

## ONLINE APPENDIX

### **The Vulnerability of Minority Homeowners in the Housing Boom and Bust**

Patrick Bayer

Fernando Ferreira

Stephen L Ross

#### **Appendix A: Supplementary Tables for The Vulnerability of Minority Homeowners in the Housing Boom and Bust**

Table A1 presents all parameter estimates for the foreclosure models with underwriting controls presented in Table 3 of the paper with the exception of large vectors of fixed effects. The first column presents the estimates for the home purchase sample and the second presents the estimates for the refinance sample. Estimates are quite similar for the delinquency models, and most patterns identified hold for both home purchase and refinance mortgages. Starting with the top rows. The estimates show that gender differences and differences for Asians and Native Americans are small. The incidence of foreclosure increases with age (home purchase only) and with income. The age results arise in large part due to the inclusion of controls for credit history and loan to value ratio, and older borrowers on average have substantially higher credit scores and down payments. Similarly, the income results arise only after the inclusion of controls for census tract median income, and foreclosure rates fall with tract income. Foreclosure is also moderately more likely in neighborhoods with a high share African-American, high poverty rate, high rate of owner-occupancy, and a high price to rent ratio, which is often seen as a measure of equity risk. The next set of variables identify the lender's regulator where national banks regulated by the Office of the Currency of the Comptroller form the omitted category. On average, foreclosure rates are higher for state chartered banks, which are regulated by the Federal Deposit Insurance Corporation and the Federal Reserve, as well as non-depository lenders who are regulated by the Department of Housing and Urban Development and savings and loans who are regulated by the Office of Thrift supervision.

Turning to the additional controls for risk that were provided by the merge with transaction and credit information, foreclosures are more likely on loans without a coborrower, jumbo loans, loans with a second lien, adjustable rate loans, and smaller properties with more bedrooms given the housing unit's size (home purchase only). The estimates on the credit score bins show a strong negative, monotonic relationship between foreclosure and credit score, and the estimates on the housing expense to income ratio bins show a similarly strong, positive monotonic relationship. Debt payment to income ratio's are relatively weak predictors of foreclosure after controlling for the housing expense to income ratio, except for very high ratios in the home purchase market. Original loan to value ratio is similarly a weak predictor of foreclosure except at loan to value ratios near one. The lack of significance should not be surprising given other

results in the paper. Foreclosure and delinquency depend strongly on current loan to value ratio, but only when households are exposed to low employment rates. Original loan to value ratio is only an imperfect predictor of the loan value ratio in any given year and does nothing to identify the borrowers who are exposed to unemployment shocks. Finally, foreclosure is higher among refinance borrowers who had a previous foreclosure filing on record. In the home purchase sample, there are simply too few borrowers with a previous foreclosure to identify a relationship.

Table A2 presents a series of models in which additional controls are added to the underwriting models in Table A1 and columns 2 and 6 of Table 3 in order to build to the subprime model in columns 3 and 7 of Table 3. The first and fifth columns of Table A2 include a dummy for rate spread loan, as defined by the Home Mortgage Disclosure Act in order to capture loans with subprime interest rates. The direct effect of obtaining a rate spread loan on the likelihood of foreclosure is sizable and statistically significant in both the home purchase and refinance market. The rate spread loan variable clearly contains information about inherent risk associated with either the borrower and/or the loan terms. However, the inclusion of the rate-spread indicator at most moderately reduces the estimated racial differences in foreclosure and delinquency rates. For example, the foreclosure coefficients for blacks and Hispanics in the purchase sample falls by 19 and 13 percent, respectively, and the decline in the refinance sample is even smaller. Columns 2 and 6 include lender fixed effects, and Columns 3 and 7 control for census tract fixed effects. These controls lead to moderate reductions in racial and ethnic differences, but these reductions are never more than 10 percent and often less than 5 percent. The fourth and the last columns present estimates after including additional controls for subprime borrowing recognizing that the impact of key loan terms on borrower outcomes may vary between prime and subprime borrowers. We identify borrowers with Vantage scores below 701 as subprime borrowers and then interact the subprime borrower dummy with dummy variables associated with key thresholds of loan to value ratio, debt to income ratio, mortgage payment to income ratio, as well as with the presence of subordinate debt and whether the primary mortgage is adjustable rate. The estimates of racial and ethnic differences are practically identical to the ones reported in the previous column, but many of the interactions are highly significant specifically implying a much larger impact of initial loan terms on foreclosure for subprime credit score borrowers. Thus, while these variables have considerable explanatory power, they have little effect on estimated racial and ethnic differences in mortgage outcomes.

