SECTION 3

ALTERNATIVE EXPLANATIONS FOR DIFFERENCES IN DEFAULT PROBABILITIES ACROSS TRACTS

If differences in default probabilities of individual loans are related to differences across tracts in racial composition and income, holding constant a wide variety of observable characteristics of the loan, the property, and the borrower, what might lie behind such neighborhood effects? In this and the next section we consider a few explanations and present an empirical analysis that will provide some tentative answers. In particular, here we entertain the possibility that these neighborhood effects are traceable to (a) past default behavior within these same tracts that leads to abandoned structures and declining neighborhood amenities, or (b) past turnover of homeownership within these same tracts, resulting in undesirable neighborhood instability, or (c) transitions in racial or ethnic composition within these tracts. Under any of these possibilities, the effect on default of individual loans may operate through changes in local house prices, or the primary event may act as a "trigger" event, increasing the probability of default among homes for which the default option is already "in-the-money." Indeed, if one result is an adverse change in local house prices, then it may make sense for resident homeowners to treat the primary event as a trigger, for the primary event then forecasts adverse house price changes that will reinforce current default incentives. Notice in this regard that if a decline (or slower growth) in neighborhood house prices is the vehicle by which default probabilities are affected, such tract-level differences in house price growth would not be revealed in the work presented in the last section. Calculations of contemporaneous home values there relied on MSA-wide house price growth; as noted earlier, corresponding tract level data are unavailable directly from standard sources.

Consider then the first of the explanations offered above. As noted earlier, an NTIC study has suggested that default activity results in vacant structures; the consequent neighborhood decay may in turn lead to other defaults. The presence of abandoned structures could act as a trigger for default, causing borrowers to default on homes that were ripe for default in any case.

Alternatively, or in addition, declines in local home prices could act as a mediating event. That is, defaults spawn vacant structures, and the consequent deterioration of the neighborhood adversely affects home prices in the area, leading in turn to more defaults. As noted earlier, this explanation begs the question of what sets off the initial increase in defaults in certain neighborhoods, and why the frequency of these events is correlated with tract racial composition or neighborhood income. It does, however, provide a rationale for defaults to continue for a time following a shock in the neighborhood default rate.

Two other explanations are motivated by a somewhat different view of the effects of tract racial composition on default and prepayment. The results in Panel B of Table 12 indicate that borrowers in more heavily minority tracts may have higher probabilities of prepayment (other than FHA refinancing). Although we have no way of knowing the precise components of this prepayment activity, changes of residence are surely one part, perhaps an important part. We also have seen that default probabilities may be higher in tracts with heavier black representation. Noting that high default probabilities and high prepayment probabilities seem to go hand in hand, one possible explanation is that neighborhood instability in the form of more rapid turnover of homeowners, as reflected in the departure of homeowners following default or in simple changes of residence (a component of prepayment), makes minority neighborhoods less desirable.[56] Higher turnover may act as a trigger event that brings on default, or local house price changes may act as a mediating factor. This explanation is somewhat unsatisfying because it offers no reason for the initial increase in turnover in certain neighborhoods, and in particular, it does not indicate why higher turnover is correlated with racial composition of the neighborhood.

A possibly more satisfying explanation is that higher default and prepayment probabilities in more heavily minority neighborhoods reflect movements out of neighborhoods in transition. That is, as minority representation rises, homeowners may leave in greater numbers via both avenues of departure, default and prepayment (which again is assumed to represent primarily changes of residence). Increasing minority representation may act as a trigger event for either

[56] The estimated impacts of propmove in Panels A and B of Table 9 above are consistent with this story as well.

default or change of residence, and declines in home prices may ensue, further reinforcing default behavior. According to this explanation, we should find that changes in neighborhood racial composition affect prepayment (read change of residence) and default probabilities. Unfortunately, data on changing racial composition of the tract for the appropriate time period are unavailable.[57] It may be possible to extract useful information from the racial composition of FHA endorsements, though we have not yet attempted to do so. For now, this alternative explanation remains an essentially unexplored idea. One could argue that the neighborhoods-in-transition-lead-to-default explanation is subsumed — somewhat poorly to be sure — under the high-turnover-leads-to-default explanation. That is, under the high-turnover-leads-to-default explanation, as well as under the neighborhoods-in-transition-lead-to-default explanation, we expect to find lagged defaults and prepayments associated with higher current default rates.[58] A safer and more conservative view, however, is that more convincing evidence on the neighborhoods-in-transition theory must await additional empirical work.

