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An Evaluation of the Impact of Density Regulation on Land Markets in Mumbai

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The economic justification for regulation of land markets through land use controls and other policy instruments is a well-studied subject in developed countries. However, in the recent years, there has been an increasing realisation that the regulation of urban land use and its development has been resulting in some undesirable impacts, in particularly, on the operation of land or property markets, which result in increases in land prices and a reduction in the welfare of people. This paper presents an empirical evaluation of the density regulation impact on land prices in Mumbai city. The study finds that the impact of density regulation is highest on the already highly demanded space in the CBD; also, the impact is significant in the suburbs. The study results, however, need to be interpreted more carefully in the light of other land use and housing regulations already in operation.

Keywords

land use regulation; density regulation; land market and land prices

Introduction

Land is an important resource for economic development; urban land, in particular, is considered to be highly important because of the high concentration of economic forces in urban space and the existence of externalities as well as public goods associated with it. The allocation as well as regulation of land for various uses and its development have traditionally been in the hands of government all across the world. Methods and of degrees of control over land resource, however, differs across countries, which have different institutions for the allocation and management of urban land. Balchin et al. (2000), for example, observe that a wide range of land management policies have been used in different countries including: (i) long-term national and sub-national land use planning in the UK, Netherlands, and Japan; (ii) redevelopment of schemes in France, West Germany, and Japan; (iii) special land use control in areas of development in Italy and Japan; (iv) pre-emptive rights in France and India.

Land use planning is an important institution that exists in various countries in various forms with the primary responsibilities of land allocation, land use regulation and development control (Harrison, 1977). However, governments also intervene, either directly or indirectly, in the operation of land markets through a wide range of economic, policy, and administrative tools. The intervention of government in the regulation of land has often been justified by the gains to the society but its unintended consequences that result in costs to the society have not been given attention. It is only recently that the researchers began to focus on these impacts. The current study is one of such attempts to examine an important aspect of land use regulation–the impacts of density regulation or density controls. Density regulation or density control is essentially a part of the development controls that regulate density of development on a parcel of land by setting controls like floor area ratios, plot densities, and building height restrictions (Harrison, 1977).

In theory, land use planning/regulation provides an important as well as significant opportunity to organize activities that could lead to a harmonious development of land. However, in recent years its effectiveness has been questioned (Corkindale, 1996; Cheshire and Sheppard, 1997; Bramley et al., 1995). The planning system competes and at times conflicts with alternative systems of resource allocation e.g. markets and legislation, in attaining the common goal of increasing societal welfare[1]. It is now reported by several authors across the world that land use planning/regulation in some form or other has affected the operation of land markets and housing, thereby, resulting in welfare losses to consumers. These costs may be detrimental to the ability of low-income groups in obtaining dwelling space on urban land. The distributional impacts of high prices as a result of density regulation have been examined and discussed in details in another paper (Nallathiga, 2005). This paper, however, evaluates the density regulation impact on land markets in Mumbai using quantitative methods. This section provided a brief overview of land use planning/regulation; the impact and operation of density regulation in Mumbai is being discussed. We will discuss the economic theory of land regulation, and review literature as well as approaches taken

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[1] In this study only an economic perspective of land use planning/regulation and its impacts is considered; an alternative perspective from law can also be helpful to understand it in a different manner. Webster (1998), for example, provides such a law perspective of impacts.

for the assessment of land use regulation impacts in the next section. Subsequently, the current study approach and research methodology are discussed; and, finally, its findings as well as its implications are discussed.

