balances, whom we do not include in our empirical work. Nonetheless, the CPS, in spite of its very different sampling frame, confirms the temporal patterns observed in TU-LP and Equifax.

Table C-2 shows correlations for the variables in our regressions with individual and ZIP × year fixed effects removed. This is informative about how closely our regressors are correlated after the demeaning that is implicitly done by the regression algorithm when fixed effects are included. Our demeaned regressors are not very correlated with the exception of the change in equity, which correlates quite highly with the equity categories.

Table C-3 examines if our results are specific to certain types of mortgages. We compare our results to those for all mortgages combined, in column (1) of Table 2. Scanning the results, the general pattern regarding equity and mobility found in Table 2 holds up. Columns (1) and (2) repeat the specifications of columns (1) and (2) of Table 2 using the largest number of observations available for each specification. The results are very close to those reported in Table 2 even if the number of observations differs substantially for column (1).[8] Column (3) uses a sample of prime jumbo loans, and the results

reported, for example, in Molloy, Smith and Wozniak (2011). Higher moving rates in TU-LP could be due to higher risk tolerance of homeowners with non-standard mortgages, and higher mobility of more risk-tolerant individuals across labor markets (see Dohmen et al. 2010 for some evidence on the latter).

[8]In column (2), the number of observations drops by over two million relative to column (1) because the lagged change in equity relies on data going back to 2005 where some of the loans are missing because they are not yet originated.

are very similar for this group, even if this sample comprises individuals who are quite different from those in the subprime or non-jumbo prime samples. In column (4), labeled "Subprime," we report the results for the sample of consumers with subprime mortgages only. The results are very similar. The next column considers individuals with Alt-A loans: the mobility patterns are similar to those found in the subprime sample. In the column "Subprime score," we focus on individuals with a credit score below 641 in the first year they are observed and find results similar to results in the previous columns. In the column labeled "No invest.," we drop homes purchased for investment. The results are virtually unchanged from the corresponding column of Table 2, column (2). In the last column, (individuals holding) investment loans or (short-term) hybrid loans are dropped. The results are again very similar to the previous ones.

Table C-4 examines robustness along other dimensions while focusing on CBSA mobility for the full sample. The first column considers only individuals living in non-recourse states, where lenders cannot pursue defaulting borrowers for losses beyond the collateral (house) pledged.[9] The results are again similar to those found earlier, except that we find a slightly higher mobility of individuals with very positive equity, compared with those with moderately positive equity, in CBSAs with positive labor market shocks, but the mobility

[9]In a non-recourse mortgage state, lenders may not sue borrowers for additional funds beyond the revenue obtained from selling the property pledged as collateral. If the foreclosure sale does not generate enough money to satisfy the loan, the lender must accept the loss. Ghent and Kudlyak (2011) find higher tendencies to default in non-recourse states for the period 1997–2008. It will take us too far afield to study whether this result holds up for our sample period, but the Great Recession may well be atypical in this dimension due to the very large number of defaults.

of these individuals is still lower than for those with highly negative equity. In the second column, we use the number of vacancies in the CBSA to measure local labor market conditions. We define dummy variables similarly defined as the ones for change in unemployment (with the signs properly adjusted) for changes in local employment and local vacancy rates (vacancy rates are based on help-wanted data from The Conference Board). The results are similar to our baseline results with slightly smaller estimated coefficients. The results in the third column, using employment growth in the CBSA as the measure of local labor market conditions are also very similar.

Table C-5 departs from the main regression of Table 2 by adding more equity categories. In weak and strong labor markets, we find a monotonic decline in the propensity to move CBSAs with increasing equity. The pattern of higher mobility of households with low equity is robust and mobility is nearly monotonically declining in equity. We conclude that our results are not caused by having a small number of equity categories.

Table C-6 examines the case of three types of labor markets where "Rel. High Unemp." is a dummy taking a value of one, if the change in unemployment is at least 0.5 percentage points higher than the CBSA average, "Rel. Low Unemp." refers to the case of 0.5 percentage points less than the average change, and the average group are the remaining CBSAs. (The cut-offs are chosen to obtain groups of similar size.) The pattern of higher mobility of low-equity individuals remains significant. There is no lock-in in any of the labor-market groups, but the tendency for low equity households becomes weaker when the labor market becomes stronger. This is intuitive and is reflected in the regressions on simulated data—in particular, when directly considering employed versus unemployed—so we conclude that the inclusion of more labor markets does not cast doubt on our conclusions. It should be kept in mind that our regressions capture only whether low-equity individuals are more likely to move than high-equity individuals—they do not capture whether people on average are more likely to stay in strong labor markets.

Table C-7 repeats the estimations of Table 3 including ZIP $\times$ year fixed effects. The results for the empirical regressions are quite similar whether ZIP $\times$ year fixed effects are included or not.

Table C-8 shows that our results are robust to controlling for credit scores. We define "Credit score" as TransUnion's VantageScore, which has a range from 501 to 990. We create "Subprime score" and "Near prime score" dummy variables equal to one if the VantageScore takes values below 641, and between 641 and 700, respectively. Individuals with low scores are more likely to move CBSA and because a low score is correlated with negative equity, the coefficients to negative equity become a little smaller, but they remain highly significant.[10] The third column of Table C-8 shows the results of our main specification when individual fixed effects are not included. The patterns for low-equity individuals (no lock-in effect) are qualitatively similar to the results of Table 2, in which the regressions, properly, we argue, include individual fixed effects. In column (3), the coefficients on "Subprime score" and "Near prime score" turn negative and the coefficient to lagged change in

[10] A study by VantageScore defines individuals with scores below 641 as those with "subprime" scores, and individuals with scores between 641 and 699 as those with "near prime" scores. The study is available here: `http://vantagescore.com/research/stability/`.

equity turns positive. This illustrates that "permanent" differences between individuals can correlate quite differently with the dependent variable than the individual-level changes over time that are isolated by including fixed effects. Our conjecture is that more-educated individuals are more mobile and also have higher scores, but having established that our main result of interest is robust, we do not explore this issue further.

The results tabulated in Table C-9 are from regressions similar to our main regressions in Table 2 but they include CBSA $\times$ year fixed effects instead of ZIP $\times$ year fixed effects. The results are quite similar to those reported in the main text, with slightly less significant coefficients. Mechanically, the interpretation is that changes in equity relative to the average in the ZIP code (in a given year) correlates more with mobility than the change in equity relative to the average in the CBSA. One might have expected the latter to be more significant, as less variation is absorbed, but we do not explore this issue further.

In Table C-10, we repeat the main regression of Table 2 using current equity as reported by CoreLogic in their TrueLTV dataset.[11] Current equity is likely endogenous to mobility (why pay on a mortgage, if one has decided to walk away from the house in the near future?), and because CoreLogic does not perform property-level appraisals, except at origination, we believe the estimates contain significant measurement error. These results are, therefore, presented only for "full disclosure," but the finding of relatively high mobility

[11] CoreLogic matched mortgages found in the LoanPerformance dataset to subsequent liens taken out on the same property. The resulting total mortgage indebtedness was combined with CoreLogic's Automated Valuation Model (AVM) to estimate "true LTV."

for households with very negative equity remains robust in weak labor markets, although high-equity individuals are also more likely to move in strong labor markets.

Table C-1: Moving Rates (percent)

Year	ZIP	CBSA	State
TransUnion, TU-LP			
2007	6.47	2.31	1.55
2008	7.63	2.31	1.38
2009	5.78	1.77	1.10
Overall	6.63	2.15	1.35
Equifax, FRBNY CCP			
2007	4.34	1.52	1.13
2008	3.93	1.44	1.06
2009	3.56	1.15	0.81
Overall	3.93	1.37	1.00
Current Population Survey, CPS			
Year	County	CBSA	State
2007	2.55	2.41	1.16
2008	2.07	1.95	0.96
2009	1.89	1.75	0.91
Overall	2.17	2.04	1.01

Notes: The table shows moving rates calculated from two credit bureau datasets and from the Current Population Survey (CPS). The first column shows the fraction of homeowners who moved to a different ZIP code between years $t-1$ and t for the credit bureau data, and the fraction of homeowners who moved from one county to another for the CPS, because ZIP code identifiers are not available in the CPS. The second column shows the fraction of homeowners who moved to a different CBSA. The third column shows moving rates from one state to another. The rates have been multiplied by 100 to yield percentages.