To provide a preliminary exploration of the first two possibilities, we begin by examining the relationship between aggregate data on house prices, on the one hand, and previous defaults and prepayments, on the other. That is, we first explore explanations for neighborhood default effects under the assumption that changes in house prices may act as a mediating force. Under the defaults-lead-to-neighborhood-deterioration theory, we expect to find default activity resulting in lower neighborhood house prices, but with a lag long enough to allow exit of the defaulted homeowner and possible deterioration of the property. Presumably, the lag effects would endure as long as the property remains vacant or in a state of disrepair. Under the high-

[57] Calvin Bradford suggests comparing the fraction of minority homeowners in a census tract in 1990 with the fraction of home purchase loans to the same minority group in the succeeding years of HMDA data for the same census tract. See Bradford, Calvin, et al, "Crisis in Deja Vu: A Profile of the Racial Patterns in Home Purchase Lending in the Baltimore Market," The Public Justice Center, May 2000.

[58] One could argue that under the latter explanation, defaults and prepayments may operate without a lag as well since contemporaneous default or prepayment may be indicative of current neighborhood transition activity. Under the high-turnover theory, however, the response to default must presumably lag because it is the exit of the owner, which likely follows the default action, that generates the subsequent responses. Given the lags with which individuals respond to stimuli, however, it seems imprudent to try to distinguish between these explanations based on observed lag lengths.

turnover-leads-to-default theory, we expect to find defaults resulting in lower neighborhood house prices, but again with a lag long enough for the defaulting homeowner to exit the residence. Under this theory, however, changes of residence (one form of prepayment) should operate almost immediately, though the full impact may be delayed because of informational lags or lags in buyers' responses. Notice, moreover, that the existence of home price responses to current and lagged prepayment activity could in principle be used to distinguish the two theories, since only one of the two theories implies such responses.

3.1. Estimation of Tract-Level Models for House Prices in the Chicago MSA

3.1.1. Aggregate Models and Data

Our study of house prices and default activity utilizes data from the Chicago MSA only. Although this particular choice of MSA is arbitrary, and we cannot be certain that findings would apply to other MSAs, the choice of Chicago is dictated in part by its large number of FHA endorsements over the observation period. Data on all Chicago MSA endorsements[59] of FHA-insured loans were provided for the years 1986 through mid-1999. The data were aggregated by quarter of origination within neighborhoods, as defined below. For each quarterly aggregate, we calculated the average house price, as well as the average income, assets, and other characteristics of the borrowers for these same loans. Data on defaults were also aggregated on a quarterly basis within each neighborhood, but in this case the aggregation was over all defaults on originations that had occurred over the previous six years; average values for various borrower and mortgage characteristics were calculated for these same loans.

Although it would be preferable to use tract boundaries to define neighborhoods for the purposes of this study, changes in tract definitions over time made this procedure infeasible. We chose instead to aggregate all tracts that had split off from a single tract. The resulting

[59] As with the data used in estimating the hazard models above, the sample was restricted to loans that were not streamline refinances.

aggregates, which we denote "supertracts," were used as neighborhoods for the purposes of this portion of the study.[60]

The statistical model followed for this exercise is a linear regression utilizing time series of cross sections, where a calendar quarter is the time series unit of observation and the supertract is the cross sectional unit of observation. Given the requirements for data construction and the requirements for lag variables, observations used in the (log of the) house price regression ran from 1994 through mid-1999. The dependent variable is the log of the average sales price for all FHA-insured homes that originated within each calendar quarter in each supertract. The explanatory variables are listed in Table 13. Discussion is required on what is included, as well as what is excluded, from this regression.

Notice first that the house prices are averaged over only those homes that were financed with FHA-insured mortgages. The limitation to FHA-insured loans — which in any case was dictated by the available data — implies much smaller sample sizes than would be obtained if conventionally financed homes were included as well. This limitation does, however, serve an important purpose in focusing on the particular segment of the market in which our interest lies --- FHA-insured loans. It is possible that prices in different segments of the housing market move at different rates; if so, we wish to follow the segment that most closely matches that served by FHA. Because our sample is so limited, however, quarterly samples of homes sold within supertracts are sometimes very small; for this reason, we include only observations with sales price averages based on at least ten homes.[61]

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[60] The alternative of using 6-digit zip codes as neighborhoods was judged inferior, given the presumed lack of homogeneity of the population within zip codes. Because the number of tracts in the Chicago MSA varies over time, it is difficult to give a precise estimate of the numbers of tracts that are collapsed to arrive at supertracts. To give some indication, we note that for the first quarter of 1992, our data contain approximately 1600 tracts that are collapsed to about 1200 supertracts.

