Land use regulation and new construction

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Abstract

This paper describes the relationship between land use regulation and residential construction. We characterize regulations as either adding explicit costs, uncertainty, or delays to the development process. The theoretical framework suggests that the effects on new construction vary by the type of regulation. Using quarterly data from a panel of 44 U.S. metropolitan areas between 1985 and 1996, we find that land use regulation lowers the level of the steady-state of new construction. Our estimates suggest that metropolitan areas with more extensive regulation can have up to 45 percent fewer starts and price elasticities that are more than 20 percent lower than those in less-regulated markets. One implication of regulations that lengthen the development process is that the short- and long-run effects of demand shocks will vary relative to conditions in markets without such delays. We find support for this observation in the data. As well, we find other differences by type of regulation: development or impact fees have relatively little impact on new construction, but regulations that lengthen the development process or otherwise constrain new development have larger and more significant effects.

1. Introduction

Land use regulation is one of the most acrimonious areas of local government

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activity. Builders and developers frequently clash with local residents over the extent of new development. There is a considerable body of research that studies the theoretical and empirical effects of various land use regulations on urban form, development patterns, and the price of housing. Theory indicates that regulations such as zoning, growth controls, and development fees affect housing market outcomes both by constraining supply and increasing demand. Yet, nearly all of the existing empirical work has explored the impact of regulation on house prices, with the bulk of the papers finding that increased local regulation leads to higher house prices.[1] The nearly exclusive focus on prices is problematic because researchers cannot directly measure whether higher price increases are due to higher demand or lower supply.[2] Constraints on supply result in higher house prices, but so too does the capitalization of benefits that regulations provide for local residents. In this paper we present a structural model that formally captures the relationship between aggregate market supply and local government land use regulation.

In the empirical work that follows, we identify both static and dynamic effects of various types of land use regulation. The results show that land use regulation not only lowers the steady-state level of new construction, but can also reduce the speed of adjustment of new construction to demand and cost shocks. Our empirical work also suggests that purely financial regulations, such as development fees, have a much smaller effect on new construction activity than regulations that induce additional delays and lengthen the construction process.

The empirical work in this paper estimates a quarterly new housing supply function for 44 U.S. metropolitan areas for the years 1985 to 1996. Consistent with theory, the results show that regulation has a strong negative impact on new construction. U.S. metropolitan areas with a high degree of regulation, measured by longer delays in land development and the number of potential growth management policies, have steady-state new construction levels that are up to 45 percent lower than in U.S. metropolitan areas with less regulation. We also find strong dynamic effects of regulation. Restrictions that delay development or are intended to manage growth lower the price elasticity of new construction by over 20 percent. This reduction in the price elasticity is concentrated in the longer lags of the supply response, after the existing inventory of developable lots has been exhausted.

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[1]See Fischel (1990) for a review of the empirical literature on land use regulation. Empirical work that looks at regulations and supply is basically limited to Mayo and Sheppard's (1996) evaluation of variation in regulatory oversight and housing supply in Korea, Malaysia, and Thailand, Thorson's (1997) analysis of agricultural zoning, McFarlane's (1997) working paper on development fees, and Skidmore and Peddle's (1998) work on building permits and impact fees. There are also rudimentary regressions by Glickfield and Levine (1992) on local growth control initiatives and construction activity in California.

[2]One exception is Pollakowski and Wachter (1990). They provide a methodology for identifying within MSA supply restriction effects by observing prices in adjacent communities that lack the regulations and testing for spillovers from regulating jurisdictions.

The results in this paper build upon existing work (Mayer and Somerville, 2000), which shows that new housing construction is appropriately modeled as a function of changes in house prices and costs rather than as a function of the levels of those variables. As well, this paper is one of the handful that estimates a housing supply equation at the MSA level. Most empirical work on housing supply research uses national data, despite the absence of a national housing market.[3] The national supply functions are subject to more of the aggregation bias described in Goodman (1998) than are studies using MSA data. Comparing our results with those for U.S. national data in Mayer and Somerville, we find that the price elasticity of construction at the U.S. metro area level is only slightly larger than the national price elasticity, but the MSA data exhibit a slower response to price shocks.

The paper is structured as follows. A framework for looking at the static and dynamic response of construction to development fees and regulatory delays is described in Section 2. Section 3 describes the data used, while Section 4 presents the empirical analysis. Finally, we conclude with some policy implications and suggestions for future research in Section 5.

2. Land use regulation in a model of new construction

To begin, we utilize the basic structure in Mayer and Somerville (2000) to analyze the effects of land use regulation on housing supply. They show that housing starts are best specified as a function of the change in house prices rather than of their level. House prices regulate the stock of housing, balancing aggregate supply and demand. In contrast, new construction, the dependent variable used in most empirical analyses of housing supply, is the change in the stock. As a consequence, housing starts should depend on the change in house prices, not their level. From an econometric perspective, this specification of housing supply avoids the econometric problems related to using a non-stationary explanatory variable (house price levels) in a time series equation with a stationary dependent variable (housing starts or building permits).[4] In addition, the level of house prices ensures a spatial equilibrium among residents of a given city, so that house prices change with city size and growth. Both large, slow-growing cities and smaller, fast-

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[3]See Olsen (1987) and DiPasquale (1999) for critical surveys of the existing literature on housing supply. Among the few supply studies to use metropolitan area data are Poterba's (1991) panel of permits, Stover's (1986) translog housing supply cost function, and Dreiman and Follain's (1998) VAR model for the housing demand and supply equilibrium.

[4]Research by Holland (1991) and numerous other researchers finds that the real price of existing housing is not stationary in levels ($I(0)$), but is instead stationary in differences ($I(1)$). The stock of housing is also non-stationary in levels. Starts are the first difference in the stock, net of demolitions. With U.S. regional and national data, Mayer and Somerville (1996, 2000) find that the stock is non-stationary and starts are stationary in levels.

growing cities can have high house prices, yet these two types of cities will have a very different pattern of housing starts. In the Mayer and Somerville model, new construction is modeled as a function of changes in house prices, changes in the cost of capital, and changes in construction costs. Below, we incorporate land use regulations into this framework.

2.1. Land use regulations in a model of housing supply

There is no single defining form of land use regulation. Instead we observe multiple government interventions in land and real estate markets. These include explicit laws and implicit policies, all implemented with a wide range of enforcement and intensity. In this paper we consider two classes of regulations, those that impose explicit financial costs on builders, typically development or impact fees, and those that delay or lengthen the development process. We choose these two types of regulations both because of data availability, but also because many types of regulation can be collapsed into these two categories. With sufficient time or money, various regulations such as minimum building standards or lot sizes can be overcome. In other cases, a sufficiently high payment or provision of amenities to affected individuals or communities can weaken or remove opposition to a project. Usually, if a developer is willing to fight long and hard enough, approvals will eventually be forthcoming.