Table C-2: Correlation matrix. Regression sample ZIP × Year and Individual Fixed Effects removed

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	Move CBSA	1.00													
(2)	Neg. shock × Equity <= −20%	0.03	1.00												
(3)	Pos. shock × Equity <= −20%	0.00	–0.03	1.00											
(4)	Neg. shock × Equity $(-20, 0)$%	0.01	–0.22	–0.05	1.00										
(5)	Pos. shock × Equity $(-20, 0)$%	0.00	–0.09	–0.12	–0.08	1.00									
(6)	Neg. shock × Equity >= 20%	0.01	0.09	–0.02	–0.08	–0.08	1.00								
(7)	Pos. shock × Equity >= 20%	–0.01	–0.12	–0.03	–0.12	–0.05	–0.45	1.00							
(8)	Lagged change in equity	–0.03	–0.42	–0.09	–0.25	0.00	–0.03	0.38	1.00						
(9)	Neg. shock × Home value	0.02	0.23	–0.07	0.26	–0.24	0.54	–0.61	–0.44	1.00					
(10)	Pos. shock × Home value	–0.02	-0.25	0.07	–0.28	0.22	–0.50	0.65	0.45	–0.99	1.00				
(11)	Neg. shock × Mortgage balance	0.02	0.24	–0.07	0.27	–0.24	0.52	–0.61	–0.45	1.00	–0.99	1.00			
(12)	Pos. shock × Mortgage balance	–0.02	–0.25	0.07	–0.28	0.23	–0.49	0.64	0.45	–0.99	1.00	–0.99	1.00		
(13)	Neg. shock × Equity < 0%	0.01	–0.11	0.01	0.12	0.04	–0.05	0.30	0.42	–0.32	0.34	–0.32	0.33	1.00	
(14)	Pos. shock × Equity < 0%	0.01	0.03	–0.11	0.02	0.13	0.19	0.00	0.06	0.21	–0.20	0.21	–0.20	–0.08	1.00

Notes: The table shows correlation coefficients for the variables used in the regression analysis. "Moved CBSA" is a dummy variable that equals 100 if an individual moved to another CBSA since the previous year. "Neg. shock" ("Pos. shock") is a dummy variable that equals one if the difference between the annual change in the CBSA unemployment rate and the national average change is positive (negative). These dummy variables are interacted with dummies for the amount of predicted equity an individual has in the period when the moving decision is made. Mortgage balance is the logarithm of the outstanding mortgage balance, while Home value is the logarithm of the home value of imputed from initial value (deduced from borrowing LTV and original mortgage amount) adjusted for ZIP code housing appreciation from origination to period $t-1$. "Lagged change in equity" is a change in predicted equity at time $t-1$ (all other regressors are measured at time $t-1$.

Table C-3: Probability of moving to another CBSA by Type of Mortgage

	All loans (1)	All loans (2)	Prime jumbo (3)	Subprime (4)	Alt-A (5)	Subprime score (6)	No invest. (7)	No invest. Nor hybrid (8)
Neg. shock × Equity <= −20%	1.48***	1.39***	1.66***	1.43***	1.60***	1.36***	1.39***	1.60***
	(24.01)	(18.89)	(5.54)	(15.25)	(13.42)	(10.93)	(18.84)	(18.12)
Neg. shock × Equity (−20, 0]%	0.52***	0.44***	0.69***	0.46***	0.50***	0.47***	0.43***	0.51***
	(15.01)	(10.64)	(4.88)	(8.67)	(7.66)	(6.73)	(10.41)	(10.45)
Neg. shock × Equity [0, 20)%	excluded group	excluded group	excluded group	excluded group	excluded group	excluded group	excluded group	excluded group
Neg. shock × Equity >= 20%	–0.16***	–0.12***	–0.52***	–0.11**	–0.25***	–0.10*	–0.13***	–0.25***
	(–5.77)	(–3.88)	(–5.34)	(–2.40)	(–4.50)	(–1.75)	(–3.87)	(–6.88)
Pos. shock × Equity <= −20%	1.07***	1.21***	2.18***	1.14***	1.42***	1.03***	1.20***	1.43***
	(8.58)	(8.42)	(3.68)	(5.78)	(6.32)	(4.49)	(8.32)	(8.86)
Pos. shock × Equity (−20, 0]%	0.48***	0.44***	0.69***	0.46***	0.50***	0.43***	0.43***	0.54***
	(10.67)	(8.05)	(2.68)	(7.06)	(5.06)	(5.62)	(7.89)	(7.97)
Pos. shock × Equity [0, 20)%	excluded group	excluded group	excluded group	excluded group	excluded group	excluded group	excluded group	excluded group
Pos. shock × Equity >= 20%	0.07**	0.06	–0.33**	0.00	0.04	0.03	0.06	–0.09*
	(2.04)	(1.56)	(–2.32)	(0.00)	(0.61)	(0.48)	(1.45)	(–1.93)
Lagged change in equity		–1.63***	–1.84***	–1.60***	–2.26***	–1.26***	–1.65***	–1.53***
		(–9.47)	(–3.62)	(–7.48)	(–7.20)	(–4.92)	(–9.49)	(–7.74)
ZIP × year effects	Y	Y	Y	Y	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y	Y	Y	Y	Y
No. obs.	9,384,908	6,917,601	1,018,559	2,911,479	2,326,887	1,580,597	6,750,488	5,279,187
No. clusters	5,629	5,627	4,033	5,618	5,618	5,616	5,626	5,625

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. Pos./Neg. shock are dummy variables that capture positive and negative shocks to unemployment in a CBSA and the four equity measures are dummy variables for the amount of home equity at time $t-1$. $D_{zt-1} \times \mu_{t-1}$ are (lagged) ZIP × year fixed effects, and ν_i are individual fixed effects. Column "Prime jumbo" refers to individuals who hold prime loans, the majority of which are jumbo loans. Column "Subprime" refers to individuals whose loans are labeled so by CoreLogic, while column "Alt-A" includes individuals who hold Alt-A loans, of which many are held by investors. Column "Subprime score" refers to individuals with a VantageScore less than 641, while column "No invest" drops individuals who are identified by CoreLogic as buying property primarily for investment purposes. Column "No invest. nor Hybrid" further drops holders of "hybrid" loans (loans with an initial fixed rate which adjusts annually after the initial period). Sample: TU-LP, 2007–2009. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10]% level.

Table C-4: Moving to another CBSA. No-Recourse and Alternative Measures of Labor Market Shocks

	Non-recourse states (1)	All states, vacancy rates (2)	All states, empl. growth (3)
Neg. shock × Equity <= −20%	1.26***	1.19***	1.14***
	(13.13)	(15.17)	(13.63)
Neg. shock × Equity (−20, 0]%	0.33***	0.34***	0.29***
	(5.90)	(7.92)	(6.26)
Neg. shock × Equity [0, 20)%	excluded group	excluded group	excluded group
Neg. shock × Equity >= 20%	–0.15***	–0.09***	–0.03
	(–3.46)	(–2.93)	(–0.82)
Pos. shock × Equity <= −20%	1.31***	0.82***	0.81***
	(4.18)	(5.03)	(5.58)
Pos. shock × Equity (−20, 0]%	0.54***	0.21***	0.29***
	(3.49)	(3.64)	(5.32)
Pos. shock × Equity [0, 20)%	excluded group	excluded group	excluded group
Pos. shock × Equity >= 20%	0.41***	0.09**	0.20***
	(4.66)	(2.45)	(5.36)
Lagged change in equity	–1.64***	–1.48***	–2.08***
	(–6.50)	(–8.51)	(–12.38)
ZIP × year effects	Y	Y	Y
Individual effects	Y	Y	Y
No. obs.	2,904,674	5,541,584	6,917,601
No. clusters	1,656	3,974	5,627

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. Pos./Neg. shock are dummy variables that capture positive and negative shocks to CBSA's unemployment rates (first column), vacancy rates (second column) or employment growth (third column); the four equity measures are dummy variables for the amount of home equity at time $t-1$. $D_{zt-1} \times \mu_{t-1}$ are (lagged) ZIP × year fixed effects, and ν_i are individual fixed effects. Column "Non-recourse states" reports regressions from the subsample of individuals living in states where lenders typically cannot pursue claims on assets other than the collateral pledged. Columns labeled "All states, vacancy rates" and "All states, empl. growth" use the full TU-LP sample but CBSA's vacancy rates and employment growth rates, respectively, for construction of the labor market shocks. Sample: TU-LP, 2007–2009. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10]% level.

