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ABSTRACT

Despite housing's importance to the economy and worries about recent financial and economic turmoil traceable to housing market difficulties, little has been written on how distress in the housing market, measured by foreclosures, affects home prices, or how these variables interact with other macroeconomic or housing variables such as employment, housing permits or sales. Employing a panel VAR model to examine quarterly state-level data, our paper is the first to systematically analyze these interactions. There is substantial regional variation across states, which facilitates our ability to identify linkages among variables. Importantly, price-foreclosure linkages work in both directions; foreclosures have a significant, negative effect on home prices, while an increase in prices alleviates distress by lowering foreclosures. Similarly, employment and foreclosures have mutually negative effects on each other. The impact of foreclosures on prices, while negative and significant, is quite small in magnitude. We demonstrate this by simulating house price changes in response to extreme foreclosure shocks. Even under extremely pessimistic scenarios for foreclosure shocks, average U.S. house prices, as measured by the comprehensive OFHEO house price index (which we argue is the most reliable and useful measure of house prices to use for our purposes), likely would decline only slightly or remain essentially flat in response to foreclosures like those predicted for the 2008-2009 period. This suggests that home prices are quite sticky, and that fears of a major fall in house prices, with all of its attendant negative macroeconomic consequences, typically are not warranted even in extreme foreclosure circumstances.

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I. Introduction

Midway through 2008, the US housing market was widely regarded to be in a state of crisis. Housing permits had been in a steady and deep decline since 2006 (a year prior to the outbreak of the subprime credit collapse). The collapse in the values of subprime mortgages, which began in the middle of 2007, brought with it a substantial increase in foreclosures, and unusually large declines in house prices in some states – especially in Arizona, California, Florida, Michigan, Ohio, and Nevada. Widespread loose mortgage credit – as exemplified by the infamous "liar" mortgages of the 2005, 2006 and 2007 cohorts – was reflected in unprecedented default and foreclosure rates for those cohorts of mortgage originations. After the bursting of the subprime "bubble," many analysts feared that rising foreclosure rates would lead to deep and widespread house price declines.

In addition to the obvious difficulties that price declines and foreclosures create for homeowners and participants in the housing industry, housing has been shown to have a major impact on the economy (Leamer, 2007, Green, 1997, Coulson and Kim, 2000, Gauger and Snyder, 2003). Indeed, Leamer (2007) titles his study "Housing IS the Business Cycle," to illustrate the importance that the housing sector has in U.S. income fluctuations. Gauger and Snyder (2003) find that, while always important, the impact of housing on the economy has become more pronounced in recent decades.

Figure 1 illustrates the possible cause for concern about house price declines in the wake of widespread foreclosures. Using data for the 2007 year as a whole, regressing price change at the state level on foreclosures growth at the state level (where we use the OFHEO sale and refinancing index to measure price, and the Mortgage Bankers

Association quarterly delinquency surveys to measure outstanding foreclosures relative to mortgages), we find a close fit between the two series (an R-squared of 0.72). Of course, Figure 1's description of the low-frequency association between price change and foreclosures growth says nothing about the causal relationships between prices and foreclosures, and should not be interpreted as providing an estimate of the response of prices to foreclosure shocks. This regression line reflects a combination of three influences: (1) the responses of prices to foreclosure shocks, (2) the responses of foreclosures to price shocks, and (3) the responses of both foreclosures and prices to shocks originating in other variables.

We focus our attention in this paper on measuring the size of the effect that shocks to housing market distress (foreclosures) have on house prices. To our knowledge, ours is the first paper to estimate the impact of foreclosures on house prices for the U.S. as a whole, and the first to investigate that question within a dynamic model of housing market conditions and the local economy. To estimate the impact of foreclosures on house prices, we develop a dynamic model of the housing market at the state level, which is capable of disentangling the various contributing influences that explain the low-frequency association between foreclosures and price changes, and thus allowing us to gauge the potential housing-price and macroeconomic consequences of continuing mortgage distress.

Modeling the housing market at the state level is helpful for improving empirical identification. Quarterly data on the main housing variables of interest exist for each state going back to 1981. Although there have been only three nationwide housing cycles since the 1980s, there have been numerous state- or regional-level cycles, which often have entailed significant price growth decline and foreclosures. Furthermore, even within a given national economic cycle there is wide variation across states in employment growth, net migration, and other factors that can affect local housing markets. As a result, there is substantial variation in housing market experiences across states, which can be useful for identifying empirical linkages among variables.

Our paper is organized as follows. Section II reviews the existing literature on the relationships among home prices, foreclosures and other housing and economic variables. Section III presents the results of our estimation model, in which we find a negative, significant effect of foreclosures on prices. The magnitude of this effect, however, is small. This suggests that house prices are quite sticky even in the face of high financial distress. In order to quantify this result in an intuitive way, Section IV develops two-year, out-of-sample forecasts for house prices – for individual states and for the US as a whole – using the model developed in Section III and state-level forecasts of foreclosures for the 2008-2009 period kindly provided by Economy.com. We find that even in response to an extreme shock in foreclosures in excess of those predicted for this period, average U.S. home price declines would be relatively small. This suggests that home prices are quite sticky and that fears of a major fall in house prices, with all of its attendant negative macroeconomic consequences, typically are not justified even in the face of extreme foreclosure shocks. Section V discusses differences in the meaning of housing price indices, and their relative desirability for our purposes. Section VI concludes. A detailed description of our data and a discussion of some technical aspects of our methodology can be found in the appendix.

II. Literature Review

Leamer (2007) notes that no macroeconomics textbook contains any lengthy treatment of real estate, despite its role as a leading indicator of business cycle conditions. Instead, academic studies tend to focus on aspects of the housing market and the broader economy in isolation from each other, such as examining the interaction of house prices and home sales, but nothing else. Despite the importance of housing to the economy, little has been written about the interaction between prices and foreclosures at the aggregate level, and to our knowledge nothing has been written that links prices and foreclosures dynamically within the broader context of the macroeconomic environment and other conditions in the housing market. This is an important omission when one considers that the impact of financial liquidation on measures of prices and output in the economy is sometimes quite large, as indicated, for example, by Anari, Kolari and Mason (2005).

Within the real estate literature, some studies have found important interdependencies among various market indicators. DiPasquale and Wheaton (1994) examine the impact of such variables as changes in land value, and financing and construction costs on housing starts. Coulson and Richard (1996) investigate the impact of severe weather events, such as extreme heat or precipitation, on starts and find an effect, although only in the north central region of the U.S. Coulson (1999) examines the time series properties of housing starts and completions, and finds that the two variables are cointegrated. Moreover, the author finds that completions are not much affected by factors such as materials costs, income, interest rates, or housing prices. This finding is supportive of the idea that once a housing start occurs, completion is a nearly foregone conclusion.

Several papers have examined the relationship between home prices and other variables. Clayton, Miller and Peng (2008) find that home prices and turnover in the home market predict each other, but that most of the positive co-movement between the two variables is caused by responses to common financial, labor market and mortgage shocks. Wheaton and Nechayev (2008) forecast home prices with population, income and interest rate regressors. The authors find that current fundamentals substantially under-predict the recent run-up in home prices. Neither paper examines the effect of financial distress on price movements.

Some papers have examined the effect of housing on aggregate economic activity as measured by GDP. Green (1997) examines residential investment and GDP, and finds the former Granger-causes the latter. Coulson and Kim (2000) find that residential investment shocks are important in predicting consumption and GDP growth. Gauger and Snyder (2003) use a vector error-correction (VECM) model and find, as did Green (1997), that residential investment has a positive impact on GDP. Leamer (2007) performs a series of estimations and historical decompositions and finds that residential investment is the best predictor of future recessions in the U.S.

There have been several papers measuring the effect of prices and sales volume on each other. Clayton, Miller and Peng (2008) find that sales and prices have mutually positive effects on each other. The authors find that most of the positive correlation can be explained by co-movement of prices and sales in response to other variables. Wheaton and Lee (2008), on the other hand, find that price increases predict lower sales, which is in keeping with standard demand-side stories and contradicts the results of Clayton, Miller and Peng (2008), as well as some models of loss aversion and down payment constraints which had been advanced to explain the positive sales-price correlation.

Little has been written about the empirical relationships between foreclosures, or other measures of financial distress, and home prices at the macro-level, although some have examined how price volatility may affect the probability of default (Foster and Van Order, 1984).

Recently, a number of studies have used micro data to assess the interaction of foreclosures and prices. Willen, Gerardi and Shapiro (2008), using data from Massachusetts, find that the recent decrease in prices was a major catalyst in pushing sub-prime borrowers into foreclosure. Examining the opposite direction of causality, Lin, Rosenblatt and Yao (2008) use a random sample of about twenty percent of all U.S. mortgages, including only those which are conforming, and find that there is a clear negative impact of foreclosures on prices of local homes. However, this effect is much larger during a housing downturn than during a boom, indicating the importance of the state of the housing cycle for the effects of foreclosures. Leonard and Murdoch (2008) investigate foreclosures in the greater Dallas area, and similarly uncover a negative effect of distress on prices, which diminishes as distance from the foreclosed property grows. Finally, Rogers and Winter (2008) examine foreclosures in St. Louis county. They find the expected negative impact. Interestingly, they also find that the marginal impact of additional foreclosures actually falls as foreclosures increase, which contradicts the proposition that rising foreclosures may have a rising marginal effect on prices.

Despite the recent increased interest in modeling the relationship between prices and foreclosures, illustrated by these papers, our study is the first of which we are aware to systematically investigate the interaction of financial distress, housing market conditions and the local economy.

III. A Quarterly Panel VAR Model of the State-Level Housing Market, 1981-2007

We model home prices and foreclosures at the state level, using quarterly data since 1981, and treat the growth of home prices and the foreclosure rate as part of a five-variable system of equations, which also includes the growth rates of employment, single-family permits, and existing home sales. We employ a panel vector autoregressive model (PVAR), which captures dynamic linkages among all the five variables, which are all treated as mutually endogenous.

The variables are defined as follows: the log difference of seasonally-adjusted total non-farm employment, the log difference of seasonally-adjusted existing home sales, the log difference of seasonally-adjusted single-family housing permits, the log difference of the OFHEO home price index (inclusive of same-home sales and refinancings; below, we also discuss results when we employ the purchase-only index),[1] and the log of the ratio of outstanding foreclosures relative to total mortgages (based on Mortgage Bankers Association surveys). A detailed description of each of the variables used in our analysis can be found in the appendix.

We also ran the model defining foreclosures as the log difference of the ratio of foreclosures relative to total mortgages, which produced very similar results. We report

[1] As we discuss in more detail below, we believe that including refinancings when measuring price change is desirable, because it reduces any bias arising from variation in the types of homes that sell over different phases of the housing cycle.

results using the log foreclosure ratio because doing so seems to better capture the effects of cumulative financial distress on house prices, as we explain further below.

All data run from 1981 through the first quarter of 2008. Due to the forward (Helmert) de-meaning of observations used to control for state fixed effects, we lose the last observation, and thus our useable sample runs through the fourth quarter of 2007.[2] After some experimentation with different lag lengths, we found that eight quarterly lags encompassed quite well all the significant dynamic relationships among these five variables. The PVAR regression results are shown in Table 1.

In order to generate impulse responses and variance decompositions, one must identify the sources of covariance among the residuals in each of the five equations. We follow the existing PVAR literature by employing the Choleski decomposition, which models the residuals matrix as a recursive, triangular system. The main advantage of that approach is its simplicity: one selects an ordering of variables that posits the degree of within-quarter endogeneity among each of the five endogenous variables.

We experimented with various possible orderings among the five variables and found that our key results regarding the relationship between home prices and foreclosures were robust to the orderings chosen. We report only one ordering: employment, sales, permits, prices, foreclosures. Employment appears first in our ordering, since we assume that any correlations between within-quarter innovations in employment and the within-quarter innovations in our four housing-sector variables reflect the role of employment as a source of disturbance (both with respect to the labor market and as a general macroeconomic barometer).

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[2] We follow Love and Ziccino (2006) in our methodology for Helmert de-meaning. This process was first proposed by Arellano and Bover (1995).

Foreclosures are placed at the end of our ordering because foreclosure reflects the strategic decisions of borrowers and lenders; thus we think it is appropriate to allow foreclosure decisions to respond to other variables within the quarter. We place price changes second to last in our system. Within-quarter price shocks are not strongly correlated with foreclosure shocks (the correlation is -0.095, as shown in Table 2); allowing prices to follow the other three variables and precede foreclosures maximizes the extent to which contemporaneous price changes can reflect other influences within the quarter, while still allowing within-quarter foreclosures to respond to all other variables' changes within the quarter. Allowing prices to come late in the ordering seemed appropriate given that a primary objective of our study is to bound the potential downward movements in home prices resulting from other shocks. If, alternatively, we place prices at the end of the ordering, with foreclosures immediately before, our results are similar to those reported below.

The impulse responses (Figure 2) of the five endogenous variables to orthogonalized shocks that are identified by the recursive orthogonalization do not impose clear structural identifying restrictions. Still, it can be possible to connect observed impulse responses to structural influences in an intuitive way, based on the combination of observed patterns of response. For example, if a housing sales shock is associated with rising initial impulse responses for prices and permits, as in our study, that could be viewed as reflecting housing market demand-side influences. In the same way, if a housing price shock is associated with positive sales and permits impulse responses, as in our study, that too could be viewed as indicative of housing market demand-side influences.

Our impulse responses display a number of reassuring and robust tendencies: in particular, foreclosure shocks (increases in the quarterly log foreclosure rate that are unforecastable on the basis of lagged values of the five variables and contemporaneous values of the other four variables) predict declining employment and declining prices. Foreclosure shocks, however, are associated with increases in sales and permits. These impulse responses are somewhat puzzling, and may reflect the fact that foreclosure shocks are more likely to occur late in the down phase of a housing cycle.

The variance decompositions (Table 3) gauge the importance of shocks originating in the five endogenous variables for each of the five variables. For the most part, the variables do not contribute importantly to each other's forecast variance, however, there are exceptions: sales and permits shocks are important for employment growth, employment shocks are important for foreclosures, and foreclosure shocks are important for all other variables, especially prices (foreclosure shocks explain 26 percent of the 20-quarter forecast variance of house price growth).

