Regional Housing Supply and Credit Constraints

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Housing construction plays a critical role in the economy. Increases in housing starts raise construction employment, and recent home buyers often purchase other consumer durables, leading through the multiplier effect to increased employment. Construction is especially important for the business cycle, because changes in residential construction tend to lead recessions and recoveries. In addition, the elasticity of the supply of new housing is a determinant of movements in house prices, which affect both housing affordability and the wealth position of homeowners. Despite its importance, empirical research on housing supply is surprisingly rare. The dearth of work is particularly apparent when compared to the extensive literature on housing demand, a discrepancy noted in housing market overviews by Olsen (1987) and Smith, Rosen, and Fallis (1988), among others.

This article develops an empirical model of new housing supply based on the model of the conversion of raw land to urban use in Mayer and Somerville (1996). New single-family residences tend to be constructed at the fringe of the urban area, where raw land must first be converted into urban use as developed lots before construction can occur. Yet most empirical analyses of supply tend to ignore the relationship between land development and residential construction. Using this framework, the study shows that new housing starts are best modeled as a function of the change in the price of existing homes. In contrast, most previous work models starts as a function of the level of house prices.

This approach resolves several problems that can arise from treating housing starts as a function of the level of house prices alone. Urban theory suggests that house prices adjust to ensure an equilibrium between the stock of housing and the demand for it. Thus starts, a flow variable that equals the change in the stock of units (adjusted for depreciation and removals), should depend on changes in prices.[1]

We use this approach to examine regional differences in the supply of new housing. With the exception of Abraham and Shauman (1991), studies of housing market dynamics tend to ignore regional differences. By comparing supply functions for the four U.S. Census regions, we uncover regional differences in the way builders respond to market signals. Following the literature, we estimate the price elasticity of starts, rather than a true supply elasticity, which would be the elasticity of the total stock of units. The results indicate notable differences in the supply elasticity of new construction across regions, from a low of 0.9 in the South to a high of 3.9 in the Northeast. One possible explanation for these differences in regional elasticities is the variation in the location of employment within urban areas across the regions. Finally, the response of starts to a given change in house prices is quicker in the South and Midwest than in the West and Northeast.

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A well-specified model that separately identifies supply and demand permits a search for other factors that might affect regional construction. We use this methodology to investigate credit availability. Various commentators have suggested that excessive bank regulation during regional downturns has caused banks to restrict lending below market equilibrium levels—a condition known as a "credit crunch." (See Browne and Rosengren 1992.) Because of the difficulty in measuring credit availability, researchers disagree as to whether credit restrictions are present and, if they exist, whether they have significant effects on aggregate output (Hubbard 1995). New construction should be highly susceptible to credit restrictions because the typical residential builder is dependent on banks for funds to finance land acquisition, up-front infrastructure expenses, and construction. We look for evidence of a credit crunch by examining the residuals from a supply equation during various periods that commentators have identified as potentially credit constrained. Credit constraints are consistent with prolonged periods of lower-than-predicted construction. The results show evidence of lower-than-predicted construction in the most recent downturn in the Northeast, but no evidence of reduced construction during other regional recessions, including the oil patch bust in 1986 and the general recession in 1982.

I. Theoretical Issues in Modeling New Construction

The standard empirical model characterizes new construction as a function of the level of house prices—which is expected to fully capture demand for new units—and "exogenous" cost shifters, such as interest rates and labor and materials prices. This specification ignores the implications of spatial conditions such as current or future growth in city size. Furthermore, because house prices equilibrate the total stock of housing with the total demand for residential space, they may not be an accurate measure of the demand for new construction, which is a flow variable, approximating the change in total stock, less removals.

Mayer and Somerville (1996) propose an alternative model of new residential construction based on the land development process. By incorporating spatial issues, the authors present a treatment of housing supply well-suited for comparisons of new construction across regions. The result of this approach is a model that treats housing starts as a function of changes in housing prices instead of the current level of house prices.

A simple example demonstrates why the level of housing prices can be an inappropriate measure of demand for new construction. Imagine a city composed of a stable number of homogeneous households. The city is not growing, so the housing market is at its long-run equilibrium, with house prices constant. As long as the physical condition of existing units does not depreciate, housing starts are equal to zero. Suppose an unexpected, one-time influx of population takes place. When this influx occurs, demand for new residences increases, land and house prices rise, new construction is undertaken, and the city grows in size to accommodate the new residents. At

[1] Also, previous research (for example, Clayton 1994, Meese and Wallace 1994, and Rosenthal 1995) shows that the real price of existing housing may not be stationary in levels, possibly because of increases in population or real income over time, but it is stationary in differences—that is, house prices are I(1), not I(0). Housing starts, on the other hand, appear to be stationary in levels.

the new equilibrium, the city is physically larger, house prices are higher at any given location than they were before the population inflow, and starts are again zero. Starts occur only when the city makes the transition from one equilibrium to another, a period identified by the increase in the price level. Aggregate starts are uncorrelated with the house price level, but are positively correlated with the change in prices.