[61] We additionally require that default and prepayment rates be based on at least 20 loans. The requirement that the appropriate lags be available also limits the number of usable observations. More specifically, there are approximately 14,000 quarterly observations on Chicago supertracts with at least one home sale. The sample declines to about 8500 when appropriate lags are required. The sample further declines to about 2800 when we require that price averages be based on 10 sales and default and prepayment rates be based on 20 loans.

Notice next that the identities of homes sold change from quarter to quarter; in particular, these are not prices for repeat sales. Moreover, the list of explanatory variables contains no direct measures of house quality, again a necessary consequence of the data at our disposal. For this reason we are unable to hold house quality fixed in any direct fashion while the samples of homes sold change over time. To help overcome this problem, though surely in crude fashion, we include (in a manner to be explained) the average incomes and assets of the homebuyers as a way of controlling for house quality. The hope is that the latter controls, together with the fact that we are working within supertracts, serve to standardize adequately for house quality; of course, these precautions may be inadequate.

One of the main ingredients in our linear regression is (the log of) average house prices in the same supertract four quarters earlier. The use of house prices four quarters ago, rather than, say, in the previous quarter, helps correct for possible seasonality in prices and also helps to make the distinction between the two house price readings (current and lagged four quarters) more likely to reflect true house price changes, as opposed to simple measurement error or sampling error. That is, the signal-to-noise ratio should be higher when using a longer lag in house prices.

The remaining explanatory variables attempt to explain the new level of average sales price (*i.e.*, as given by the dependent variable) within the supertract, given the observed average price four quarters earlier. Many of these variables are expressed as differences in the current quarter relative to their values four quarters ago. These include the difference in rates on 30-year fixed rate mortgages (FRM30), the unemployment rate in the MSA (unemmsa), the (log of) average income of the homebuyers (loginc), the (log of) assets of homebuyers having positive assets,[62] the fraction of homebuyers recorded as having no assets (ass0rt), and the (log of the) house price index at the MSA level (loghindx). The percentage change in the number of homes sold, comparing the current quarter to that four quarters ago, is included in anticipation of the possibility that increases in FHA-insured home sales may be associated with changes in the FHA share of sales at different places along a fixed house price distribution, rather than shifts in the house price distribution itself. Additional controls include characteristics of the supertract

[62] Assets are measured prior to closing; assets after closing were deemed to be more error-ridden.

obtained from the 1990 census:[63] the unemployment rate in the supertract (tractune), the percentage of the supertract population that is black (blkpct) or Hispanic (hsppct), and supertract median income (medinc). A trend term (the number of the quarter, amtg, relative to an arbitrary time in the past) allows for unexplained growth.

The final entry in the list of explanatory variables is a set of lags in the quarterly default rates (defrt) and prepayment rates[64] (preprt) for the supertract.[65] Once again, the nature of the data prevents us from including homes with conventional financing in the calculations of default and prepayment rates, but the hope is that this restriction is not fatal in that either (a) the default and prepayment rates on FHA-insured loans are good proxies for the corresponding rates on all loans, or (b) that behavior within the segment of the market at issue here is better represented by rates on FHA-insured loans. The fact that our rate calculations are restricted to cover loans made in the previous six years[66] is also a potential defect, though we assume that these default and prepayment rates are adequate proxies for rates on the full range of FHA-insured loans.

The appropriate lag structure for defaults and prepayments is unknown. As noted above, under the defaults-lead-to-neighborhood-deterioration theory, lags in default must be long enough to result in vacant properties, and effects would presumably last until the vacant properties were rehabilitated. Note that we have no way of knowing when, if ever, the defaults

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[63] Population weighted averages were used to convert tract-level variables to values at the supertract level.

[64] This analysis included all prepayments in the calculated prepayment rate, though in principle FHA refinances should have been excluded. Because FHA refinances were only about 12 percent of all prepayments in these Chicago MSA data, it is unclear how much difference such a restriction would have made. Again, the fact that other prepayments contain refinances through conventional sources is a general disadvantage for the purposes of this analysis.