IV. Bounding the Effects of Foreclosures on House Price Decline

In order to better illustrate and quantify the relationship between prices and foreclosures, we use the dynamic, quarterly, state-level model developed in Section III to generate out-of-sample forecasts of housing price changes, by state and for the country as a whole, for 2008 and 2009 (eight quarters beyond the end of our estimation sample).[3] As Figure 3 shows, there is substantial variation across states in each of the variables in our

[3] As noted above, our model is estimated using data through the end of 2007Q4. In our simulations we use actual 2008Q1 values (which are not in our estimation sample because of forward Helmert de-meaning) and then forecast future values through the end of 2009.

model, which confirms the importance of taking account of state-level differences when forecasting price changes.

One approach to forecasting price changes would assume a zero-shock scenario for all five variables and derive implied housing prices using that scenario. We label this the "baseline" scenario. That scenario would be reasonable if one had no basis for believing that any of the five variables was likely to experience shocks going forward. Because our model is derived for de-meaned variables, we must add back the forecasted long-term mean to our simulated impulse responses in order to derive forward-looking estimates of the variables in our system; we assume that the forward-looking means are equal to the historical sample means of the variables.

In our PVAR model, any anticipated shocks (based on knowledge not captured by the lagged variables in the model) that are expected to occur in 2008 and 2009 should be incorporated into the simulation exercise for that period. Given the change to much looser lending standards over the past decade – the credit extended with little or no documentation, and the spreading use of sub-prime and so-called Alt-A loans – there are legitimate reasons to believe that foreclosures could spike upwards substantially, and in excess of levels that would be forecast based on historical experience.

Thus, the current "foreclosure crisis" provides a natural experiment for analyzing the broader relationship between foreclosures and home prices. We incorporate estimates of these exogenous foreclosure shocks and allow our model to take into account feedback effects from these shocks on the other variables in our five-variable system. To take into account foreclosure shocks beyond those predicted by our model, we employ Mark Zandi's "Economy.com" forecasts for quarterly foreclosures at the state level, which were kindly provided to us by him.[4] Note that because foreclosures appear last in the PVAR ordering, foreclosure shocks only affect the other variables with a lag.[5] After one quarter, all variables in the system are affected by foreclosure shocks, and in subsequent quarters, via the various channels that connect the five variables in our model.

In our simulations, we do not incorporate shocks to the other four variables in our system. We do this for two reasons. First, and most importantly, the primary purpose of our paper is to isolate and highlight the impact that foreclosures have on home prices. As a result, including additional shocks to sales or permits, for instance, would be counter productive to this goal.

Second, from a pure contemporaneous forecasting perspective, we do not believe that there is a reasonable basis for assuming adverse shocks to employment, permits and home sales (that is, declines beyond what would be forecast from the data for 2006 and 2007). In our view, recent macroeconomic trends suggest that employment may be flat or improve in 2008-2009. Judging from a longer-term perspective based on previous housing cycles (that is, adding information about the housing cycle not already captured by our PVAR model in growth rates), it appears that permits have likely bottomed out, having fallen for six quarters by a much larger amount than in previous housing cycles. On similar grounds, it would also be difficult to argue for anticipated negative house sales shocks going forward. Figure 4, Panel A, displays the long-term cyclical patterns of housing permits and sales for the nation as a whole since 1980. Figure 4, Panel B, reports residential construction relative to GDP, which is available for a much longer time frame.

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[4] We were provided forecasts of the seasonally-adjusted foreclosure start rate. We used these data to predict the log levels of the outstanding foreclosure rate. Details of this process are discussed in the appendix.

[5] As noted above, we did run our simulations using an ordering in which foreclosures appeared before prices and obtained virtually identical results to those reported here.

These graphs show that, from the standpoint of the typical longer-term reversion of the growth of sales, permits, and residential construction, there is probably more reason to expect positive shocks (from the perspective of our PVAR model) in sales and permits than continuing negative shocks.

Although we only report the results of one version of our model here – which defines foreclosures as the log foreclosure ratio, uses the comprehensive OFHEO all-transactions price index, and begins the estimation period in 1981 – we also experimented with seven other versions of the model (which are available from the authors upon request). The eight versions we ran varied according to the definition of foreclosures (log ratio vs. log difference of the ratio), the definition of house prices (log difference of the OFHEO all-transactions index vs. log difference of the OFHEO purchase-only index), and the starting date chosen (1981 vs. 1988).

Table 4 reports the cumulative simulated average US house price change from the second quarter of 2007 through the end of 2009 for each of the versions of the model, using the Economy.com implied foreclosure forecasts as shocks in the simulations. As Table 4 shows, the model that employs the comprehensive OFHEO all-transactions index, defines foreclosures as the log ratio, and begins the sample period in 1981 is the only model that results in a cumulative average price decline from 2007 to 2009 (-2.1 percent).

There are two reasons to prefer this model to the others. First, as we discuss further below, using the foreclosure ratio, rather than growth rate, appears to allow us to capture important nonlinear effects. Second, given that the thrust of our findings is the limited effects of foreclosure shocks on house prices, it seems desirable to be conservative by choosing the model that implies the largest price impact of foreclosure shocks.

One possible concern about the simulation results reported in Table 4 is that they are based on a linear model of the relationship between foreclosure growth and housing price change. The impact of foreclosures on prices may reflect nonlinear (or threshold) effects (that is, a rise in foreclosures when foreclosure rates are high may have a bigger effect on prices than a rise in foreclosures when foreclosure rates are low). This is a significant concern for our simulation, since the average foreclosure shock implied by the Economy.com forecasts for the 2008-2009 period raises the log of the foreclosure ratio by 0.22.

While we cannot incorporate nonlinearities into our PVAR model directly, we can estimate the model's house price equation on a stand-alone basis as a function of all of the variables already in our model plus the square of foreclosure growth for each of the eight lags of foreclosures included in the model, compare the effects of foreclosure shocks on prices in this quadratic form with the linear form already estimated (see the notes to Table 5 for a detailed description), and make adjustments to our simulated shocks as implied by the differences between the linear and nonlinear model.

Table 5 reports the total effects at each lag of foreclosures on prices from the price equation, measured as the sum of linear and quadratic coefficients at each lag for the two foreclosure variables, evaluated at the mean of each state's projected foreclosure rate for 2008-2009, using the foreclosure-shock scenario. These total effects are also graphed in Figure 5. This provides a comparison of the impact of foreclosure growth on price growth (excluding the feedback effects that would be present in the full PVAR model) for the quadratic and linear functional forms. We emphasize that because this stand-alone regression (unlike our PVAR model) does not allow feedback effects among the variables in the system, it only provides a rough gauge of the differences in impact of foreclosure shocks on prices under linear and nonlinear specifications.

As Table 5 shows, the overall cumulative effects of the two functional forms are quite different; the quadratic version implies a 53 percent larger cumulative price decline from a foreclosure shock than the linear version. We interpret this to mean that taking into account nonlinear functional forms would produce greater simulated price declines than suggested by our linear model. To adjust for this nonlinear effect, we increase the Economy.com foreclosure forecasts by 53 percent. In our tables and figures we describe simulations derived from this assumed path of foreclosures as the "Foreclosure Shock" scenario.

We also construct an "extreme-shock" scenario, which raises the Economy.com foreclosure projections by 75 percent rather than 53 percent. We regard this as a highly-conservative scenario, since it implies actual foreclosure rates substantially greater than those that have been forecast by informed market participants, even after taking into account the effects of nonlinearity.

The predicted paths of foreclosures and prices, expressed both in growth rates and in levels, for the baseline, foreclosure-shock, and extreme-shock scenarios are presented graphically in Figure 6 for selected states and for the country as a whole.[6] The predicted paths of house prices vary by state significantly, which reflects differences both in states'

[6] Because our forecasts are state-level forecasts, the nationwide figures are the weighted-averages of the individual states, where weighting is based on the estimated number of housing units in each state (derived from annual estimates by the Bureau of the Census); in these calculations, Alaska and New Hampshire are excluded because of missing data for these states.

experiences in recent years and their expected foreclosure shocks. Overall, none of the three scenarios predicts a severe decline in price for the nation as a whole. U.S. housing prices peak during our sample in the second quarter of 2007. The cumulative expected U.S. price changes between this peak and the end of 2009 under the three scenarios are -0.44 percent, -4.67 percent, and -5.47 percent, respectively.

As Figure 7 shows, even under the extreme-shock scenario, not only is the average price decline likely to be low for the country as a whole, but few states are projected to experience significant declines. Only twelve states are projected to experience cumulative declines from 2007Q2-2009Q4 of 6 percent or more – in order of severity according to projected decline: Nevada, Florida, California, Arizona, Michigan, Rhode Island, Minnesota, Virginia, Massachusetts, Maryland, Hawaii and Indiana.

Why are housing prices so robust in the face of large foreclosure shocks? Our interpretation of these results is that foreclosure shocks do not have as large an effect on housing prices as simple graphs (such as Figure 1 above) might suggest. Furthermore, housing price growth is strongly mean reverting over the cycle, reflecting all the other dynamic interrelationships captured by our model. For example, it may not be surprising that shocks that have already produced one and a half years of low housing starts (which has substantially reduced the pipeline of supply for housing) might help to limit the extent of housing price decline going forward.

We conclude that the effects of foreclosure shocks on prices may be much smaller than people have supposed. Even in the face of an extreme foreclosure wave such as that experienced in 2007, our evidence indicates that foreclosure shocks have relatively small effects on U.S. house prices.[7]

Our PVAR model estimates the effect of foreclosure shocks on prices by imposing the restriction that all states have similar vector autoregressive systems relating the five endogenous variables dynamically. We also investigated how our conclusions would differ if instead of imposing that restriction we estimated the relationships among the five endogenous variables separately for each state. Specifically, using quarterly data since 1981, and assuming eight quarterly lags for the five variables in our system, we estimated separate VAR models for each of the states. We then calculated impulse response functions from these VAR models, including impulse responses that examined the price consequences of foreclosure shocks.

We regard these alternative estimates as relatively unreliable, since the small number of observations relative to estimated parameters results in little statistical power for state-specific VAR estimates. In fact, the estimated cumulative impulse responses of foreclosures on prices was *positive* for 16 of the 49 states for which we were able to calculate state-level VAR estimates, including several states with the most severe foreclosure shocks such as Florida, Michigan and Ohio. Even so, our conclusion that foreclosure shocks have small price consequences is fairly robust to this alternative approach, with average U.S. price declines of only 4.5 percent between 2007Q2 and 2009Q4 under our baseline scenario.[8]

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[7] We also note that one disaggregated study of home price decline (OFHEO 2007b) found no evidence that, on average, neighborhoods with high foreclosure rates suffered greater price declines, ceteris paribus.

[8] In the state-by-state analysis, the baseline scenario is the only reliable and directly comparable forecasting scenario. Given that 16 of the states had a positive cumulative price response to a foreclosure shock and another 15 had responses that were smaller in magnitude than our PVAR estimates, incorporating foreclosure shocks would likely *raise* prices compared to our baseline scenario. Furthermore, it is not clear how to consistently adjust for possible nonlinearities in the state-by-state models.

It is worth emphasizing that the unprecedented levels of foreclosure rates for the nation as a whole in early 2008 do not undermine the usefulness of our model for gauging the effects of foreclosures on prices. Because our estimates are derived from a model estimated at the state level, the domain of foreclosure values in our sample generally includes current observed levels. Indeed, for many of the states in our sample, the high 2008Q1 foreclosure rate is not very different from previous peaks in that series (see Figure 3). Moreover, Figure 8 demonstrates that while there are many states for which recent foreclosure rates are above their own historical experience, most of these do fall well within the range of foreclosure rates experienced over the panel as a whole (as shown by the average U.S. data on the right-hand side of the figure). A key advantage of estimating the foreclosure-price relationship at the state level, rather than using nationwide time series, is the ability to estimate that relationship using a range of state-level foreclosure experiences that include levels comparable to or greater than the high levels currently experienced in many states. Thus, our findings cannot be dismissed as out-of-sample estimates, despite the unprecedented high foreclosure rate for the country as a whole.

V. Different Measures of Home Prices

Our model uses the comprehensive OFHEO sales and refinancings (all-transactions) index as our measure of house prices in each state in each quarter. Even a casual observer of data on home price movements in recent quarters will have noticed that there are several measures reported in the press, they are constructed differently and that they offer very different pictures of the changes in U.S. home prices. The measured declines in housing prices based on the comprehensive OFHEO index are much smaller from those of the Case-Shiller index and the median sales price of existing homes, and differ somewhat from the OFHEO purchase-only index (which excludes refinancings). Is the comprehensive OFHEO index we employ biased in some way that might affect our results?

As we have already noted above, using the comprehensive OFHEO index results in a stronger price response to foreclosure shocks than using the purchase-only index. We also believe on a priori grounds that the comprehensive OFHEO index is the least biased concept of price to employ for the purposes of this study.[9]

Conceptually, changes in the median sale price of existing homes (reported by the National Association of REALTORS®) is far inferior to the other measures, since it does not control for quality differences in homes over time (which introduces important potential biases if homes of different quality have a greater or lesser probability of being sold at different points in the cycle).

The Case-Shiller index and the OFHEO indices are based on value comparisons over time for the same house. That is, a house only contributes to the index if and when a current transaction can be compared to a prior transaction. This avoids the need to try to control for home characteristics over time using a hedonic pricing model. There is still selectivity bias present in all the Case-Shiller and OFHEO indices, since the probability of a home with a given set of characteristics (e.g., lower value, poor condition, distressed seller, renovated recently) being sold may vary over time. For example, if sellers who sell early in the cycle are selling because they are being offered prices that are very high

[9] It is noteworthy that central banks (e.g., the Fed and the Bank of Canada) also employ the OFHEO rather than the Case-Shiller index in their macroeconomic models of the U.S. economy, perhaps for some of the same reasons we enumerate here.

(higher than fair value), or if sellers that sell late in the cycle (after the boom) systematically are eager to sell (and so underprice their homes compared to what a buyer with average patience would demand) that will make home prices appear more volatile than they actually are. The Case-Shiller and OFHEO purchase-only index potentially suffer much more from selectivity bias, since using only sales substantially reduces the number of observations used to construct the index (sales are about one third of the observations contained in the OFHEO sales and refinancings index, according to OFHEO 2007a).