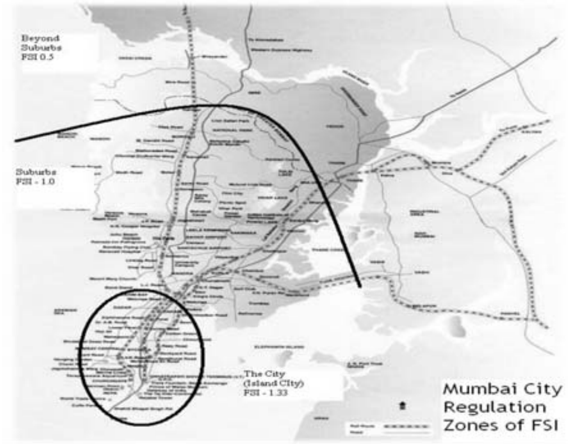
Density Regulation in Mumbai

Density regulation is an important development control regulation, which is a part of the larger system of land use regulation, in Mumbai. Development Control Regulations (DCRs) in Mumbai cover provisions in land use zones, density zoning in terms of dwelling units per unit area and the total development area. They form an integral part of the development plan prepared by the Municipal Corporation of Greater Mumbai (MCGM) (Phatak, 2000). However, there exists another class of development regulations that operate through building bylaws laid by the MCGM in the same DCRs, which is not within the scope of the current study. These building bylaws use parameters like ground coverage, maximum height, light angle, height in relation to width of road to control the volume of built-up area on a given plot of land (Phatak, 2000). Essentially, it is the impact of density regulation in the form of floor space index (FSI) restrictions that will be examined in this study. FSI is the maximum permissible ratio of floor space (or built-up) area to plot area that was first introduced in 1964. The 1964 DCRs prescribed FSI as high as 4.5 for CBD to 1.0 for suburbs, in step-wise decrease based on the concept of one-third ground coverage. However, they were substantially reduced through the modified 1991 DCRs to the range of 1.33 in the city to 0.5 in the areas beyond suburbs (in rural areas), while confining to the one-third ground coverage rule. The spatial distribution of FSI restrictions in Mumbai is shown in Figure 1.

Economic Theory and Modeling of Land Use Regulation Impact

It is well laid in urban economics literature that the economic rationale for land use planning/ regulation has root in the welfare economic arguments such as public goods and services, externalities associated with their production and consumption, market failures arising from structural imperfections, information asymmetry, and alternative public policies (Harrison, 1977). The economic justification for land use planning/regulation comes from alternative schools of thought, such as neo-classical economics, welfare economics, institutional economics, public choice theory, and socialist economics.

Figure 1: The spatial distribution of FSI restrictions in Mumbai



However, the same economic theory purports that planning/regulation affects markets by influencing demand for and supply of land for housing, and hence equilibrium quantity and price in a neo-classical economic sense (Monk et al., 1991). From a welfare economic perspective, it may reduce efficiency and equity of land allocation through markets (Hirsch, 1979), and from the Marxian socialist economic perspective, it may result in class struggle over land or lead to displacement of the working class by filtering down (Lyons, 1996). Institutional economists and public choice theorists argue that it reduces the scope for private bargaining (Mills, 1991) while promoting harmful practices (Mills, 1989). The wider theoretical base implies the need for examining each case of land use regulation impacts in the context of existing operational framework of the planning/regulatory system before drawing policy implications.

Although a wider literature exists in the theoretical frameworks of alternative economic thoughts, neo-classical theory has been the most favoured framework, as evident from the extent of its use in empirical literature, in which land and housing are treated as marketed goods under the operation of equilibrating forces - demand and supply. Alternatively, spatial equilibrium of land and housing has been dealt with in urban economic theory in an analytical fashion built upon Von Thunen's mono-centric city model or its deviants, as spatial impacts have the roots in urban economic theory. Land use regulation is exclusively modeled as a constraint in the optimisation of a choice economic variable in a hypothetical city in these studies, and the outcomes are compared with those that of standard urban economic theory. Both these theories provide the much-needed framework for the argument of land use regulation impacts and their assessment.

The impact of land use regulation on land and housing markets caught the attention of empiricists some time ago. As early as in 1973, Drewett found that the rapid rise of land prices in the UK during 1967-1970 was more than that of house prices, which, therefore, contributed to an increased proportion of total cost of housing. This might also be partly due to inelastic supply arising from landowner's decision to wait; yet, the impact of regulatory system would have been substantial in this case (Drewett, 1973). Subsequently, the impact of land use regulation in the UK was well examined by several researchers e.g., Cheshire and Sheppard (1987), Monk and Whitehead (1999), Bramley (1993), Cheshire and Sheppard (1995), and Monk et al. (1996). Similarly, in the North America, land use regulation impacts have been extensively discussed with reference to impacts of zoning of varied kinds, which is the characteristic of American land use planning system, and to some extent upon the development control regulations. However, the nature of regulations are some what different in the UK in terms of their focus on the containment of cities through drawing boundaries or green belts around them, and on the regulation of planning permissions given for development of housing in the cities.