Table C-5: Moving CBSA. More equity dummies

	(1)		(2)
Neg. shock × Equity $< -50\%$	2.36*** (12.64)	Pos. shock × Equity $[-40, -30)\%$	1.07*** (4.50)
Neg. shock × Equity $[-50, -40)\%$	1.53*** (9.97)	Pos. shock × Equity $[-30, -20)\%$	1.10*** (6.66)
Neg. shock × Equity $[-40, -30)\%$	1.23*** (10.76)	Pos. shock × Equity $[-20, -10)\%$	0.71*** (7.77)
Neg. shock × Equity $[-30, -20)\%$	0.79*** (9.16)	Pos. shock × Equity $[-10, 0)\%$	0.34*** (5.90)
Neg. shock × Equity $[-20, -10)\%$	0.50*** (7.50)	Pos. shock × Equity $[0, 10)\%$	excluded group
Neg. shock × Equity $[-10, 0)\%$	0.26*** (5.34)	Pos. shock × Equity $[10, 20)\%$	0.04 (0.96)
Neg. shock × Equity $[0, 10)\%$	excluded group	Pos. shock × Equity $[20, 30)\%$	0.03 (0.48)
Neg. shock × Equity $[10, 20)\%$	–0.13*** (–3.11)	Pos. shock × Equity $[30, 40)\%$	0.26*** (3.68)
Neg. shock × Equity $[20, 30)\%$	–0.14*** (–2.90)	Pos. shock × Equity $[40, 50)\%$	0.60*** (6.93)
Neg. shock × Equity $[30, 40)\%$	0.03 (0.52)	Pos. shock × Equity $\geq 50\%$	1.01*** (9.59)
Neg. shock × Equity $[40, 50)\%$	0.23*** (2.90)	Lagged change in equity	–1.43*** (–8.15)
Neg. shock × Equity $\geq 50\%$	0.54*** (5.60)		
Pos. shock × Equity $< -50\%$	2.76***	No. obs.	6,917,601
	(4.85)	No. clusters	5,627
Pos. shock × Equity $[-50, -40)\%$	1.35***	ZIP × year effects	Y
	(3.51)	Individual effects	Y

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. See Section II.C for a detailed variable description. $D_{zt-1} \times \mu_{t-1}$ are (lagged) ZIP × year fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10] percent level.

TABLE C-6: MOVING CBSA. ALL LOANS. MORE UNEMPLOYMENT SHOCK CATEGORIES

	(1)	(2)
Rel. High Unemp. × Equity ≤ −20%	1.62***	1.44***
	(18.48)	(16.25)
Rel. High Unemp. × Equity (−20, 0)%	0.40***	0.35***
	(6.70)	(5.80)
Rel. High Unemp. × Equity [0, 20)%	excluded group	excluded group
Rel. High Unemp. × Equity ≥ 20%	–0.41***	–0.35***
	(–9.41)	(–7.94)
Ave. Unemp. × Equity ≤ −20%	1.27***	1.13***
	(13.40)	(11.83)
Ave. Unemp. × Equity (−20, 0)%	0.47***	0.42***
	(11.02)	(9.93)
Ave. Unemp. × Equity [0, 20)%	excluded group	excluded group
Ave Unemp. × Equity ≥ 20%	0.05	0.10***
	(1.55)	(2.95)
Rel. Low Unemp. × Equity ≤ −20%	0.79**	0.67**
	(2.29)	(2.00)
Rel. Low Unemp. × Equity (−20, 0)%	0.34***	0.29***
	(3.09)	(2.62)
Rel. Low Unemp. × Equity [0, 20)%	excluded group	excluded group
Rel. Low Unemp. × Equity ≥ 20%	–0.14**	–0.09
	(–2.10)	(–1.38)
Lagged change in equity		–1.58***
		(–9.22)
ZIP × year effects	Y	Y
Individual effects	Y	Y
No. obs.	6,917,601	6,917,601
No. clusters	5,627	5,627

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. Rel. High/Rel. Low/Ave. Unemp. are dummy variables that capture shocks to unemployment in a CBSA/state, which are 0.5 percentage points higher, 0.5 percentage points lower, or with [–0.5,0.5] of the change in the national unemployment rate. The four equity dummies capture the amount of home equity at time $t-1$. $D_{zt-1} \times \mu_{t-1}$ are (lagged) ZIP × year fixed effects, and ν_i are individual fixed effects. Sample: TU-LP, 2007–2009. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10] percent level.

Table C-7: Probability of Moving to Another CBSA. The Role of home value and Mortgage Size. Including ZIP × Year Fixed Effects

	(1)	(2)	(3)
Neg. shock × Home value	–1.94***	–2.31***	–2.26***
	(–14.56)	(–16.64)	(–16.39)
Neg. shock × Mortgage balance		1.69***	1.51***
		(12.98)	(11.64)
Neg. shock × Equity < 0%			0.57***
			(16.21)
Pos. shock × Home value	–1.73***	–1.77***	–1.83***
	(–13.24)	(–13.42)	(–13.85)
Pos. shock × Mortgage balance		1.26***	1.16***
		(9.55)	(8.90)
Pos. shock × Equity < 0%			0.46***
			(10.10)
ZIP × Year effects	Y	Y	Y
Individual effects	Y	Y	Y
No. obs.	9,384,908	9,353,077	9,353,077
No. clusters	5,629	5,629	5,629

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + +D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. Pos./Neg. shock are dummy variables that capture positive and negative shocks to CBSAs's unemployment rates. $D_{zt-1} \times \mu_{t-1}$ are (lagged) CBSA × year fixed effects or state × year effects in column (3), and ν_i are individual fixed effects. A dummy for negative employment shock is included but not displayed. Sample: TU-LP, 2007–2009. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10]% level.

Table C-8: Probability of moving to another CBSA. Including Credit Scores/Excluding Individual-Level Fixed Effects

	(1)	(2)	Dropping Fixed Effects (3)
Neg. shock × Equity <= −20%	1.46***	1.37***	0.86***
	(23.82)	(18.69)	(20.59)
Neg. shock × Equity (−20, 0]%	0.52***	0.42***	0.41***
	(14.87)	(10.50)	(14.47)
Neg. shock × Equity >= 20%	–0.15***	–0.12***	–0.50***
	(–5.67)	(–3.77)	(–28.99)
Pos. shock × Equity <= −20%	1.05***	1.20***	0.47***
	(8.50)	(8.34)	(5.64)
Pos. shock × Equity (−20, 0]%	0.47***	0.43***	0.24***
	(10.57)	(7.96)	(8.16)
Pos. shock × Equity >= 20%	0.07**	0.06	–0.36***
	(2.09)	(1.62)	(–21.83)
Subprime score	0.26***	0.27***	–0.19***
	(9.29)	(7.91)	(–15.33)
Near prime score	0.11***	0.10***	–0.06***
	(4.75)	(4.00)	(–5.25)
Lagged change in equity		–1.64***	0.15
		(–9.58)	(1.47)
ZIP × year effects	Y	Y	Y
Individual effects	Y	Y	N
No. obs.	9,384,908	6,917,601	7,843,726
No. clusters	5,629	5,627	5,630

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1}\ (+\nu_i) + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. Pos./Neg. shock are dummy variables that capture positive and negative shocks to unemployment in a CBSA/state and the four equity dummies are variables for the amount of home equity at time $t-1$. See Section II.C for a detailed variable description. $D_{zt-1} \times \mu_{t-1}$ are (lagged) CBSA × year fixed effects or state × year effects in column (3), and ν_i are individual fixed effects. Sample: TU-LP, 2007–2009. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10] percent level.

Table C-9: Probability of moving to another CBSA. CBSA × year fixed effects

	(1)	(2)
Neg. shock × Equity <= −20%	1.26***	1.26***
	(20.52)	(17.33)
Neg. shock × Equity (−20, 0]%	0.45***	0.38***
	(13.32)	(9.59)
Neg. shock × Equity [0, 20)%	excluded group	excluded group
Neg. shock × Equity >= 20%	–0.05*	–0.04
	(–1.74)	(–1.15)
Pos. shock × Equity <= −20%	0.78***	0.93***
	(7.00)	(7.08)
Pos. shock × Equity (−20, 0]%	0.40***	0.36***
	(8.97)	(6.75)
Pos. shock × Equity [0, 20)%	excluded group	excluded group
Pos. shock × Equity >= 20%	0.18***	0.16***
	(5.00)	(4.00)
Lagged change in equity		–0.32**
		(–2.08)
CBSA × year effects	Y	Y
Individual effects	Y	Y
No. obs.	9,384,919	6,917,607
No. clusters	5,631	5,629

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. Pos./Neg. shock are dummy variables that capture positive and negative shocks to unemployment in a CBSA/state and the four equity dummies are variables for the amount of home equity at time $t-1$. See Section II.C for a detailed variable description. $D_{zt-1} \times \mu_{t-1}$ are (lagged) CBSA × year fixed effects or state × year effects in column (3), and ν_i are individual fixed effects. Sample: TU-LP, 2007–2009. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10] percent level.