The Case-Shiller index suffers from additional problems. Most obviously, it does not go back as far in time, and it does not cover the entire U.S. market. Leventis (2007) reports that the Case-Shiller index omits 13 states and has incomplete coverage of another 29 states. According to the 2006 American Community Survey estimates of the number of single-family, owner-occupied units in each state, the Case-Shiller national index entirely misses states with 11.28 percent of the housing stock, has only partial coverage in states containing 78.58 percent of the housing stock, and has full coverage for states with only 10.13 percent of the housing stock. Furthermore, the omitted parts of the U.S. market seem to be doing better than the included parts. As Figure 9 shows (see also Calomiris 2007), the omitted or incompletely covered regions have had a different and more positive experience from the complete coverage regions, according to the OFHEO data (which are similar in coverage across regions).

It is also worth considering how the Case-Shiller and OFHEO indexes differ from the perspective of the macroeconomic relevance of the indexes. Some market commentators argue for using the Case-Shiller measure rather than the OFHEO measure on the grounds that Case-Shiller includes more houses actually undergoing foreclosure (since it includes homes financed by subprime mortgages). According to this argument, excluding subprime mortgages leads to too optimistic a view of home price change.

This argument, however, confuses the observed price changes of houses placed on the market with changes in the housing wealth of consumers. Subprime borrowers typically invested very little wealth in their homes; thus, housing price decline related to subprime homes contributes little to housing wealth loss of consumers. The fact that a foreclosure results in a "fire sale" of a subprime house, per se, may have little effect on housing wealth of consumers. If, however, foreclosures drive down prices in the market generally, they could affect the housing wealth of non-subprime homeowners with substantial wealth invested in their homes. This is the wealth effect that should matter for consumption.[10]

Furthermore, both theoretical and empirical work suggest that the most important group of homeowners from the standpoint of the elasticity of consumption to home price change is young homeowners who have invested significant equity in their homes. This group is better captured by the OFHEO index, which does not include either subprime borrowers (many of whom have little wealth in their homes), or jumbo borrowers (who tend to be wealthier, older, and whose consumption should be less affected by borrowing constraints). The combination of including jumbo mortgages, and value-weighting homes, implies that the Case-Shiller index attaches substantial weight to the wealthiest homeowners.

[10] A second argument sometimes made by advocates of employing the Case-Shiller index is that it exhibits a stronger negative correlation with foreclosures. This fact, however, even if true, is irrelevant from the standpoint of deciding which house price measure provides a better indicator of the consequences of a house wealth decline.

From a theoretical standpoint, Buiter (2008) argues that there should be no house price wealth effects for consumption in the absence of market imperfections related to borrowing constraints. This implies that consumption wealth effects related to house prices should be smaller than wealth effects of non-housing wealth, and should be relatively large for younger individuals with substantial wealth in their homes (the group whose house prices are best captured by the OFHEO index).

As a result, the OFHEO index provides a better indicator of the representative American homeowner and captures the experience of the vast majority of American homeowners. Houses with conforming mortgages represent a large share of homes with mortgages. According to the Mortgage Bankers Association, as of 2008Q1, subprime loans serviced represented 5.54 million of the 45.22 million mortgages serviced. Jumbo mortgages comprise fewer than 6 million mortgages. Together these facts imply that roughly three fourths of outstanding mortgages are conforming.[11] Perhaps with this in mind, macroeconomic modelers, including central banks, define house price wealth effects with respect to the OFHEO index.

The magnitudes of house wealth effects are controversial, as there have been mixed results in the empirical literature regarding the existence and magnitude of any house price wealth effect. A major problem with empirical studies of the wealth effect is the use of current income, rather than hard-to-measure permanent income, alongside housing in the consumption equation; the interpretation of the coefficient on housing

[11] Reliable data on the composition of mortgages by type are not readily available. According to OFHEO (http://www.ofheo.gov/media/pdf/mortmarket1990to2004.pdf), 15 percent of the value of conventional (non-subprime) mortgage originations from 1990 to 2004 consisted of jumbos. Since jumbos, by definition, are larger than conforming loans, this implies that jumbo mortgages comprise less than 15 percent of the number of conventional mortgages originated.

wealth is questionable, since house prices reflect and may serve as a proxy for anticipated future income of homeowners.

The functional form of the wealth effect is also controversial. Recent work by Case, Quigley and Shiller (2005), which employs the OFHEO index to measure consumption wealth effects of housing, suggests that such an effect does indeed exist, but that it is asymmetric. The authors find that while an increase in housing prices raises consumption, a decline has no significant effect. This finding is especially relevant in light of concerns expressed over current falling house prices and consumption.

A recent microeconomic study by Gan (2007) criticizes existing empirical studies of the housing wealth effect in the U.S. (which she argues suffer from poor data availability) and provides estimates of housing wealth effects on consumption based on the household behavior of Hong Kong residents (for whom better data are available). She finds a marginal propensity to consume from household wealth of 1.6 percent, on average, which is much smaller than the magnitude found in many other studies, and she finds that the wealth effect is driven entirely by the behavior of young people who substitute between housing wealth gains and precautionary savings from income. If Gan's results generalize to the U.S., they imply that wealthier (older) homeowners have lower marginal propensities to consume out of their housing wealth, which implies a smaller prospective consumption decline per dollar of housing wealth decline in the U.S. today than if the decline in housing wealth were broad-based.

We performed a simple regression analysis of consumption, in which we regressed consumption on its own lags as well as the current and past house price index, and found no significant relationship of house prices, whether the index is defined as the

OFHEO or the Case-Shiller. However, in terms of raw correlation, the OFHEO had a slightly higher correspondence to consumption than the Case-Shiller.

We conclude from these theoretical and empirical perspectives that, from the standpoint of a macroeconomic interest in house prices, because the OFHEO index captures better the variation in wealth of households that are likely to display significant consumption responses to wealth, it is a better indicator of a possible consumption response than the Case-Shiller index.

There is one aspect of the comprehensive OFHEO index which has received criticism. Since it employs refinancings, about two-thirds of the transactions included in the comprehensive index measure appraised value rather than sale value. In our view, this is not obviously an important problem. After all, banks rely on these appraisals to approve refinancings, often at very high leverage ratios. If appraisals for the purpose of refinancing were inaccurate, especially when leverage ratios are high, as in the U.S., lenders would be placed at significant risk. Furthermore, as shown in Table 4, relying on the purchase-only index has little effect on our results, and actually reduces simulated price effects in the wake of high foreclosures. This finding provides no support for the view that the comprehensive OFHEO index fails to measure price changes in response to changing market conditions.

VI. Conclusion

Our study is the first to model the high-frequency dynamic relationships among house prices, foreclosures, employment, house permits, and house sales. We do so using a PVAR model at the state level for the United States for the period 1981-2007.

We offer the following summary of our findings:

(1) It is important to take account of the enormous variation across states, which facilitates identification of links among variables.

(2) Foreclosures and prices are closely associated at low frequency, but that reflects a combination of linkages, not just the effects of foreclosure shocks on prices.

(3) Our PVAR model is able to identify the dynamic relations among the key housing market variables and the macroeconomy, taking advantage of the high degree of variation in the experiences of different states over the past two decades. The identified relationships make sense, and the variables explain a large amount of each other's forecast variance.

(4) We quantify the relatively small effect foreclosures have on house prices by combining our PVAR model and Economy.com forecasted foreclosure rates for 2008 and 2009. After considering possible biases relating to nonlinearity in the foreclosure-price relationship, we conservatively (over-)estimate that the national average price decline for houses from the 2007:Q2 peak to 2009:Q4 will be roughly 5.5 percent. We conclude that a reasonable estimate of the future path of U.S. housing market prices is that they will remain essentially flat, on average, for the next two years, notwithstanding the large predicted increase in foreclosures.

(5) We argue that, from a variety of perspectives, the OFHEO comprehensive measure of price change that we employ is the appropriate index of housing prices for our purposes. It is important for readers of our study to recognize that our measure of house price change (the comprehensive OFHEO index) has produced less volatile house price changes in the past, and has declined much less than the Case-Shiller or median sales

indices in recent times. We argue that the comprehensive OFHEO index provides a more reliable picture of the representative house in each of the states, and a more important picture of the housing market from the standpoint of consumption wealth effects.

Needless to say, we do not have a crystal ball. Our estimates are based on relationships among house prices, foreclosures, and other variables observed in the past. It is conceivable that unusually tight consumer credit conditions, or other factors, could weigh on the housing market and produce more price decline than we estimate. Such a decline, however, would reflect a continuing sales shock, not the impact of foreclosures. Our estimates provide a useful benchmark. Based on the past experience of the housing cycle, even when one proverbially bends over backwards to inflate estimated foreclosures and take account of possible nonlinearities in their effects on house prices, there is no reasonable basis from past empirical relationships for believing (as many commentators do) that the housing wealth of consumers has fallen or will fall by a substantial amount.

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Table 1 – Panel VAR Regression Results

		Employment	Sales	Permits	Prices	Foreclosures
Employment						
	L1	0.399702***	1.162652*	3.990796**	-0.019136	-2.140017**
		(0.039863)	(0.503227)	(1.418862)	(0.089524)	(0.713470)
	L2	0.202720***	0.613139	2.893245**	-0.112046	-0.557794
		(0.028122)	(0.440973)	(1.051846)	(0.079807)	(0.700723)
	L3	0.098326***	-0.359233	1.064496	-0.043000	-0.366241
		(0.025349)	(0.484226)	(0.968182)	(0.075616)	(0.758493)
	L4	-0.123412***	-0.186061	-1.434417	0.204454*	-0.182663
		(0.022480)	(0.448507)	(1.052604)	(0.083746)	(0.611040)
	L5	0.019607	0.194391	1.976591*	-0.086341	-0.386291
		(0.021092)	(0.439694)	(0.866468)	(0.072642)	(0.633853)
	L6	0.015775	-0.687481	1.401577	0.027847	1.941353**
		(0.017836)	(0.394824)	(0.824182)	(0.073159)	(0.666763)
	L7	0.023390	0.508244	1.546669*	-0.108545	0.640251
		(0.017252)	(0.378845)	(0.693752)	(0.066934)	(0.604947)
	L8	-0.048962**	-0.188016	0.582125	0.016060	0.015795
		(0.016850)	(0.346061)	(0.618150)	(0.080704)	(0.519287)
Sales						
	L1	0.002839***	-0.251266***	0.262331***	0.002941	-0.102247**
		(0.000838)	(0.026617)	(0.044184)	(0.003074)	(0.032113)
	L2	0.003780***	-0.104449***	0.261145***	0.005685	-0.020384
		(0.000963)	(0.022991)	(0.054765)	(0.003583)	(0.032303)
	L3	0.000698	-0.070913**	0.270109***	0.004653	-0.009800
		(0.000888)	(0.023058)	(0.051457)	(0.003934)	(0.030680)
	L4	0.000187	0.023803	0.123732**	-0.001243	-0.021280
		(0.000869)	(0.021743)	(0.039150)	(0.003403)	(0.030117)
	L5	0.000004	0.016779	0.124148**	0.006944*	-0.024590
		(0.000846)	(0.022322)	(0.038734)	(0.003471)	(0.030444)
	L6	0.000208	0.059451**	0.124981*	0.001861	-0.029940
		(0.000779)	(0.020823)	(0.048806)	(0.003277)	(0.032343)
	L7	0.000952	0.036284	0.126146**	0.001671	0.027349
		(0.000727)	(0.021388)	(0.047891)	(0.003308)	(0.027698)
	L8	0.000964	-0.003179	0.072283	-0.000604	0.030441
		(0.000739)	(0.020301)	(0.041591)	(0.003537)	(0.029753)

Table 1 – Panel VAR Regression Results

		Employment	Sales	Permits	Prices	Foreclosures
Permits						
	L1	0.002041***	0.056678***	-0.291377***	0.004630*	-0.046834***
		(0.000557)	(0.014339)	(0.073095)	(0.002033)	(0.014107)
	L2	0.001724*	0.042428***	-0.144466*	0.003465	-0.060820***
		(0.000742)	(0.009921)	(0.068179)	(0.002010)	(0.017195)
	L3	0.002488***	0.033093**	-0.011806	0.001152	-0.050186**
		(0.000705)	(0.010429)	(0.075987)	(0.001834)	(0.017780)
	L4	0.002065***	-0.003555	-0.019940	0.000975	-0.034131*
		(0.000572)	(0.012282)	(0.065399)	(0.001990)	(0.016307)
	L5	0.002380***	-0.008470	0.034723	0.003481*	-0.034792*
		(0.000653)	(0.012470)	(0.055328)	(0.001711)	(0.017081)
	L6	0.001399*	0.002749	-0.050021	0.001694	-0.036844*
		(0.000587)	(0.010458)	(0.071671)	(0.002045)	(0.018101)
	L7	0.000105	-0.015840	-0.209010*	0.003753*	-0.016502
		(0.000538)	(0.010254)	(0.085817)	(0.001816)	(0.014060)
	L8	-0.000313	-0.019454	-0.137440*	0.001623	-0.013375
		(0.000485)	(0.013214)	(0.067634)	(0.001726)	(0.012845)
Prices						
	L1	-0.005459	0.864046***	1.607469***	0.025877	-0.910381***
		(0.005879)	(0.130032)	(0.293966)	(0.045860)	(0.197272)
	L2	0.008598	0.423651**	1.113285***	0.103935*	-0.234117
		(0.006103)	(0.130021)	(0.330080)	(0.046908)	(0.222452)
	L3	-0.009180	0.223636	0.774800**	0.119899*	-0.617658**
		(0.005374)	(0.133897)	(0.246822)	(0.050414)	(0.187955)
	L4	-0.008067	0.178210	0.901444***	0.106964**	-0.291176
		(0.005329)	(0.112789)	(0.238550)	(0.036857)	(0.184257)
	L5	-0.009734*	0.121851	0.604186**	0.051992	-0.149291
		(0.004558)	(0.092479)	(0.201100)	(0.055007)	(0.147804)
	L6	-0.009610*	0.087539	0.566473**	0.018389	0.003648
		(0.004107)	(0.093601)	(0.195867)	(0.034494)	(0.138890)
	L7	-0.010670**	0.191847*	0.800464***	0.025357	0.136487
		(0.003811)	(0.094654)	(0.209222)	(0.039030)	(0.145194)
	L8	-0.004322	-0.029736	0.595480***	-0.002022	-0.005777
		(0.003104)	(0.087292)	(0.153848)	(0.021523)	(0.122687)