Table A3 presents a series of models in which additional controls are added to the subprime model in columns 3 and 7 of Table 3 in order to build to the contemporaneous controls model in columns 4 and 8 of Table 3. Columns 1 and 5 of Table A3 present the subprime model after the inclusion of county by credit year fixed effects. We find that the inclusion of flexible controls for county trends in foreclosure leaves the direct effect of the race and ethnicity indicators on foreclosures virtually unchanged. In the second and sixth column of Table A3, we also include an indicator for negative equity, based on initial loan to value ratio and the county-year variation in prices based on a Dataquick transaction sample. We also interact negative equity with a measures of the employment rate for prime age males for each county and year using the public use sample of the American Community Survey. In both samples, we find a strong positive relationship between being in negative equity and foreclosure, but only in counties and credit years with relatively low employment rates. Columns 3 and 7 present similar estimates using dummies for whether the current loan to value ratio is between 1.0 and 1.1, 1.1 and 1.3, 1.3 and

1.5, and above 1.5. Again, we find a strong positive relationship between foreclosure and the extent of negative equity. However, in no cases, do we observe any meaningful change in the estimated parameters on race or ethnicity. Finally, columns 4 and 8 present estimates where the employment rate variable is based on the county, the current year and the race and ethnicity of the individual. The estimates on the negative equity and employment interactions are relatively similar, but after allowing for lower employment rates among black prime age males the estimated coefficient on race is substantially lower in both samples, as discussed in the main body of the paper.

Tables A4 and A5 present models for the refinance data by home purchase year where the data is split based on an indicator of the change in mortgage amount during the refinance. Specifically, the sample is split into above and below median loans on the ratio of the total loan amount from the transaction/lien data (Dataquick) and the outstanding total loan amount from the credit report data as of March 31 in the year of the refinance mortgage, remembering that the refinances occur between May and August. The median ratio is approximately 1.13 suggesting that a majority of loan amounts are higher than the outstanding mortgage debt, but some of this difference may involve the inclusion of closing costs and points into the mortgage amount as opposed to a formal Cash-out refinance. Table A4 replicates Table 3 Panel 2 in the body of the paper for these two subsamples. While racial differences are somewhat smaller in the “cash-out” subsample with no controls, the differences across the subsamples erode as more controls are added and are effectively zero in the last column that includes contemporaneous controls. Table A5 panels 1 (delinquency) and 2 (foreclosure) replicate Table 6 from the paper for the same two subsamples. While the estimates are noisier than in Table 6, the qualitative results are qualitatively similar with larger racial differences for home purchases in the later 2000’s. As in Table 6, these effects are strongest for Hispanics. Comparing the differences across the subsamples did not indicate any clear regularities, but it is notable that the dip in racial and ethnic differences in Foreclosure that arose in 2006 shown in Table 6 and Figure 4 only arises for the low to non-“Cash-out” subsample. Note that the difference in samples sizes between the above and below median subsamples arises because a March 31 credit report in the year after the mortgage is not observed for a small portion of our sample and this portion is allocated unequally between the below and above median subsamples.

Table A1: Complete Parameter Estimates for Foreclosure Models

| Control Variables    | Home Purchase Sample       | Refinance Sample           |
|----------------------|----------------------------|----------------------------|
| Male                 | -0.005844***<br>(0.001553) | -0.005113***<br>(0.001267) |
| Female               | -0.019316*<br>(0.010244)   | 0.013143<br>(0.014375)     |
| Native               | 0.010569<br>(0.012889)     | -0.003207<br>(0.011551)    |
| Asian                | 0.005766**<br>(0.002442)   | 0.012062***<br>(0.002751)  |
| Black                | 0.041556***<br>(0.003571)  | 0.016815***<br>(0.002351)  |
| Hispanic             | 0.038351***<br>(0.002469)  | 0.023669***<br>(0.001963)  |
| Age 36-42            | 0.003179**<br>(0.001574)   | -0.005385**<br>(0.002386)  |
| Age 42-49            | 0.006726***<br>(0.001751)  | 0.000994<br>(0.002388)     |
| Age 49-56            | 0.007254***<br>(0.001887)  | -0.000681<br>(0.002326)    |
| Age 56+              | 0.019954***<br>(0.001965)  | 0.003005<br>(0.002402)     |
| Age missing          | 0.055745***<br>(0.001727)  | 0.035029***<br>(0.002536)  |
| Income 2rd Decile    | 0.013018***<br>(0.002492)  | 0.012951***<br>(0.002053)  |
| Income 3th Decile    | 0.027593***<br>(0.002915)  | 0.021493***<br>(0.002236)  |
| Income 4th Decile    | 0.038123***<br>(0.002995)  | 0.025937***<br>(0.002318)  |
| Income 5th Decile    | 0.046593***<br>(0.003229)  | 0.031140***<br>(0.002701)  |
| Income 6th Decile    | 0.056766***<br>(0.003780)  | 0.039863***<br>(0.002753)  |
| Income 7th Decile    | 0.067004***<br>(0.003655)  | 0.044505***<br>(0.002881)  |
| Income 8th Decile    | 0.070940***<br>(0.003770)  | 0.052082***<br>(0.003333)  |
| Income 9th Decile    | 0.088984***<br>(0.004441)  | 0.061211***<br>(0.003638)  |
| Income 10th Decile   | 0.108689***<br>(0.005377)  | 0.073302***<br>(0.004459)  |
| tract_median_income  | -0.000000***<br>(0.000000) | -0.000000***<br>(0.000000) |
| tract_perc_afr_amer  | 0.000295***<br>(0.000068)  | 0.000052<br>(0.000044)     |
| tract_perc_asian     | -0.000009<br>(0.000089)    | -0.000071<br>(0.000074)    |
| tract_perc_hispanic  | 0.000003<br>(0.000066)     | 0.000043<br>(0.000054)     |
| tract_perc_own_occup | 0.000242***                | 0.000183***                |