[65] As with the FHA data used in the loan-level study above, the times of default and prepayment are recorded in the FHA database.

[66] The reason that defaults are limited to those occurring among the previous six years of originations is that there are severely limited numbers of quarterly observations, a problem that is exacerbated by the presumption that default and prepayment effects operate with a lag. Increasing the range of originations covered by the default and prepayment rates reduces the number of quarters that may be used in the house price regression.

in our samples result in vacant structures. For this reason, we include various lags of the default rate, but we are unsure about the appropriate lag length. Similarly, the high-turnover-leads-to-default theory can justify lags in the effects of default and prepayment, but again the appropriate lag structure is unclear. As indicated above, however, it seems logical that, because change of ownership is likely to be more immediate in a prepayment (assumed here to represent a change of residence) than in a default, shorter lag lengths might be anticipated for prepayments. For this reason, we include the current value of the prepayment rate, but not the current default rate, in the regressions to explain house prices.

3.1.2. Estimation Results

Panels A, B, and C of Table 14 provide estimates of various specifications of the regression model, estimated with quarterly supertract observations from 1994 through mid-1999, to explain house prices within the supertracts.[67] Specifications differ only in the number of included lags of the prepayment and default rates. Most coefficient estimates tend to be qualitatively similar in all specifications. Many effects are in the expected direction; in particular, higher incomes and asset levels among homebuyers, and higher rates of MSA-wide house price growth, are associated with larger increases in sales prices over the four-quarter interval. Contrary to expectations, however, higher mortgage rates and higher MSA unemployment rates are associated with higher sales prices as well. Notice also that supertracts marked by higher 1990 unemployment rates and higher 1990 percentages of black residents have lower house prices, other things the same. The influence of supertract income (which always has an estimated negative impact) and the percentage of the population that is Hispanic (which always has a positive impact) often cannot be statistically distinguished from zero.

It is noteworthy that the house price regressions seem to show that house prices tend to be

[67] Serial correlation in the residuals is a concern, but we made no attempts to correct for this potential problem. Time series for individual supertracts need not be complete and may have holes, making attempts to estimate and correct for serial correlation more difficult. In addition, we acknowledge the possibility of a simultaneous equations problem in estimating this aggregate relationship.

lower, other things the same, in supertracts with heavier black representation. Hence, attempting to take the explanation back one step further raises a new question: why house prices appear to lag in black neighborhoods, other things the same, even after controlling for sales prices four quarters earlier, lagged default and prepayment behavior, and a variety of other factors.

The lagged effects of the supertract default rate indicate that higher default activity does appear to lead to lower house prices. Many of the individual lags are statistically significant, and the sum of the lag effects is statistically significant as well.[68] A one percentage point increase in the default rate[69] is estimated to lead in the long run to a 14 percent reduction in house prices (Panel A). Although a response in house prices of this magnitude may seem large, it is not necessarily unreasonably large. A one percentage point increase in the default rate is, after all, a sizable increase, and thus a related reduction in house prices of 14 percent might be a reasonable point estimate within the range of the data. (The estimated long run impact of a one percentage point increase in the default rate is estimated to be even larger in Panels B and C — a 17 percent reduction in house prices.)

Although these estimates offer some support for the hypothesis that increases in default rates adversely affect house prices in later periods, these results should be interpreted with caution. The fact that the first quarterly lag effect is always the strongest seems to cast some doubt on the possibility that the default rate is really picking up abandoned structures or changes in homeownership.[70] Additional caveats are offered below.

Current and lagged effects of prepayment rates generally have positive estimated effects, and

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[68] The F-tests on the sum of effects are as follows: in Panel A, $F(1,2751) = 18.51$, significant at better than 0.0001; in Panel B, $F(1,2747) = 20.26$, significant at better than 0.001; in Panel C, $F(1,2743) = 15.18$, significant at 0.0001.

[69] The impact is estimated as the sum of the coefficients on the lagged default rates divided by one minus the coefficient on the four quarter lag in log house price.

[70] Rapid responses may, however, be consistent with default rates proxying changes in racial composition of the neighborhood.

the sum of the coefficients on the current and lagged values is positive and significant as well.[71] Assuming that the prepayments here represent changes of ownership, these findings are inconsistent with the turnover-leads-to-default theory discussed above. Since these prepayments contain both refinancing and changes of residence, however, it may of course be that the refinancing component is dominant and is masking the change-of-residence component on which the empirical specification is based.