Table 1 – Panel VAR Regression Results

	Employment	Sales	Permits	Prices	Foreclosures
Foreclosures					
L1	-0.002593***	0.023659	0.108690***	-0.010422***	0.716992***
	(0.000549)	(0.013815)	(0.024006)	(0.002195)	(0.035988)
L2	0.000344	0.031819*	0.037476	0.001860	0.207630***
	(0.000583)	(0.013501)	(0.020373)	(0.002544)	(0.048615)
L3	0.001485**	-0.008694	0.009482	-0.003261	0.061486
	(0.000532)	(0.014999)	(0.017300)	(0.002790)	(0.045232)
L4	-0.001259*	-0.007781	0.012388	0.001742	0.057642
	(0.000579)	(0.014683)	(0.019610)	(0.002372)	(0.039978)
L5	0.000594	0.011557	0.003807	0.002597	-0.008396
	(0.000578)	(0.014300)	(0.018908)	(0.002802)	(0.031446)
L6	-0.000457	-0.010606	-0.038180*	-0.001816	-0.056287
	(0.000579)	(0.014848)	(0.019234)	(0.002518)	(0.031975)
L7	0.000166	-0.023710	-0.022152	0.002657	0.039016
	(0.000550)	(0.014258)	(0.019304)	(0.002859)	(0.033826)
L8	0.000590	0.002107	-0.028833	0.005709	-0.084044**
	(0.000547)	(0.012584)	(0.018870)	(0.003214)	(0.030750)

Notes: Standard errors are presented in parentheses below the regression coefficients.
*** Coefficient significant at the 0.1% level.
** Coefficient significant at the 1% level.
* Coefficient significant at the 5% level.
The variables used in the analysis are as follows:

- **Employment –** Growth rate (log difference) of the quarterly average of seasonally-adjusted monthly total non-farm employment for the state.
- **Sales –** Growth rate (log difference) of the seasonally-adjusted annual rate of existing home sales for the state in the quarter.
- **Permits –** Growth rate (log difference) of the quarterly average of the seasonally-adjusted number of monthly single-family residential building permits for the state.
- **Prices –** Growth rate (log difference) of the quarterly OFHEO house price index (all transactions) for the state.
- **Foreclosures –** Log level of the MBA quarterly foreclosure inventory as a percent of loans serviced for the state.

All regression variables were de-meaned using a Helmert transformation, while the actual values of the variables were used as instruments to obtain consistent estimates.

Table 2 – Residuals Correlation Matrix

	Employment	Sales	Permits	Prices	Foreclosures
Employment	1				
Sales	0.0500 (0.0000)	1			
Permits	0.0422 (0.0028)	0.2220 (0.0000)	1		
Prices	0.0164 (0.2441)	0.0386 (0.0062)	0.0440 (0.0018)	1	
Foreclosures	-0.0960 (0.0000)	-0.0389 (0.0058)	0.0010 (0.9455)	-0.0953 (0.0000)	1

Notes: All variables are Helmert de-meaned log differences of levels except for foreclosures, which is the (de-meaned) log foreclosure rate (see the notes on Table 1 and the appendix for a complete description of the variables); p-values are reported in parentheses.

Table 3 – Variance Decompositions

	Lag	Employment	Sales	Permits	Prices	Foreclosures
Employment	4	0.9306	0.0281	0.0283	0.0026	0.0104
	8	0.8311	0.0690	0.0794	0.0063	0.0142
	20	0.7716	0.1002	0.0790	0.0351	0.0141
Sales	4	0.0046	0.9626	0.0123	0.0162	0.0044
	8	0.0062	0.9505	0.0145	0.0223	0.0065
	20	0.0062	0.9476	0.0156	0.0238	0.0067
Permits	4	0.0130	0.0645	0.8953	0.0167	0.0104
	8	0.0186	0.0661	0.8675	0.0317	0.0160
	20	0.0201	0.0668	0.8612	0.0352	0.0167
Prices	4	0.0005	0.0082	0.0053	0.9642	0.0218
	8	0.0085	0.0258	0.0192	0.9070	0.0396
	20	0.0129	0.0439	0.0255	0.8788	0.0389
Foreclosures	4	0.0353	0.0173	0.0122	0.0443	0.8909
	8	0.0627	0.0512	0.0425	0.1024	0.7412
	20	0.0795	0.1197	0.0712	0.2564	0.4731

Note: Percent of row variable explained by the column variable at the specified lag.

Table 4 – Cumulative Simulated U.S. House Price Changes between 2007Q2 and 2009Q4 by Model Version Assuming Foreclosures Follow Economy.com Forecasts

Price Data Used	Log Level of Foreclosure Rate		Log Difference of Foreclosure Rate	
	1981-2007	1988-2007	1981-2007	1988-2007
OFHEO all-transactions index	-2.1%	+0.1%	+6.1%	+5.5%
OFHEO purchase-only index	+3.0%	+2.8%	+2.1%	+2.2%

Notes: Eight different versions of the model were run based on the choice of data start point (1981 vs. 1988), price data used (OFHEO all-transactions index vs. purchase-only index), and foreclosure variable used (log level of the foreclosure rate vs. the log difference of the foreclosure rate). Table entries report the cumulative simulated house price changes for the U.S. as a whole between 2007Q2 and 2009Q4 resulting from foreclosure rate shocks implied by Economy.com forecasts.

Table 5 – Difference in the Effect of a Change in the Foreclosure Rate on Home Price Appreciation using Linear and Quadratic Specifications

Lag	Linear Specification	Quadratic Specification	Percentage Difference
0	-0.00271	-0.00320	18.14
1	-0.00074	0.00041	-155.04
2	0.00089	-0.00100	-212.18
3	-0.00051	-0.00004	-92.18
4	0.00048	0.00185	285.80
5	0.00057	-0.00010	-117.64
6	-0.00050	-0.00050	-0.74
7	0.00077	0.00058	-24.77
8	0.00115	0.00108	-6.51
Cumulative	-0.00060	-0.00092	53.26

Notes: Cumulative effects are the sum of all the lags, and represent the effect of a mean value (0.22) shock that persists for nine periods. These effects are graphed in Figure 5.

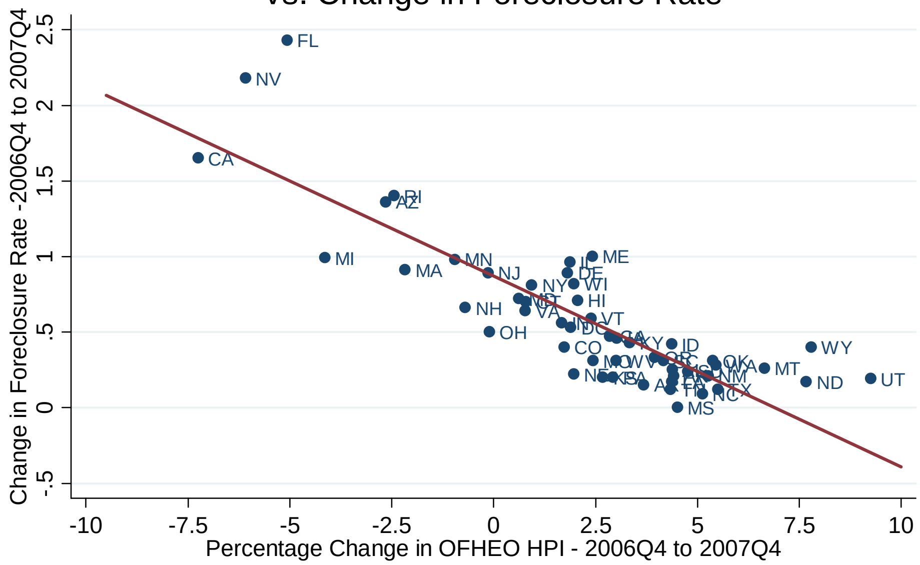
Explanation of Table 5: The entries above were calculated as follows. For the second column (Linear Specification), fixed-effect panel regressions of the HPI growth rate on eight lags of all five system variables along with contemporaneous values of the four exogenous variables were run. As in the text, fixed effects were controlled for by Helmert de-meaning the data, while the actual values of the variables were used as instruments to obtain consistent estimates. The column 2 values are then derived by taking the coefficients for each lag of the log foreclosure rate and multiplying them by 0.22, the mean value of the de-meaned log foreclosure rate derived from the Economy.Com implied foreclosure forecast. Thus, the table entries represent the total impact on the HPI growth rate from a mean value shock in the log level of the foreclosure rate the specified number of periods in the past.

For column 3 (Quadratic Specification), a quadratic term on the log foreclosure rate is included in the above panel regression. The values in this column are calculated in a similar fashion, providing an estimate of the total price impact (both linear and quadratic) of a mean value shock to the growth rate of foreclosures.

The final column is the percentage difference between the second and third column; a positive number indicates that a foreclosure shock has a bigger price impact under a quadratic specification than it does with a linear specification.

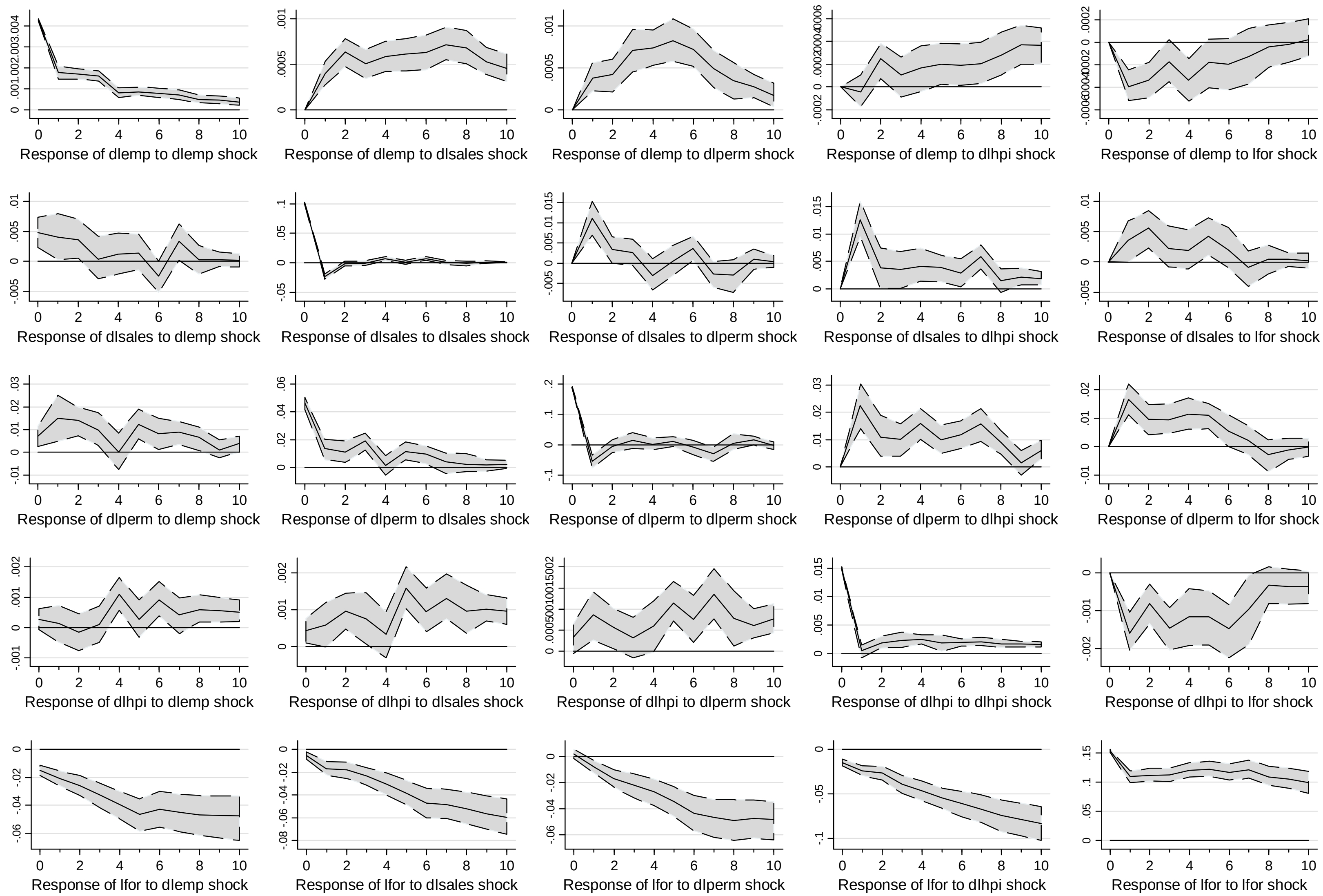
Detailed regression results for both the Linear and Quadratic Specifications are available from the authors upon request.

Figure 1: Annual Change in OFHEO HPI
vs. Change in Foreclosure Rate



Note: Slope coefficient = –0.126 with an R-square of 0.72.

Figure 2: Impulse Response Functions



Note: Impulse responses are based on growth rates (difference of logs) of all variables in the system except the foreclosure rate, which is modeled as a log level. The impulse responses are derived using a Cholesky decomposition with the following ordering: employment, sales, permits, prices (HPI), and foreclosure rate.