Following Mayer and Somerville, prices for developed sites are defined as the present discounted value of house rents. These prices capture the opportunity cost of the forgone agricultural rents, the capital cost of developing the land and building the structure, and the value of the location. The value is the savings in commuting costs at a given site when compared with more distant locations. To ensure a spatial equilibrium in the land market, this value declines as units are located closer to the urban fringe and farther from the employment subcenters. At the border, where landowners are indifferent between leaving land in agricultural use or developing it, equilibrium house prices must equal the agricultural value and the cost of the structure, so that location rents equal zero.[2] Beyond the boundary it is not economic to develop. At those points the implicit location value is negative, and while house prices there may exceed the agricultural values, they do so by less than the cost of developing the land and building the structure.

This model treats housing starts as a function of changes in housing prices instead of the current level of house prices.

New land is developed as the general level of house prices increases. Population growth triggers increases in the general price level of housing in the city as demand for housing rises at all locations. To accommodate the new residents, the area of the city must expand. And in a larger city, spatial equilibrium is achieved only if rents and prices at interior locations rise. At locations formerly beyond the area of urbanization, prices rise sufficiently to make it profitable to develop those sites; the raw land is now ripe for development because these formerly undeveloped sites yield greater returns in urban use as housing than as farm land.

In the aggregate, increases in the general citywide level of prices bring new land into development and allow new residential construction to occur. The process outlined above describes the mechanism by which a change in the price level leads to the development of raw land and housing starts. It reflects the equilibrium condition that house prices adjust to equate the total stock of housing with total demand for residential space. Changes in this stock, that is, starts, must then be a function of changes in price. For a given period, total housing starts equal the change in the stock, which is a function of the change in house prices over that period. The long-run equilibrium reflects the relationship between stock and price levels, where prices reflect demand.

Most existing empirical work on housing supply either combines supply and demand relationships together into a single equation or attempts to estimate starts as a function of the price level. In the former case, a single reduced form equation is used by authors such as Muth (1960), Follain (1979), Stover (1986), and Malpezzi and Maclennan (1994) to derive estimates of housing supply elasticities. They find no evidence of a statistically significant long-run relationship between price levels and demand measures, suggesting that the supply curve for new housing is perfectly elastic. Because the models do not separately identify supply and demand, the coefficient estimates may be unreliable, however.

Direct modeling of new housing supply curves by Poterba (1984, 1991), Topel and Rosen (1988), and DiPasquale and Wheaton (1994) yields a very different result, an upward-sloping supply curve. They directly compare housing starts with the general level of new home prices and prices for labor and material inputs, that is, output and input prices. The measures of the price elasticity of starts for these studies are around 3.0, dramatically lower than the levels found in the reduced form estimation.

The model in Topel and Rosen borrows heavily from the general investment literature. Investment models may be adequate to describe the supply of residential structures, but they are not appropriate for the role of land. This spatial aspect is a distinguishing

[2] This class of model describes the supply decision at the urban fringe, rather than redevelopment. However, since most new detached single-family construction occurs at the urban border, constraining ourselves to a model that describes dynamics at the border is not unreasonable. We are also ignoring the option value of undeveloped land, a topic developed in Titman (1985), Capozza and Schwann (1989), Capozza and Helsley (1990), and Williams (1991), among others.

feature of housing. For instance, new housing is not identical to existing housing because their locations differ. New construction tends to occur at the urban fringe, increasingly distant from existing units and the city center as an urban area grows. The price paths of new and existing housing units are also different: In a growing city, the price of existing units rises relative to the price of new housing, because with growth in city size the location premium for existing units increases. Yet, like other researchers, Topel and Rosen measure demand using the price series for new housing. Also, spatial conditions can cause cities with very different demands for new housing to have similar price levels. As DiPasquale and Wheaton note, house price levels in a large slow-growing city and a smaller fast-growing city may be identical, but their existing housing stocks and the amounts of new construction will differ dramatically.

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DiPasquale and Wheaton use a stock adjustment framework to include land in the housing starts equation. The stock adjusts slowly, so that current starts are a function of the desired stock and the stock in the previous period. Lagged stock reflects the historic path of development and, with price, describes prevailing land market conditions. At a given price level, the larger the lagged stock, the lower are starts, because the city is closer to its long-run equilibrium in the housing market. A large, slow-growing city can have high land prices, and thus high house prices, and still have few starts because the existing stock is large relative to the price level. In contrast, a small, fast-growing city might have similarly high prices, which capitalize the future growth in housing demand, with a much smaller existing stock. Starts are higher, while the existing stock is small relative to the price level. The combination of price and the lagged stock allows DiPasquale and Wheaton to capture aspects of demand that are not revealed by the price level alone. Empirically, however, the stock of housing is notoriously difficult to measure in non-Census years, because physical depreciation is unobserved and not all starts are completed with the same lag. The authors are forced to assume constant decennial rates of removals or demolitions (which in fact vary significantly across time as well as across regions).[3]

Though the formal structure of the model we use differs from that of DiPasquale and Wheaton, our approach very much builds on their work. The model from Mayer and Somerville (1996) formalizes the interrelationship among movements in housing prices, land development, and the existing stock that is implicit in the DiPasquale and Wheaton treatment. But instead of including lagged stock in a starts equation, this relationship is captured by changes in house prices. This approach uses a more formal characterization of the land development process than they use, together with the same equilibrium relationship between the price of existing homes and the stock of housing.