It should also be noted that these statistical results are fragile. Estimated impacts vary with the number of origination years over which the default and prepayment rates are calculated, the number of lagged values of (the log of the) house price included as explanatory variables, and the number of lags of default and prepayment rates that are included in the regression.

Because these regression specifications clearly omit numerous important factors, many of which could easily be correlated with the included variables, we have reestimated one of the models as a fixed effects model. This model permits each supertract to have a supertract-specific effect that may be correlated with any or all of the included explanatory variables. Estimates of the fixed effects model are presented in Table 15. Focusing on the effects of default and prepayment rates, we again see that lagged default effects are estimated to be negative, and the sum of the effects is also statistically significant.[72] The implied long run impact of a one percentage point increase in the default rate is a 2 percent reduction in house prices, a much smaller estimate than those found in any of the panels of Table 14. Prepayment effects now look very different that they did in Table 14. Individual coefficients now tend to be negative, and the sum of the coefficients is now negative and statistically significant as well.[73] The implied long run impact of a one-percentage point increase in the prepayment rate is to reduce house prices by 0.3 percent.

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[71] The F-tests on the sum of the coefficients are: in Panel A, $F(1,2571) = 8.89$, significant at a level of 0.0029; in Panel B, $F(1,2747) = 14.32$, significant at 0.0002; in Panel C, $F(1,2743) = 22.43$, significant at better than 0.0001.

[72] The F-test on the sum is $F(1,2368) = 3.45$, significant at the 0.0635 level.

[73] The F-test on the sum is $F(1,2368)=2.77$, significant at the 0.0961 level.

These fixed effect models are also fragile, however. In particular, both the default and the prepayment effects depend heavily on the lag structure; reestimating the fixed effect model with four lags or eight lags, rather than six, yields sums of coefficients that are no longer statistically significant.

Although the fragility of the estimated models raises questions about which, if any, estimated effects are to be believed, there are at least hints that lagged defaults in particular have an adverse effect on subsequent house price growth. It is unclear, of course, whether the reason is that defaults lead to abandoned structures, or whether defaults are one component of undesirable instability in homeownership, or whether some other default-related impact is at work. Effects of lagged prepayment rates are on even less certain standing.

To provide some additional information on whether the lagged default effects are truly capturing the effects of abandoned structures or turnover of homeownership, we performed another experiment. In particular, although one interpretation of these findings is that defaults lead to subsequent weakness in house prices, it is also possible that some other force is leading to both additional defaults and the subsequent effects on house prices. To explore this possibility further, we reran two of the house price regressions with one and two quarter leads of the default rate and prepayment rate. If the role of default rates in the price regressions arises solely because past defaults lead to abandoned structures or turnover of homeownership, which in turn adversely affects house prices, then we would expect to find that future default rates do not affect current house prices. That is, it is reasonable to believe that abandonment of the structure or turnover of ownership does not precede the default date. Similarly, future prepayment rates are not expected to affect current prices if they are picking up changes in homeownership.

Panels A and B of Table 16 give the findings using two of the previous regression specifications, one of them the fixed effects model. Looking first at Panel A, we see that default rates one quarter ahead have an estimated effect on current house prices that borders on statistical significance. One interpretation of this finding is that future default rates, and probably past default rates as well, are proxying the effects of other influences on house prices. That is, while some of the lag effect of default rates on house prices may operate through abandonments and the like, other portions of this impact may reflect the presence of other forces that work to increase defaults and simultaneously lower house price growth. Similarly, the two quarter lead in prepayment rates has a statistically significant estimated impact on house prices, suggesting that prepayment rates and house prices are picking up common factors leading both to increase.[74]

The fixed effects model in Panel B again presents a different story. Now neither of the leads in the default rate has a statistically significant effect. The one quarter lead in the prepayment rate has an impact of marginal statistical significance, but in contrast with the Panel A results, now the prepayment effect is negative. Once again, the conflict between the standard regression and the fixed effects model makes any conclusions hazardous.