Table C-10: Moving CBSA. CoreLogic-estimated current equity

	(1)	(2)
Neg. shock × Equity ≤ −20%	0.42***	0.38***
	(4.75)	(3.73)
Neg. shock × Equity (−20, 0)%	0.05	0.06
	(0.69)	(0.65)
Neg. shock × Equity [0, 20)%	excluded group	excluded group
Neg. shock × Equity ≥ 20%	0.21**	0.14
	(2.54)	(1.46)
Pos. shock × Equity ≤ −20%	0.24*	0.32**
	(1.72)	(1.96)
Pos. shock × Equity [0, 20)%	–0.06	–0.08
	(–0.72)	(–0.77)
Pos. shock × Equity (−20, 0)%	excluded group	excluded group
Pos. shock × Equity ≥ 20%	0.35***	0.29***
	(3.93)	(2.88)
Lagged change in equity		–0.02***
		(–5.07)
ZIP × year effects	Y	Y
Individual effects	N	N
No. obs.	1,087,091	780,733
No. clusters	5,334	5,293

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. Pos./Neg. shock are dummy variables that capture positive and negative shocks to unemployment in a CBSA and the four equity dummies are variables for the amount of home equity at time $t-1$. See Section II.C for a detailed variable description. $D_{zt-1} \times \mu_{t-1}$ are (lagged) ZIP × year fixed effects. Sample: TU-LP, 2007–2009. Robust standard errors are clustered by ZIP code of residence at time $t-1$. *** (**) [*] significant at the 1 (5) [10] percent level.

D Supplementary Model Results

The remaining tables report results from simulated data. They are intended to help explain the workings of the model better and to demonstrate robustness to reasonable permutations of the regression specification and the calibration.

In order to better understand the mechanisms of the model, we tabulate instructive frequencies by equity categories for strong and weak regions in Table D-1. The first column shows the share of people, within the strong/weak regions, in each equity category. There are no big differences in the proportions of individuals in the equity categories, although a few more people have negative equity in the weak regions. Prices evolve similarly in both types of regions by construction, and the tabulation reveals that the evolution of house prices, rather than labor market conditions, is the main cause of underwater mortgages. The second column shows that unemployment rates do not differ much between the regions. The third column further helps to explain the model: the unemployed are significantly more likely to move and even more so if they are underwater, with the pattern being more pronounced for weak regions. The fourth column shows, for both strong and weak regions, that the propensity of employed people to move is clearly and monotonically declining in equity, as captured by our four categories.

Table D-2 displays correlations of the simulated variables when the equity dummies are interacted with dummies for weak and strong labor markets after the removal of fixed effects. Comparing these correlations with their empirical counterparts of Table C-2, the model matches the data in terms of the correlation of mobility with the lagged change in equity. The model displays a larger correlation of mobility with the interaction of strong regions with negative equity than in the data (comparing local strong to positive shock CBSAs).

Table D-3 shows correlations involving actual unemployment in weak and strong regions. Of note is the strong correlation of foreclosure with mobility and with negative equity for both employed and unemployed individuals.

Table D-4 repeats the estimations of Table 6 allowing for region $\times$ year fixed effects. The coefficients to the lagged mortgage balance and equity are similar but the coefficient to the lagged home value is small and insignificant. This is an artifact of the way the model is constructed, because most of the variation in home values is by construction at the region × year level.

From (model) Table 7, unemployment plays a major role in mobility and the higher mobility of individuals with very negative equity in weak markets is likely a reflection of that. In Table D-5, we return to the detailed equity categories and compare the moving propensities of employed versus unemployed workers, using predicted equity. We include region × year fixed effect here in order to compare to (empirical) Table 2. All coefficients are relative to employed consumers with low positive equity.[12] From column (1), unemployed individuals in strong regions are much more likely to move than employed individuals, and this holds even more strongly in weak regions, see column (3), where a smaller fraction of job offers are local. Employed individuals with low equity are more likely to move than employed individuals with high equity. A positive equity shock reduces the probability of moving, but including these has little effect on the mobility impact of being underwater for the unemployed; however, the inclusion of the equity shock renders the effect of being underwater insignificant for the employed, indicating that the equity shock is more correlated with the underwater dummies for this group. Overall, employment status is a strong predictor of mobility, but its impact is about twice as high for those with negative equity.

Table D-6 explores whether our results are dependent on the subprime-sample approximation used in Table 5, with overweight of low-equity individuals to match the empirical sample scheme of Table 2. It turns out that the propensity to move for people with low equity is still higher and significant in most cases, but the coefficients are smaller than in Table 5. In an unreported regression, we dropped the region × year fixed effect, and the effects were more similar to those found using the "subprime" sample.[13] We believe that this pattern occurs because the sample now has less variation, with 75.83 percent of the ob-

[12]There are seven identified equity-employment status interaction dummies in these regressions because we use individual-level unemployment status instead of region-level unemployment rates.

[13]Without regional dummies, the dummy variables are orthogonal to each other and the results do not change by having more individuals in other categories.

servations in the highest equity category, but we do not explore this further. Because actual equity is determined by individual-specific shocks to a much larger extent, the variation in the region-year demeaned terms is larger, and the results for this simulated sample are very similar to the "subprime" sample. In either event, there is no lock-in.

We examine the effect of dropping individuals after they move, which we do in order to match the empirical sampling. Table D-7 reports results from a sample where movers remain in the sample. From comparison with the previous table, it is clear that this does not affect the results.

The following tables report results, using the same regression specification as Table 5, but changing the model itself. The main point of these tables is to show that the relationship between equity and mobility is robust to reasonable changes in model assumptions.

Table D-8 examines how the results change if unemployed individuals who move suffer a bigger loss of matching capital; that is, if moving entails a larger loss of permanent income (now 3 percent compared with the benchmark 1 percent). The results do not change much.

Table D-9 makes the gain of moving larger for the employed. The effect of this is to make the moving propensity of negative-equity individuals higher in strong regions than in weak regions. This is not surprising, but nothing much changes otherwise.

Table D-10 adjusts the probabilities of receiving external offers such that they are the same for employed and unemployed workers, by lowering the probability of outside offers for the unemployed in the strong region and increasing the probability of outside offers for the employed in the weak region.[14] The main impact is to increase the tendency of low-equity individuals to move from weak regions.

Table D-11 limits the gains/losses from moving to the transitory income component and keeps the permanent income component the same as in the home region. In this specification, the unemployed have to accept a negative transitory shock when accepting an out-of-region job offer while the out-of-region job offers considered by the employed entail a positive transitory shock. In this setup, negative-equity unemployed consumers are still more likely to move than those with positive equity, although the coefficients become smaller when the

[14] The parameters labelled a_2 and b_2 in the model are now 5 percent in both types of regions.

shock to equity is included.

Table D-12 shows that the results change little if the moving costs are lowered. The benefit of getting a job dominates moving costs, and making them lower does not affect our results (which do not depend on the number of people moving, but on the relative tendencies to move between people in different equity categories).

Table D-1: Frequencies by Equity Category in the Model. (Owners with positive mortgage balance, aged 25–60)

	Equity % in category (1)	Unemployed % in category (2)	% Moving: Unemployed (3)	% Moving: Employed (4)	% Moving: All (5)
Weak Region, Actual Equity					
Equity $\leq -20\%$	1.6	9.9	21.6	4.9	6.6
Equity $(-20, 0)\%$	13.1	7.1	19.9	2.5	3.7
Equity $[0, 20)\%$	11.8	8.3	16.5	0.7	2.0
Equity $\geq 20\%$	73.6	4.4	19.0	0.4	1.2
Weak Region, Predicted Equity					
Equity $\leq -20\%$	2.8	7.7	23.3	1.7	3.4
Equity $(-20, 0)\%$	13.3	6.3	19.2	1.9	3.0
Equity $[0, 20)\%$	19.3	5.2	19.9	0.8	1.8
Equity $\geq 20\%$	64.6	5.0	18.0	0.4	1.3
Strong Region, Actual Equity					
Equity $\leq -20\%$	1.5	10.0	9.9	4.8	5.3
Equity $(-20, 0)\%$	12.8	6.9	9.6	2.5	3.0
Equity $[0, 20)\%$	11.5	6.9	6.0	0.7	1.1
Equity $\geq 20\%$	74.3	4.7	9.2	0.3	0.7
Strong Region, Predicted Equity					
Equity $\leq -20\%$	2.9	7.8	11.2	1.7	2.4
Equity $(-20, 0)\%$	13.2	6.1	8.3	1.9	2.3
Equity $[0, 20)\%$	19.6	5.2	8.5	0.8	1.2
Equity $\geq 20\%$	64.3	5.1	8.8	0.4	0.8

Notes: Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80% and 90%, respectively). We pool data from all individuals and all four periods of the simulated data used in the regressions reported in Table 5. Employment status and equity categories are defined year-by-year, so individuals may move between these categories.