2.1.1. Fixed costs: fees and exactions

It is quite common in many parts of North America for developers and builders to make payments to local governments for the right to develop. Altshuler and Gomez-Ibanez (1993) survey a number of communities and find that by the mid-1980s, approximately 60 percent of U.S. localities impose development or impact fees. These fees can be quite high; in a nationwide survey in the mid-1990s, a U.S. builder organization found that fees and charges in highly regulated jurisdictions averaged $21,012, and were approximately $28,000 on a $200,000 house (NAHB, 1996).

A large body of theoretical research explores the effects of fees and exactions on the timing, intensity, and spatial distribution of development.[5] In the typical urban model, fees result in a smaller city. In a Capozza and Helsley (1979) city with a known exogenous growth process for housing rents and fixed lot and house sizes, developers maximize profits by selecting the optimal time to convert raw land to urban use and build houses. Fees increase the cost of construction. Consequently, at a given distance from the center of the city, the rent level that

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[5]Downing and McCaleb (1987) and Fischel (1987) review the effects of fees. A more complex theoretical treatment can be found in Brueckner (1997, 1998), who models fees with externalities and as a choice for infrastructure finance. McFarlane's (1999) theoretical analysis investigates variation in the timing and intensity of development by type of fee.

triggers development must be explicitly higher in a city with fees. As a result of higher fees, development occurs later. Another way to express this relationship is to note that, at any given point in time, a city with fees is smaller than an otherwise identical city with no fees. Other types of regulation that raise construction costs will have a similar effect on starts.

While impact fees reduce the equilibrium size of a city, once this adjustment has occurred, fees should have no further impact on construction activity.[6] However, once we add depreciation to this model, higher fixed fees will lead to fewer steady-state housing starts. In a city that is not growing, housing starts occur to replace the portion of the stock lost to depreciation, deterioration, and demolition. The direct effect of impact fees is that a smaller city will have fewer units that need to be replaced or renovated every year. In addition to this first-order effect, fees also impact the decision to renovate an existing unit versus moving into a new unit. Montgomery (1992) shows that households are more likely to renovate than move as house prices rise. Thus, fees act as a tax on new development, raising the price of new units relative to existing structures. In response to higher fees, homeowners will choose to live in existing units longer, resulting in fewer removals and less new construction.

Most existing empirical articles focus on how fees affect the level of house prices, rather than new construction, with two notable exceptions. McFarlane (1997) finds that builders accelerate the application for permits in advance of the imposition of fees. Using somewhat limited data from DuPage Co., Illinois, Skidmore and Peddle (1998) model building permits as a function of city and year fixed effects, local government revenue and taxation policies, and the presence of fees. They find that the presence of impact fees is associated with a 25 percent reduction in building permits.

2.1.2. The land use regulatory process: reviews and delays

Local land use regulation often adds long delays into the development process by introducing multiple reviews that a developer must pass before completing a unit. These stages include obtaining subdivision permits, re-zoning existing parcels, filing environmental impact statements, and finally receiving building permits.[7] Fig. 1 presents a flow chart of the development process for the construction of new residences at the urban fringe. We focus on the two important points in the development cycle where many regulatory delays tend to occur. The

[6]The actual effect depends on the nature of the growth of the city. If the area of the city expands arithmetically, then starts are constant over time and fees have no effect. If the border expands geometrically, because city area is convex in the city's radius, then the introduction of a development fee lowers subsequent starts by placing the city on a permanently lower growth path.

[7]In characterizing delays we combine together the effects of a longer time interval between start and completion of a project and that the result of the review process typically effects project characteristics and construction and development costs.

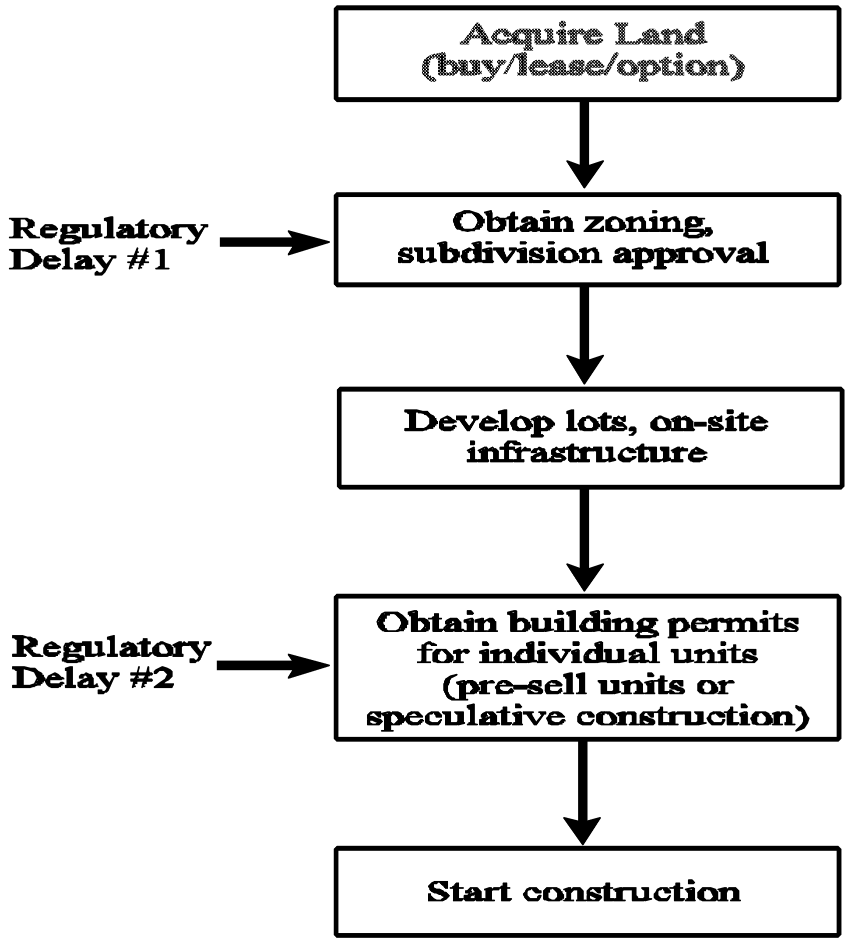

Fig. 1. Flow chart of the development process.

first is when an application is filed to re-zone a tract from agricultural use and subdivide it into lots appropriate for individual houses. Hold-ups occur as developers and officials negotiate over the size, density, and form of the proposed project and the provision of on- and off-site infrastructure. The second stage of regulatory delay occurs when the developer applies for building permits prior to constructing houses on the finished lots.[8]

There are several ways in which the regulatory process affects development.