II. The Empirical Model and Data

Based on the model described in the previous section, we construct an estimating equation for starts as a function of changes in house prices and input costs. Costs include the expected real interest rate, $E(r)$, and construction costs, c. In levels, construction costs determine price levels, so we use the change in construction costs to develop the following estimating equation:

$$starts_t = f(\Delta p_t, \Delta p_{t-1}, E(r_t), \Delta c_t). \qquad (1)$$

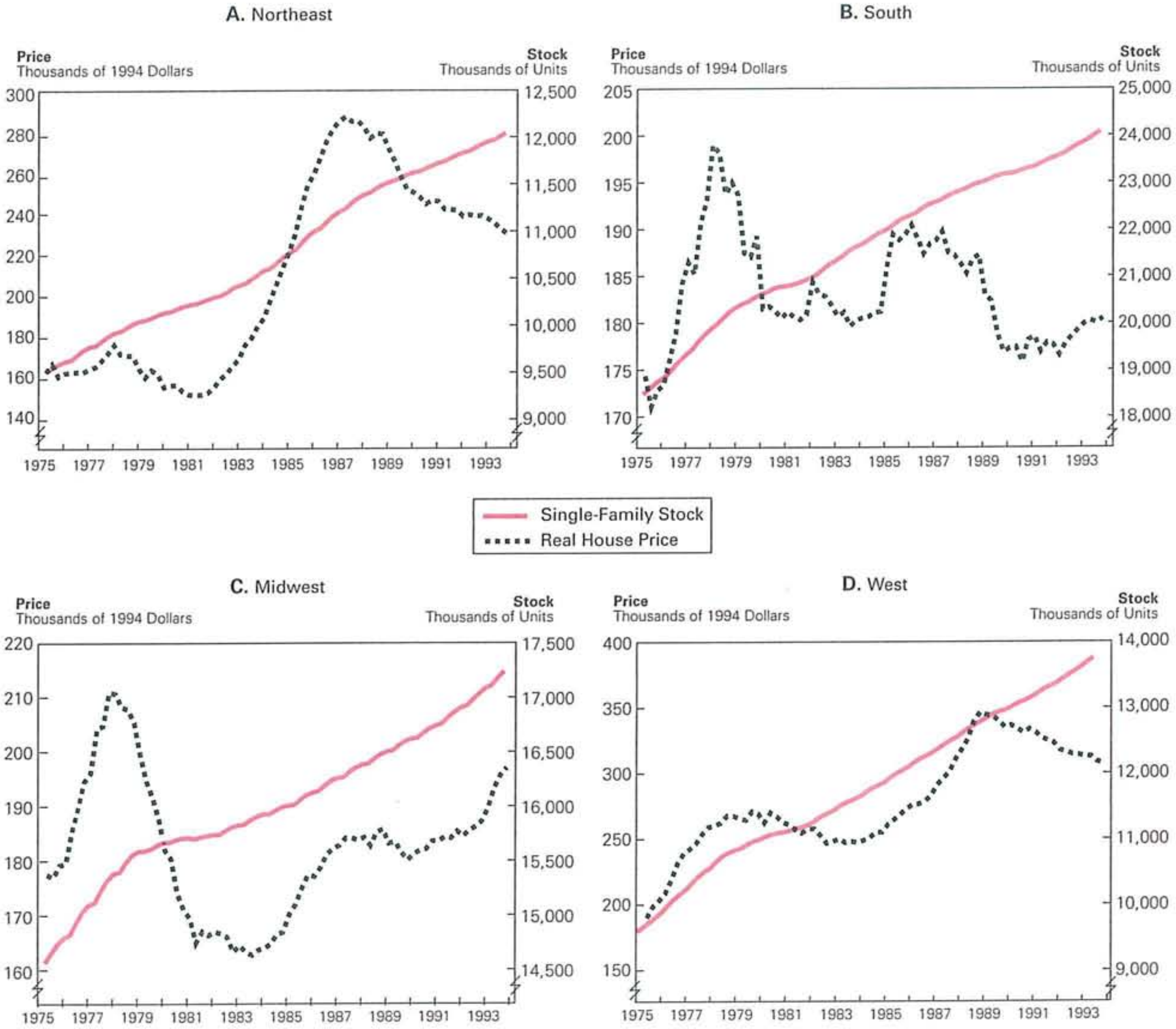
Builders indicate that their cost of funds depends on the prime rate rather than mortgage rates or rates on Treasury bills, so we construct an expected real interest rate using the current nominal prime rate and expected inflation. Because builders may not be able to respond immediately to changes in market conditions, possibly because of lags in the land assembly and permitting process, the estimating equation allows for one quarterly lag in changes in prices and in the prime rate.

Figures 1A to 1D graph the data for the four Census regions on housing prices and stock used

[3] The stock of housing in a given quarter is calculated by taking the stock last quarter, adding last quarter's starts, and subtracting the decennial average removal rate.

Figure 1

Stock of Single-Family Houses and Real House Prices



Source: Freddie Mac house price index and authors' calculations.

in this paper. The stock series is based on the 1970, 1980, and 1990 Census counts and the 1993 American Housing Survey estimate of the number of year-round single-family residences. Inter-decennial removal rates are linearly interpolated to ensure that for any inter-Census period, stock in the base year plus total starts, minus units estimated to have been removed, equals the end-year stock. The annual removal rates vary by region and decade, ranging from 0.12 to 0.91 percent of the stock.