|   |                            |                           |
|---|----------------------------|---------------------------|
| tract_perc_poverty                                | (0.000050)<br>0.000758***  | (0.000040)<br>0.000320**  |
| tract_price_rent_ratio                            | (0.000176)<br>3.313829***  | (0.000141)<br>1.476529*** |
| Federal Reserve System (FRS)                      | (0.603140)<br>0.006020***  | (0.469437)<br>-0.000923   |
| Federal Deposit Insurance Corporation (FDIC)      | (0.001850)<br>0.029415***  | (0.001742)<br>0.014615*** |
| Office of Thrift Supervision (OTS)                | (0.003528)<br>0.015613***  | (0.002812)<br>0.004074*** |
| National Credit Union Administration (NCUA)       | (0.001793)<br>0.004577     | (0.001477)<br>0.000037    |
| Department of Housing and Urban Development (HUD) | (0.002936)<br>0.018098***  | (0.002258)<br>0.011178*** |
| Consumer Financial Protection Bureau (CFPB)       | (0.001555)<br>0.015794     | (0.001374)                |
| Has Coborrower                                    | (0.035383)<br>-0.022673*** | -0.013752***              |
| Jumbo loan  | (0.001420)<br>0.014468***  | (0.001330)<br>0.004687**  |
| Borrower has a second lien                        | (0.002683)<br>0.026933***  | (0.002373)<br>0.028809*** |
| Borrower has a third lien                         | (0.001923)<br>-0.024833*** | (0.006986)<br>0.054435*** |
| First Lien is Variable rate loan                  | (0.006403)<br>0.032263***  | (0.009607)<br>0.024129*** |
| Second Lien is Variable rate loan                 | (0.001378)<br>-0.011099*** | (0.001200)<br>-0.016935   |
| Third Lien is Variable rate loan                  | (0.002733)<br>0.105529     | (0.010495)                |
| Lot_size  | (0.070429)<br>-0.000000*   | -0.000000                 |
| Number of Stories                                 | (0.000000)<br>-0.000125    | (0.000000)<br>-0.000116   |
| Number of Units in structure                      | (0.000278)<br>-0.000021    | (0.000467)<br>-0.000014   |
| Condo   | (0.000025)<br>0.011516     | (0.000017)<br>0.004349    |
| Mobile home                                       | (0.011590)<br>-0.018072    | (0.004898)<br>-0.018440*  |
| Single Family                                     | (0.016532)<br>0.006816     | (0.009925)<br>0.004768    |
| Number of bedrooms 1                              | (0.011514)<br>0.002307     | (0.004488)<br>0.016792**  |
| Number of bedrooms 2                              | (0.006783)<br>0.000748     | (0.007814)<br>0.002725    |
| Number of bedrooms 3                              | (0.005447)<br>0.004150     | (0.004045)<br>0.002623    |
| Number of bedrooms 4                              | (0.005005)<br>0.006864     | (0.003945)<br>0.001307    |
| Number of bedrooms 5                              | (0.005101)<br>0.013854*    | (0.004200)<br>0.006637    |
| Number of bedrooms 6                              | (0.007489)<br>0.031339**   | (0.005871)<br>-0.008842   |
| Number of bedrooms 7                              | (0.014690)<br>0.060849     | (0.007730)<br>0.005302    |

|                               |                            |                            |
|-------------------------------|----------------------------|----------------------------|
| Square Footage in Quantile 1  | (0.045737)<br>-0.002153    | (0.022063)<br>-0.002367    |
| Square Footage in Quantile 2  | (0.004586)<br>-0.008486**  | (0.004664)<br>-0.005723    |
| Square Footage in Quantile 3  | (0.004295)<br>-0.012398*** | (0.004506)<br>-0.002882    |
| Square Footage in Quantile 4  | (0.004279)<br>-0.009305**  | (0.004512)<br>-0.005389    |
| Square Footage in Quantile 5  | (0.004248)<br>-0.009481**  | (0.004518)<br>-0.006527    |
| Square Footage in Quantile 6  | (0.004291)<br>-0.015113*** | (0.004562)<br>-0.007772*   |
| Square Footage in Quantile 7  | (0.004511)<br>-0.013215*** | (0.004592)<br>-0.008497*   |
| Square Footage in Quantile 8  | (0.004505)<br>-0.014698*** | (0.004666)<br>-0.009981**  |
| Square Footage in Quantile 9  | (0.004591)<br>-0.013654*** | (0.004603)<br>-0.007653    |
| Square Footage in Quantile 10 | (0.004555)<br>-0.018857*** | (0.004807)<br>-0.010504**  |
| Vantagescore 501-520          | (0.004984)<br>0.019088     | (0.005191)<br>0.003249     |
| Vantagescore 541-560          | (0.020365)<br>-0.015374    | (0.014203)<br>-0.019114*   |
| Vantagescore 561-580          | (0.015026)<br>-0.008949    | (0.010326)<br>-0.012746    |
| Vantagescore 581-600          | (0.014017)<br>-0.001575    | (0.009593)<br>-0.015840*   |
| Vantagescore 601-620          | (0.013788)<br>-0.013754    | (0.009263)<br>-0.006893    |
| Vantagescore 621-640          | (0.013218)<br>-0.017192    | (0.009311)<br>-0.013857    |
| Vantagescore 641-660          | (0.013028)<br>-0.022623*   | (0.009052)<br>-0.024227*** |
| Vantagescore 661-680          | (0.012826)<br>-0.022339*   | (0.008976)<br>-0.019098**  |
| Vantagescore 681-700          | (0.012764)<br>-0.033323*** | (0.008856)<br>-0.019583**  |
| Vantagescore 701-720          | (0.012703)<br>-0.032881**  | (0.008973)<br>-0.027447*** |
| Vantagescore 721-740          | (0.012867)<br>-0.042365*** | (0.008753)<br>-0.024868*** |
| Vantagescore 741-760          | (0.012577)<br>-0.050061*** | (0.008843)<br>-0.034009*** |
| Vantagescore 761-780          | (0.012523)<br>-0.051129*** | (0.008897)<br>-0.038521*** |
| Vantagescore 781-800          | (0.012475)<br>-0.064755*** | (0.008727)<br>-0.040655*** |
| Vantagescore 801-820          | (0.012468)<br>-0.064480*** | (0.008758)<br>-0.045484*** |
| Vantagescore 821-840          | (0.012462)<br>-0.069028*** | (0.008709)<br>-0.046011*** |
| Vantagescore 841-860          | (0.012371)<br>-0.068095*** | (0.008681)<br>-0.049368*** |
| Vantagescore 861-880          | (0.012401)<br>-0.070356*** | (0.008743)<br>-0.050443*** |