[8]In general, at the urban fringe the longest delays occur at the time of subdivision and rezoning (development permit). Once a project has passed through that stage building permits are usually granted as requested. For development in built up areas, obtaining the building permit may pose the greatest barrier.

First, just navigating the process adds explicit financial and time costs. The effects of those direct costs are similar to those of fees. Second, both the outcome and the length of the regulatory process are uncertain. Developers do not know the extent to which local authorities will demand costly changes in project density, design, or type before granting a final approval.[9] For risk adverse developers, this uncertainty will reduce the level of new construction above the direct effect of higher mean construction costs.

In choosing when to build, a developer solves a compound option.[10] At each step a builder must choose between proceeding with the project, delaying to learn more information about future market conditions or construction costs, or abandoning a project altogether as demand and cost uncertainty are revealed over time. The irreversible nature of residential development gives this process the characteristic of the exercise of a real option. The regulatory process can affect development timing in this framework either by increasing the time it takes to develop or by creating more defined and distinct stages to the development process, or through both of these mechanisms. While in most cases we would expect that lengthening delays and adding stages would directly raise the cost of development and thus reduce the amount of new construction, there are some circumstances in which the combination of these effects could actually lead to more construction in the short run.

Grenadier (1995) and Bar-Ilan and Strange (1996) find that delays can actually reverse the traditional negative correlation between uncertainty and investment. These papers generate circumstances in which there can be greater investment with delay than in a case with uncertainty but no or shorter lags. Their results are in contrast to other papers in the literature (see Majad and Pindyck, 1987) and depend on the nature of the underlying stochastic process governing returns. In addition, Bar-Ilan and Strange (1998) demonstrate that investment (construction) can be higher when there are multiple options, relative to a single stage process. The existence of a second stage option increases the incentive for exploratory investment — the exercise of the first stage option — relative to a single stage development process. With two stages, there are some intermediate states of the world when a firm will choose to exercise the first of two options (i.e., sinking a portion of their total investment), when it would not have chosen to exercise a single option that involved sinking the entire investment. Contingent on having sunk the expenditure in the first stage, the marginal cost to completion is lower.

In looking at the impact of regulatory delay on new construction, we use a

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[9]This type of uncertainty is not the same as that found in real option models. The uncertainty in the outcome of the regulatory process is not revealed with time, so that delaying the decision to proceed does not allow bad states of nature to be avoided.

[10]There is a well developed theoretical literature that looks at land development as a real option (Titman, 1985; Williams, 1991). This framework has been extended to a number of areas including city growth (Capozza and Helsley, 1980), overbuilding in office markets (Grenadier, 1995), and the effects of potential regulatory taking (Riddiough, 1997), among others.

framework that has many similarities to the model of Bar-Ilan and Strange (1996). An optimal response for a developer facing long delays in developing raw land can be to keep an inventory of developed lots to meet expected demand. This is similar to the behavior of a manufacturer keeping a buffer stock of raw materials to meet uncertain demand for the final product. An increase in the length of the development delay may cause builders to keep a larger buffer stock of lots and reduce the trigger price required to begin new construction (conditional on having the buffer stock of approved lots). When a builder completes the first stage, a portion of development costs, such as design and engineering costs and some site work, are sunk. Thus, the marginal cost of completing a house is lower than it would be for a developer in an unregulated market who has not started the development process.[11] In addition, the inventory of developed and permitted lots, which is the completion of the first stage of development, allows the builder to respond more quickly to positive demand shocks in a second stage and build units when demand is realized.[12]

In choosing the inventory of lots, a builder trades-off two possible effects. If future demand turns out to be very high, the inventory of lots places an upper limit on the quantity of houses the builder can produce. In bad states of the world, however, the builder will have a large inventory of lots that are unused and will have lost the (sunk) costs required to get approval for those lots. In setting the optimal inventory, builders must take into account both expected demand and the time it takes to get approval for new lots. We expect that the optimal buffer stock will increase with the length of time required to gain approval for additional lots.

If developers choose to hold a larger inventory of approved lots in markets with greater regulatory delays, there are some circumstances in which new construction in the short run might actually be higher in these markets than in locations with little regulation. When developers have a buffer stock of approved lots, the incremental cost of completing a unit is lower. Thus developers in a market with regulation actually face a lower hurdle rate to begin new construction than in a market with little regulation where builders have not accumulated a large inventory of approved lots.

Fig. 2 illustrates the alternative scenarios of short-run supply responses to demand shocks depending on the regulatory environment. In both cases the maximum level of starts in the regulated market is determined by the existing inventory of developed lots. In an unregulated market, we assume the extreme case of instant land conversion, so no inventory is needed. In Fig. 2a we present the

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[11]Asymmetries between owners can exacerbate this problem. Building on approved lots may be preferable to selling them if there is a large wedge between the value to the current owner and another developer. This occurs when approvals or permits cannot be transferred or when a new buyer faces additional hurdles from local officials.

[12]Discussions with builders in Boston suggest that some developers hold as much as a 2 year inventory of developable land.