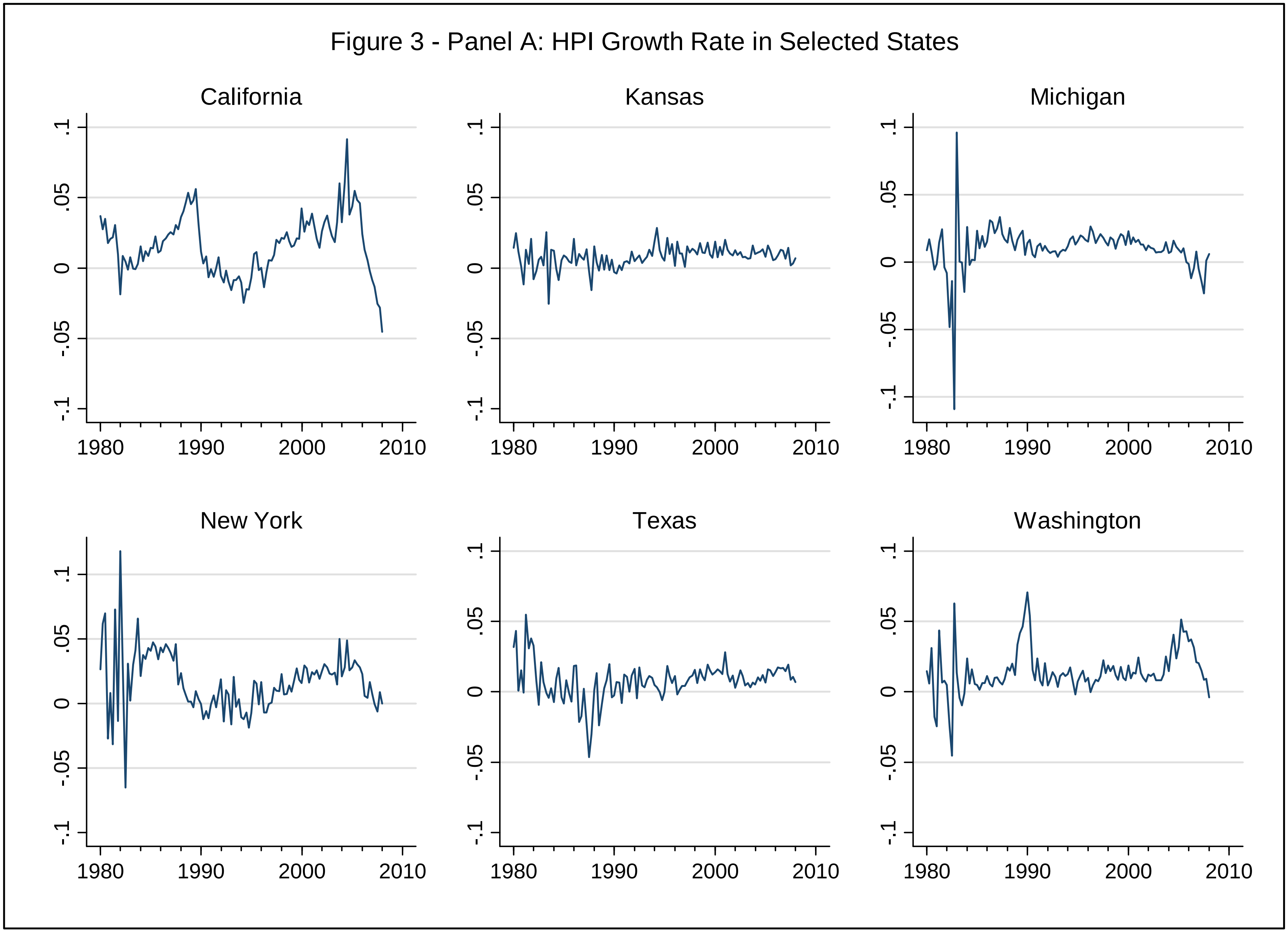


Figure 3 - Panel A: HPI Growth Rate in Selected States
California
Kansas
Michigan
New York
Texas
Washington
.1
.05
0
-.05
-.1
1980
1990
2000
2010

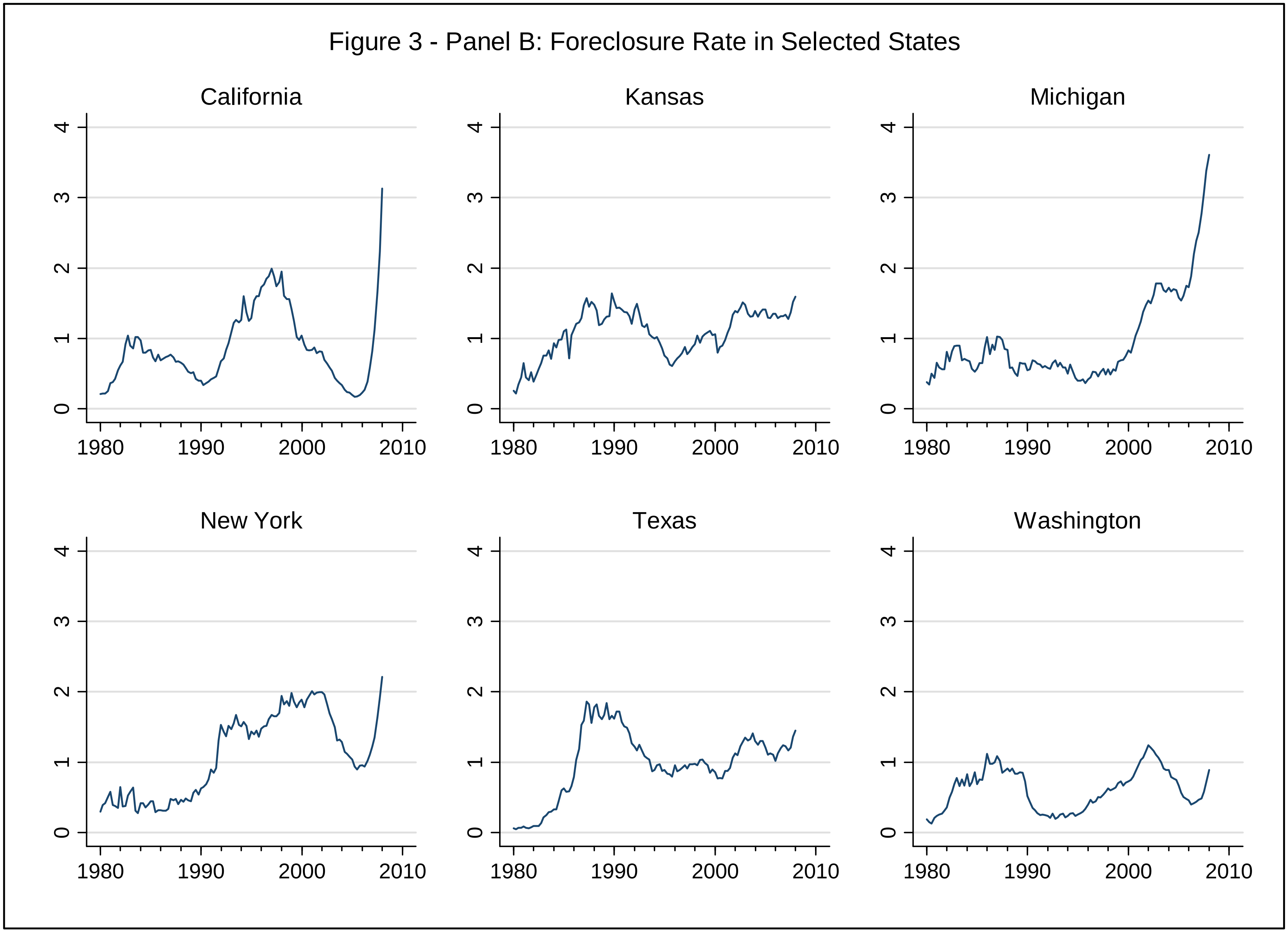


Figure 3 - Panel B: Foreclosure Rate in Selected States
California
Kansas
Michigan
New York
Texas
Washington
0
1
2
3
4
1980
1990
2000
2010

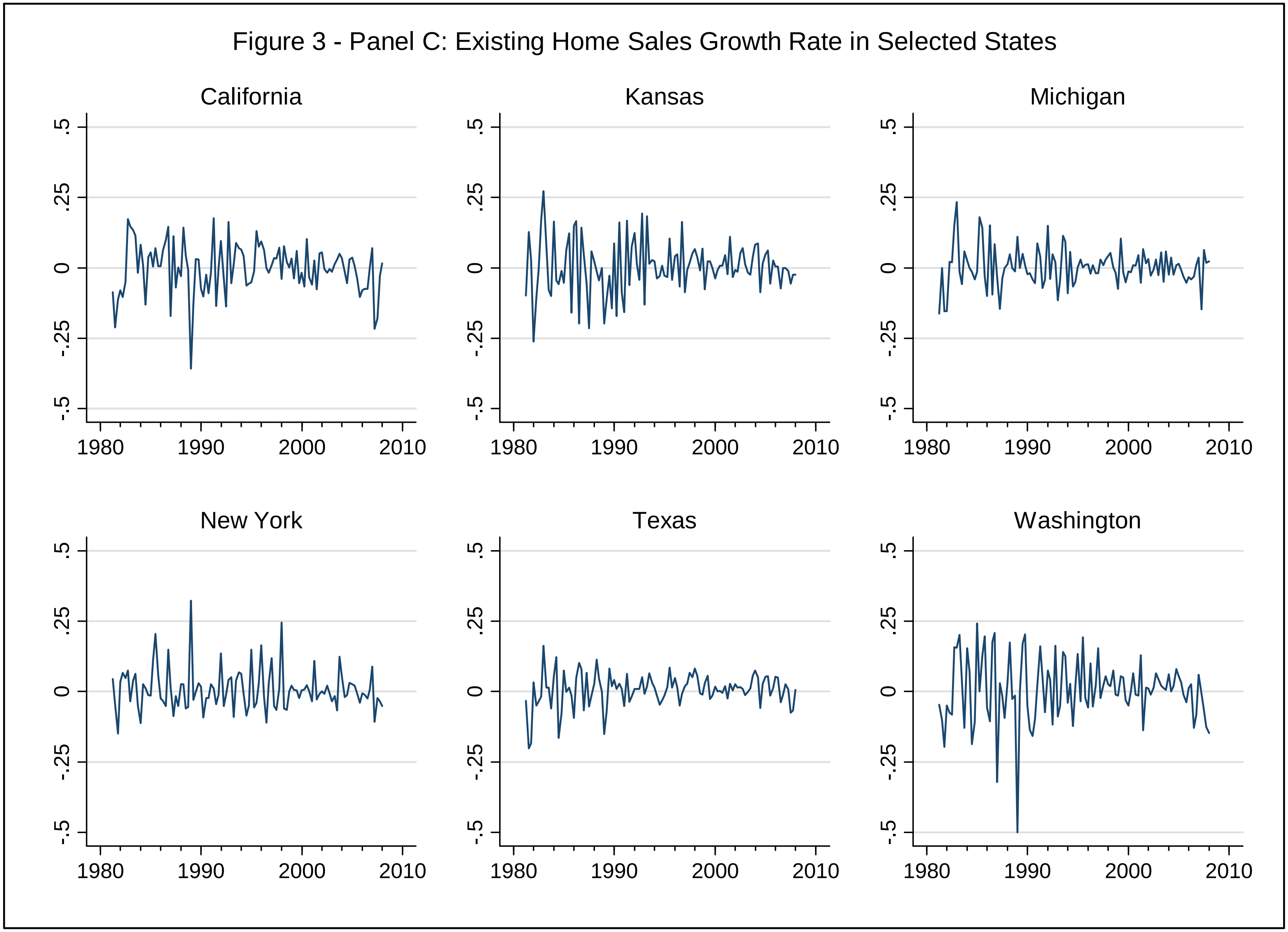


Figure 3 - Panel C: Existing Home Sales Growth Rate in Selected States
California
Kansas
Michigan
New York
Texas
Washington
.5
.25
0
-.25
-.5
1980
1990
2000
2010

Figure 3 - Panel D: Single-family Building Permits Growth Rate in Selected States