|                                      |                            |                            |
|--------------------------------------|----------------------------|----------------------------|
| Vantagescore 881-900                 | (0.012382)<br>-0.067798*** | (0.008672)<br>-0.051644*** |
| Vantagescore 901-920                 | (0.012396)<br>-0.071262*** | (0.008780)<br>-0.055254*** |
| Vantagescore 921-940                 | (0.012428)<br>-0.076811*** | (0.008617)<br>-0.054853*** |
| Vantagescore 941-960                 | (0.012531)<br>-0.081360*** | (0.008767)<br>-0.055695*** |
| Vantagescore 961-980                 | (0.012639)<br>-0.085685*** | (0.008745)<br>-0.057030*** |
| Vantagescore 981+                    | (0.012642)<br>-0.094541*** | (0.009153)<br>-0.064500*** |
| Mortgage payment to Income 0.1-0.2   | (0.012686)<br>0.000105     | (0.008754)<br>-0.006573    |
| Mortgage payment to Income 0.2-0.24  | (0.009165)<br>-0.009590    | (0.009036)<br>-0.007983    |
| Mortgage payment to Income 0.24-0.29 | (0.009102)<br>0.007205     | (0.009130)<br>0.002778     |
| Mortgage payment to Income 0.29-0.31 | (0.009216)<br>0.017223*    | (0.009221)<br>0.007931     |
| Mortgage payment to Income 0.31-0.33 | (0.009210)<br>0.024431***  | (0.009219)<br>0.015247     |
| Mortgage payment to Income 0.33-0.35 | (0.009308)<br>0.031666***  | (0.009319)<br>0.017939*    |
| Mortgage payment to Income 0.35-0.39 | (0.009649)<br>0.038377***  | (0.009596)<br>0.020364**   |
| Mortgage payment to Income 0.39-0.43 | (0.009798)<br>0.046981***  | (0.009475)<br>0.031245***  |
| Mortgage payment to Income 0.43-0.56 | (0.009673)<br>0.049483***  | (0.009586)<br>0.031255***  |
| Mortpaym/HMDAinc missing             | (0.010029)<br>0.116591***  | (0.009652)<br>0.072701***  |
| Debtpaym/hmdainc 0-0.2               | (0.011176)<br>0.027351***  | (0.010134)<br>0.015225***  |
| Debtpaym/hmdainc 0.2-0.26            | (0.005374)<br>0.023440***  | (0.002585)<br>0.014988***  |
| Debtpaym/hmdainc 0.26-0.32           | (0.005143)<br>0.019691***  | (0.002939)<br>0.013862***  |
| Debtpaym/hmdainc 0.32-0.35           | (0.004952)<br>0.017109***  | (0.002964)<br>0.013533***  |
| Debtpaym/hmdainc 0.35-0.38           | (0.004975)<br>0.017152***  | (0.003164)<br>0.008175**   |
| Debtpaym/hmdainc 0.38-0.41           | (0.005134)<br>0.017758***  | (0.003338)<br>0.006014*    |
| Debtpaym/hmdainc 0.41-0.44           | (0.005121)<br>0.017244**   | (0.003413)<br>0.001124     |
| Debtpaym/hmdainc 0.44-0.50           | (0.007024)<br>0.012537**   | (0.003481)<br>0.004055     |
| Debtpaym/hmdainc 0.56+               | (0.005031)<br>0.064593***  | (0.003745)<br>0.001874     |
| Debtpaym/hmdainc Missing             | (0.006854)<br>0.011560*    | (0.003961)<br>0.017024***  |
| Total LTV 0.6-0.8                    | (0.005940)<br>0.030603***  | (0.004288)<br>0.006773     |
| Total LTV 0.8-0.85                   | (0.004742)<br>0.005674     | (0.004390)<br>0.004343     |