We construct a series for real house prices that measures dollar changes in house prices in each region over time. The measure is developed by combining the quarterly Freddie Mac resale price index from 1975 to 1994 for the four Census regions, to determine the rate of change in prices, and the hedonic

Table 1
Descriptive Statistics, 1975 to 1994

	Northeast	South	Midwest	West
Single-Family Stock (000)				
Mean	10,769	21,570	15,962	11,644
Standard Deviation	798	1,645	700	1,213
Maximum	12,077	24,064	17,205	13,703
Minimum	9,479	18,321	14,438	9,409
Starts (000)				
Mean	33.72	116.33	51.99	61.80
Standard Deviation	13.81	24.18	23.24	17.47
Minimum	71	179	118	104
Minimum	9	62	9	24
Real Price (1994$)				
Mean	101,274	72,915	71,321	124,888
Standard Deviation	22,521	2,472	4,677	19,961
Maximum	140,022	79,354	82,642	158,117
Minimum	74,834	68,244	64,056	79,941
Change in Real Price (1994$)				
Mean	387.0	40.6	118.2	794.3
Standard Deviation	2,188	888	1,019	2,078
Maximum	6,191	2,312	3,146	6,276
Minimum	−3,950	−3,031	−2,447	−3,099
Expected Real Prime Rate (%)				
Mean	4.83	4.83	4.83	4.83
Standard Deviation	3.50	3.50	3.50	3.50
Maximum	13.93	13.93	13.93	13.93
Minimum	−1.10	−1.10	−1.10	−1.10

Source: U.S. Bureau of the Census, Freddie Mac, and the Board of Governors of the Federal Reserve System.

regional series developed in DiPasquale and Somerville (1995) that estimates constant-quality prices by region for identical units, to fix price levels across regions. The Freddie Mac index is a repeat sales index developed from observations, either sales or refinancings, of the same properties over time. It is consistent with the measure of house prices described in our model because it is based on houses at fixed locations. In contrast, the Census C-27 new house price series, used by most previous studies of new construction, measures houses in ever-changing locations.

Table 1 describes the data used in this study.[4] The national CPI-less-shelter series is used to measure inflation rates. The expected real prime rate series is the estimated value generated by regressing the current change in the real prime on two of its own lags. As is apparent from Figures 2A to 2D, housing starts vary significantly over the cycle and across all four regions. Annual starts as a percentage of the total stock range from a low of 0.3 in the Northeast in the first quarter of 1982 to a high of 4.2 in the West in the second quarter of 1977.

III. Empirical Results

Table 2 shows the results of estimating the empirical equation (1) separately for each region.[5] All regressions allow for first-order serial correlation (AR1) and use instrumental variables to control for the endogeneity of prices. Instruments include lagged changes in mortgage rates, changes in employment net of construction employment, changes in energy prices, and, following Buse (1989), lagged values of all other exogenous variables.

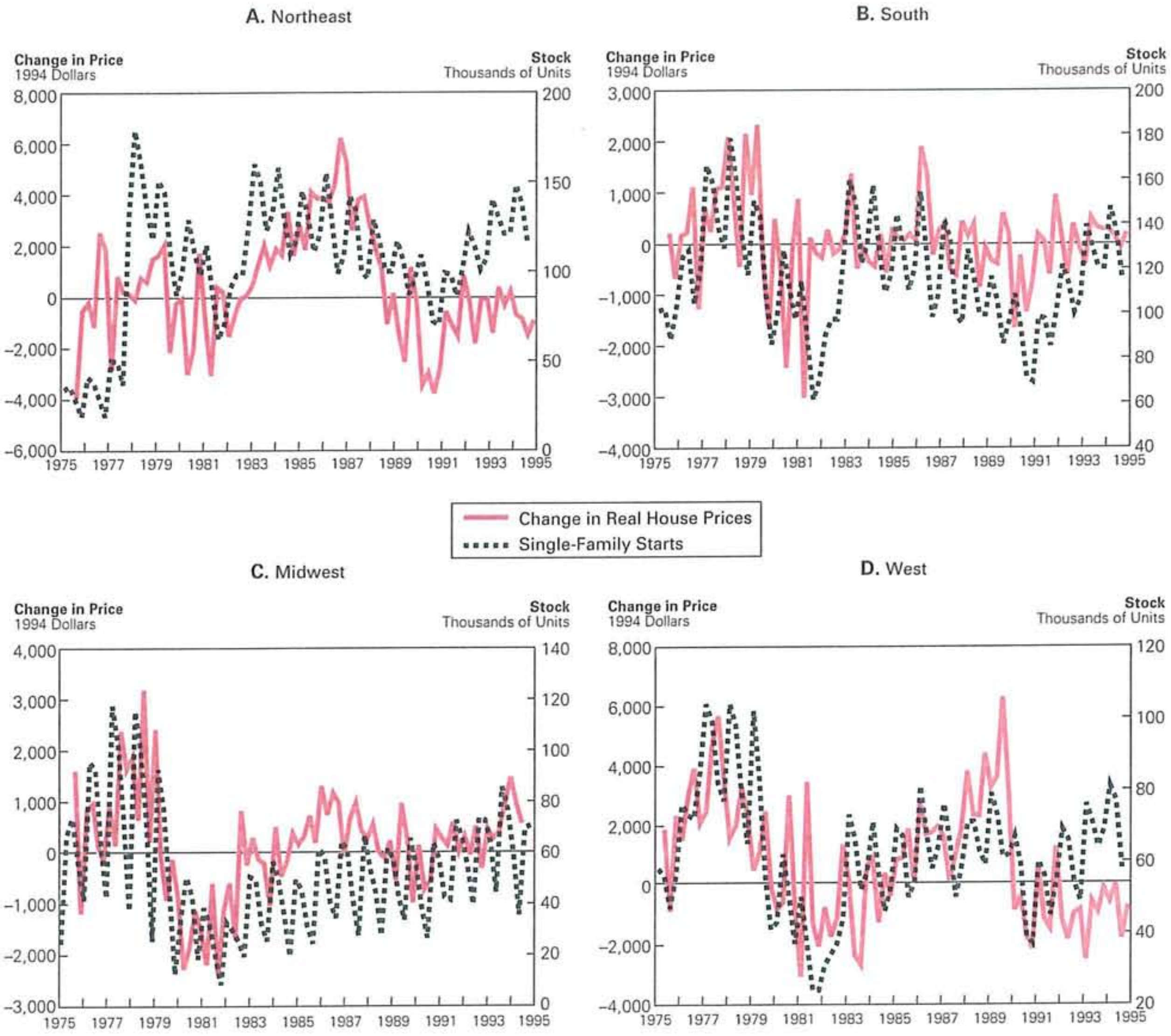
The coefficients on current changes in prices and current expected real interest rates are uniformly significantly different from zero across regions, while coefficients for lagged changes are mixed in significance. The effect of a $1,000 increase in real house prices is not uniform across regions. In the Northeast,