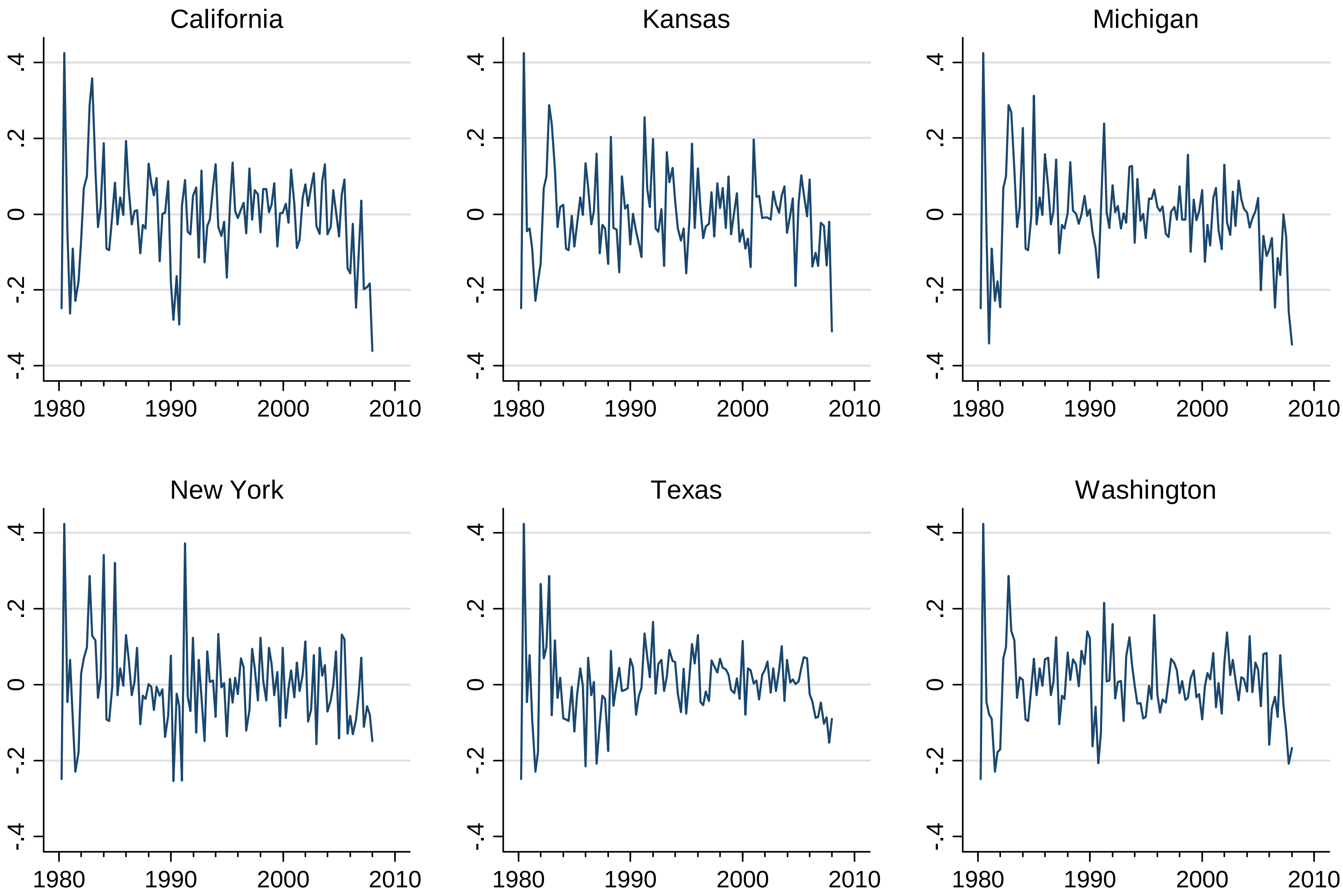
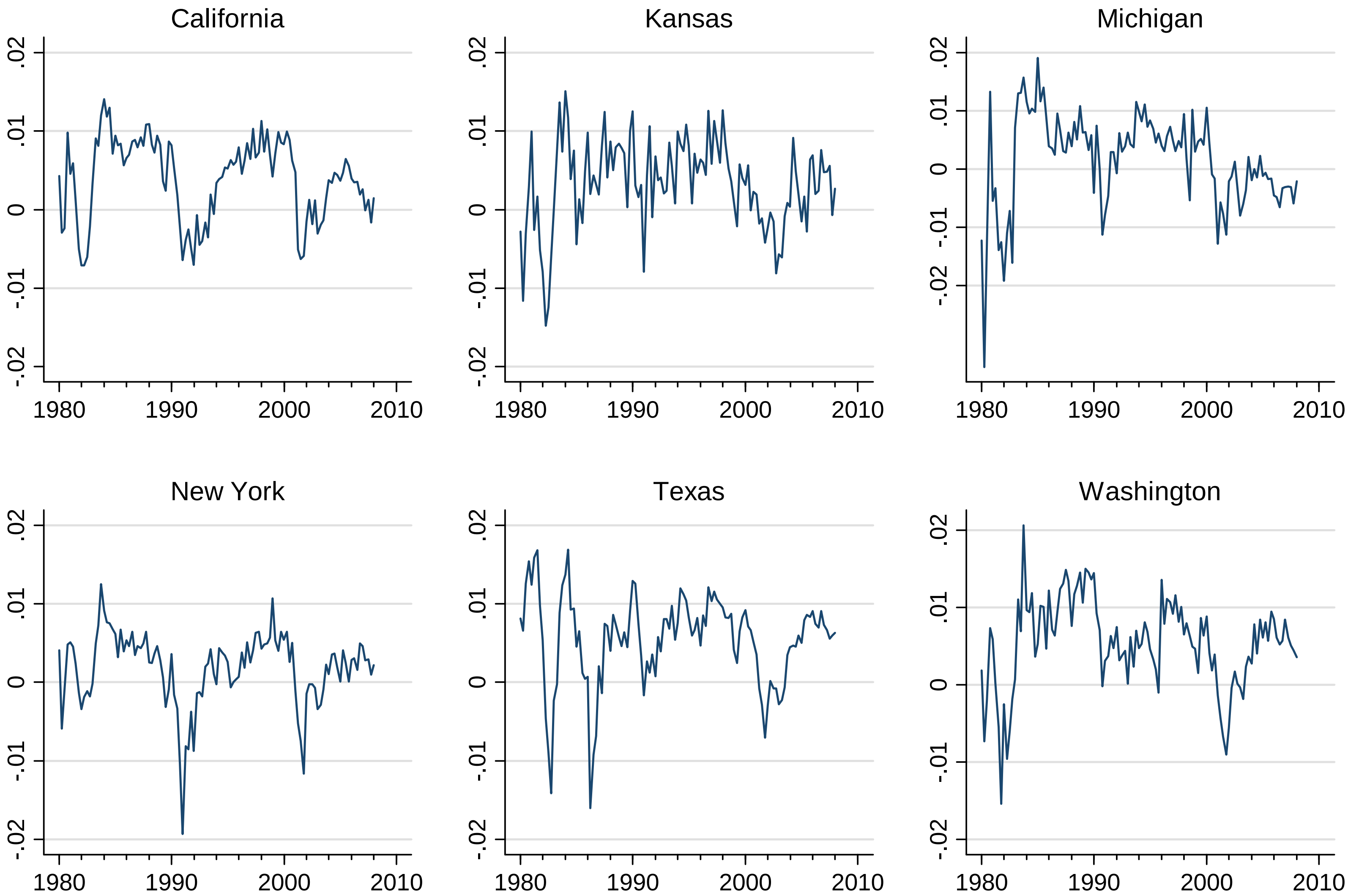


Figure 3 - Panel E: Employment Growth Rate in Selected States



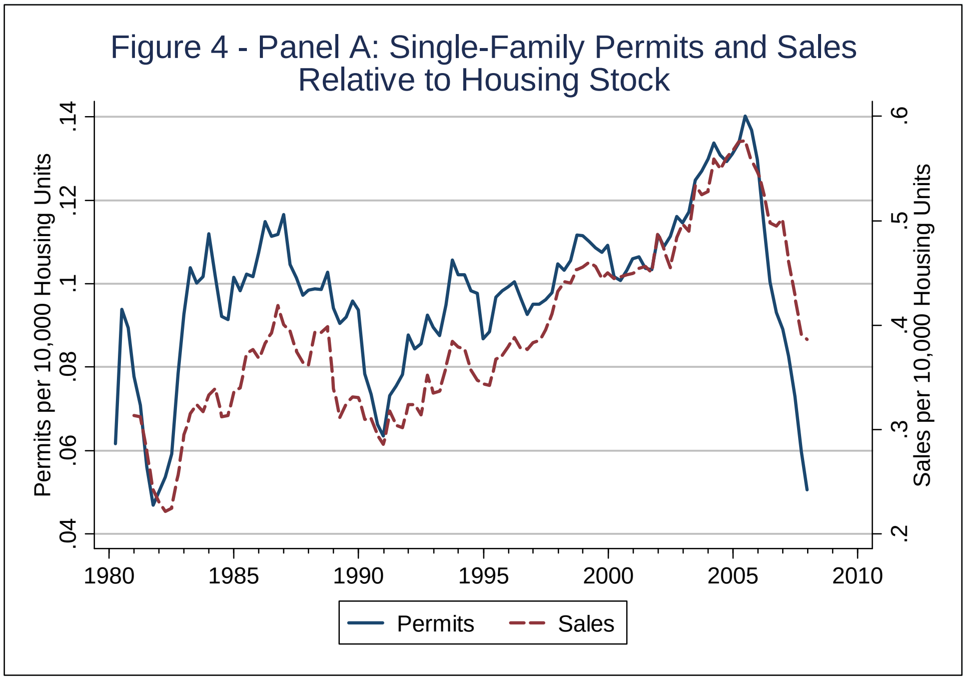


Figure 4 - Panel A: Single-Family Permits and Sales Relative to Housing Stock
Permits per 10,000 Housing Units
Sales per 10,000 Housing Units
.04
.06
.08
.1
.12
.14
.2
.3
.4
.5
.6
1980
1985
1990
1995
2000
2005
2010
Permits
Sales

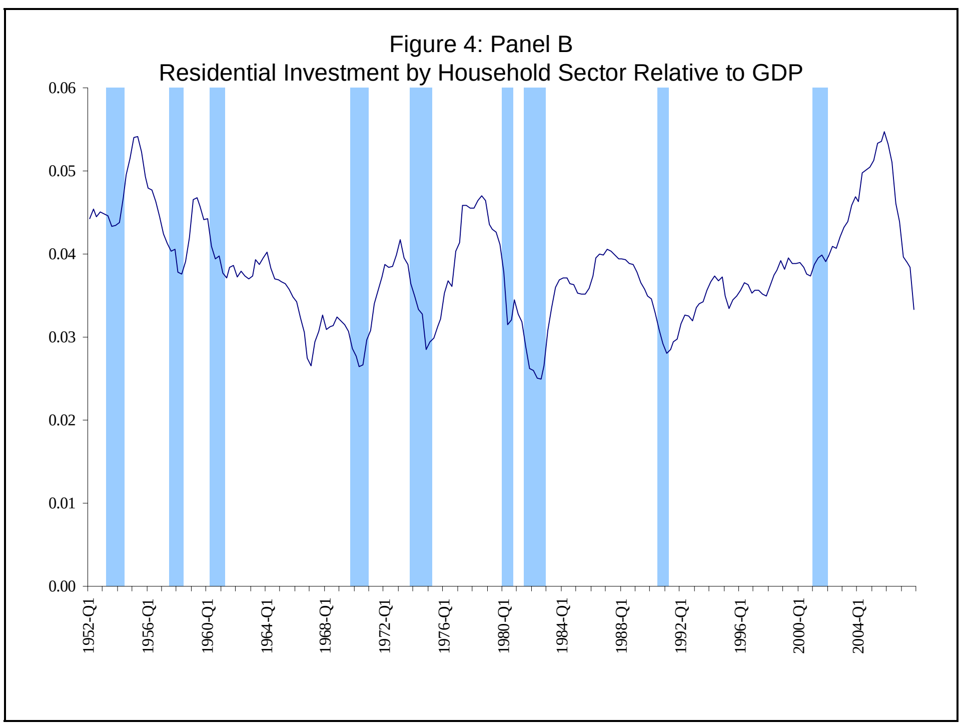
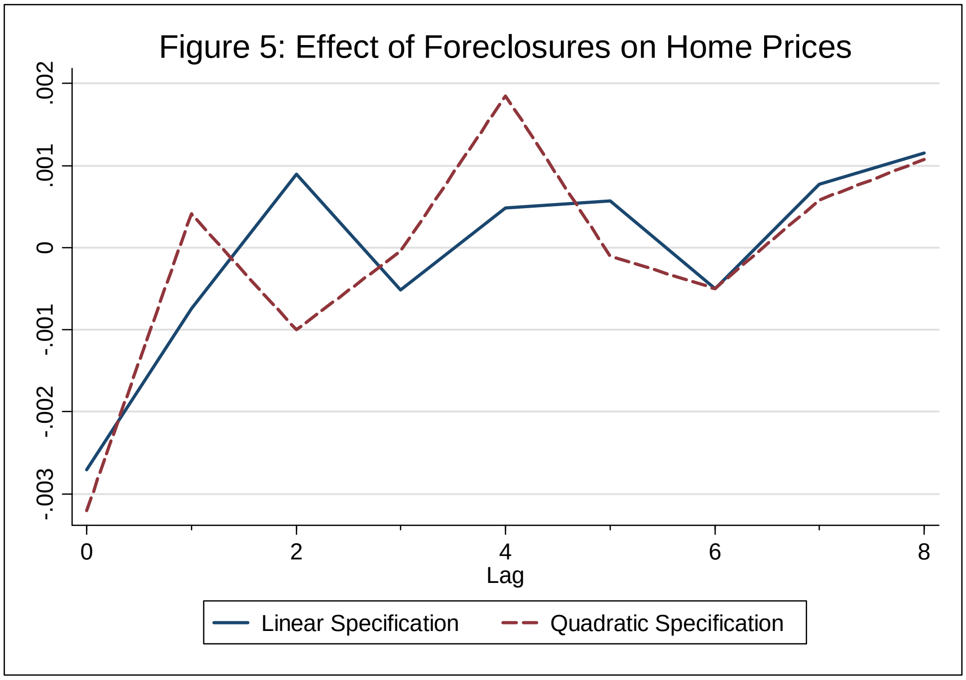
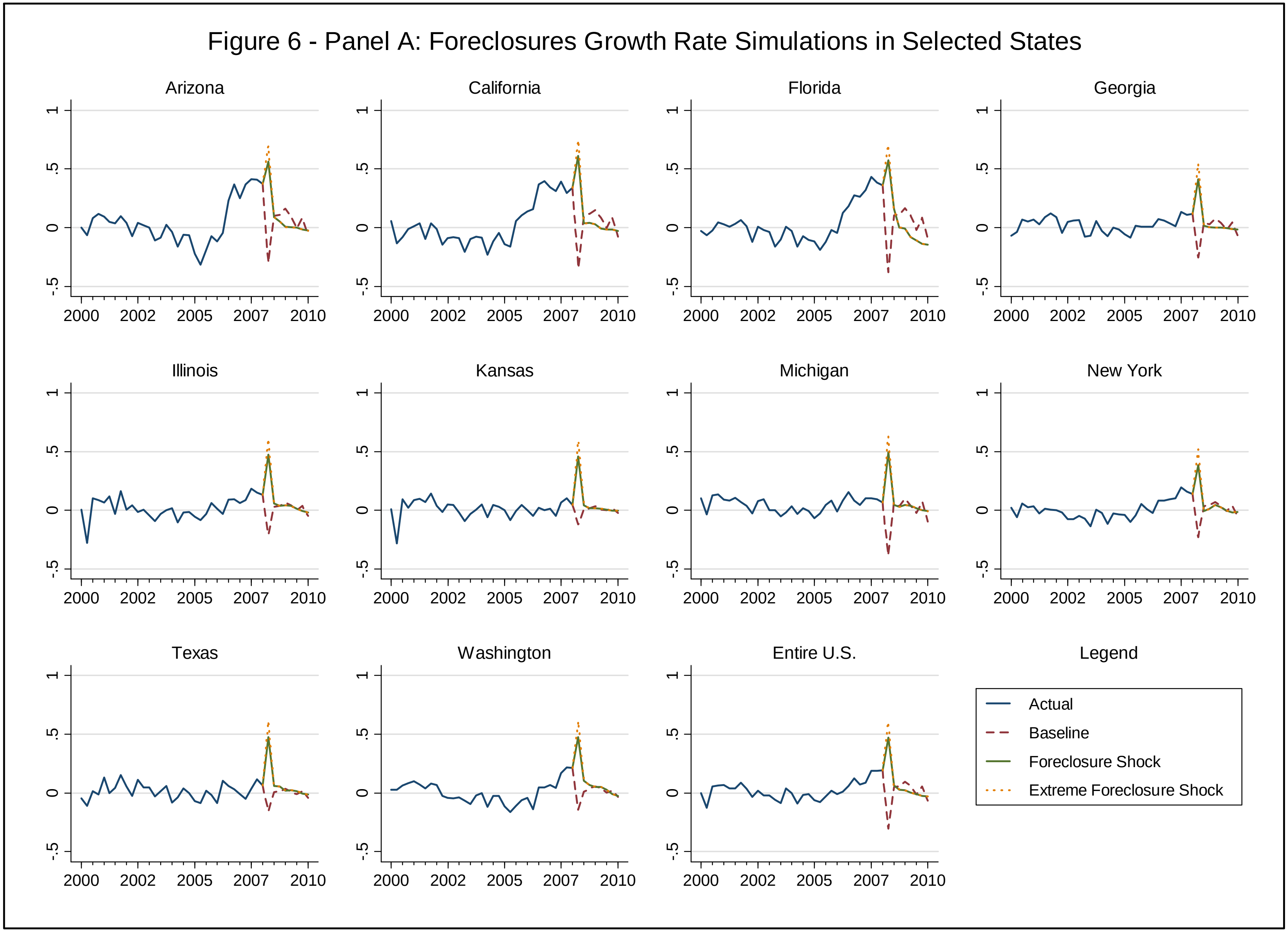