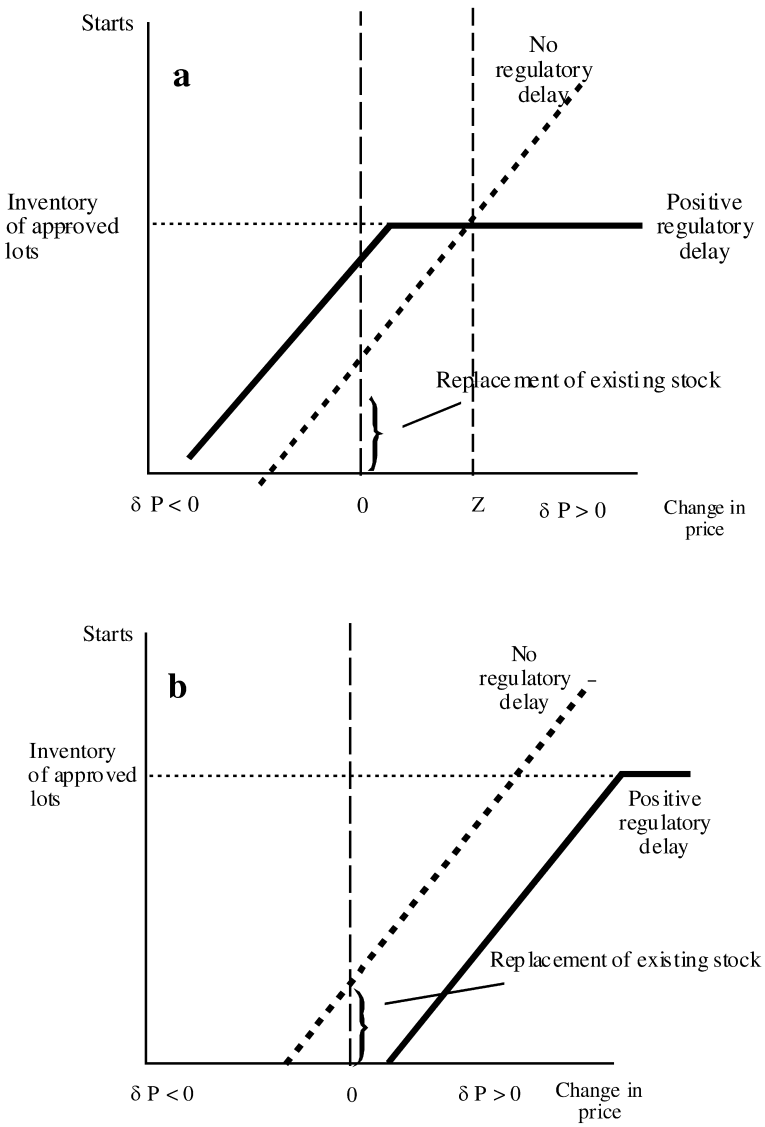

Fig. 2. Contingent on inventory of approved lots. Impact of regulatory delay on construction. (a) Effect of lower marginal cost of completion for sites with regulation dominates higher cost of development effect from regulation. (b) Effect of higher cost of development dominates lower marginal cost of completion for sites with regulation.

case where the *short-run* impact of regulation for some shocks to demand is higher. Here, for $\delta P < Z$, the short-run effect (more development in the second stage of a two stage process) dominates the long-run effect — lower development. This is not a steady-state outcome, but one where the marginal cost to completion is lower in the regulated market because some costs of development were paid as part of the regulatory process. In Fig. 2b we show the second and more intuitive case, where the higher costs and uncertainty from regulation ensure that short-run starts are always lower in the market with regulatory delays, although the existence of a two stage process partially offsets this effect.

As the above discussion indicates, the aggregate effect of the regulatory process and delays on new development becomes an empirical question as there are a number of offsetting factors. In the long run, the theoretical implications of regulatory delays are clear: the financial and time costs will reduce steady-state starts. However, for the reasons outlined above, there can be short-run conditions where construction activity is actually higher in a market with regulation. Empirically, it is important to control for these effects. In an unregulated city, the mean impact of a price change on new construction, the coefficient on price change in a linear regression, is the slope of the straight (dashed) line in Fig. 2a,b. However, in regulated markets, the regression coefficient would be the average slope of the kinked line, which is clearly lower than in the unregulated market. One empirical test that we conduct below is to evaluate this trade-off and determine whether there are differences between the short-run and long-run responses to a demand shock depending on the regulatory environment in a housing market. As long as builders have not exhausted their inventory of lots, the change in quantity for a given demand shock would be similar across markets, but once the constraint binds differences in price elasticities between the regulated and unregulated markets could be sizeable.

3. Data

Table 1 gives descriptive statistics for the key variables used in the empirical work by U.S. metropolitan statistical area (MSA). The real house price series is the quarterly percentage change in prices using data for 1985 to 1996. In the absence of housing starts data for all but a few MSAs, we use the number of new single family building permits issued on a quarterly basis — seasonally unadjusted — as our measure of new construction.[13] MSA definitions are standardized to their post-1993 boundaries. Changes in the cost of financial inputs to builders are measured as arithmetic changes in the real prime rate. This measure seems

[13]Somerville (forthcoming) studies the relationship of starts and permits using a panel of Canadian cities. He finds the starts in period t are a function of permits in period t and $t-1$ and that approximately 90 percent of permits become starts within these two quarters.

Table 1
Descriptive statistics

City	Quarterly growth rate in real house prices (%)		Mean quarterly new housing permits issued	Months to approve subdivision	Number of growth mgt. techniques	Use development fees
	Mean	S.D.				
Akron PMSA	0.63	1.20	528	9.5	2	0
Atlanta MSA	0.10	1.20	7,466	1.5	1	0
Baltimore PMSA	0.39	1.30	3,005	1.5	1	1
Boston PMSA	0.42	2.60	1,456	4.5	2	1
Buffalo MSA	0.58	1.50	579	1.5	0	0
Charlotte MSA	0.39	1.10	2,202	4.5	0	1
Chicago PMSA	0.74	1.00	5,518	1.5	0	1
Cincinnati PMSA	0.37	0.80	1,482	4.5	2	1
Cleveland PMSA	0.54	0.90	1,256	3	0	0
Columbus, OH MSA	0.45	0.80	1,613	1.5	0	0
Dallas PMSA	−0.66	1.50	3,521	1.5	0	0
Denver PMSA	0.08	1.50	2,061	4.5	0	0
Detroit PMSA	0.92	1.10	3,027	4.5	0	1
Gary PMSA	0.60	1.30	474	7	2	0
Greensboro MSA	0.16	1.10	1,524	4.5	0	0
Houston PMSA	−0.69	1.60	2,388	1.5	0	1
Indianapolis MSA	0.33	0.80	1,838	1.5	0	0
Kansas City MSA	−0.02	1.00	1,964	4.5	0	0
Memphis MSA	0.12	1.50	1,502	1.5	0	1
Miami PMSA	0.22	1.20	1,553	7	1	1
Minneapolis MSA	0.17	1.00	3,626	3	0	0
Nashville MSA	0.28	1.30	1,760	4.5	2	0
New Orleans MSA	−0.32	1.90	723	1.5	1	0
New York PMSA	0.48	2.50	974	4.5	2	1
Newark PMSA	0.38	2.60	791	3	4	0
Oakland PMSA	0.38	1.90	1,787	7	2	1
Oklahoma City MSA	−0.85	2.20	761	1.5	0	1
Orange Co., CA PMSA	0.13	2.30	1,728	1.5	0	1
Orlando MSA	−0.12	1.20	3,181	4.5	2	0
Philadelphia PMSA	0.54	1.90	3,619	1.5	3	0
Phoenix MSA	−0.18	1.60	5,130	4.5	0	0
Pittsburgh MSA	0.38	1.00	1,149	3	0	0
Portland, OR PMSA	0.91	1.40	1,979	4.5	3	1
Richmond MSA	0.16	1.10	1,646	1.5	0	0
Sacramento MSA	0.23	2.00	2,452	4.5	2	1
St. Louis MSA	0.15	1.00	2,435	3	0	1
Salt Lake City MSA	0.66	2.10	1,367	4.5	2	0
San Antonio MSA	−0.93	3.50	947	4.5	0	1
San Diego MSA	0.20	1.90	2,227	1.5	2	1
San Francisco PMSA	0.66	2.30	375	7	2	1
San Jose PMSA	0.59	2.50	647	4.5	1	1
Seattle PMSA	0.75	1.90	2,451	7	1	0
Tampa MSA	−0.16	1.50	2,858	3	1	1
Washington, DC PMSA	0.41	1.60	6,514	4.5	0	0
Mean across MSAs	0.24	1.57	2,184	3.67	0.93	0.48
S.D. across MSAs	0.43		1,561	2.01	1.09	0.51
Min. of MSA aggregate	−0.93	0.80	375	1.5	0	0
Max. of MSA aggregate	0.92	3.50	7,466	9.5	4	1