[4] Casual observation suggests that both the housing stock and prices are almost certainly non-stationary because the mean of these variables is increasing over time. This evaluation is not surprising given that both series depend on such non-stationary factors as population or real income. However, using non-stationary data as the dependent variable in an ordinary least squares equation poses problems because it violates the assumption of a finite variance. Instead, we focus on the relationship between two stationary variables, the change in the stock (starts) and the change in real prices. These series (shown in Figures 2A to 2D) appear to be strongly correlated. Previous research has shown that the real price of existing housing is stationary in differences. Housing starts are also likely to be stationary, but in levels. Augmented Dickey-Fuller (ADF) tests for stationarity give somewhat mixed results. Test statistics do not allow rejection at conventional levels (95 percent confidence interval) of the hypothesis that these series are non-stationary. The estimated Dickey-Fuller coefficients, where 1.0 is equal to the presence of a unit root—which indicates non-stationary data—run from 0.925 to 1.003 for the stock and from 0.604 to 0.861 for starts. For prices the range is 0.852 to 0.968, while for change in prices the range is 0.332 to 0.786. However, small sample size and high levels of noise mean that the power of these tests is low (Faust 1993). In estimating equation (1) we rely on the above-mentioned research that demonstrates the stationarity of house prices, as well as the theory presented in the earlier section. While stationarity is not always demonstrated in an ADF sense in these data, the data plots and the ADF tests are more consistent with our treatment of housing starts as a function of changes in prices than with the conventional estimation of starts as a function of the price level.

[5] We exclude construction costs from the regressions because, like other researchers, we find the coefficient on these costs to be statistically insignificant. Somerville (1996) finds that some construction cost measures are biased and endogenous, and that price coefficients estimated with and without conventional cost measures are similar. Lacking good national instruments for materials costs, we have chosen to leave construction costs out of the regressions.

Figure 2

Single-Family Starts and Change in Real House Prices



Source: U.S. Bureau of the Census and Freddie Mac.

this increase would raise starts by 5,150 units (3,390 units in the quarter of the price increase and 1,760 units in the next quarter), whereas starts would grow by 5,770 units in the South, by 10,930 units in the Midwest, and by 4,180 in the West. The coefficient on the current expected real prime rate is negative and significant at the 5 percent level in all four regions, but the lagged value is not. In all four regions the AR1 autocorrelation coefficient on the lagged error term is positive and significant.

Lagged price changes are significant in the Northeast and West, but insignificant in the South and Midwest, suggesting a faster adjustment process in the latter two regions. This result is not surprising given that environmental regulations and development constraints in the Northeast and in California, Oregon,

Table 2
Regression Results
AR1 Instrumental Variable Estimation[a]

	Northeast	South	Midwest	West
Current Change in Price	.00339 (.00066)	.00432 (.00197)	.00905 (.00153)	.00291 (.00083)
Lagged Change in Price	.00176 (.00050)	.00145 (.00157)	.00188 (.00125)	.00127 (.00053)
Current Expected Prime Rate	−.9187 (.400)	−2.203 (.804)	−2.453 (.605)	−2.132 (.475)
Lagged Expected Prime Rate	−.1525 (.401)	−1.164 (.898)	−.6296 (.580)	−.3919 (.507)
Time Trend	.1052 (.051)	−.2049 (.287)	−.0343 (.062)	.0783 (.127)
Second-Quarter Dummy	21.22 (1.83)	27.76 (2.54)	37.32 (2.71)	17.39 (1.76)
Third-Quarter Dummy	17.84 (2.02)	18.16 (2.97)	30.8 (2.85)	9.824 (2.05)
Fourth-Quarter Dummy	10.28 (1.88)	−2.891 (2.58)	15.84 (2.80)	−7.495 (1.82)
Constant	15.22 (4.48)	143.3 (26.87)	47.7 (5.62)	59.12 (11.79)
Number of Observations	75	75	75	75
AR1 Coefficient	.3093	.7946	.206	.6752
Adjusted-R sq	.765	.682	.841	.673
Log Likelihood	−238.6	−281.3	−265.7	−250.6

Standard errors in parentheses.
[a]Instruments for change in price include current and lagged values of change in non-construction employment, real energy prices, and nominal mortgage rates.