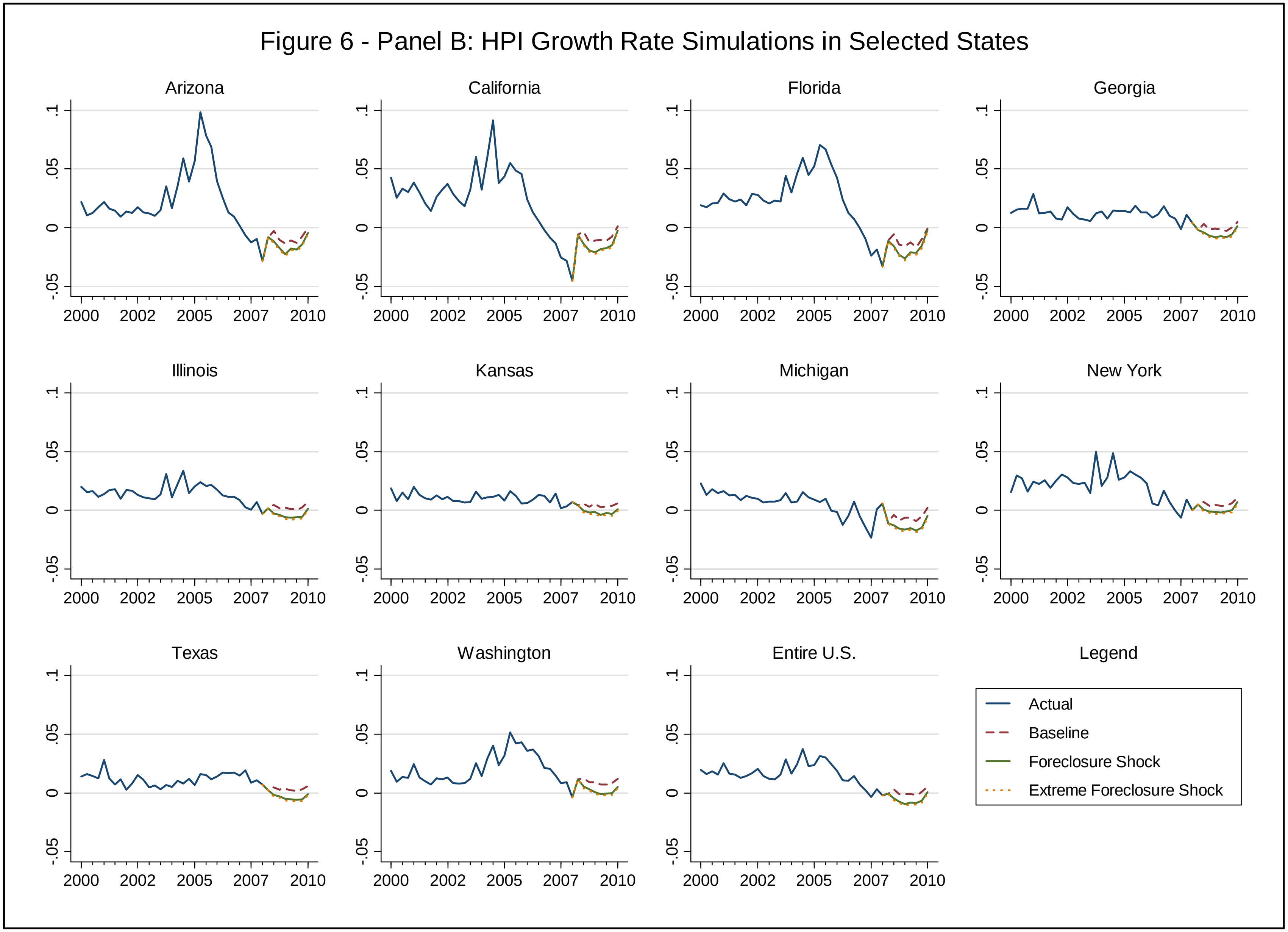
Figure 4: Panel B
Residential Investment by Household Sector Relative to GDP
0.00
0.01
0.02
0.03
0.04
0.05
0.06
1952-Q1
1956-Q1
1960-Q1
1964-Q1
1968-Q1
1972-Q1
1976-Q1
1980-Q1
1984-Q1
1988-Q1
1992-Q1
1996-Q1
2000-Q1
2004-Q1



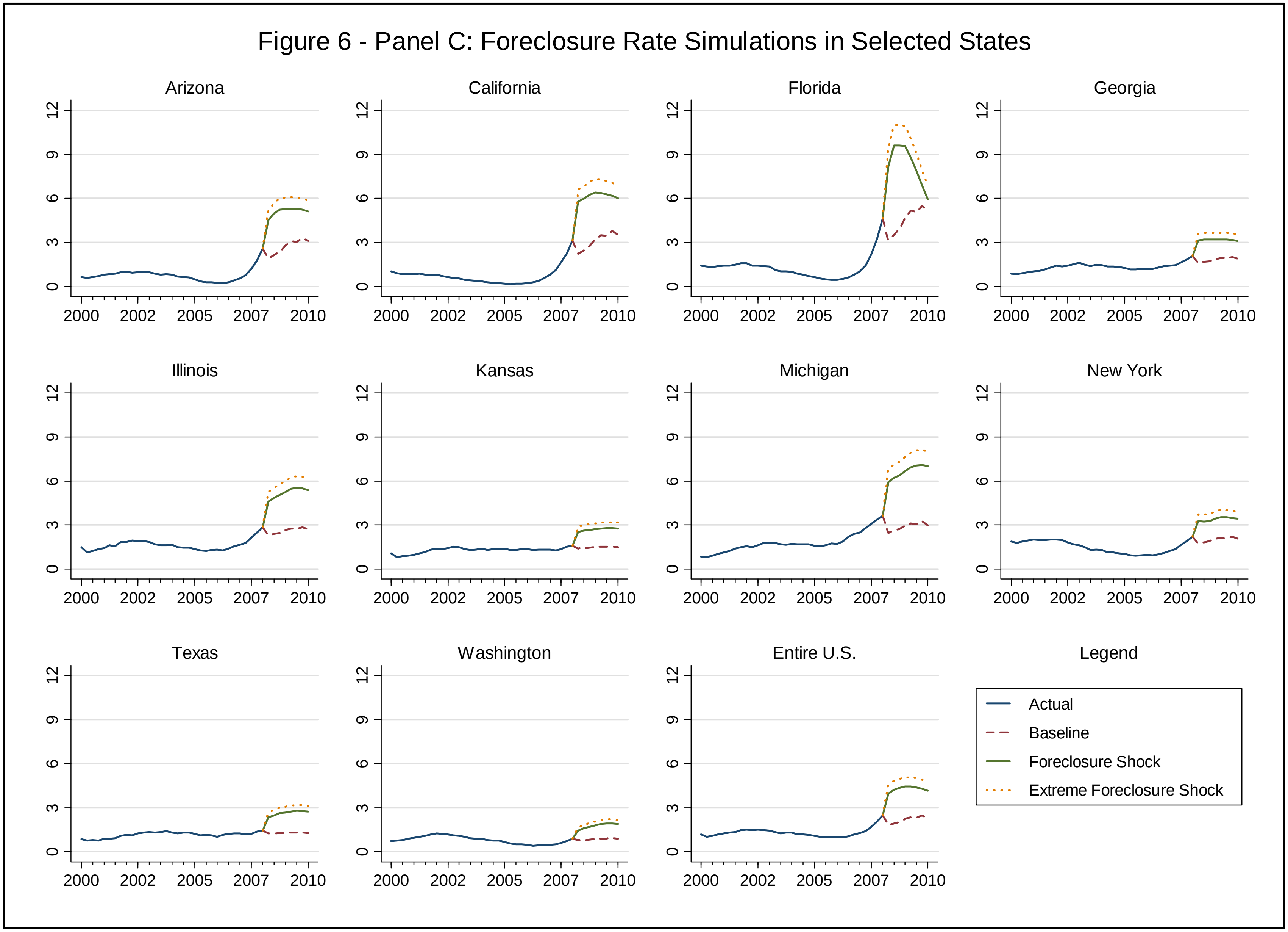
Note: Lines show the total impact of a mean value (0.22) log foreclosure rate shock on the HPI growth rate at the specified lag if the impact of foreclosures is modeled using the indicated specification. A detailed description of their calculation is provided in the notes to Table 5.



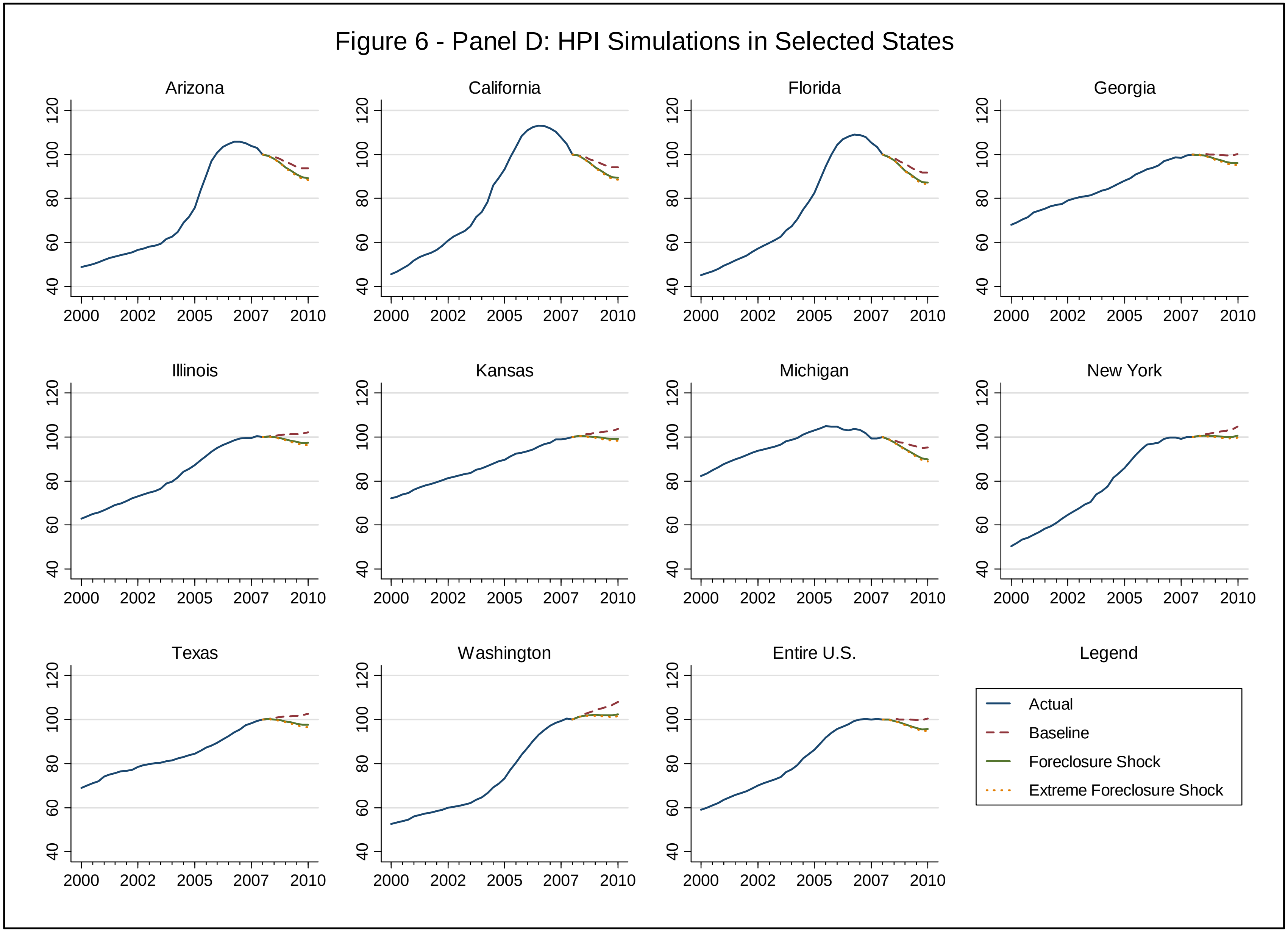
Note: The variable graphed in this panel is the quarterly log difference of the percent of mortgages in foreclosure; the Entire U.S. forecasts are the weighted average of the state forecasts, where weighting is based on the estimated housing stock in each state. The Foreclosure Shock scenario is based on Economy.com forecasts, adjusted for possible non-linear effects. The Extreme Foreclosure Shock scenario assumes foreclosures are 75 percent higher than those in the Economy.com forecasts.



Note: The variable graphed in this panel is the quarterly log difference of the OFHEO HPI (all-transactions index); the Entire U.S. forecasts are the weighted average of the state forecasts, where weighting is based on the estimated housing stock in each state. The Foreclosure Shock scenario is based on Economy.com forecasts, adjusted for possible non-linear effects. The Extreme Foreclosure Shock scenario assumes foreclosures are 75 percent higher than those in the Economy.com forecasts.