Table D-2: Model Data: Correlation Matrix for Aggregate Regressions. Region × Year and Individual Fixed Effects Removed

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Moved non-locally	1									
(2) Local Weak × Equity $\leq -20\%$	0.020	1								
(3) Local Weak × Equity $(-20,0)\%$	0.035	–0.031	1							
(4) Local Weak × Equity $\geq 20\%$	–0.0054	–0.081	–0.18	1						
(5) Local Strong × Equity $\leq -20\%$	0.010	–0.014	–0.032	–0.083	1					
(6) Local Strong × Equity $(-20,0)\%$	0.020	–0.032	–0.071	–0.18	–0.032	1				
(7) Local Strong × Equity $\geq 20\%$	–0.035	–0.082	–0.18	–0.48	–0.084	–0.18	1			
(8) Lagged change in equity	–0.037	–0.29	–0.41	0.27	–0.29	–0.41	0.28	1		
(9) Lagged actual equity	–0.070	–0.12	–0.34	0.29	–0.11	–0.34	0.30	0.47	1	
(10) Lagged equity	–0.047	–0.19	–0.35	0.42	–0.20	–0.35	0.41	0.60	0.63	1

Notes: The table shows correlation coefficients for the variables used in the regression analysis with simulated data. "Moved non-locally" is a dummy variable that equals 100 if an individual moved to another region since the previous year. "Local Weak" ("Local Strong") is a dummy variable that equals one if the frequency of local to non-local job offers for the unemployed is 80–20 (90–10). The frequency of non-local offers for the employed is the same across regions, 5 percent. These dummy variables are interacted with the dummies corresponding to the amount of *predicted equity* an individual has in the period when the moving decision is made. Equity refers to predicted equity unless otherwise indicated.

Table D-3: Correlation Matrix for Individual Regressions. Region × Year and Individual Fixed Effects Removed

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Strong Regions										
(1) Moved non-locally	1									
(2) Unemployed × Equity $\leq -20\%$	0.066	1								
(3) Unemployed × Equity $(-20, 0)\%$	0.066	0.00062	1							
(4) Unemployed × Equity $> 20\%$	0.061	–0.013	–0.030	1						
(5) Employed × Equity $\leq -20\%$	0.011	–0.012	–0.0083	–0.070	1					
(6) Employed × Equity $(-20, 0)\%$	0.00045	–0.0021	0.054	–0.095	–0.046	1				
(7) Employed × Equity $\geq 20\%$	–0.060	–0.0021	–0.064	–0.091	0.012	–0.23	1			
(8) Lagged change in equity	–0.033	–0.12	–0.17	0.044	–0.43	–0.57	0.40	1		
(9) Foreclosed dummy	0.15	0.085	0.14	–0.030	0.11	0.32	–0.088	–0.34	1	
(10) Unemployed dummy	0.15	0.20	0.27	0.47	–0.043	–0.058	–0.45	–0.019	0.045	1
Weak Regions										
(1) Moved non-locally	1									
(2) Unemployed × Equity $\leq -20\%$	0.097	1								
(3) Unemployed × Equity $(-20, 0)\%$	0.13	0.00080	1							
(4) Unemployed × Equity $> 20\%$	0.097	–0.020	–0.040	1						
(5) Employed × Equity $\leq -20\%$	0.0044	–0.010	–0.0095	–0.061	1					
(6) Employed × Equity $(-20, 0)\%$	–0.017	–0.0019	0.050	–0.096	–0.040	1				
(7) Employed × Equity $\geq 20\%$	–0.090	–0.0031	–0.071	–0.081	0.011	–0.24	1			
(8) Lagged change in equity	–0.033	–0.11	–0.17	0.041	–0.42	–0.58	0.42	1		
(9) Foreclosed dummy	0.16	0.091	0.13	–0.021	0.11	0.31	–0.096	–0.34	1	
(10) Unemployed dummy	0.25	0.20	0.29	0.46	–0.040	–0.063	–0.44	–0.025	0.062	1

Notes: The table shows correlation coefficients for the variables used in the regression analysis with simulated data. "Moved non-locally" is a dummy variable that equals 100 if an individual moved to another region since the previous year. "Unemployed" ("Employed") is a dummy variable that equals one if the individual is unemployed (employed) the period when the moving decision is made. These dummy variables are interacted with the dummies corresponding to the amount of *predicted equity* an individual has in the period when the moving decision is made. Equity refers to predicted equity unless otherwise indicated.

Table D-4: Model. The Role of Variables with Empirical Counterparts: Home Value and Mortgage Size. Including Region × Year Fixed Effects

	Actual House Val./ Equity			Predicted
	(1)	(2)	(3)	(4)
Local Weak × Home value	–2.87**	–2.82**	0.00	–0.83
	(–2.63)	(–2.57)	(0.00)	(–0.75)
Local Weak × Mortgage balance		0.14***	0.09*	0.15***
		(2.97)	(1.80)	(3.13)
Local Weak × Equity< 0			3.23***	1.12***
			(9.72)	(4.56)
Local Strong × Home value	–2.49***	–2.48***	–0.13	–0.87
	(–2.98)	(–2.98)	(–0.18)	(–1.04)
Local Strong × Mortgage balance		0.02	–0.02	0.03
		(0.63)	(–0.65)	(0.83)
Local Strong × Equity< 0			2.98***	1.03***
			(8.38)	(5.15)
Region × Year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs	190,129	190,129	190,129	190,129
No. clusters	54	54	54	54

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{t-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column of the table. $D_{t-1} \times \mu_{t-1}$ and ν_i are region × time fixed effects and individual fixed effects. Home value and mortgage balance are log transformed.

Table D-5: Model. The Role of Employment Status (Predicted Equity). (Owners with positive mortgage balance, aged 25–60)

	Strong Regions		Weak Regions	
	(1)	(2)	(5)	(6)
Unemployed × Equity $\leq -20\%$	11.07***	10.67***	20.27***	19.78***
	(4.22)	(4.09)	(6.02)	(5.90)
Unemployed × Equity $(-20, 0)\%$	8.54***	8.30***	19.59***	19.32***
	(4.58)	(4.50)	(7.49)	(7.41)
Unemployed × Equity $[0, 20)\%$	4.66***	4.66***	9.43***	9.41***
	(4.38)	(4.38)	(8.65)	(8.62)
Unemployed × Equity $\geq 20\%$	4.52***	4.71***	9.08***	9.31***
	(9.19)	(9.22)	(17.78)	(17.01)
Employed × Equity $\leq -20\%$	0.63**	0.23	0.63*	0.13
	(2.49)	(0.77)	(2.01)	(0.35)
Employed × Equity $(-20, 0)\%$	0.45**	0.24	0.39*	0.13
	(2.26)	(0.95)	(1.97)	(0.53)
Employed × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Employed × Equity $\geq 20\%$	–0.06	0.13	–0.12	0.11
	(–0.41)	(0.77)	(–0.63)	(0.55)
Lagged change in equity		–1.88*		–2.29*
		(–1.94)		(–1.97)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	95,510	95,510	94,511	94,511
No. clusters	27	27	27	27

Notes: The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Results are for the Great Recession calibration described in Section III.C.

Table D-6: Moving in the Model. Not Matching the Distribution of Equity

	Predicted Equity		Actual Equity	
	(1)	(2)	(3)	(4)
Local Weak × Equity $\leq -20\%$	0.23*	0.07	5.10***	5.11***
	(1.89)	(0.52)	(7.10)	(7.10)
Local Weak × Equity $(-20, 0)\%$	0.25**	0.17*	2.62***	2.61***
	(2.54)	(1.79)	(8.94)	(8.94)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Weak × Equity $\geq 20\%$	–0.08	–0.01	–1.89***	–1.87***
	(–1.14)	(–0.11)	(–10.79)	(–10.55)
Local Strong × Equity $\leq -20\%$	0.15	–0.01	4.41***	4.41***
	(1.51)	(–0.10)	(6.00)	(6.00)
Local Strong × Equity $(-20, 0)\%$	0.21**	0.13	2.38***	2.38***
	(2.65)	(1.61)	(7.78)	(7.77)
Local Strong × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Strong × Equity $\geq 20\%$	0.01	0.08	–0.67***	–0.64***
	(0.11)	(1.40)	(–7.33)	(–6.83)
Lagged change in equity		–0.72***		–0.06
		(–3.77)		(–1.43)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	1,516,695	1,516,695	1,516,695	1,516,695
No. clusters	54	54	54	54

Notes: Model parameters as in Table 5. The sample is different from that of Table 5 because here we do not adjust the sample to match the distribution of negative equity in the TU-LP data, where roughly 15 percent of the sample hold negative equity. In this sample, the distribution of predicted equity is as follows: (1) equity ≤ -20: 1.66%; (2) equity $(-20, 0)$: 4.95%; (3) equity $[0, 20)$: 17.86%; (4) equity ≥ 20: 75.83%. The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80 percent and 90 percent, respectively). Results are for the Great Recession calibration described in Section III.C.