appropriate given that most construction financing is based on adjustable interest rates that vary with the prime rate.[14] Demand-side effects of changes in interest rates should be reflected in movements in housing prices.

We measure house price movements with the Office of Federal Housing Enterprise Oversight (OFHEO) repeat sales price index.[15] The repeat sales methodology of the series evaluates price changes holding location within a city constant. This aspect of the series is important as it is consistent with the Mayer and Somerville treatment described in Section 2. In contrast, other empirical papers on housing supply use the price index for new homes, which violates the fixed location requirement. The new house price index controls for unit quality, but not unit location within the metro area. The problem is that new construction typically occurs at the urban fringe, which is increasingly distant as a city grows.

Data on land use regulation comes from the Wharton Urban Decentralization Project (Linneman and Summers, 1991). These data summarize surveys sent to local planners in a sample of 60 MSAs, of which we have price data for 44 MSAs. We include a number of measures of regulation, including the estimated number of months required for subdivision approval, a count of the number of ways growth management techniques have been introduced in the MSA, and whether development or impact fees are imposed in the cities in the MSA. In the survey, time for subdivision approval is a categorical variable for the estimated number of months until approvals are obtained to subdivide a properly zoned property of a given size for residential development. We convert the categorical variables into months using the midpoint of each grouping and the top censoring point. The number of growth management techniques is the sum of five different dummy variables, which each indicate whether one of the following approaches for introducing growth management policies are prevalent in the MSA: citizen referendum, legislative action by municipalities, counties, and the state, and administrative action by public authorities.[16] We assume that the more kinds of actions taken and the greater the number of groups which act to control development, the more constrained is the regulatory environment.

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[14]We also used percentage changes in the BLS construction materials and the softwood lumber price indexes to measure materials costs. As indicated below the estimated coefficients on these costs were never statistically different from zero.

[15]The series is constructed from mortgage transactions filed with Freddie Mac and Fannie Mae. These repeat sales indexes were first used by Abraham and Shauman (1991) and Abraham and Hendershott (1992) in research on U.S. house price dynamics. The series is available from http://www.ofheo.gov/house/download.html.

[16]We are forced to create this ad-hoc index because of the relatively small number of cross-sectional observations in our sample. With a greater number of cities, we would be able to determine if each type of growth management has a different estimated effect on new construction.

4. Empirical results

4.1. Static effects of regulation

We begin by applying the empirical model used in Mayer and Somerville (2000) to metropolitan area data and adding the regulation variables to the right-hand side. Table 2 presents the results of various regressions of log permits on the current and five lags of changes in log house prices, the change in the real prime rate, which is intended to capture changes in financing costs for builders, quarterly dummies, a separate time trend variable for each city, two variables to measure differences in local regulation, and log 1980 population (to control for city size). We exclude measures of construction costs from these regressions. In other regressions with materials and lumber prices indexes, we did not obtain statistically significant or robust coefficient estimates on either cost measure. The result for construction costs is consistent with results in other supply papers. Typically, coefficients on these costs are not statistically significant and often have the wrong sign in housing starts or permits regression.[17] Regression (1) is a simple OLS specification. The coefficients on price changes are highly significant. The estimates show that a 1 percent increase in house prices results in a temporary 15 percent increase in new construction spread over the current and the ensuing five quarters. Comparable estimates by Mayer and Somerville (1996) using national data show an 18 percent increase in construction over three quarters.[18] In this specification, the rise in construction from a price increase is temporary, and after six quarters new construction returns to its steady-state level.

As expected, regulation has a negative effect on the steady-state level of construction. The coefficients on the delay and growth control variables are negative and in most specifications are statistically different from zero. Following Kloek (1981), we correct the standard errors on the coefficients for the regulation, population, and interest rate variables for downward bias resulting from aggregation, since these variables are either constant over time for a given city or across cities for a given quarter. The coefficient on the estimated number of months to receive subdivision approval shows that a one standard deviation increase in the number of months of delay results in a reduction of 20–25 percent in the number of permits obtained by builders. The coefficient on growth management has a

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[17]Somerville (1999) discusses the estimated construction cost coefficients in the literature. Using hedonic cost indexes constructed from micro-data, he demonstrates that existing cost indexes can suffer from data and simultaneity bias.

[18]The U.S. national estimates were made using starts rather than permits. Using Canadian metropolitan area data, Somerville (forthcoming) finds that the process of converting permits to starts is essentially unaffected by changes in housing market conditions so the estimates for permits should be roughly comparable to those for starts.

Table 2
Housing supply — alternative specifications. Dependent variable: log(single family permits)[a]