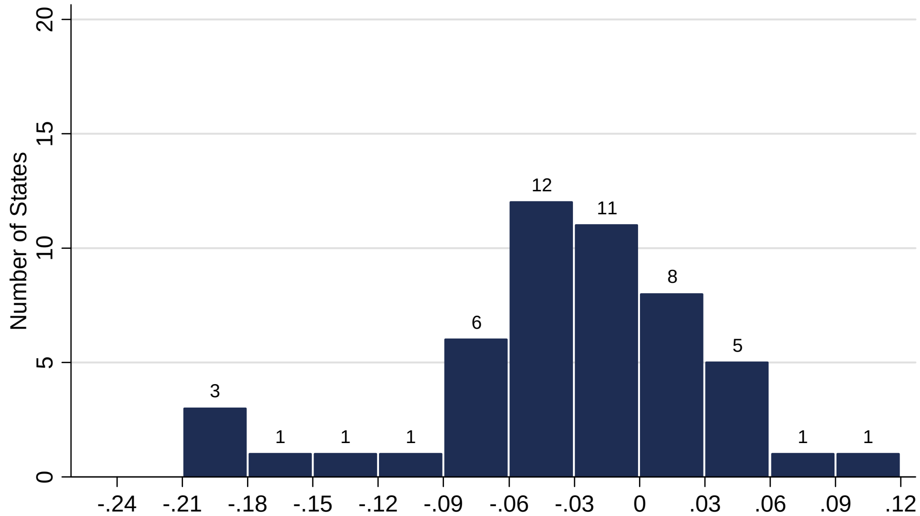
Note: The variable graphed in this panel is the percent of mortgages in foreclosure; the Entire U.S. forecasts are the weighted average of the state forecasts, where weighting is based on the estimated housing stock in each state. The Foreclosure Shock scenario is based on Economy.com forecasts, adjusted for possible non-linear effects. The Extreme Foreclosure Shock scenario assumes foreclosures are 75 percent higher than those in the Economy.com forecasts.



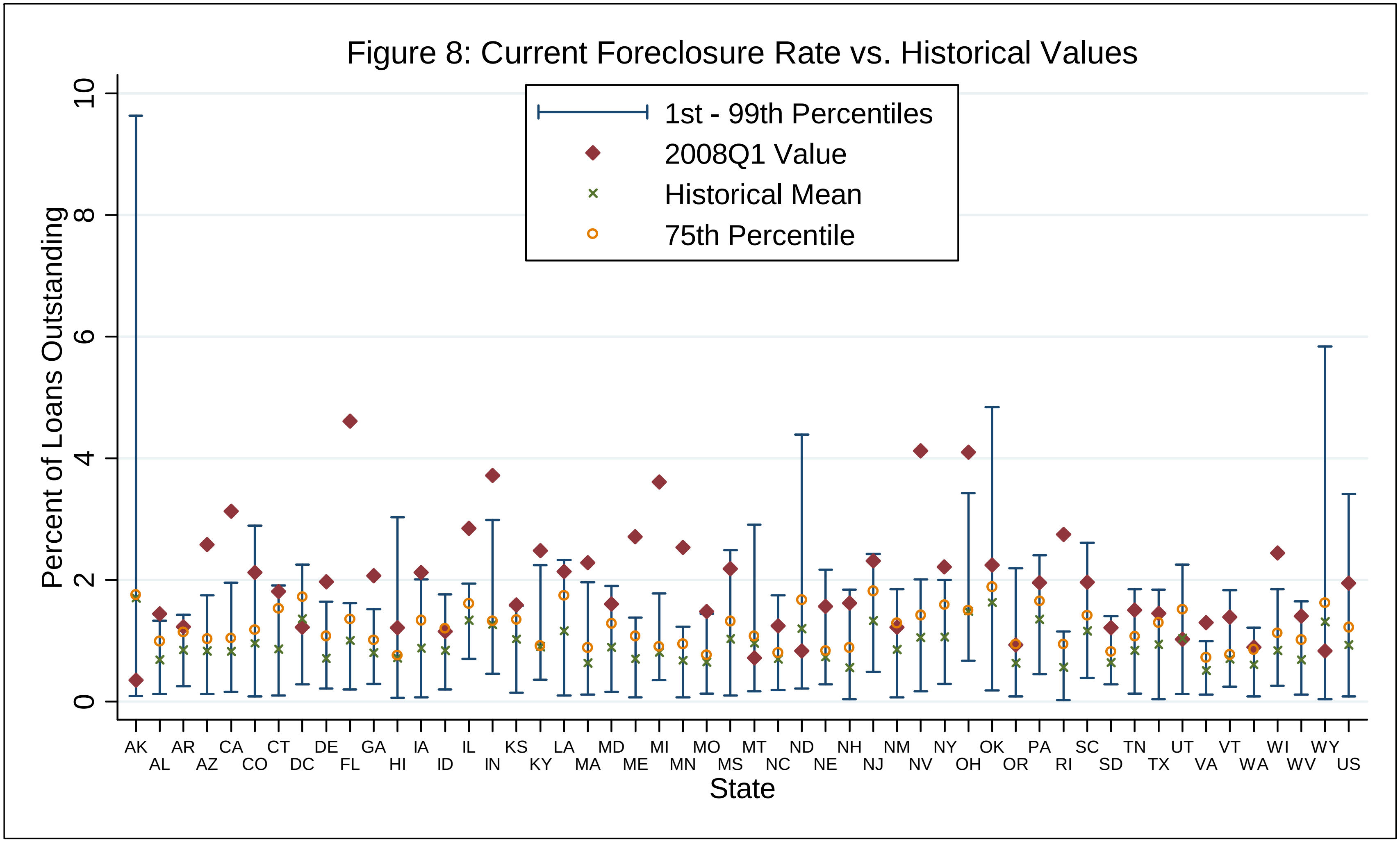
Note: The variable graphed in this panel is the OFHEO HPI (all transactions index) for each state, renormalized to set 2008q1 = 100; the Entire U.S. forecasts are the weighted average of the state forecasts, where weighting is based on the estimated housing stock in each state. The Foreclosure Shock scenario is based on Economy.com forecasts, adjusted for possible non-linear effects. The Extreme Foreclosure Shock scenario assumes foreclosures are 75 percent higher than those in the Economy.com forecasts.

Figure 7: Distribution of Total House Price Changes between 2007Q2 and 2009Q4

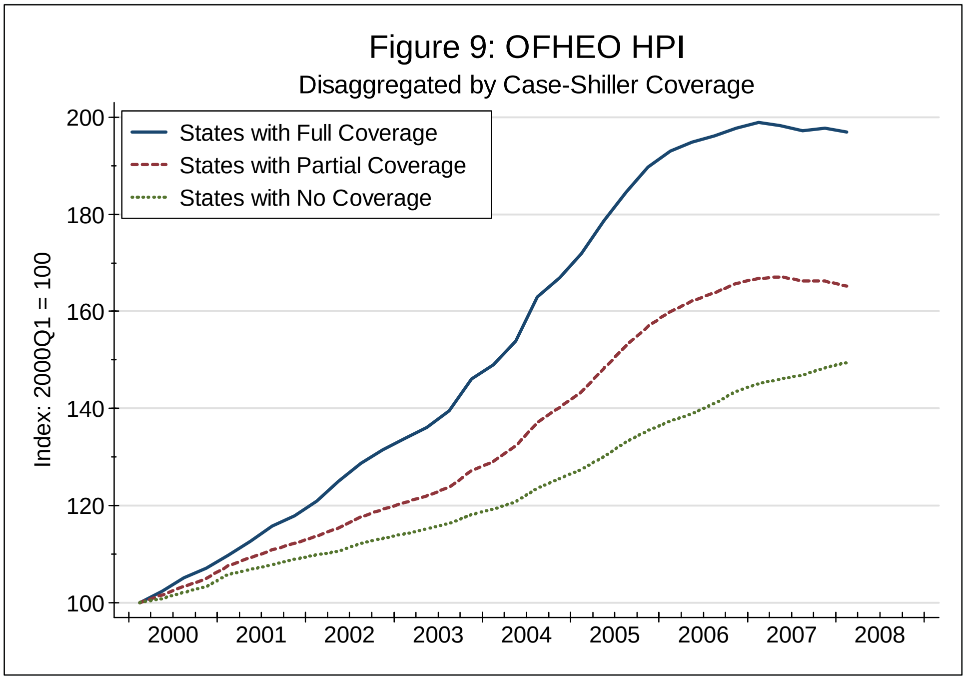
Extreme Foreclosure Shock



Note: Alaska and New Hampshire are not included because of data limitations; the District of Columbia is included.



Notes: The bars show the range of historical foreclosure rate values (1st through 99th percentiles) for each state between 1979 and 2005; the historical mean and 75th percentile figures are calculated using this same time frame. The red diamonds show the most recent foreclosure rate for the state. U.S. average values are found on the right, and represent the simple average of the states (not the U.S. aggregate figures as reported by the MBA). Note that many states with 2008Q1 foreclosure rates outside their own historical experiences are well within the range of the other states within the panel, meaning our PVAR simulations are largely in-sample events.



Note: This figure shows the weighted-average of OFHEO state-level price indices aggregated on whether the states are covered in the Case-Shiller national house price index. Weighting is based on the estimated number of housing units in each state according to the 2006 American Community Survey.

Data and Methodology Appendix

<u>Data Sources</u>

Prices Variant 1: *OFHEO All-Transactions House Price Indices*

Our primary home price appreciation measure comes from the state-level, all-transactions house price indices produced by the Office of Federal Housing Enterprise Oversight (OFHEO). We use the 2008Q1 release of these data, which include observations from 1975Q1 through 2008Q1. We renormalize these indices to set 2008Q1 as the base quarter. All of our regressions measure home price appreciation as the log difference of these indices, not seasonally adjusted.

Prices Variant 2: *OFHEO Purchase Only House Price Indices*

In our robustness checks, we make use of the 2008Q1 release of the OFHEO purchase-only indices. For regressions requiring observations prior to 1991Q1 (the beginning point of the purchase-only indices), we join the purchase-only index with the corresponding all-transactions index (both renormalized to 1991Q1) to provide full coverage through the entire sample period. The resulting spliced indices are then normalized to set 2008Q1 as the base quarter. Once again, appreciation is measured as the log difference of this series, not seasonally adjusted.

Foreclosures: *Foreclosure Rate*

Historical values of the foreclosure rate come from the Mortgage Bankers Association (MBA) Quarterly Delinquency Survey, which provides the number of mortgage loans in foreclosure as a percent of all loans serviced. These data run from 1979Q1 through 2008Q1 and are not seasonally adjusted.

We use the log level of the foreclosure rate in our primary regression specifications, although in our robustness checks we also run specifications that use the log difference of the foreclosure rate.

In the "Foreclosure Shock" and "Extreme Foreclosure Shock" scenarios, forecasted values of the foreclosure rate are derived as follows. We obtained state-level historical (2007Q4 and earlier) and forecasted (2008Q1 and later) values of seasonally-adjusted foreclosure starts (the percent of mortgages entering into foreclosure during the quarter) from Economy.com. On a state-by-state basis, we regressed the log level of the MBA foreclosure rate on four lags of itself and the contemporaneous value and four lags of the log level of the foreclosure start rate. Using the estimated coefficients from these regressions and the Economy.com forecasts of the foreclosure start rate, we dynamically predicted the log level of the foreclosure rate in each state through the end of 2009. Copies of the regression output for each state and graphs depicting actual and predicted values from this exercise are available from the authors upon request.

Note that because forecasts of the foreclosure start rate were not available for Alaska, we were unable to include Alaska in any of our simulations.

Permits Variant 1: *Single-family Residential Building Permits, 1988-2007 Data*

The Bureau of the Census prepares a monthly release of building permits by state (not seasonally adjusted); these are available back to January 1988. For our 1988-2007 regressions, we seasonally adjusted each monthly state series using the Census X12 program using default settings. We then calculated the quarterly average of these figures. All of our regressions measure the growth rate of permits as the log difference of these quarterly averages.

Permits Variant 2: *Single-family Residential Building Permits, 1981-2007 Data*

Economy.com provided us with monthly, seasonally-adjusted, annualized rate of single-family building permits by state dating back to January 1980. According to Economy.com, the original raw data that underlie these series come from the Bureau of the Census. As noted above, the raw (non-seasonally adjusted monthly figures) are available from the Bureau of the Census dating to 1988, although these data are incomplete in that they do not include all permitting offices that are included in the annual series.[12] For observations between 1980 and 1988, Economy.com derived the monthly values based on the annual data reported by the Bureau of the Census.

In our primary results, we use the quarterly average of these monthly data as our measure of permits. All of our regressions measure the growth rate of permits as the log difference of these quarterly averages. Because permits are zero in some states for some quarters (most notably the District of Columbia), we added one to each of the quarterly permit values before taking logs.

Employment: *Total Non-farm Employment*

Total non-farm employment by state (not seasonally adjusted) is available from the Bureau of Labor Statistics dating back to 1960. We seasonally adjusted each monthly state series using the Census X12 program using default settings.[13] We then calculated the quarterly average of these figures. All of our regressions measure the growth rate of employment as the log difference of these quarterly averages.

[12] These unadjusted data are also problematic because the permit issuing places included in the series change over time.

[13] The BLS also provides seasonally-adjusted employment data; these data are only available back to 1990, however.

Sales: *Single-family Existing Home Sales*

The monthly, seasonally-adjusted annual rate of existing, single-family home sales for each state is available from the National Association of REALTORS®. These data are available dating back to the beginning of 1981.

One quarter's observation was missing for Indiana and three were missing for Idaho. In order to keep these states in our simulation (the missing quarters occur in 2006, within our simulation forecast window), we interpolated values based on the growth rates of existing home sales in neighboring states. Specifically, we assumed that the growth rate (percentage change from the prior quarter) in Indiana in the missing quarter was equal to the average growth rate in Illinois, Kentucky, Michigan and Ohio. The missing value is then calculated as this average growth rate applied to the prior period sales in Indiana. Similarly, missing values in Idaho are interpolated based on the average sales growth rate in Montana, Wyoming and Utah.[14]

Finally, note that no sales are reported for New Hampshire between 2004Q1 and 2007Q4. As a result, this state was excluded from our analysis.

PVAR Methodology

Because of the lagged dependent variables inherent in a PVAR model, we follow Arellano and Bover (1995) and de-mean our variables using Helmert's transformation:

$$y_{it}^{*} = w_i \left[y_{it} - \frac{1}{T-t} (y_{i(t+1)} + \cdots + y_{iT}) \right], \quad t = 1, \ldots, T-1,$$

[14] Washington and Oregon were excluded here because they were deemed to be "Pacific" states rather than "Mountain" states and thus less comparable for Idaho.

where $w_t^2 = (T - t)/(T - t + 1)$. In other words, each of the first $T - 1$ observations are de-meaned using all future observations (with the next-to-last observation demeaned by the final observation, which is lost from the sample). The weighting w_t^2 is included to equalize the variances.

Consistent parameter estimates then be obtained by using two-stage least squares on these transformed variables, using the non-transformed values of the variables as instruments. We performed out estimation in Stata, using a PVAR program provided by Inessa Love with the World Bank.