|                                 |                           |   |
|---------------------------------|---------------------------|---|
| Total LTV 0.85-0.9              | (0.004624)<br>0.002597    | (0.004382)<br>0.004705                  |
| Total LTV 0.9-0.95              | (0.004607)<br>0.000846    | (0.004963)<br>0.006728                  |
| Total LTV 0.95-1                | (0.004638)<br>0.003403    | (0.004872)<br>0.010955*                 |
| Total LTV 1-1.05                | (0.004632)<br>0.026224*** | (0.005846)<br>0.009547*                 |
| Total LTV 1.05+                 | (0.004462)<br>-0.002307   | (0.005047)<br>0.007769                  |
| Total LTV Missing               | (0.005119)                | (0.005126)<br>0.011573***               |
| Had foreclosure before mortgage | 0.027330<br>(0.017802)    | (0.004434)<br>0.090703***<br>(0.011547) |
| Observations                    | 331,608                   | 309,137                                 |
| R-squared                       | 0.074                     | 0.045                                   |

Notes: This appendix contains the parameter estimates for all control variables from the underwriting controls models of foreclosure presented in Table 3.

**Table A2: Submodels between Underwriting and Subprime Models**

| Variables                                   | Foreclosure Home Purchase Sample |                           |                           |                           | Foreclosure Refinance Sample |                           |                           |                           |
|---|----------------------------------|---------------------------|---------------------------|---------------------------|------------------------------|---------------------------|---------------------------|---------------------------|
|   | Rate Spread                      | Lender FE's               | Lender and Tract FE       | Add'l Subprime Controls   | Rate Spread                  | Lender FE's               | Lender and Tract FE       | Add'l Subprime Controls   |
| Asian                                       | 0.004612*<br>(0.002419)          | 0.005435**<br>(0.002456)  | 0.005856**<br>(0.002665)  | 0.005902**<br>(0.002650)  | 0.011752***<br>(0.002749)    | 0.012562***<br>(0.002799) | 0.012212***<br>(0.002710) | 0.012321***<br>(0.002713) |
| Black                                       | 0.034134***<br>(0.003516)        | 0.032956***<br>(0.003547) | 0.029831***<br>(0.003870) | 0.029516***<br>(0.003861) | 0.015391***<br>(0.002353)    | 0.014316***<br>(0.002371) | 0.014461***<br>(0.002517) | 0.014564***<br>(0.002519) |
| Hispanic                                    | 0.032748***<br>(0.002485)        | 0.029344***<br>(0.002483) | 0.030327***<br>(0.002699) | 0.030509***<br>(0.002704) | 0.023128***<br>(0.001961)    | 0.021525***<br>(0.001978) | 0.020658***<br>(0.002098) | 0.020815***<br>(0.002101) |
| Rate Spread                                 | 0.079876***<br>(0.003190)        | 0.061631***<br>(0.003976) | 0.058622***<br>(0.003943) | 0.056799***<br>(0.003994) | 0.028100***<br>(0.002151)    | 0.024515***<br>(0.002557) | 0.023909***<br>(0.002489) | 0.023093***<br>(0.002550) |
| LTV 0.8-0.9 * Subprime                      |                                  |                           |                           | 0.0116074*<br>0.0068297   |                              |                           |                           | 0.0150063**<br>0.0051688  |
| LTV 0.9-0.95 * Subprime                     |                                  |                           |                           | 0.025115***<br>0.0074787  |                              |                           |                           | 0.010377*<br>0.0077638    |
| LTV 0.95-1.0 * Subprime                     |                                  |                           |                           | 0.0252388***<br>0.0064066 |                              |                           |                           | 0.0062627*<br>0.0062187   |
| LTV >1.0 * Subprime                         |                                  |                           |                           | 0.0252713***<br>0.0077782 |                              |                           |                           | 0.0109427***<br>0.0030852 |
| Debtpayment/Income 0.36-0.45 *Subprime      |                                  |                           |                           | -0.0106233<br>0.0045692   |                              |                           |                           | -0.008789<br>0.0033652    |
| Debtpayment/Income >0.45 *Subprime          |                                  |                           |                           | 0.0197239**<br>0.0063003  |                              |                           |                           | -0.0119213<br>0.0039256   |
| Mortgage payment/Income 0.28-0.33 *Subprime |                                  |                           |                           | 0.0056474*<br>0.0047057   |                              |                           |                           | 0.0065671*<br>0.0040774   |
| Mortgage payment/Income >0.33 *Subprime     |                                  |                           |                           | 0.0251063***<br>0.0057904 |                              |                           |                           | 0.0181419***<br>0.0043118 |
| First Loan Adjust * Subprime                |                                  |                           |                           | 0.009058**<br>0.0038572   |                              |                           |                           | 0.0051476*<br>0.0028835   |
| Subordinate Lien * Subprime                 |                                  |                           |                           | -0.0157182<br>0.0407403   |                              |                           |                           | 0.0073566**<br>0.0039256  |
| Observations                                | 331,608                          | 331,608                   | 331,608                   | 331,608                   | 309,137                      | 309,137                   | 309,137                   | 309,137                   |
| R-squared                                   | 0.079                            | 0.086                     | 0.122                     | 0.122                     | 0.047                        | 0.052                     | 0.095                     | 0.095                     |

Notes: This table presents the race, ethnicity and additional estimates for models that add additional controls to the underwriting foreclosure model in order to build to the subprime foreclosure model (additional subprime controls) from Table 3. The rate spread column adds an additional control whether the loan is a high cost loan, the lender FE column adds fixed effects for the respondent identification number, and lender and tract FE adds fixed effects for both respondent and census tract. The additional subprime control model differs from the lender and tract FE model by the addition of interactions between subprime credit score and key loan terms as described in the text of the paper.