	Regr. (1)	Regr. (2)	Regr. (3)	Regr. (4)	Regr. (5)
Regression type:	OLS	GLS	PCSE	GLS	IV quasi-differ.
Error structure:		Panel, AR1	Panel	Panel, AR1	Panel
Variable					
Price growth rate	3.42	3.43	3.42	3.42	2.68
	(0.48)	(0.31)	(0.55)	(0.31)	(0.34)
Price growth rate	3.64	3.99	3.64	4.00	3.54
$(t-1)$	(0.48)	(0.31)	(0.53)	(0.31)	(0.35)
Price growth rate	2.70	2.63	2.70	2.64	2.85
$(t-2)$	(0.46)	(0.30)	(0.53)	(0.30)	(0.35)
Price growth rate	1.84	2.05	1.84	2.06	2.25
$(t-3)$	(0.45)	(0.29)	(0.50)	(0.30)	(0.34)
Price growth rate	2.35	2.21	2.35	2.21	2.17
$(t-4)$	(0.44)	(0.29)	(0.48)	(0.29)	(0.34)
Price growth rate	1.14	1.21	1.14	1.21	0.96
$(t-5)$	(0.42)	(0.26)	(0.47)	(0.26)	(0.30)
Months to receive	−0.127	−0.100	−0.127	−0.100	−0.093
subdivision approval	(0.017)	(0.029)	(0.018)	(0.029)	(0.053)
No. of growth manage-	−0.062	−0.080	−0.062	−0.071	−0.383
ment techniques	(0.031)	(0.045)	(0.030)	(0.046)	(0.114)
Use development fees				−0.131	
(dummy variable)				(0.094)	
Change in real prime	0.0255	−0.0089	0.0255	−0.0089	−0.0026
rate	(0.0223)	(0.0117)	(0.0222)	(0.0115)	(0.007)
Ln(MSA population	0.405	0.307	0.405	0.329	0.432
in 1980)	(0.055)	(0.082)	(0.050)	(0.085)	(0.118)
Constant	4.58	5.24	4.58	5.12	4.51
	(0.42)	(0.62)	(0.42)	(0.64)	(0.95)
Time period	1985–96	1985–96	1985–96	1985–96	1985–86
No. of observations	2086	2086	2086	2086	2086
Adjusted R^2	0.866				
AR(1) ρ value		0.642		0.646	0.65[b]
Log likelihood		1667.9	999.8	1606.6	

[a] Standard errors are in parentheses. Data are quarterly. All regressions include quarterly dummies and a city-specific time trend. 'Panel' allows for city-specific error terms, 'AR1' includes a common AR1 parameter. Standard errors for variables aggregated by city or time period are adjusted to correct aggregation bias. Regression (5) is an IV regression using quasi-differenced values to correct for serial correlation. Instruments are used for the regulation variables.

[b] Indicates an estimated ρ value for quasi-differencing.

similar effect; each method available for introducing growth management is correlated with a 7 percent decline in residential construction. Combining these two effects is striking: an MSA with 4.5 months delay in approval where growth management actions have been introduced through two different approaches will have about 45 percent less new construction than an MSA with a minimal 1.5 month delay and no growth management policies.

While the above results are substantial, the standard errors might be biased if the regression does not satisfy all of the OLS assumptions. In particular, previous work with national data suggests that we should allow for serial correlation. Also, the variance of the residual might not be constant across MSAs, possibly due to differences in the types of shocks suffered by local economies. To control for possible biases in the standard errors, we estimate a GLS equation in regression (2) that allows for AR1 serial correlation and a city-specific variance. The coefficient estimates are quite similar to the OLS estimates, though the standard errors for the regulation variables rise.[19] The third column reports the results from an equation using OLS estimates and panel-corrected standard errors as in Beck and Katz (1995). Once again, the estimated coefficients on the regulation variables are little changed and retain their statistical significance.

In regression (4) we test for the effect of impact fees on new construction. Using the city-specific variance and common AR1 parameter specification from regression (2), we add a dummy variable for whether jurisdictions in the MSA assess impact fees. Although the coefficient on impact fees is negative, it is not statistically different from zero at conventional levels. While this is not inconsistent with the model, we cannot rule out measurement error as an explanation.[20]

At first, these results might seem surprising. Fees have a smaller impact on new construction than a 2 month increase in the approval delay, even though the time cost of this delay is smaller than the cost of fees in many cities. However, this finding is consistent with the comments of builders, who complain that the uncertainty surrounding the permit and zoning approvals process creates greater problems than predictable costs associated with fees. If builders must commit up-front capital as part of the regulatory review process, they may be less likely to undertake projects in high delay cities. We explore the dynamic effects of delay further in a subsequent section.

A potential problem with these results is that regulation may be endogenously

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[19]In other regressions, we removed constraints on the form of the variance–covariance matrix and allowed both city-specific AR1 coefficients and for residuals that were also correlated across MSAs. The standard errors in this specification are considerably lower than those reported in Table 2. However, that GLS specification has a large number of estimated terms in the variance covariance matrix (over 1000 separate terms in a regression with slightly over 2000 observations) and is subject to the Beck and Katz (1995) critique of downward bias in the standard errors.

[20]We do not include the amount of the fee because the data on impact fees in the Wharton database is noisy. While the general pattern of impact fees appears consistent, the estimated amount of the fees appears to be quote low, averaging less than $US 1500 even in MSAs acknowledged to have very high fees. These amounts are substantially below those reported by most builders and may be biased downward by the inclusion of many communities within an MSA who assess no fees, but also have little new construction.

determined with new construction. For instance, faster growing localities might be more likely to regulate new construction because of congested local public goods. Alternatively, slow growing areas may actively support development to foster economic growth. There is a small literature that allows for endogenous land use regulations.[21] For the most part that literature is limited to regulations within a single or small number of MSAs and does not provide substantive guidance to the cross-sectional issues we face in this data set. To correct for any endogeneity we re-estimate regression (2) using a two stage approach where we create quasi-differenced values for our variables to correct for autocorrelation in the errors and then use an IV estimation on the quasi-differenced variables. The first stage AR1 regression generates a ρ of 0.65. We use the following variables as instruments for the regulation variables: the number of jurisdictions with land use control (see Hamilton, 1978), Reagan's share of the MSAs 1984 U.S. presidential vote, an index of traffic congestion, MSA 1975 per capita income, the percentage of the adult population with only high school degrees, 1980 population, and whether the state has citizen referendums (following Downes and Figlio, 1997). The results of this regression are shown in column (5). With instrumental variables the standard errors rise on the regulation coefficients, but we still find that regulation has a strong negative effect on MSA housing starts. Surprisingly, there is a large increase in the coefficient on growth management techniques. We believe this effect to be too strong and suspect it is a result of our choice of instruments. Nonetheless, these results indicate quite clearly that the negative effect of regulation on housing starts is not an artifact of endogeneity but of a real impact on builder behavior. Experiments with other instruments lead to similar or somewhat weaker results, but the qualitative pattern is robust.