Fischel (1975) first acknowledged that the impacts of zoning were reflected in 'windfall gains' to some whose land received positive benefits of zoning, and 'wipe-outs' to some whose land received negative benefits of zoning. Fischel (1987) observed that zoning regulation facilitated the adoption of rules, encouraged exchange of entitlements, and protected property rights; yet, it imposed costs like suburban sprawl, which might not have arisen under free market allocation. Similarly, suburban zoning led to efficient allocation of local public goods (via *Tie-bout* model) but only at equity losses. The theory and empirical aspects of zoning and other local government regulations are also discussed in DiPasquale and Wheaton (1996) and O'Sullivan (2004). A further detailed discussion of empirical studies on economic impacts of zoning in the USA can be found in Pogodzinski and Sass (1991), and a similar in the UK can be found in Monk et al. (1991). A summary of selected studies in terms of study hypothesis, methodology, model, and results is provided in the appendix. However, a brief summary of analysis and results of these studies is presented here to shed lights on the different analytical frameworks used by empirical researchers in assessing the impacts of various kinds of land use regulations on markets - both on supply as well as demand sides.

On the supply side, Courant (1976) found that a large lot zoning as a ceiling on capital/land ratio, which determines the cost of producing housing services at the zoned location, could result in an unambiguous housing price rise and a decline in welfare. Moss (1977) discussed the impacts of minimum lot zoning, maximum density zoning and maximum bulk zoning as a ceiling on capital/land ratio, but his analytical model did not account for spatial variation. Similarly, Buttler (1981) analyzed zoning regulation using a monocentric model by distinguishing three types of zoning regulations – storey height, building height and density. However, it was Sheppard (1988) who formally modeled two growth control policies – supply of space restrictions and containment – in a spatial model by incorporating different classes of consumers. It brings out the complexity inherent in the impacts on different classes across different locations. The absence of restrictions on the supply of space lowers rents at all locations for any class, but increases suburbanization of all classes more centrally located, and effectively reduces the radius of city (or, urban sprawl) as well as increases utility for all classes. Whereas, the inner-containment policy lowers rents for all classes in the contained group, increases rents for centrally located unconstrained classes, and also increases utility for all classes in the contained group. But, it has no effect on less centrally located classes. Although it suggests marginal effects of containment policy on unconstrained classes, it avoids externality effects associated with parcel of land, which are important in cities.

On the demand-side, the impact of regulation (in the form of zoning) has been modeled as an explicit restriction on the choice set of consumers. Henderson (1985) studied two kinds of zoning – large lot zoning and density regulation – under alternative hypotheses of whether zoning was capitalized into land prices. He modeled lot size restriction on the supply side as a restriction on the substitutability of capital in the production of housing, and then traced through the effects of this restriction on the demand for housing. In this approach, the production function assumes constant returns to scale and the large lot zoning acts like a fixed factor of production. The large lot zoning increases costs up to a certain level of housing production in short run. However, the effect would be less in the long run under perfect competition. Similarly, Cheshire and Sheppard (1987) modeled demand side restrictions through a hedonic demand function to assess the comparative effect of planning system/control on housing prices in Darlington and Reading for various classes of housing. Another important study is that of Mayer and Somerville (2000), which modeled the relationship between land use regulation and residential construction. They found that land use regulation lowered the steady state of new construction up to 45% fewer starts, and lowered price elasticity more than 20% than those in the less regulated markets.

Conceptual Framework

The neoclassical economic theory suggests that urban land and housing markets are in equilibrium due to the operation of demand and supply forces. In the short run, the supply of land (rather built space) is fixed (S) (Harrison, 1977). The density regulation reduces the built space available from S to S', thereby resulting in a price rise from P to P'. Density regulation also raises the demand for built space (due to scarcity and price) from D to D' which results in a price rise from P to P''', which is well above 'the free market' level (Bramley et al., 1995) (as shown in Figure 2). In this approach, the 'price effect' of land use regulation can be evaluated by modeling the equilibrium of demand and supply functions. In conventional economic terms, the quantity of good land parcel/housing unit demanded and supplied can be expressed as

$$Q_d = f\{Y, P_n, \ldots\} \text{ and } Q_s = f\{P, T, \ldots\}.$$

Here Y, P, P_n, and T are household income, price of the good, population, and technology. As the supply of land (and housing) is fixed in the short run, by equating the quantity demanded to that supplied yields a reduced form equation as below.