Table D-7: Moving in the Model. Not dropping those who move nor matching the distribution of equity

	Predicted Equity		Actual Equity	
	(1)	(2)	(3)	(4)
Local Weak × Equity $\leq -20\%$	0.24*	0.12	5.03***	5.03***
	(1.97)	(0.97)	(7.08)	(7.08)
Local Weak × Equity $(-20, 0)\%$	0.28***	0.23**	2.60***	2.59***
	(3.00)	(2.45)	(9.45)	(9.44)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Weak × Equity $\geq 20\%$	–0.07	–0.02	–1.83***	–1.81***
	(–0.99)	(–0.23)	(–10.75)	(–10.48)
Local Strong × Equity $\leq -20\%$	0.16	0.05	4.36***	4.36***
	(1.64)	(0.46)	(6.15)	(6.15)
Local Strong × Equity $(-20, 0)\%$	0.24***	0.18**	2.37***	2.36***
	(3.10)	(2.30)	(8.48)	(8.47)
Local Strong × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Strong × Equity $\geq 20\%$	–0.00	0.05	–0.67***	–0.65***
	(–0.04)	(1.00)	(–7.87)	(–7.32)
Lagged change in equity		–0.50***		–0.06
		(–3.19)		(–1.42)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	1,534,325	1,534,325	1,534,325	1,534,325
No. clusters	54	54	54	54

Notes: Model parameters as in Table 5. The sample is different, because we do not attempt to match the distribution of negative equity in the TU-LP data (roughly 15 percent), nor do we drop consumers after their first move. In this sample, the distribution of predicted equity is as follows: (1) equity ≤ -20: 1.68% ; (2) equity $(-20, 0)$: 4.94%; (3) equity $[0, 20)$: 17.80%; (4) equity $\geq$ 20: 75.59%. The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80 percent and 90 percent, respectively). Results are for the Great Recession calibration described in Section III.C.

Table D-8: Moving in the Model. Higher Loss for the Unemployed, 3% vs. 1%.

	Predicted Equity		Actual Equity	
	(1)	(2)	(3)	(4)
Local Weak × Equity $\leq -20\%$	1.20***	0.63*	6.16***	6.16***
	(3.63)	(1.74)	(7.25)	(7.25)
Local Weak × Equity $(-20, 0)\%$	1.06***	0.76**	2.60***	2.60***
	(3.68)	(2.41)	(6.96)	(6.98)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Weak × Equity $\geq 20\%$	–0.12	0.14	–0.68**	–0.68**
	(–0.60)	(0.63)	(–2.26)	(–2.24)
Local Strong × Equity $\leq -20\%$	1.23***	0.68	5.25***	5.25***
	(2.96)	(1.47)	(6.82)	(6.82)
Local Strong × Equity $(-20, 0)\%$	0.68***	0.39	2.39***	2.39***
	(2.79)	(1.52)	(7.76)	(7.79)
Local Strong × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Strong × Equity $\geq 20\%$	0.07	0.33*	–0.15	–0.15
	(0.43)	(1.78)	(–0.70)	(–0.70)
Lagged change in equity		–2.57***		0.00
		(–3.27)		(0.03)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	188,808	188,808	188,808	188,808
No. clusters	54	54	54	54

Notes: Model parameters as in Table 5 except that the unemployed experience higher income loss when moving non-locally for a job (3 percent vs. 1 percent). The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80 percent and 90 percent, respectively). Results are for the Great Recession calibration described in Section III.C.

Table D-9: Moving in the Model. Higher Gain for the Employed, 3% vs. 1%.

	Predicted Equity		Actual Equity	
	(1)	(2)	(3)	(4)
Local Weak × Equity $\leq -20\%$	1.08**	0.30	4.80***	4.78***
	(2.19)	(0.63)	(7.06)	(7.02)
Local Weak × Equity $(-20, 0)\%$	0.83***	0.40*	2.53***	2.55***
	(3.57)	(1.72)	(7.39)	(7.47)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Weak × Equity $\geq 20\%$	–0.41	–0.04	–0.98***	–1.14***
	(–1.33)	(–0.13)	(–3.34)	(–3.62)
Local Strong × Equity $\leq -20\%$	1.39***	0.60	4.71***	4.69***
	(3.65)	(1.54)	(8.62)	(8.56)
Local Strong × Equity $(-20, 0)\%$	0.90***	0.48**	2.62***	2.65***
	(4.42)	(2.31)	(9.63)	(9.64)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Strong × Equity $\geq 20\%$	–0.10	0.27*	–0.12	–0.28
	(–0.67)	(1.80)	(–0.82)	(–1.61)
Lagged change in equity		–3.66***		0.36**
		(–5.42)		(2.53)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	188,961	188,961	188,961	188,961
No. clusters	54	54	54	54

Notes: Model parameters as in Table 5 except that the employed receive a higher income increase when moving non-locally for a job (3 percent vs. 1 percent). The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80 percent and 90 percent, respectively). Results are for the Great Recession calibration described in Section III.C.

Table D-10: Moving in the Model. Same probability of external offers for employed/unemployed

	Predicted Equity		Actual Equity	
	(1)	(2)	(3)	(4)
Local Weak × Equity $\leq -20\%$	2.44***	1.48***	9.28***	9.27***
	(8.01)	(4.20)	(11.96)	(11.96)
Local Weak × Equity $(-20, 0)\%$	2.45***	1.95***	4.95***	4.97***
	(7.84)	(6.66)	(13.30)	(13.26)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Weak × Equity $\geq 20\%$	0.26	0.71***	–0.76**	–0.82***
	(1.33)	(3.38)	(–2.57)	(–2.79)
Local Strong × Equity $\leq -20\%$	0.76**	–0.20	4.76***	4.75***
	(2.38)	(–0.53)	(6.07)	(6.05)
Local Strong × Equity $(-20, 0)\%$	0.68***	0.19	2.14***	2.15***
	(3.70)	(0.97)	(6.82)	(6.86)
Local Strong × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Strong × Equity $\geq 20\%$	–0.02	0.41**	0.31*	0.25
	(–0.12)	(2.17)	(1.91)	(1.42)
Lagged change in equity		–4.42***		0.15
		(–5.11)		(1.35)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	196,413	196,413	196,413	196,413
No. clusters	54	54	54	54

Notes: Model parameters as in Table 5 except for the probabilities of job offers. In this case, the probability of a non-local job offer is the same for the employed and the unemployed, 5 percent in strong regions and 10 percent in weak regions. The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80 percent and 90 percent, respectively). Results are for the Great Recession calibration described in Section III.C.

Table D-11: Moving in the Model. Only transitory gains/losses to Income from Non-Local Moves

	Predicted Equity		Actual Equity	
	(1)	(2)	(3)	(4)
Local Weak × Equity $\leq -20\%$	1.41***	0.55	5.54***	5.53***
	(3.95)	(1.45)	(8.62)	(8.59)
Local Weak × Equity $(-20, 0)\%$	1.21***	0.76***	2.64***	2.65***
	(4.85)	(2.79)	(7.61)	(7.61)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Weak × Equity $\geq 20\%$	–0.47**	–0.08	–0.95***	–1.01***
	(–2.13)	(–0.36)	(–3.01)	(–3.05)
Local Strong × Equity $\leq -20\%$	1.05***	0.20	5.31***	5.30***
	(3.82)	(0.69)	(7.92)	(7.90)
Local Strong × Equity $(-20, 0)\%$	0.87***	0.42*	2.53***	2.54***
	(3.86)	(1.70)	(7.98)	(8.04)
Local Strong × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Strong × Equity $\geq 20\%$	0.00	0.40**	0.01	–0.04
	(0.02)	(2.44)	(0.07)	(–0.21)
Lagged change in equity		–3.95***		0.13
		(–5.45)		(1.00)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	189,183	189,183	189,183	189,183
No. clusters	54	54	54	54

Notes: Model parameters as in Table 5 except that income gains/losses after accepting a non-local job offer are only transitory. Unemployed workers receive the lowest transitory shock when moving and employed workers receive the highest. The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80 percent and 90 percent, respectively). Results are for the Great Recession calibration described in Section III.C.