House prices may also be simultaneously determined with new construction. However, any bias of this type is unlikely given our specification. The new construction variable used is housing permits. The new houses themselves will not be completed for another one to five quarters, and some of the units will never be started or finished at all. In addition, the house price index utilizes sales of existing homes. The reported transaction prices reflect agreements made between buyers and sellers when the purchase and sales agreement was signed, typically 6–12 weeks before the closing. The combination of a leading measure of supply and a lagging measure of prices makes endogeneity quite unlikely. Nonetheless, we tested two additional specifications. In the first we dropped the contemporaneous

[21]Most of the endogenous regulation literature estimates the determinants of broad classes of zoning, either directly (Rolleston, 1987) or in estimating land value (Wallace, 1988; McMillen, 1989; McMillen and McDonald, 1989, 1991; Thorson, 1994). An exception is Fu and Somerville (forthcoming), who study constraints on the allowed density of development within a single city. Other papers that estimate models of regulations include Dubin et al. (1992) for growth controls and Brueckner (1998), who identifies strategic behavior by cities in setting growth controls.

change in house price term. In the second we instrumented for the contemporaneous house price change with a user cost of capital and the change in an index of employment in the MSA, which we construct using one digit standard industrial classification (SIC) code shares of employment in the MSA multiplied by changes in U.S. national employment for those SIC codes. The instruments for price changes performed quite poorly, but in both cases the coefficients on regulation were little changed in magnitude or statistical significance.

4.2. Dynamic effects of regulation

The results from the previous section suggest that regulation has a significant negative effect on steady-state levels of new construction. This finding is consistent with the theoretical framework presented earlier, as well as other research that finds that regulation increases the equilibrium price of housing. A second prediction of the theory is that some types of regulation should reduce the price elasticity of new construction. In particular, regulation that increases the delay between starting and completing the development process will reduce the ability of builders to respond quickly to demand shocks. With stages in the development process, these regulatory delays need not effect the immediate response of starts to a price shock, but will bind once the inventory of available lots is depleted. A third question is whether markets with regulatory delays have a different short-term response to demand shocks than markets without such delays.

To test for these dynamic effects, in Table 3 we include additional variables that interact a dummy variable for more regulated markets with the current and lagged price changes in the basic GLS equation from the previous section. Two alternative specifications are presented. In the first column, the dummy variable equals one if the delay in obtaining subdivision approval is greater than or equal to the median value of 4.5 months. In the second column, the dummy variable represents metro areas where government has introduced at least one growth management tool. Both equations include the delay and growth management variables as continuous variables, as well as the dummy variables used in the dynamic interactions.

The results in Table 3 are consistent with the framework presented above. When the interactions are included, the starts elasticity in the current and lagged quarters increases from 15 to 18 for metro areas with little regulatory delay, but falls to 14.4 in metro areas with longer delays, a statistically significant difference of 20 percent. Much of the decline occurs in the 3rd, 4th, and 5th lagged quarters. This is consistent with the hypothesis that, in the presence of delays, there is a difference between the short- and long-run supply response. When demand increases in markets with long regulatory delays, builders can only respond using sites from the inventory of developed lots. The time required to obtain land and make the improvements to the land needed for lots suitable for the construction of

Table 3
Housing supply regressions — regulation/price change interaction. Dependent variable: log(single family permits)[a]

Regression and error type: Variable	Regr. (1) GLS — Panel, AR1		Regr. (2) GLS — Panel AR1		Regr. (3) GLS — Panel AR1, 2SLS	
Change in log price	3.57	(0.46)	3.72	(0.42)	3.43	(0.34)
Change in log price (−1)	4.04	(0.49)	4.25	(0.43)	4.10	(0.34)
Change in log price (−2)	2.23	(0.48)	3.08	(0.41)	3.21	(0.33)
Change in log price (−3)	2.63	(0.48)	3.12	(0.41)	2.73	(0.33)
Change in log price (−4)	3.43	(0.46)	3.09	(0.39)	2.72	(0.32)
Change in Log Price (−5)	2.12	(0.39)	1.69	(0.34)	1.43	(0.28)
Interact price change and regulation dummy						
Change in log price*dummy	−0.23	(0.60)	−0.59	(0.59)	0.48	(0.79)
Change in log price (−1)*dummy	0.04	(0.62)	−0.15	(0.60)	0.61	(0.79)
Change in log price (−2)*dummy	0.69	(0.60)	−0.55	(0.58)	−2.27	(0.77)
Change in log price (−3)*dummy	−0.85	(0.60)	−1.99	(0.58)	−2.19	(0.77)
Change in log price (−4)*dummy	−1.82	(0.58)	−1.65	(0.57)	−1.37	(0.75)
Change in log price (−5)*dummy	−1.46	(0.51)	−0.79	(0.51)	−0.39	(0.75)
Regulation dummies						
Approval time >4 months	0.711	(1.166)			−0.752	0.174
Growth mgmt. techniques >0			1.218	(0.197)		
Months to subdivision approval	−0.260	(0.053)	−0.127	(0.027)	0.201	(0.053)
Number of growth management techniques	−0.110	(0.045)	−0.0556	(0.092)	−0.269	(0.067)
Change in real prime rate	−0.0078	(0.0116)	−0.0073	(0.0119)	−0.0084	(0.0112)
Population in 1980	0.372	(0.081)	0.357	(0.078)	0.568	(0.081)
Constant	4.97	(0.61)	3.28	(0.58)	2.59	(0.65)
Number of observations	2068		2068		2068	
AR1	0.633		0.625		0.628	
Log likelihood	1611.8		1621.5		1622.0	
Chi(6) for interaction terms	15.2		18.6		19.4	

[a] Standard errors are in parentheses. Data are quarterly 1985–96. All regressions include quarterly dummies and a city-specific time trend. Error structure assumes city-specific error terms, but a common AR1 parameter. Standard errors for variables aggregated by city or time period are adjusted to correct for aggregation bias. Regression (3) uses predicted values of regulation variables in the linear and interaction terms to correct for endogeneity bias.

new homes constrains their response. However, within a year-absent regulation, developers are able to bring land into development. With regulation either the response time is extended or the response is altogether lower. In column 2, the results are even more dramatic. Elasticities drop from 19 to slightly above 13 in more highly regulated communities. The results do not indicate that the contemporaneous effect of a price shock is larger in more regulated markets. These coefficients suggest that the overall negative effect of regulations on starts offsets any short-run positive effect that might result from lags and multiple stages.

Just as in Table 2, we test for the possibility of endogeneity between regulation and housing starts. We lack sufficient instruments to try an instrumental variables approach with the interaction terms. Instead, we use an explicit 2SLS approach, generating predicted values for the regulation variables in a first stage and then using these in the regression presented in column 3 of Table 3.[22] Though coefficient values change, the overall tenor of the results are the same as in regressions (1) and (2). The construction response to a given price shock is lower in more regulated cities and this reduction comes in the later quarters.