**Table A3: Submodels between Subprime and Contemporaneous Models**

| Controls               | Foreclosure Home Purchase Sample |                                |                            |  | Foreclosure Refinance Sample |                                |                            |  |
|------------------------|----------------------------------|--------------------------------|----------------------------|--|------------------------------|--------------------------------|----------------------------|--|
|                        | Cnty-Year FE                     | Negative Equity and Employment | LTV Bins and Employment    | Negative Equity and Race Specific Employment | Cnty-Year FE                 | Negative Equity and Employment | LTV Bins and Employment    | Negative Equity and Race Specific Employment |
| Asian                  | 0.005384**<br>(0.002649)         | 0.005426**<br>(0.002649)       | 0.005344**<br>(0.002644)   | 0.006442**<br>(0.002644)                     | 0.012119***<br>(0.002709)    | 0.012215***<br>(0.002711)      | 0.012290***<br>(0.002711)  | 0.012696***<br>(0.002707)                    |
| Black                  | 0.029211***<br>(0.003866)        | 0.029178***<br>(0.003863)      | 0.028211***<br>(0.003857)  | 0.016820***<br>(0.004299)                    | 0.014472***<br>(0.002516)    | 0.014510***<br>(0.002517)      | 0.014487***<br>(0.002517)  | 0.007019**<br>(0.002969)                     |
| Hispanic               | 0.029854***<br>(0.002698)        | 0.029691***<br>(0.002698)      | 0.028372***<br>(0.002702)  | 0.025001***<br>(0.002770)                    | 0.020425***<br>(0.002100)    | 0.020436***<br>(0.002100)      | 0.020479***<br>(0.002100)  | 0.018647***<br>(0.002136)                    |
| High Ratespread        | 0.055410***<br>(0.003987)        | 0.055095***<br>(0.003983)      | 0.050336***<br>(0.003936)  | 0.049575***<br>(0.003913)                    | 0.022707***<br>(0.002556)    | 0.022800***<br>(0.002559)      | 0.022549***<br>(0.002554)  | 0.022296***<br>(0.002558)                    |
| Negative Equity        |                                  | 1.136174***<br>(0.080348)      |                            |  |                              | 0.379452***<br>(0.050813)      |                            |  |
| Emp*Neg Equity         |                                  | -1.195664***<br>(0.084632)     |                            |  |                              | -0.400653***<br>(0.053579)     |                            |  |
| LTV 100-110            |                                  |                                | 0.416567***<br>(0.112955)  | 0.233104***<br>(0.071934)                    |                              |                                | 0.226617**<br>(0.111487)   | 0.072948<br>(0.071110)                       |
| LTV 110-130            |                                  |                                | 0.550649***<br>(0.116582)  | 0.391584***<br>(0.069716)                    |                              |                                | 0.062029<br>(0.083709)     | 0.051569<br>(0.052803)                       |
| LTV 130-150            |                                  |                                | 0.923042***<br>(0.144026)  | 0.877983***<br>(0.090799)                    |                              |                                | 0.191609*<br>(0.102485)    | 0.175001***<br>(0.059428)                    |
| LTV above 150          |                                  |                                | 1.062540***<br>(0.131339)  | 0.879536***<br>(0.069987)                    |                              |                                | 0.524255***<br>(0.062157)  | 0.359048***<br>(0.044544)                    |
| Emp*LTV 100-110        |                                  |                                | -0.443396***<br>(0.118834) |  |                              |                                | -0.242624**<br>(0.117647)  |  |
| Emp*LTV 110-130        |                                  |                                | -0.566013***<br>(0.122816) |  |                              |                                | -0.070144<br>(0.088592)    |  |
| Emp*LTV 130-150        |                                  |                                | -0.914062***<br>(0.153606) |  |                              |                                | -0.199230*<br>(0.108548)   |  |
| Emp*LTV above 150      |                                  |                                | -1.034768***<br>(0.141900) |  |                              |                                | -0.549264***<br>(0.065790) |  |
| LTV Missing            |                                  |                                | 0.003713<br>(0.024051)     |  |                              |                                | 0.230607<br>(0.148459)     |  |
| Race*Emp by Year       |                                  |                                |                            | 0.198902***<br>(0.045006)                    |                              |                                |                            | -0.001527<br>(0.041490)                      |
| Race Emp*LTV 100-110   |                                  |                                |                            | -0.248310***<br>(0.075436)                   |                              |                                |                            | -0.079284<br>(0.075045)                      |
| Race Emp*LTV 110-130   |                                  |                                |                            | -0.395174***<br>(0.073133)                   |                              |                                |                            | -0.058268<br>(0.056149)                      |
| Race Emp*LTV 130-150   |                                  |                                |                            | -0.865472***<br>(0.096821)                   |                              |                                |                            | -0.181073***<br>(0.063185)                   |
| Race Emp*LTV above 150 |                                  |                                |                            | -0.837054***<br>(0.075381)                   |                              |                                |                            | -0.370938***<br>(0.047321)                   |
| LTV *Race Emp Missing  |                                  |                                |                            | -0.066074<br>(0.159522)                      |                              |                                |                            | -0.000020<br>(0.005429)                      |
| Observations           | 331,608                          | 331,608                        | 331,608                    | 330,912                                      | 309,137                      | 309,137                        | 309,137                    | 308,459                                      |
| R-squared              | 0.132                            | 0.133                          | 0.136                      | 0.137  | 0.101                        | 0.101                          | 0.102                      | 0.102  |