Table 3
Estimated Elasticities by Region

	Northeast	South	Midwest	West
Price Elasticity of Stock	.048	.020	.049	.045
Price Elasticity of Starts	3.87	.90	3.75	2.11
Percent of Total Increase in Starts in Initial Quarter of Price Increase	65.7	74.9	82.8	69.6

and Washington (a very large component of the West) may well delay the response of builders to changes in market conditions. Respectively, 74.9 and 82.8 percent of the eventual increase in starts occurs immediately in the South and the Midwest, as compared with 65.7 and 69.6 percent in the Northeast and West (Table 3). These results suggest that the development process is fastest in the South and Midwest.

Table 3 converts regression coefficients into estimated elasticities using the mean values of the relevant variables. Elasticities are computed for the total supply of housing (the stock) as well as for starts. The results are quite provocative. The total supply is almost completely price inelastic, with implied elasticities of less than 0.05 in all regions. This should not be too surprising, because starts are such a small fraction of the total stock, less than 2 percent on average for an entire year. For the true supply elasticity to equal unity, the price elasticity of starts would have to equal approximately 50, and be higher in areas such as the Midwest and the Northeast where annual starts comprise an even smaller percentage of the total stock. The estimates for the regional price elasticities of starts, a measure estimated in most housing supply models, range between 0.9 and 3.9, with an overall average of 2.7. Somewhat surprisingly, these results are similar to Topel and Rosen's estimate for national data in regressions of starts on price levels.

The low elasticity of starts in the South and the modest size of the elasticity in the West are striking, given the strong employment and population growth in those regions. One possible explanation for the lower than expected elasticities in the South and West is that the empirical model used in this article is based on a monocentric model of urban development, which may be less appropriate for these areas. The relationship between starts and price changes becomes less clear if employment and population are distributed more uniformly throughout a metropolitan area. In the extreme, if employment grows at the same locations as new housing (generally at the border of the metropolitan area), then the price of existing houses does not rise with employment growth. In this case, land values (for residential use) at the border of an urban area will rise sufficiently to support new development, but land values for existing units will remain unchanged. Edge cities appear to be more common in the South and the West, areas that have experienced much of their growth in the recent era of suburban employment.

IV. Testing for Evidence of a Credit Crunch

Claims of regulatory-induced reductions in credit availability—often referred to as a credit crunch—

have existed for many years. Early research on credit restrictions looked at the impact of interest rate regulation on the availability of credit. However, the passage of the Depository Institutions Deregulation and Monetary Control Act in 1980 phased out interest rate ceilings that were believed to have limited banks' ability to raise funds. During the mid 1980s, the national economy was strong and capital regulation was not as well developed as it would be in subsequent years. Beginning in 1986, however, the combination of falling oil prices and over-aggressive commercial real estate lending by banks and S&Ls in the oil patch states and the Southwest exacerbated interest rate losses that these institutions faced in the early 1980s (due to the mismatched term structure of assets and liabilities) and led to massive failures. (See Browne and Rosengren 1992 for a summary of this literature.)

A strong international banking agreement also led to a greater focus on bank capital regulation in the late 1980s. The Basle Accord, signed in 1987 and implemented between 1989 and 1992 by the major industrial countries, specified different risk weights for various categories of loans and effectively encouraged banks to increase their holdings of government securities and residential mortgages at the expense of other types of lending.[6]

As a reaction to the banking problems in the oil patch states in the late 1980s, some critics have argued that banks were scrutinized more carefully and in some cases forced to "mark to market" their distressed assets to a greater extent than in previous downturns. For example, in New England after 1989, regulators began to require banks to establish reserves for loans that were currently making payments but whose underlying collateral had fallen below the remaining loan balance, the so-called "performing nonperforming loans" (Litan 1992).

Later, the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA) required regulators to set explicit capital thresholds and take prompt corrective action to ensure that banks met these requirements. Under the new capital thresholds implemented after FDICIA, banks with a leverage ratio (total tier 1 capital, including equity, divided by total average assets) of as low as 4 percent were considered undercapitalized and were required to shrink asset growth (loans), cut dividends, or raise additional equity capital. For the first time, regulators had relatively little discretion to permit poorly capitalized banks to deviate from these new requirements. Regulators began enforcing the more stringent leverage ratios after 1991. These were often included in "formal actions," under which troubled institutions agreed to meet the new, higher leverage ratio threshold in as little as two years.

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The Northeast, and in particular New England, was the first region to suffer a recession after the implementation of the stricter capital regulations and the signing of the Basle Accord. The region also suffered a sharp decline in commercial real estate values that reduced bank capital significantly. Because raising new capital to meet regulatory requirements was extremely difficult during the economic downturn, banks under "formal action" often chose to shrink their assets. Real estate lending was particularly hard hit, possibly because regulators looked much more carefully at new real estate loans and because banks were unwilling to make new loans in a sector where they recently had suffered such severe losses (Peek and Rosengren 1996). This shrinkage in real estate and other types of small business lending led several researchers (Peek and Rosengren 1994, 1995a, 1995b, and 1996 and Litan 1992) to conclude that the region suffered from a credit crunch in the early 1990s.