To demonstrate the dynamic effect of regulation on new construction, we show the effect of a one time 5 percent increase in the price of housing for two hypothetical cities, identical in all respects (using mean values from the data) except that in one the approval time is 1.5 months, and in the other it is 4.5 months. These effects are displayed in Fig. 3 and are developed from the coefficients in regression (1) in Table 3. Looking at both the coefficients on the interaction terms in Table 3 and Fig. 3 it is evident that the initial effects of a price increase on new construction are quite similar in both regulated and less regulated markets. However, in the regulated markets, the effects of longer lags in price change on permits are noticeably lower. We find this result to be consistent with the observation that in these regulated markets the inventory of developed lots acts as a much greater constraint on new construction than in markets where raw land can be quickly readied for new construction.

5. Conclusion

In this paper we present a theoretical framework to describe the relationship between land use regulation and new residential construction and provide empirical estimates using quarterly data on a panel of 44 metro areas from 1985 to 1996. We find that land use regulations have significant effects in lowering the steady-state level of new construction and reducing the responsiveness of local supply to price shocks (the estimated price elasticity). Our estimates show that mean starts can be up to 45 percent lower in cities that have more extensive regulation. In addition, metro areas with greater regulation have price elasticities that are more than 20 percent lower than in cities with less regulation. The presence of development or impact fees has little effect on new construction, but

[22]The predicting equations have adjusted R^2 values of approximately 0.3, and the exogenous variables are typically statistically different from zero. The first stage exogenous variables are those used as instruments in the regulation IV regression in Table 2.

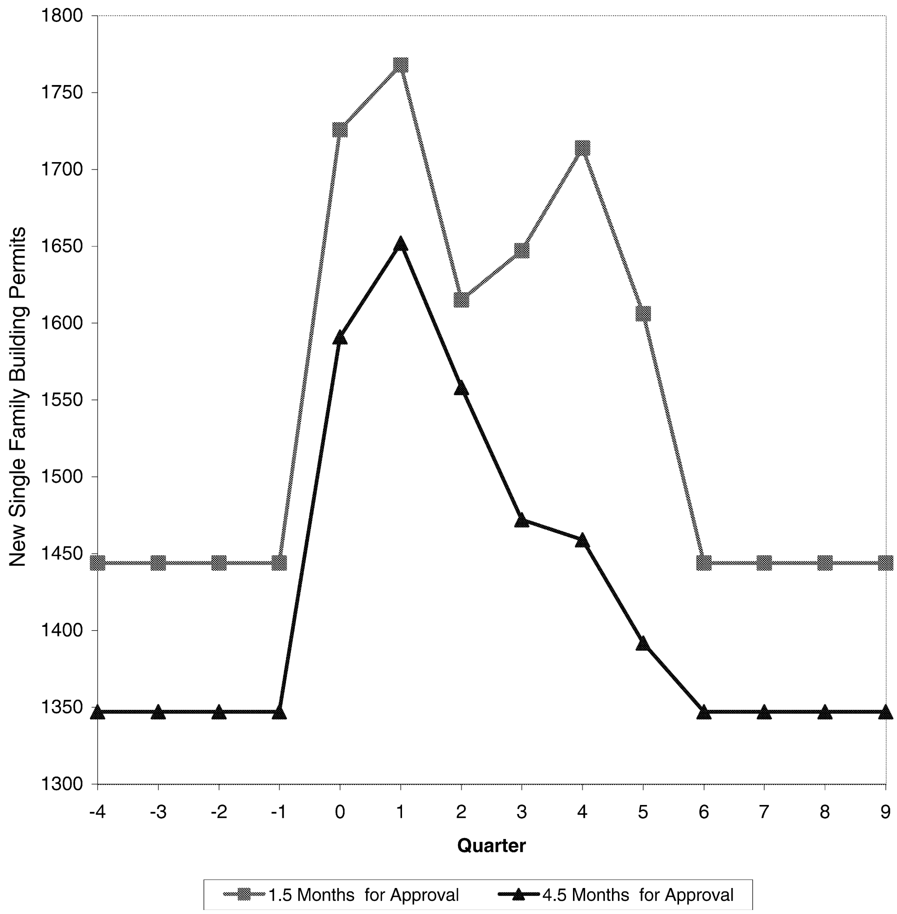

Fig. 3. Effect of a one time 5 percent increase in prices.

regulations which lengthen the development process or constrain new development in other ways have similar and significant effects on the volume of new construction. We also find that regulations that lengthen the development process have an uneven temporal effect on the supply elasticity. It is unchanged in the initial quarters following a shock, but then substantially lower in later quarters, yielding the aggregate 20 percent reduction mentioned above. Finally, a comparison between our local area supply function and a similarly specified national supply function reveals that the aggregated national data may slightly overestimate the price elasticity of new construction and underestimate the time required to respond to price shocks.

These results suggest a number of questions, as well. One issue is the extent to which communities recognize the impact that uncertainty and delay have in deterring additional construction. Localities often would like to limit new construction, but face legal constraints on their ability to levy high costs or impose outright prohibitions. Consider, for example, the recent US Supreme Court decision in City of Monterey v. Del Monte Dunes. In that case, the court ruled that the City of Monterey could not unjustly deny the plaintiff's use of their land without providing compensation.[23] Even in that case, however, the City of Monterey was able to repeatedly turn down development applications by the owner for a number of years before finally denying any use of the land at all. Had the city just pursued this delay tactic without the final denial, it is likely that the case would never have gone to court. Our findings suggest that efforts to reduce construction through delay can be quite effective. In fact, repeated delay can be much more effective than the imposition of higher fees.

Another outstanding question is the extent to which the regulations themselves are endogenous. While we have attempted to instrument for possible simultaneity of new construction and regulation, such instruments are difficult to come by, and it is possible that communities pass more onerous regulations in locations where there is inherently lower demand for new construction. Alternatively, locations with the greatest demand for new construction are the places most likely to impose the most stringent land use regulations. As well, given that the effects vary by the type of regulation, some communities may strategically adjust their mix of regulations depending on market conditions and developer behavior. Future work should consider this issue.

From a policy perspective, our results suggest additional social costs to policies that regulate through adding delay or uncertainty. We show that such policies reduce the ability of builders to respond quickly to market signals and may even encourage a less stable aggregate housing market. In other work, Capozza et al. (1997) show that house prices in markets with high construction costs (possibly due to local land use regulations) exhibit a greater degree of serial correlation, making these markets more susceptible to price overshooting or undershooting in the face of large demand shocks.

Finally, we should also note that there may also be possible social benefits from these delays. For instance, if development imposes negative congestion externalities and delays allow communities to improve public infrastructure to ameliorate these externalities, then the welfare effects could be positive. Future research on regulation should focus on better understanding the range of welfare effects that land use regulations generate, taking into account the costs that we document in this article.

[23]City of Monterey v. Del Monte Dunes — 119 S. Ct. 1624(1999).

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