Table D-12: Moving in the Model. Non-Local Employer Pays Half of the Moving Cost

	Predicted Equity		Actual Equity	
	(1)	(2)	(3)	(4)
Local Weak × Equity $\leq -20\%$	1.47***	0.85**	6.06***	6.05***
	(4.80)	(2.52)	(8.69)	(8.65)
Local Weak × Equity $(-20, 0)\%$	0.95***	0.63**	2.71***	2.71***
	(3.65)	(2.24)	(8.38)	(8.39)
Local Weak × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Weak × Equity $\geq 20\%$	–0.05	0.24	–0.34	–0.38
	(–0.18)	(0.93)	(–1.12)	(–1.27)
Local Strong × Equity $\leq -20\%$	1.08***	0.46	5.11***	5.10***
	(3.22)	(1.29)	(7.71)	(7.70)
Local Strong × Equity $(-20, 0)\%$	0.95***	0.63***	2.24***	2.25***
	(4.49)	(2.89)	(7.18)	(7.21)
Local Strong × Equity $[0, 20)\%$	excluded group	excluded group	excluded group	excluded group
Local Strong × Equity $\geq 20\%$	0.16	0.45**	–0.08	–0.13
	(0.80)	(2.17)	(–0.44)	(–0.60)
Lagged change in equity		–2.87***		0.09
		(–4.09)		(0.65)
Region × year effects	Y	Y	Y	Y
Individual effects	Y	Y	Y	Y
No. obs.	192,238	192,238	192,238	192,238
No. clusters	54	54	54	54

Notes: Model parameters as in Table 5 except that moving costs are 50 percent lower when accepting a non-local job offer (a government or employer subsidy). The table shows estimated coefficients (and t-statistics in parentheses) from the equation $M_{it} = X_{it-1}\beta + D_{zt-1} \times \mu_{t-1} + \nu_i + u_{it}$, where M_{it} is an indicator variable that equals 100 if individual i moves between period $t-1$ and t, and zero otherwise. X is a vector of (lagged) regressors listed in the first column, $D_{zt-1} \times \mu_{t-1}$ is the product of (lagged) region fixed effects and time fixed effects, and ν_i are individual fixed effects. Robust standard errors are clustered by region. *** (**) [*] significant at the 1 (5) [10] percent level. Local weak regions and local strong regions differ in the intensity of local versus non-local job offers (80 percent and 90 percent, respectively). Results are for the Great Recession calibration described in Section III.C.

E Further Details on the Model

E.1 The household problem in recursive form

The consumer's optimization problem in its recursive formulation can be written as follows:

$$V(A,H,M,P,q,l,j) = \max\left\{V^{NF}(A,H,M,P,q,l,j), V^{F}(A,H,M,P,q,l,j)\right\},$$

where A, H, M, and P denote deposits, housing, mortgage, and permanent income, respectively; l denotes the employment state (employed or unemployed), q is the house-price state, which differs from the house price (q^* denotes the house price; the difference between q and q^* is discussed below), and j is age. NF and F denote "no foreclosure" and "foreclosure." Let C be nondurables, S housing services acquired in the rental market, o an indicator for homeownership, ζ_{j+1} the probability of being alive at age $j+1$, and ρ the discount factor. Let $U()$ and $B()$ be the utility function and the bequest function, respectively. The value function when there is no foreclosure can be written as follows:

$$\begin{aligned} V^{NF}(A,H,M,P,q,l,j) &= \mathbb{E}\Big[\max_{C',A',H',M',S'} \big\{U(C', o'H' + (1-o')S', j) \\ &+ \frac{1}{1+\rho}\sum_{q'} \pi(q'|q)\Big(\zeta_{j+1}V(A',H',M',P',q',l',j+1) \\ &+ (1-\zeta_{j+1})B(A',H',M',q')\Big)\big\}\Big], \end{aligned}$$

where houses are purchased at the beginning of the period (after income, labor and moving shocks have been realized) and render services the same period. Age changes at the end of the period. (The expectations operator is spelled out in equation (E-1)). The following constraints must be satisfied.

Non-negativity constraints:

$$C \geq 0;\ A \geq 0;\ M \geq 0; H \geq 0; S \geq 0.$$

Individuals cannot be owners and renters at the same time:

$$\begin{cases} H' = 0,\ S' > 0 & \text{if } o' = 0, \\ H' > 0,\ S' = 0 & \text{if } o' = 1. \end{cases}$$

Let I_m be a moving indicator (changing houses or receiving an exogenous moving shock, m_s):

$$I_m = \begin{cases} 0 & \text{if} \quad |H'/H - 1| \leq \xi \text{ and } \quad m'_s = 0, \\ 1 & \text{if} \quad |H'/H - 1| > \xi \text{ or } \quad m'_s = 1. \end{cases}$$

The budget constraint at age j can be written as:

$$\begin{aligned} & C' + r_s S' + A' + q^* H'(1 + \kappa I_m) - M' \\ & = (1 - \tau_y) W' + [1 + r_a(1 - \tau_y)]A - [1 + r_m(1 - \tau_y \tau_m)]M + (1 - \delta_h)(1 - \chi_j I_m) q^* H\,, \end{aligned}$$

where κ and χ_j represent buying and selling costs, respectively. The selling cost increases with age. Income is taxed at the rate τ_y and mortgage interest payments can be deducted at the rate τ_m.

There is a maximum LTV ratio for new mortgages but non-movers are not subject to margin calls:

$$\begin{cases} M' \leq (1-\theta)q^* H' & \text{if} \quad I_m = 1, \\ M' < M & \text{if} \quad I_m = 0. \end{cases}$$

The value function when defaulting (only possible for owners) can be written as:

$$\begin{aligned} V^F(A,H,M,P,q,l,j) &= \mathbb{E}\Big[\max_{C',A',S'} \Big\{U(C',S',j) \\ &+ \frac{1}{1+\rho}\sum_{q'} \pi(q'|q)\Big(\zeta_{j+1}V(A',0,0,P',q',l',j+1) \\ &+ (1-\zeta_{j+1})B(A',0,0,q')\Big)\Big\}\Big]. \end{aligned}$$

Owners who default on their mortgage must rent for a period.

The budget constraint becomes:

$$C' + r_s S' + A' = (1-\rho_W)(1-\tau_y)W' + (1-\rho_A)[1+r_a(1-\tau_y)]A - \rho_H(1-\delta_h)q^* H\,,$$

where the penalties for default are the loss of any positive equity, payment of a percentage ρ_W of current income, and payment of small percentages ρ_H

and ρ_A of the home value and deposits, respectively. Individuals who default lose their home and their home equity (if any) but discharge all mortgage debt. The losses associated with foreclosure (in terms of assets) are included to produce a life-cycle profile of foreclosure that first increases with age and then decreases.

Income evolves as follows:

$$W' = \begin{cases} P'\nu\phi; \quad P' = P\gamma_j\epsilon\varsigma & \text{if } j \leq R \\ bP_R & \text{if } j > R, \end{cases}$$

where ν is an idiosyncratic transitory shock, ϕ is 1 for employed workers and less than one for unemployed workers, γ_j is a hump-shaped non-stochastic life-cycle component, ϵ is an idiosyncratic permanent shock, and ς is a factor that determines whether wages go up or down when moving to another location for a job.