Notes: This table presents the race, ethnicity and rate spread estimates of individual models that add to the subprime foreclosure model and build up to the Contemporaneous control foreclosure model (Negative Equity and Race Specific Employment). The first column adds county by credit year fixed effects to the subprime model. The second column retains these fixed effects and adds controls for whether the current loan to value ratio is above one (negative equity) based on county price indices and initial loan to value ratio and an interaction of this negative equity dummy with the county by year prime age employment rate from the American Community Survey. The third column replaces the negative equity dummy and the employment interaction with dummy variables for a series of negative equity bins and their interactions. The final column replaces the overall employment rate with employment rates for each race and ethnicity subgroup.

**Table A4: Mortgage Delinquency and Foreclosure for Refinance Mortgages**

| Above Median Ratio of New Mortgage to Initial Mortgage Balance |                           |                           |                           |                           |                           |                           |                           |                           |
|--|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
|  | Delinquency               |                           |                           |                           | Foreclosure               |                           |                           |                           |
| Race   | Unconditional             | Underwriting              | Subprime                  | Contemporaneous           | Unconditional             | Underwriting              | Subprime                  | Contemporaneous           |
| Black  | 0.024349***<br>(0.001879) | 0.010014***<br>(0.002396) | 0.008558***<br>(0.002605) | 0.000809<br>(0.003892)    | 0.024492***<br>(0.002178) | 0.015628***<br>(0.002996) | 0.014741***<br>(0.003111) | 0.007164<br>(0.004381)    |
| Hispanic   | 0.026700***<br>(0.001738) | 0.012354***<br>(0.001946) | 0.013117***<br>(0.002234) | 0.010936***<br>(0.002263) | 0.040532***<br>(0.002454) | 0.024067***<br>(0.002943) | 0.025406***<br>(0.003246) | 0.022990***<br>(0.003307) |
| Sample Size  | 127,544                   | 127,544                   | 127,544                   | 127,259                   | 127,544                   | 127,544                   | 127,544                   | 127,259                   |
| R-Squared  | 0.004                     | 0.048                     | 0.127                     | 0.134                     | 0.005                     | 0.050                     | 0.136                     | 0.145                     |

| Below Median Ratio of New Mortgage to Initial Mortgage Balance |                           |                           |                           |                           |                           |                           |                           |                           |
|--|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
|  | Delinquency               |                           |                           |                           | Foreclosure               |                           |                           |                           |
| Race   | Unconditional             | Underwriting              | Subprime                  | Contemporaneous           | Unconditional             | Underwriting              | Subprime                  | Contemporaneous           |
| Black  | 0.042187***<br>(0.002883) | 0.023472***<br>(0.003488) | 0.015148***<br>(0.003841) | 0.004910<br>(0.004991)    | 0.043211***<br>(0.004084) | 0.021712***<br>(0.004785) | 0.014787***<br>(0.005389) | 0.004638<br>(0.005948)    |
| Hispanic   | 0.039387***<br>(0.002193) | 0.019058***<br>(0.002276) | 0.014402***<br>(0.002647) | 0.011570***<br>(0.002805) | 0.051577***<br>(0.002912) | 0.025330***<br>(0.003290) | 0.020402***<br>(0.003585) | 0.017375***<br>(0.003710) |
| Sample Size  | 128,000                   | 128,000                   | 128,000                   | 127,714                   | 128,000                   | 128,000                   | 128,000                   | 127,714                   |
| R-Squared  | 0.007                     | 0.050                     | 0.141                     | 0.148                     | 0.005                     | 0.049                     | 0.153                     | 0.162                     |

Notes: Table A4 presents racial and ethnic differences in delinquency and foreclosure for subsamples based on the ratio of the refinance mortgage amount to the outstanding mortgage balance on March 31 prior to the refinance mortgage. Panel 1 presents estimates for the subsample with above median ratios, and Panel 2 presents estimates for below median. Each column represents the estimated differences for a unique model based on a specific set of regression controls as discussed in relation to Table 3.

