A joint approach to default and prepayment would generate default rates reasonably related to the stress benchmark, while simultaneously generating prepayment rates that are consistent with the interest rate characteristics of the ten-year stress period. To estimate a multivariate default/prepayment model, OFHEO could draw on all relevant historical data, not just data from the stress benchmark. The model might include explanatory variables such as LTVs at origination, current LTVs (determined through the application of an appropriate house price index), differences between actual mortgage coupons and current market rates, interest rate paths, mortgage age, dummy variables for time period and location of mortgaged property, and additional characteristics specific to different mortgage products. The estimation procedure could allow for changing coefficients over time to reflect structural changes in prepayment and default behavior. During the stress period, explanatory or dummy variables, reflecting the special circumstances of the stress benchmark, would be set at their benchmark levels.

While multivariate models allow for the most realistic estimates of defaults and prepayments, OFHEO recognizes the difficulties of such an approach. Insufficient data may complicate model selection and the estimation of some individual parameters. One of the most simple approaches would be to measure cumulative defaults in the stress benchmark for the most common 30year, fixed-rate, 80 percent LTV mortgages and then spread those defaults evenly or according to some predetermined pattern over the ten-year stress period, with no consideration of prepayments. Losses on other mortgage types and LTVs could be set at simple multiples of the "standard" loss rate based on average historical experience. All other possible variables might be ignored.

Many approaches of intermediate complexity exist. For example, OFHEO could determine the stress benchmark default rates for standard 30-year, fixedrate, single family mortgages for several LTV categories and a few other types of mortgages. Relative defaults on additional mortgage types would be determined from more recent data using multivariate models, which would also provide adjustment factors for some mortgage features and other relevant variables. Prepayments could be modeled separately, affecting projected defaults by changing the volume of surviving loans (See "Mortgage Prepayments—Interest Rate Risk"

below). The time patterns of defaults could also be modeled separately as a function of mortgage age.

Question 15: What are the relative merits of using a joint model of default and prepayment in the stress test?

Question 16: What is an appropriate statistical method for estimating a joint model of default and prepayment?

Question 17: Should defaults be expressed in terms of conditional failure rates (hazards), cumulative default rates, or in some other manner?

Question 18: What explanatory variables should be included in a statistical model for default and prepayment?

Question 19: What is an appropriate level of statistical aggregation for the estimation of a joint model of default and prepayment?

Question 20: How should the impact of house price trends, interest rates, and other economic factors be incorporated into a model of default and prepayment?

D. Models of Loss Severity

Due to the varying quality of data on losses on defaulting loans, OFHEO may be unable to establish actual loss severities for the stress benchmark. Even if loss severities are incorporated in the stress benchmark, OFHEO may make adjustments to reflect changes in factors that affect loss severities. Consequently, OFHEO will conduct a separate analysis of loss severity based on all available data. This section examines some of the issues involved in modeling loss severity, including approaches for linking loss severity rates to the stress benchmark.

Loss severity refers to the actual dollars lost on a defaulted loan and allows credit risk to be quantified in dollar terms. Severity is the extent to which the costs associated with default, foreclosure, and disposition exceed the revenues associated with these processes. The major costs are the loss of loan principal, transaction costs at both foreclosure and disposition, and carrying costs throughout the process. The major revenues are foreclosure sale price and mortgage insurance payments.

Loss severity, like default, depends on numerous factors. Some factors original LTV ratio, LTV ratio at time of default, original loan size, occupancy status, type of structure, and presence or absence of mortgage insurance—are the factors that also influence the likelihood of default. Other factors—methods of disposition, state foreclosure laws, and home price movements after defaultinfluence severity without affecting the likelihood of default.²⁶

OFHEO is considering using a multivariate statistical model to estimate the separate effects of these factors on severity. OFHEO may develop a separate model for each of the cost and revenue components of loss severity since each component is affected by different factors. In the event that data on the individual revenue and cost components of loss severity are unavailable, an alternative approach would be to model overall loss severity directly.

Another less complex option is to estimate the individual components without multivariate statistical analysis. OFHEO could set fixed parameters for the components of severity-foreclosure costs might be x percent of unpaid principal balance (UPB), carrying costs equal to y percent of UPB and sales prices being z percent of UPB—while allowing severity to vary based on, for example, the presence or absence of private mortgage insurance or state foreclosure laws. The simplest possible option would be to assume that all defaulted loans face the same level of severity as a percentage of UPB.

There are a number of ways in which rates of loss severity may be related to the stress benchmark rates of default and the corresponding rates of default during the stress period. Given the impact of state foreclosure laws on loss severity, default rates and loss severity will be linked through the geographic location of the mortgages. For example, loss severities are likely to be lower in states where foreclosure laws are relatively more favorable to the lender.

The assumptions about changes in house prices in the stress benchmark and during the stress period will affect the determination of foreclosure sales prices and loss severity. Defaults are more likely to have occurred when borrowers' properties have appreciated much less than the average for their region. This implies that house price indexes used to model loss severity would best be based on properties that have experienced lower than average appreciation.

²⁶ See, for example, T. Clauretie and T.N. Herzog, "How State Laws Affect Foreclosure Costs," Secondary Mortgage Markets, 6(Spring):25–28, 1989; T. Clauretie and T.N. Herzog, "The Effect of State Foreclosure Laws on Loan Losses: Evidence from the Mortgage Insurance Industry," Journal of Money, Credit, and Banking, 22(2):221–233, 1990; E. Bruskin and M. Buono, "A New Understanding of Loss Severity: Time is (of) the Essence," in Mortgage Securities Research, Goldman-Sachs, September 1994; and V. Lekkas, J. Quigley, and R. Van Order, "Loan Loss Severity and Optimal Mortgage Default," AREUEA Journal, 21(4):353– 371, 1993.