account of variables that are rationally connected with the economics of the mortgage lending process.'' [20]

In the second study, Michael Schill and Susan Wachter attempt to improve on earlier studies of redlining by examining whether mortgage denials are related to neighborhood racial composition.[21] Schill and Wachter argue that HMDA data on mortgage rejections, first released in 1990, allow researchers to address perhaps the major shortcoming of earlier credit flow studies—the inability to separate demand influences from supply influences. Analyzing information on whether lenders accept or reject individual loan applicants permits Schill and Wachter to study the determinants of the supply decision separately.[22]

In their empirical work, Schill and Wachter focused on loan acceptances rather than denials. Their model posits that the probability that a lender will accept a specific mortgage application depends on characteristics of the individual loan application [23] and characteristics of the neighborhood where the property collateralizing the loan is located. Because they rely on public data, Schill and Wachter did not have information on several loan and property risk variables, such as loan-to-value ratio, that are known to affect the mortgage decision. To compensate for the lack of these variables, the study includes neighborhood risk proxies that are likely to affect the future value of the properties.[24] Finally, to test for the existence of racially-induced lending patterns across census tracts, Schill and Wachter included the percentage of persons in the census tract that were African American and Hispanic.

The authors tested their model for conventional mortgages in Philadelphia and Boston. They first estimated their model including as explanatory variables only the individual loan and racial composition variables. The applicant race variables—whether the applicant was African American or Hispanic—showed significant negative effects on the probability that a loan would be accepted. Schill and Wachter stated that this finding does not provide evidence of individual race discrimination because applicant race is most likely serving as a proxy for credit risk variables omitted from their model (e.g., credit history, wealth and liquid assets). In this first analysis, the percentage of the census tract that was African American also showed a significant and negative coefficient, a result that is consistent with redlining. However, when the neighborhood risk proxies were included in the model along with the individual loan variables, the percentage of the census tract that was African American becomes insignificant. Thus, similar to Holmes and Horvitz, Schill and Wachter stated that ''once the set of independent variables is expanded to include measures that act as proxies for neighborhood risk, the results do not reveal a pattern of redlining.'' [25]

In their conclusion, however, Schill and Wachter stated that while their results did not support the hypothesis of redlining, they could not say definitively that neighborhood race is unrelated to lenders' decisions to accept or reject loan applications. One reason for their hesitancy is that many of their individual loan variables (as well as their neighborhood risk variables) are correlated with the racial composition of the census tract. For instance, the applicant's race variable (i.e., whether the applicant is African American or Hispanic) remained highly significant and negative in all their estimations. Because of the high degree of racial segregation that exists in urban areas, the applicant race variable was positively correlated with the census tract race variable. It may be that the applicant race variable was picking up effects that should properly be attributed to the census tract race variable.[26] If this were the case, Schill and Wachter's conclusions about the existence of racially induced redlining would necessarily change.

e. Geographic Dimensions of Underserved Areas—Targeted versus Broad Approaches

An important issue for the GSE regulations is whether geographic areas under this goal should be broadly or narrowly defined. Is central city location an adequate proxy for lack of access to mortgage credit? What is gained by more targeted neighborhood-based definitions? This section reports findings from three studies that address these questions. All three support defining underserved areas in terms of the minority and/or income characteristics of census tracts, rather than in terms of a broad definition such as all areas of all central cities.

HUD's Analysis. Tables B.1 and B.2 documented the relatively high denial rates and low mortgage origination rates in underserved areas as defined by HUD. This section extends that analysis by comparing underserved and served areas within central cities and suburbs. Figure B.1 shows that HUD's definition targets central city neighborhoods that are experiencing problems obtaining mortgage credit. The 22 percent denial rate in these neighborhoods is twice the 11 percent denial rate in the remaining areas of central cities. Similarly, the average mortgage origination rate (per 100 owner occupants) in HUD-defined underserved areas of central cities is 7, much lower than the average of 15 for the remaining areas of central cities.

A broad, inclusive definition of ''central city'' that includes all areas of all OMB-designated central cities would include the ''remaining'' portions of these cities. Figure B.1 shows that these

[20] Holmes and Horvitz, page 97 (emphasis added). The authors recognize that many of the risk and demand variables in their model are rather highly correlated with the racial composition variables also included in their model. Thus, one could argue that their risk and demand variables are serving, to a certain extent, as proxies for race, which would mean that their results suggest a high degree of redlining in the Houston market. Holmes and Horvitz dismiss this argument by stating that several of their non-racial variables are reasonable proxies for other prudent lending variables such as wealth and job stability for which they did not have direct data.

[21] Schill and Wachter. Although their methodology and findings are similar to those of studies discussed in the next section, it is informative to review Schill and Wachter's study in detail because it illustrates issues that must be dealt with before definitive conclusions can be reached about redlining.

[22] Perle also agrees that micro-based models of mortgage denial rates are more appropriate for studying redlining than macro-based credit flow models that fail to separate demand and supply effects.

[23] Individual loan characteristics include loan size (economies of scale cause lenders to prefer large loans to small loans) and all individual borrower variables included in the HMDA data (the applicant's income, sex, and race).

[24] Their neighborhood risk proxies include median income and house value (inverse indicators of risk), percent of households receiving welfare, median age of houses, homeownership rate (an inverse indicator), vacancy rate, and the rent-to-value ratio (an inverse indicator). A high rent-to-value ratio suggests lower expectations of capital gains on properties in the neighborhood.

[25] Schill and Wachter, page 271. Munnell, *et al.* reached similar conclusions in their study of Boston. They found that the race of the individual mattered, but that once individual characteristics were controlled, racial composition of the neighborhood was insignificant.

[26] In their study of individual loan denial rates, Avery, Beeson, and Sniderman obtain significant and positive coefficients for the individual applicant's race. Unlike Schill and Wachter, they found that denial rates were higher in low-income tracts even after controlling for the effects of the applicant's race and income. Although denial rates were not higher overall for purchase and refinance loans in minority tracts after controlling for the race of the applicant, denial rates were higher in minority tracts for white applicants. In other words, minorities have higher denial rates wherever they attempt to borrow, but whites face higher denials when they attempt to borrow in areas dominated by minorities. In addition, denial rates were higher in minority areas for home-improvement loans. See Robert B. Avery, Patricia E. Beeson, and Mark S. Sniderman, ''Underserved Mortgage Markets: Evidence from HMDA Data,'' Working Paper Series 94–16, Federal Reserve Bank of Cleveland, October 18, 1994.