**Table A5 Panel 1: Unconditional Differences in Delinquency by Home Purchase Year - Refinance**

| Race and Ethnicity | Above Median Ratio         |                            | Below Median Ratio        |                            |
|--------------------|----------------------------|----------------------------|---------------------------|----------------------------|
|                    | Black                      | Hispanic                   | Black                     | Hispanic                   |
| Level              | 0.028861***<br>(0.003913)  | 0.033549***<br>(0.004862)  | 0.046231***<br>(0.005503) | 0.052090***<br>(0.007352)  |
| 2008               | -0.028861***<br>(0.003913) | -0.033549***<br>(0.004862) | 0.144678<br>(0.184401)    | -0.071214***<br>(0.015327) |
| 2007               | 0.083193<br>(0.063939)     | 0.044851<br>(0.038364)     | 0.049600<br>(0.048399)    | 0.046277<br>(0.045411)     |
| 2006               | 0.030459<br>(0.022264)     | 0.068114***<br>(0.023464)  | 0.037167<br>(0.028155)    | 0.046547**<br>(0.020760)   |
| 2005               | 0.032541**<br>(0.016106)   | 0.023518**<br>(0.011334)   | 0.031556*<br>(0.018448)   | 0.044301***<br>(0.015586)  |
| 2004               | 0.035552***<br>(0.013277)  | 0.033867***<br>(0.010118)  | 0.035281**<br>(0.015616)  | 0.019513<br>(0.012481)     |
| 2003               | 0.016071<br>(0.013095)     | 0.021171*<br>(0.011998)    | 0.024977<br>(0.016888)    | 0.008847<br>(0.011693)     |
| 2002               | 0.004805<br>(0.010433)     | 0.018573*<br>(0.010985)    | 0.020395<br>(0.015813)    | 0.021645<br>(0.014077)     |
| 2001               | 0.024771**<br>(0.011941)   | 0.019871*<br>(0.011562)    | 0.059035**<br>(0.029000)  | -0.014572<br>(0.011914)    |
| 2000               | -0.003209<br>(0.011604)    | -0.010582<br>(0.012000)    | -0.003453<br>(0.015875)   | -0.006087<br>(0.014711)    |
| 1999               | 0.007921<br>(0.011337)     | -0.017182*<br>(0.010295)   | 0.014445<br>(0.017861)    | -0.012622<br>(0.015221)    |
| 1998               | -0.001806<br>(0.012142)    | 0.009994<br>(0.015036)     | 0.026658<br>(0.024128)    | -0.011765<br>(0.017368)    |
| Sample Size        | 79,840                     |                            | 80,128                    |                            |
| R-squared          | 0.012                      |                            | 0.015                     |                            |

**Table A5 Panel 2: Unconditional Differences in Foreclosure by Home Purchase Year - Refinance**

| Race and Ethnicity | Above Median Ratio         |                           | Below Median Ratio         |                            |
|--------------------|----------------------------|---------------------------|----------------------------|----------------------------|
|                    | Black                      | Hispanic                  | Black                      | Hispanic                   |
| Level              | 0.021676***<br>(0.004189)  | 0.047413***<br>(0.007993) | 0.059664***<br>(0.009277)  | 0.067255***<br>(0.008108)  |
| 2008               | -0.021676***<br>(0.004189) | 0.009486<br>(0.056808)    | -0.093801***<br>(0.022709) | -0.101391***<br>(0.022259) |
| 2007               | 0.028355<br>(0.040437)     | 0.061969<br>(0.091458)    | 0.033802<br>(0.076626)     | 0.099311<br>(0.065117)     |
| 2006               | 0.033809<br>(0.021545)     | 0.042106*<br>(0.025191)   | -0.016531<br>(0.042874)    | -0.007668<br>(0.027906)    |
| 2005               | 0.017475<br>(0.017240)     | 0.046395***<br>(0.016045) | 0.032231<br>(0.026362)     | 0.054153***<br>(0.019061)  |
| 2004               | 0.030419**<br>(0.014122)   | 0.072237***<br>(0.015568) | -0.001403<br>(0.019595)    | 0.044631***<br>(0.016420)  |
| 2003               | 0.037966**<br>(0.017173)   | 0.025085*<br>(0.014862)   | -0.000685<br>(0.020384)    | 0.007083<br>(0.015891)     |
| 2002               | 0.009883<br>(0.012886)     | 0.006625<br>(0.013978)    | 0.009863<br>(0.021815)     | 0.032285<br>(0.020144)     |
| 2001               | 0.019432<br>(0.015562)     | 0.007879<br>(0.016022)    | 0.005938<br>(0.018547)     | 0.014931<br>(0.018199)     |
| 2000               | 0.003237<br>(0.012008)     | 0.005418<br>(0.016723)    | -0.016516<br>(0.020173)    | -0.014932<br>(0.016113)    |
| 1999               | 0.029426**<br>(0.013110)   | -0.008903<br>(0.014275)   | 0.009725<br>(0.026766)     | -0.017342<br>(0.017740)    |
| 1998               | 0.005994<br>(0.013079)     | 0.010018<br>(0.015769)    | -0.043955***<br>(0.016306) | -0.028251<br>(0.018373)    |
| Sample Size        | 79,840                     |                           | 80,128                     |                            |
| R-squared          | 0.014                      |                           | 0.013                      |                            |

Notes: Table A4 presents racial and ethnic differences in delinquency and foreclosure by home purchase year for subsamples based on the ratio of the refinance mortgage amount to the outstanding mortgage balance on March 31 prior to the refinance mortgage. The first two columns present estimates for the subsample with above median ratios, and the last two columns present estimates for below median. Panel 1 presents estimates for mortgage delinquency, and Panel 2 for foreclosure. All estimates follow Table 6 and so are based on the unconditional model in Table 3.