More recently, Southern California suffered a significant downturn that some have argued is similar to the credit crunch in New England and the rest of the Northeast. Bank regulation may have been similar, but the structure of the construction industry differs between the two regions. New England, and to some

[6] Loans for commercial real estate and all types of construction, regardless of the terms of the loan, were deemed risky under the Basle Accord and banks were required to hold additional capital. Because these risk-weighted capital requirements were not binding for most institutions, however, the evidence is mixed as to whether banks adjusted their assets to be more consistent with the risk weights specified in the Basle Accord. (See Hall 1993 and Hancock and Wilcox 1994.)

extent the entire Northeast, are more mature areas with slower growth and fewer large tracts of land attractive to large national builders. As a result, most new residential housing is constructed by small local builders whose output is sensitive to reductions in lending or increased down payment requirements by local banks. Southern California, on the other hand, has many large builders, who might be expected to have direct access to national debt and equity markets. Also, national building firms, which have more diversified cash flows, have a much larger market share in California than in the Northeast. Finally, the loss in real estate values in California was much smaller than the decline in the Northeast. Thus, California was less likely to have suffered from credit-related reductions in the supply of new construction.

The results in this study suggest that more attention should be paid to housing supply in understanding regional real estate cycles.

While the previous discussion suggests that recent changes in banking regulation made a credit crunch more likely after 1991, particularly in the Northeast, other researchers (Bernanke and Lown 1991; Hancock and Wilcox 1995) argue that the loss of bank capital in previous periods was also associated with a credit-related reduction in output. Using data from 1984 to 1992, Hancock and Wilcox find a negative relationship between bank capital and a variety of construction measures. As the authors indicate, their results suggest that nonbank sources of capital do not necessarily fill the vacuum when bank capital declines. While their work clearly indicates the potential real effects of credit restrictions, their use of bank capital data may be problematic if declines in capital occur contemporaneously with slowdowns in general economic activity. In that case, researchers may not be able to distinguish between lower real estate activity that results from economic conditions that reduce demand for loans, and lower real estate activity that results from declines in the supply of bank lending (the credit crunch hypothesis).[7] Also, Hancock and Wilcox's econometric results suffer from the potential specification problems associated with using price levels instead of price changes in a housing starts equation, especially if capital reductions are correlated with real estate price declines.

The estimated housing starts functions shown in Table 2 provide an alternative approach to looking for real effects of credit shortfalls. If credit for residential real estate development and construction is constrained by overly strict banking regulation, then the level of new housing starts should be lower than the level that would be predicted by a well-specified housing supply equation. According to this view, a credit crunch is consistent with a prolonged period when the residuals from the housing supply estimation are negative. A measure of credit availability is not included directly in the regression equation because of possible endogeneity for which we have no readily available instruments.

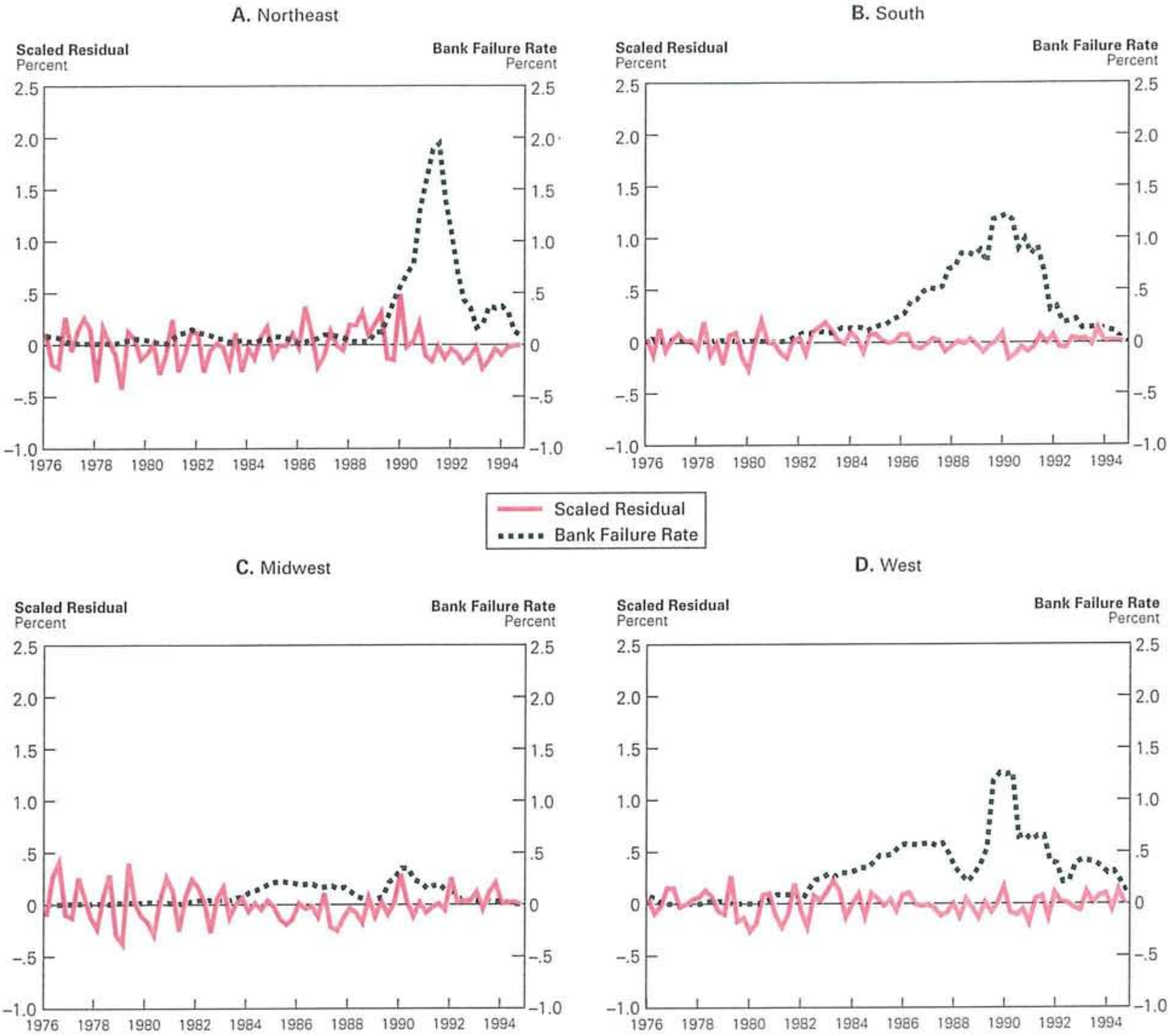
Figures 3A to 3D present graphs of the scaled residuals from the regressions in Table 2, along with a four-quarter moving average of the bank failure rate for each region. It is quite striking that for the Northeast, the residuals (the red line) are negative for an extended period in the early 1990s, a difference that is statistically significant from zero at the 10 percent level. During the same period, the region's bank failure rate was almost 2 percent per quarter, a much higher failure rate than that experienced by any other region since 1975. The high failure rate for banks was the result of a sharp decline in the region's real estate values and particularly commercial real estate, which comprised the largest part of most banks' real estate lending, possibly combined with the effects of stricter bank regulation.