$$P = f\{Y, P_n, T, \ldots\}.$$

This simple equilibrium model of household demand for and supply of built space and prices can be extended to large urban areas by including property attributes, location and infrastructure. However, the area-wise land/ property prices in cities are influenced not alone by the attributes of spatial units (the localized effects of which are nullified in the aggregates of larger areas) but also by the provision of pubic goods and the prevalence of larger externalities, which are essential components of a standard urban economic model (the distance from CBD also plays an important role). Development control regulation or any aspect of it (density regulation) enters as one variable determining land values over space.

The standard urban economic theory suggests that the land value/rent declines with distance away from CBD, as alternative uses determine the demand for land (and housing), hence its price (Evans, 1985), the bid-rent curve (RC) is formed. *Ceteris paribus*, land use regulation raises the gradient line to the level RC' above than that in its absence due to the price effect explained above, while assuming existence of spatial equilibrium in the markets with no constraints for expansion in a mono-centric city (Bramley et al., 1995). The rise of rent curve from RC to RC' for a hypothetical city is shown in Figure 3. This result of absolute price rise can be observed using a reduced form model of demand and supply, specified above, with land use regulation (here, density regulation is one aspect of it) as a policy/regulatory variable in the form of a dummy variable[2], while assuming a linear variation in land value/rent or price rather than a non-linear variation. However, as suggested in *tie bout* hypothesis, the household location choice is dependent upon the extent of local public goods (including infrastructure) provision, which is

[2] A dummy variable takes two values can be used to model qualitative explanatory variables (Gujarati 1995).

critically dependent upon the availability of public finances and the tax base of a jurisdiction (DiPasquale and Wheaton, 1996).

Figure 2: The land price/rent versus the quality of built space

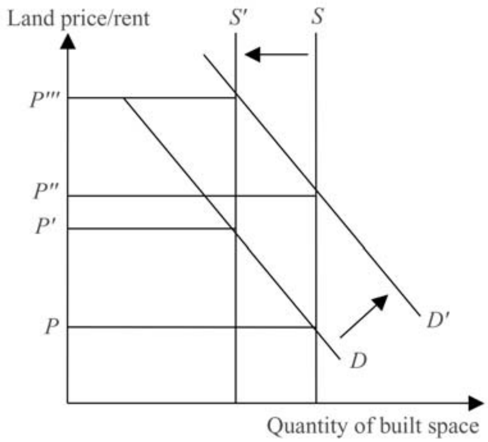
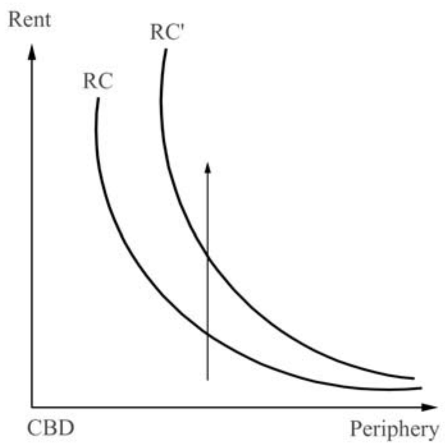


Figure 3: Rent curve from RC to RC' for a hypothetical city



Modeling land use regulation impacts involves identification of other important variables that influence land prices. The inquiry into variables influencing land prices was studied by several researchers as early as in the 1970s. Milgram (1967), based on the observation of statistical models of land price determination, found that the key variables influencing land prices were both macro variables such as average mortgage interest rate, personal income, housing starts and interest rates, as well as micro variables such as travel time to CBD, distance to major road/ public transport, and property on artery or not. Similarly, Weiss et al. (1967) found that the factors influencing land values and land development include distance to school, recreation, playground, and shopping centre. Stegman (1969) included neighbourhood quality as an important variable in the land price determination; other variables include externalities, interdependencies, levels of land and property taxation, and historical factors. Asabere and Hauffman (1999) assumed that land values were a function of location, physical and market attributes. Lastly, Pogodzinski and Sass (1991) assumed that household utility was a function of income net of housing and commuting expenditure, leisure time, consumption of housing services, housing attributes. A further detailed review of the various studies in terms of approaches, models used and results is presented in the appendix.