Although the results in this section do not lead to complete resolution of whether lagged defaults have a true structural impact on current house prices, and results for lagged prepayment rates are even more uncertain, we proceed with our explorations by applying the results in this section to reestimate default and prepayment hazards for the Chicago MSA. Recall in this regard that the house price index used to approximate house price growth in the context of the hazard models discussed earlier was an MSA-level measure. The estimation in this section, however, is performed at the level of the supertract. If the data and the estimates in this section are valid, it should be possible to apply the supertract-level estimates of house prices to the data used in the hazard estimation procedure. In addition, by including lagged neighborhood default and prepayment rates directly in the default hazard for individual loans, we may see whether these rates affect individual defaults directly rather than, or in addition to, indirectly via changes in house prices. Naturally, this extension is available for the Chicago MSA only.

3.2. Revisiting Hazard Models of Default for the Chicago MSA

We now return to hazard estimation. The estimation sample is composed of all 1994 Chicago MSA applications or originations for homes located in one of the supertracts that contained the

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[74] One might even argue that the latter spurious correlation dominates the true structural effect, yielding the "incorrect" sign (under the turnover theory) on lagged prepayment rates in the house price regressions.

requisite data.[75] There can be no claim that the resulting estimation sample is representative of even the Chicago MSA. To ensure that this sample is comparable to that used in the earlier hazard estimation or, even if it is not, to provide a benchmark for later comparisons, we first estimate a default hazard model using a specification presented earlier for the full set of 22 MSAs. The estimates for the Chicago MSA are contained in Table 17. Comparing these estimates to those in Panel A of Table 11 above indicates that the estimates are indeed similar, though of course, not identical.

Further explorations rely on some additional variables. Recall that Eq. (2) above was used to justify the inclusion of the log of house value in the hazard model. Although our hazard estimates for the sample drawn from 22 MSAs relied on house price indices measured at the MSA level, the results in the previous section suggest that those estimates are not in fact appropriate because there is variation in house price growth at the supertract level. We may express the log of current house price as

$$\ln(H_t)=\ln(H_0)+\ln(P_t/P_0)$$

where P_t / P_0 is the ratio of neighborhood house prices at time t to those at time 0. In the hazard estimation discussed in Section 2, we used MSA-level data to estimate this ratio. In this section we simply include an estimate of the log of the house price ratio $\ln(P_t / P_0)$ at the supertract level, or its predicted value,[76] in the default hazard specification. At the same time, we include lagged values of the supertract default rate and prepayment rate, thus testing directly for trigger effects on default behavior. That is, if default probabilities respond directly to previous

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[75] Data on individual Chicago MSA loans from 1992 cannot be used because the necessary variables derived from the Chicago house price regressions are not available until 1994.

[76] In practice we simply include a term that contains the new estimate of the log of the (supertract) house price ratio relative to (*i.e.*, minus) estimated MSA-wide house price growth. Now the term lnhval represents (the log of the) current house value under the assumption that house prices increase solely in accordance with MSA-wide house price growth.

default or prepayment behavior with or without intervening reductions in house prices, we should find that lagged defaults and prepayments in the neighborhood have a positive effect on the default probability of individual loans.[77]

Panels A, B, and C of Table 18 show the hazard estimates for three alternative specifications. Specifications differ in the way in which supertract house price levels are used to form the new estimates of house price growth.[78] One method, yielding the specification presented in Panel A, bases the log of the house price ratio, pric2CHG, on the observed averages of sales prices in the supertract, *i.e.*, on the dependent variable in the regression analysis presented in the last section. Other methods use average house prices predicted from one of the regression specifications in the last section; these methods offer the potential advantage of removing some of the noise in average house prices. Panel B of Table 18 uses house prices predicted using the house price regression given in Panel B of Table 14, yielding a log house price ratio denoted by pred6; Panel C of Table 18 uses the predicted values from the regression in Table 15, yielding a log house price ratio denoted by pred6x.

The results in Table 18 show that the impact of supertract-level house price growth is not significantly different from zero at conventional levels in two of the three panels, though its effect is always of the anticipated sign. Estimated house price growth effects tend to be larger when the predicted house price figures, rather than the raw averages, are used, but even then the estimated impact falls short of statistical significance in Panel B and is of somewhat marginal significance in Panel C.

Turning to lagged default rates, note first that in Table 18 the variable defx denotes the default rate lagged x quarters. The only statistically significant effect of lagged defaults is that

[77] Notice that the new variables are measured quarterly, whereas the hazard model is based on monthly observations. In practice, the quarterly variables were simply applied to each month of the appropriate quarter.