Employment takes two possible states $l = \{e, u\}$, and there are three possible individual-specific employment outcomes for employed and for unemployed workers, which we index by l_s^e and l_s^u, respectively: if $l_s^e = 1$, the individual becomes unemployed, if $l_s^e = 2$, the individual receives a non-local offer, and if $l_s^e = 3$, the individual remains employed locally. For the unemployed: if $l_s^u = 1$, the individual receives a local offer, if $l_s^u = 2$, the individual receives a non-local offer, and if $l_s^u = 3$, the individual does not receive any offers. l evolves as follows:

$$
l' = \begin{cases} \text{if } \ l = e & \begin{cases} u', & l_s^e = 1, \ p = a_1 \, ; \\ e', & l_s^e = 2, \ p = a_2 ; \ \text{non-local offer received; can take or not} \, ; \\ e', & l_s^e = 3, \ p = 1 - a_1 - a_2 \, ; \end{cases} \\ \\ \text{if } \ l = u & \begin{cases} e', & l_s^u = 1, \ p = b_1 \, ; \\ \begin{cases} u', & l_s^u = 2, \ p = b_2 \, ; \text{non-local offer rejected} \, ; \\ e', & l_s^u = 2, \ p = b_2 \, ; \text{non-local offer accepted;} \end{cases} \\ u', & l_s^u = 3, \ p = 1 - b_1 - b_2 \, . \end{cases} \end{cases}
$$

For a homeowner to accept a non-local offer, the owner must sell the home and become a renter for one period.[15]

The house-price state evolves according to a highly persistent AR(1) process:

$$
q' = \rho_q q + \varrho.
$$

The actual price paid is higher or lower by a certain percentage relative to the housing state (the shock, which has probability 0.5 of being positive or

[15]In order to limit computational demands, we do not allow homeowners who receive a non-local offer to become renters and wait for a local offer at the same time. Employed homeowners receive non-local offers with increased permanent income prospects, so the imposed reduction in the choice set is unlikely to be binding for this group. Unemployed homeowners, on the other hand, receive non-local job offers that may entail lower income going forward. Unemployed homeowners who prefer to stay after receiving a non-local offer can do so if they stay in their current home or downsize to a smaller home instead of becoming renters (that is, equity extraction is still possible for this group).

negative, is learned before decisions regarding C', S', H', A' are made):

$$q^* = q(1+\mu); \quad \mu \in \{-.05, +.05\}.$$

E.2 Computational details

Because the utility function is homothetic, we can eliminate permanent income as a state variable by normalizing deposits, mortgages, housing, and consumption by permanent income and solving a normalized version of the household problem.[16] Holding deposits may be optimal for precautionary reasons: if house prices go down, it may not be possible to extract home equity without incurring transactions costs associated with selling the house. In sum, we have to keep track of six state variables.

Because of the non-convex adjustment costs, we cannot use techniques that rely on differentiability, and we solve a discretized version of the household problem using value function iteration. To keep the problem tractable, we use three grid points (each) to approximate transitory and permanent idiosyncratic income shocks, and three points for the house-price state (high prices, average prices, low prices). When choosing the grids for the key state variables (deposits, housing, and mortgages), we start by solving the household problem with coarse grids and increase the number of points in each

[16]In a previous version of this paper with a different assumption on house prices (i.i.d. house-price growth), home prices could also be eliminated as a state variable with further normalization by house prices, which is not the case with an AR(1) process. Without house-price uncertainty, it is possible to eliminate one more state variable by combining deposits and mortgages into net financial assets, $A - M$—see Díaz and Luengo-Prado (2008) for details. With house-price uncertainty, this is not necessarily the case even if $r_m > r_a$.

grid until our results do not change significantly. Grids are denser for these three state variables around the neighborhoods where a significant fraction of households are concentrated. Grids are for the normalized variables, so even a relatively small number of points would map into a large number of outcomes for the non-normalized variables. We use 15 grid points for housing and 35 for deposits and mortgages.

Evaluating the expectation term in the discretized version of the household problem entails performing the following summation over transitory and permanent income shocks, (ν, ϵ), (assumed to be i.i.d.); moving shocks, m_s (age dependent); i.i.d. houseprice shocks, μ; and employment shocks, l_s^l, (whose probabilities depend on the employment state, l).

$$\mathbb{E} = \frac{1}{N_\nu} \sum_{\nu} \frac{1}{N_\epsilon} \sum_{\epsilon} \sum_{N_{m_s}} \pi(m_s|j) \frac{1}{N_\mu} \sum_{\mu} \sum_{N_{l_s}} \pi(l_s^l|l) \ , \tag{E-1}$$

where l is one of the labor states (e, u) and j is age.

After normalizing by permanent income, P', the budget constraints for those not defaulting and defaulting, respectively, become:

$$c' + r_s s' + a' + q(1+\mu)h'(1+\kappa I_m) - m' = (1-\tau_y)\nu\phi$$
$$+(\gamma_j \epsilon \varsigma)^{-1}\Big([1 + r_a(1-\tau_y)]a - [1 + r_m(1-\tau_y\tau_m)]m + (1-\delta_h)(1-\chi_j I_m)q(1+\mu)h\Big),$$

$$c' + r_s s' + a' = (1-\rho_W)(1-\tau_y)\nu\phi$$
$$+(\gamma_j \epsilon \varsigma)^{-1}\Big((1-\rho_A)[1 + r_a(1-\tau_y)]a - \rho_H(1-\delta_h)q(1+\mu)h\Big),$$

where lower-case variables denote upper-case counterparts divided by permanent income.

The moving indicator can be rewritten in terms of normalized variables as follows:

$$I_m = \begin{cases} 0 & \text{if} \quad |(h'\gamma_j\epsilon\varsigma)/h - 1| \leq \xi \text{ and} \quad m_s = 0, \\ 1 & \text{if} \quad |(h'\gamma_j\epsilon\varsigma)/h - 1| > \xi \text{ or} \quad m_s = 1. \end{cases}$$

The margin of adjustment before paying adjustment costs is quite realistic and it is important when solving a discretized version of the model in order to avoid "false positives" for moving.

The collateral constraint becomes:

$$\begin{cases} m' \leq (1-\theta)q(1+\mu)h' & \text{if} \quad I_m = 1, \\ \gamma_j\epsilon\varsigma m' < m & \text{if} \quad I_m = 0. \end{cases}$$

Given our assumption on the utility function, the value function must be normalized by the factor $(\epsilon\gamma_j\varsigma)^{1-\sigma}$, where σ is the coefficient of relative risk aversion.

F Welfare Analysis

We examine the welfare implications of the model even if it suppresses many of the features of a full general equilibrium model. In particular, we ignore benefits to employers, endogeneity of local wages, and potential costs to workers who may be crowded out. However, we can evaluate the order of magnitude of the benefits of being able to move to other labor markets. We report on two simple experiments where we calculate the average utility across all individuals and periods for the last four years of our Great Recession calibration. We show the results of two alternative parameterizations of the model, keeping all (income, prices, etc.) shocks the same across parameterizations. Let B and A denote baseline and alternative, i individual, and t period. We compute average utility in the baseline case as:

$$\overline{u}^B = \frac{1}{T}\sum_t \frac{1}{N}\sum_i U(C_i^B, J_i^B),$$

where housing services are $J = o \times H + (1 - o) \times S$, with o being a dummy for homeownership. We compute average utility for the alternative parameterizations of the model in the same fashion and compare $\overline{u}^B$ to $\overline{u}^A$.[17]

For our first experiment, we decrease non-local moving costs by 50 percent—which could be interpreted as a government subsidy aimed at improving geographical matching. We obtain an equivalent permanent increase in nondurable consumption (and utility) of 0.45 percent. For our second experiment,

[17] With a Cobb-Douglas utility function on nondurable and housing services and a coefficient of risk aversion of 2, utility ratios translate one-to-one into nondurable consumption ratios.

we assume that there is a zero probability of external offers and find an equivalent permanent reduction in nondurable consumption of 2.2 percent. Table F-1 reports gains/losses comparing young vs. old workers, and, unsurprisingly, the gain/loss decreases with age. Finally, we split individuals based on their equity positions at the peak of the boom under the baseline simulation into a low-equity group (less than 50 percent) and a high-equity group (50 percent or more)—where the 50 percent cut-off roughly corresponds to the median—and focus on homeowners with positive mortgage balances at the peak of the boom, aged 25–60, as in our regressions. We compare the utility of these individuals to that of individuals who receive exactly the same shocks as they receive but "live" in the alternative economies.

Lowering the non-local moving cost has a small impact, but shutting down out-of-region job offers leads to utility losses of 2.79 percent for the high-equity group and 3.24 percent for the low-equity group—the difference reflects the higher number of unemployed in the low-equity group, but we do not explore this issue further.

Table F-1: Welfare Comparisons. Gain/Loss, Nondurable Consumption (%)

Group	1/2 cost of non-local moves (1)	No non-local offers (2)
All	0.45	–2.18
Age 25–44	0.70	–2.68
Age 45–60	0.32	–2.10
Low Equity	0.08	–3.24
High Equity	0.02	–2.79

Notes: The table reports the equivalent increase/decrease in nondurable consumption when moving from our baseline calibration to the alternative calibration described by the column heading. Gains/losses are calculated over the Great Recession simulation period of our regressions, four periods with house-price states {high,high,low,low}. The age split is based on an individual's age at the peak of the boom. Low (High) Equity means equity of less (more) than 50 percent at the peak of the boom period in the baseline simulation, and the grouping excludes individuals who are renters or own their house outright.

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