Literature and empirical studies suggest that several general as well as specific variables influencing land prices, the exact number of which can only be fixed within the constraints of data availability, econometric and formal construct of the model relevant to a particular study. The equilibrium models using individual property prices and property characteristics are not applicable in this study, because such data is not collected, collated, and widely shared in Mumbai.

Methodology

The above section outlines the theoretical framework for the study, whereas in this section the empirical model for assessing the impact of FSI restriction on the operation of land markets, particularly on land prices, is presented. The exercise confined to urban land within the geographical boundaries of Mumbai city while avoiding any rural areas or hinterland. The methodology followed, in terms of model, data, and variables, is explained below.

Model specification

The basic model is a reduced form standard urban economic model of demand and supply in land/property markets, which is comparable to those used by Richardson (1977) (cited in Bramley et al., 1995), Pogodzinski and Sass (1991), and Case and Mayer (1995). The model, however, contains more explanatory variables and treats of income as a non-constant variable over space. Further, a ward or sub-region, as opposed to housing unit, is the unit of analysis in this model, which removes the effects of local externalities and reduces the variability of dependant variable (Reynolds and Amrhein[3],

[3] However, for a given correlation of dependent variable they observe the effect is *vice versa*, and the implications of effects of resolution are not quite clear.

1998). The reduced form equation for equilibrium land/property prices is:

Land price = *f* {Public goods, Externalities, Income, Tax, Density control, Transportation system}.

Or, for any ward at location *j*, the equilibrium land price is mathematically represented as follows:

$$P_j^l = f\,(\mathrm{PG}^l_j, E^l_j, I^m_j, T^l_j, \mathrm{DC}^n_j, \mathrm{TS}^n_j).$$

The superscripts in the equation denote the variability in observations with l = 1,...,20, m = 1,2,3, and n=1,2, whereas the subscripts denote the value taken at any location (j=1,...,20). The econometric translation of this model gives rise to

$$P = \beta_0 + \beta_1 \ln \mathrm{PG} + \beta_2 \ln E + \beta_3 I + \beta_4 T + \beta_5 \mathrm{DC} + \beta_6 \mathrm{TS} + \varepsilon,$$

where β_0 is the intercept, β_1-β_5 are coefficients of respective variables in the model, and ε is the error associated with it. It was expected that

$$\partial P/\partial(\mathrm{PG}) > \text{or} < 0,$$
$$\partial P/\partial E > \text{or} < 0,$$
$$\partial P/\partial I > 0,$$
$$\partial P/\partial T > 0,$$
$$\partial P/\partial(\mathrm{DC}) > \text{or} < 0, \text{ and}$$
$$\partial P/\partial(\mathrm{TS}) > 0.$$

Data and variables

The data set is comprised of ward level data of public goods and services, demographic details, and budgetary details for the years 1994 and 1999, which cover 23 wards in the island city (CBD), the suburbs, and the extended suburbs. A ward, as opposed to individual housing unit, was chosen as the unit of analysis so that the effects of externalities related to the neighborhood, property, and building services at plot level could be avoided. Moreover, local public goods and externalities become important determinants of land prices at reasonably uniform jurisdictions like wards. The other important data were FSI variations that are directly observable from DCR handbook of the MCGM and residential property prices (obtained from MMRDA), which are observed across areas/ sub-regions and broadly match the municipal wards. Therefore, the property prices data were compatible with ward level data of pubic goods, but there were few jurisdictions in which authenticated data was not recorded, hence could not be included in analysis.

As the density controls (or, FSI restrictions) were laid down zone-wise, they were translated into ward level data by making one-to-one matching using a city map featuring wards and locations. There was hardly any quantitative jurisdiction-wise information on transportation infrastructure, whereas it is one of the key determinants of land prices. In the case of Mumbai, property prices are sensitive to the location with access to rail and road transit, as the city has two major modes of transport – rail and road – running along the eastern and western parts of the city. The western parts of the city are endowed with better transport service. In the absence of quantitative data related to access to transportation systems, a qualitative (or, dummy) variable, W-Transp, is used to denote whether the ward is on the western rail and road transit. Income variable is a product of per capita income of the zone in which a ward is located[4] and prevailing ward population density. Taxes include all kinds of taxes collected by local authority. Density control, in the form of FSI, is the development control variable considered here. Owing to the fact that land price observations did not cover some of the wards and complete information for one ward did not exist, the data set used for computation consists of observations for only 20 wards. The ward-wise data obtained from the MCGM are quite detailed and comprised variables related to urban services, listed in Table 1. As most of the variables are correlated to either ward area or ward population or both, they are normalized by ward area. The specification of all variables in a single measure (or normalization) would have avoided biases associated with the size of ward (Gujarati, 1992).