[78] As in the earlier hazard models, local house price changes are assumed to affect default via the current value of the home and to operate without a lag.

from four quarters earlier (def4), but the sum of the effects is also significant as well.[79] Although all lags have a positive impact on the probability of default for an individual loan, the peak impact generally occurs at lag four, which seems a plausible lag for the change of ownership or vacancy associated with a default.

Turning next to prepayment rates in Table 18, note first that the current rate is the variable preprt, and prepayment rates lagged x quarters are denoted by prepx. Lagged prepayment rates are of mixed signs, and the sum of the effects is never statistically significant, casting substantial doubt on the role of prepayment activity (at least as measured here) as a default trigger.

Notice finally that in all three specifications the effect of supertract income and the effect of the fraction of the supertract that is black are substantially reduced relative to their values in Table 17. While the effect of supertract income remains statistically significant, the race effect is now far from statistical significance. Apparently, the introduction of supertract price growth, lagged default rates, and lagged prepayment rates serve to reduce the estimated impact of tract characteristics.[80]

There is again a question of whether these impacts of lagged defaults truly reflect their role as a default trigger, or whether lagged default rates proxy other omitted variables that affect both current individual default probabilities and lagged aggregate default rates. Performing a test like that employed above in the context of the house price regressions, we add one and two quarter leads of default and prepayment rates to one of the hazard specifications. The findings are in Table 19. The two leads of the default rate are denoted def1F and def2F, and the two leads of the prepayment rate are denoted prep1F and prep2F. The one-quarter lead in the supertract default rate (as well as in the supertract prepayment rate) appears to have a statistically significant effect on the current individual default probability, again suggesting that part of what is picked up in the effect of the lagged default rate is something other than its role as a trigger for individual

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[79] The Chi-square tests on the sum of effects (each with one degree of freedom) are as follows: in Panel A, Chi-square = 6.02, significant at 0.0142; in Panel B, Chi-square = 5.83, significant at 0.0157; in Panel C, Chi-square = 5.61, significant at 0.0178.

[80] Recall that tract racial composition enters the house price regressions, suggesting an additional source of effect of tract-level racial composition on individual default behavior.

default behavior.

To conclude, the findings from the reestimated hazard models reinforce the idea that lagged defaults may act as a trigger for later defaults, and that the price effects induced by lagged defaults (and other factors) may affect default probabilities as well. These default effects may arise because defaults result in vacant properties, leading to neighborhood decay, or because defaults are one component of undesirable turnover in neighborhood homeownership. There is no support here for a role of lagged prepayments as a trigger that induces defaults directly, and there is an uncertain role for prepayments affecting house prices. The inconsistencies and anomalies in the various specifications, data limitations, and the powerful estimated effect of future defaults, however, make these conclusions highly uncertain.

Hence, we can provide only a very tentative answer to the last question raised at the beginning of the paper. Although the evidence from the Chicago MSA is not conclusive in itself (and is of uncertain applicability to other MSAs), it appears that a portion of the default effects of neighborhood racial composition in particular may be traceable to temporary, but perhaps long lasting, responses to higher past default rates that happen to occur in more heavily black neighborhoods.

SECTION 4

CONCLUSIONS

The empirical findings in this study permit at least qualified answers to the questions raised at the outset. First, evidence from the default hazard models estimated over individual FHA-insured loans in the 22 target MSAs suggests that once one controls for a variety of borrower- and loan-related factors, including time-varying characteristics, in an appropriate econometric model of default, some neighborhood effects do persist. We find that decreases in tract income, and (less clearly) increases in representation of blacks within the tract, are associated with higher default probabilities of individual loans, and this relationship holds even when one controls for the race, ethnicity, and credit history of the borrower. Interestingly, we also observe that although neighborhood impacts remain, their importance is dramatically affected by introducing controls for characteristics of individual loans, borrowers, and the economic environment.

Second, estimation of the default hazard for individual loans also suggests that neighborhood characteristics, such as racial composition and mean income, have effects on default that are separate and distinct from the effects of these same characteristics at the individual level. Although we find that greater tract representation of blacks is probably associated with higher default probabilities, individual race effects --- black or Hispanic --- are absent. Hispanic representation at the tract level does not seem to matter in default behavior. Although tract income does seem to affect default behavior, individual income has no statistically significant impact.