Figure 3B shows similar data for the South. Somewhat surprising is the lack of evidence that housing construction was affected by credit-related problems during or shortly after the significant economic downturn in the oil patch states in 1985 and 1986. Although commercial real estate values fell even more in parts of the South than in the Northeast, regulators may have acted more slowly to close troubled banks in the South. The bank failure rate peaked in 1990, well after the trough in the region's economy. One potential problem in these findings is that this test has low power in testing for credit restrictions in areas that do

[7] The results in Peek and Rosengren (1995b) suggest that such endogeneity problems may be overstated. The authors show that declines in lending and the shrinkage in capital correspond to the timing of bank inspections and the imposition of regulatory enforcement actions rather than declines in demand.

Figure 3

AR1 Scaled Residuals and Bank Failure Rate



Note: The scaled residual is computed by dividing the actual residual by the average starts for each region.
The bank failure rate is a four-quarter moving average.
Source: Board of Governors of the Federal Reserve System and authors' calculations.

not correspond to the four Census regions used in this analysis: the "oil patch" is only a portion of the South region. Unfortunately, data on housing starts are not available for individual states.

Data from the Midwest and the West also show little evidence of credit-related constraints on new construction. Neither region suffered from as severe a decline in the number of banks as the Northeast or the South. Again, geographic aggregation may present problems in identifying credit-related problems in the West, where Southern California was suffering from a recession at the same time that the Mountain states were booming.

While by no means conclusive, these results suggest that if credit restrictions limited single-family housing construction, these effects occurred only in the Northeast. Such a credit crunch likely resulted from the deep decline in asset values that led to poorly capitalized banks, and was exacerbated by changes in bank capital regulation. This analysis includes only one measure of banking problems, the failure rate. Other measures might be relevant, especially the aggregate loss of bank capital in a region. Unfortunately, a consistent measure of bank capital is not available over the entire period of this study. Also, the omission of other, non-credit-related factors from the analysis or simple misspecification could bias these results. This problem is difficult to address because measures such as bank capital are endogenous, and there are few good instruments for this variable.

V. Conclusion

This article presents an empirical model of new housing supply, based on models of the conversion of raw land to urban use. The empirical results show that housing starts respond to changes in existing house prices rather than to the level of house prices, the measure used in previous research. We apply this model to the four U.S. Census regions in order to estimate regional supply elasticities. While housing starts are somewhat price-elastic, with an estimated elasticity of between 0.9 and 3.9, the price elasticity of the housing stock, a fuller measure of supply elasticity, is quite small—less than 0.05 in all regions. The results also show a prolonged period of below-predicted construction in the Northeast during the early 1990s that does not appear during downturns in other periods or in other regions. These findings are consistent with the hypothesis that a severe negative shock to local asset values (and thus bank capital), possibly combined with changes in banking regulation in the late 1980s and early 1990s, led to a "credit crunch" that had real output effects, including reduced new housing construction.

Finally, as noted in the introduction, few papers have studied the determinants of the supply of residential real estate, despite the importance of supply in determining prices. The results in this study suggest that more attention should be paid to housing supply in understanding regional real estate cycles. To the extent that factors such as credit constraints, permitting restrictions, or regulatory-imposed delays limit the adjustment of housing supply in a recovery, prices may be more likely to overshoot their equilibrium level, leading to an exacerbated boom-bust cycle.

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