Third, we find little evidence that race or income differences in the probability of default are traceable to differences in the probability of refinancing, which may in turn reflect differential access to funds. In particular, if default rates are higher in more heavily black neighborhoods, and if this differential reflects differential borrowing opportunities, we might expect to find that either FHA refinancing probabilities or other prepayment probabilities would be lower for blacks. Instead we find that FHA refinancing probabilities, as well as other prepayment probabilities (which include conventional refinancing activities) tend to be higher, if anything, among loans in tracts with heavier minority (black or Hispanic) representation. Among these neighborhood effects on FHA refinancing and other prepayment, only the effect of tract-level Hispanic representation on other prepayment is statistically significant at conventional levels.

We do find that individual Hispanic ethnicity is associated with lower FHA refinancing probabilities, and individual blacks and Hispanics have lower probabilities of other types of prepayment, which may or may not be the result of discrimination in refinancing against individual borrowers on the basis of race or ethnicity. Yet there are no corresponding default effects traceable to the race of individuals. Again, we find no evidence of a link between differential default activity, on the one had, and differential prepayment activity on the other, which would reveal a potential role for discrimination in access to refinancing in generating default behavior.

Tract income is positively related to the probability of prepayment (other than for FHA refinancing) but has no significant effect on the FHA refinancing probability; as noted, tract income is negatively related to default probabilities of individual loans.[81] The sign pattern is consistent with, but surely does not prove, the proposition that higher tract income helps support lower default probabilities partially through greater access to conventional refinancing. There are clearly other possible explanations for this sign pattern.

We emphasize that these assessments of the possible role of differential access to funds are very limited. Not only is this analysis restricted to effects arising among holders of FHA mortgages, completely ignoring holders of conventional mortgages, but in addition the evidence is entirely indirect. We do not account in any way for possible differences in the rate at which individuals or groups actually apply for refinancing from FHA or conventional sources.

Finally, we have used data from the Chicago MSA to examine some other possible ways in which neighborhood differences in default probabilities might arise. House price regressions for

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[81] It is less easy to assess the role of individual income within the context of default and refinancing, mainly because the estimation procedure also uses income indirectly as part of the front-end ratio. Evaluating income effects under the assumption that the front-end ratio is to be held fixed, we find that individual income has no significant effect on default but has positive impacts on probabilities of FHA refinancing and other prepayment.

tract aggregates generally appear to show that lagged neighborhood defaults lead to lower house price growth in the neighborhood; effects of neighborhood prepayment rates on house price growth are more uncertain. It is unclear, however, whether the default effects arise because defaults lead to abandoned structures and neighborhood deterioration, whether defaults are one component of undesirable instability in homeownership, or whether some other default-related impact is at work. Moreover, these results should be interpreted with caution. Additional analysis reveals that estimated effects are sensitive to specification, and there is indirect evidence that neighborhood defaults may proxy other omitted factors affecting local house prices.

Reestimation of default hazard models for individual loans in the Chicago MSA leads to additional insight. Even after controlling for house price growth at a more local level, lagged values of the neighborhood default rate generally seem to have a positive impact on the probability of default of an individual loan, but lagged prepayment rates are generally of mixed signs, again casting substantial doubt on the role of prepayment activity (at least as measured here) as a default trigger. Again caution is urged in interpreting these findings, in part because there is some evidence that lagged default rates proxy other omitted variables that affect both current individual default probabilities and lagged aggregate default rates.

It is noteworthy that introducing direct measures of neighborhood house price growth and lagged default and prepayment rates changes other estimated default effects on individual loans. In particular, the estimated effects of neighborhood income and of the fraction of the neighborhood that is black are substantially reduced. While the effect of neighborhood income remains statistically significant, the race effect is now far from statistical significance.

To conclude, the findings from the Chicago MSA data reinforce the idea that neighborhood defaults may act directly as a trigger for later defaults, and that the neighborhood price effects induced by lagged defaults (and other factors) affect individual default probabilities as well. These default effects may arise because defaults result in vacant properties, leading to neighborhood decay, or because defaults are one component of undesirable turnover in neighborhood homeownership. In either case, the result is that temporary increases in default activity may tend to persist. There is no support here for a role of lagged neighborhood prepayments as a direct influence on default, and there is an uncertain role for prepayments affecting house prices. Although various inconsistencies, anomalies, and serious data limitations (including the nonrandomness and lack of generality of the Chicago MSA data) render these conclusions highly tentative, it appears that controlling for a wider and more precise array of neighborhood characteristics may reduce the extent to which individual differences in default behavior are attributed to differences in neighborhood racial composition.

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