Table 1: Variables, measurement units, and their grouping

Variable	Unit of measurement
Public goods	
Hospitals	No./km^2
Schools	No./km^2
Parks	No./km^2
Public toilets	No./km^2
Entertainment centres	No./km^2
Fire hydrants	No./km^2
Street lights	No./km^2
Eating points	No./km^2
Water supply	No./km^2
Recreation & Welfare centers	No./km^2
Externalities	
Slums	No./km^2
Factories	No./km^2
Motor garages	No./km^2
Traffic islands	No./km^2
Commercial centres	No./km^2
Taxes	million Rs/ km^2
Income	million Rs/ km^2
Land prices	Rs/ ft^2

[4] Per capita income observed in BMRDA (1987) are converted to current level using an inflation index.

Diagnostic testing

The descriptive statistics of variables suggest that most of them are positively skewed (right tailed unsymmetrical) and their vertical profile is different from that of normal distribution, which implies non-normal distribution of data. However, for the data in spatial units, non-normal nature was anticipated. Further, the spatial distribution of most of the variables shows an anticipated declining trend in magnitude with distance away from CBD, analogous to the pattern found in a 'mono-centric city'. At this stage, it was found that the variables fire fighting and water recreation were imperfectly distributed and had shown a far divergent pattern from that anticipated, as these facilities existed merely based on the availability of space rather than demand; hence, they were dropped from further analysis. Moreover, a careful observation of data on externalities indicated that the 'slums' variable distorted the spatial distribution; hence, it was excluded in final analysis.

The correlation analysis of data suggests that high correlations are prevalent among the variables, but most of them are statistical coincidences. At the beginning, there were 17 variables that could be used in regression. Given the small size of data set and also to avoid econometric problems associated with too many variables, a majority of the variables (15) are grouped under two main variables - public goods and externalities (see Table 1). The grouping is done such that the variables under public goods entered multiplicatively, while for the variables under externalities those with positive externality effects entered multiplicatively and those with negative externality effects entered divisively. The products of grouped variables are natural log transformed to ensure that linear relation is preserved and possible hetero-skedasticity is minimized.

Regression analysis

The subsequent step is to perform regression analysis of the data by fitting the model on the lines of its specification. The primary purpose of regression analysis is to understand the effect of the key control variable, density regulation, on the dependent variable i.e., land prices, in the construct of model. This could be understood in two ways - one in the presence of controls against the absence of such (as a dummy in econometric terms), another in the variation through the stringency of controls (as a stepped variable). The regression analysis presented here used the former[5]. The density control variable, in the form of FSI, takes only 3 values, 1.33, 1.0, and 0.75, while in the analysis density controls FSI-1.33 and FSI-0.75 enter as

[5] Further, if density controls are also variable over space the relative price effects of density controls i.e., price differences across space, can also be evaluated by making use of it as a variable in the model. However, the results have to be considered more carefully due to the likely presence of 'auto correlation' in the spatial data.

independent dummy variables with the FSI-1.0 acting as a baseline variable. As data existed over two time points, pooled regression analysis[6] was also performed to compare the results with those of cross-sections data analysis. Here, another dummy variable, time, is added to the model with observations made during 1994 taking a value of 1 and those of 1999 taking a value of 0. An ordinary least squares (OLS) regression analysis is carried out using data of variables in the above-specified model.

Results and Interpretations

The results of regression analysis are summarized in Table 2 and the key interpretations are drawn subsequently.

Table 2: Summary outputs of regression analysis

	Cross-sections regression (*N*=20)		**Pooled regression (*N*=40)**	
R^2 (R^2 adjusted)	0.745 (0.596)		0.702 (0.624)	
F (Sign *F*)	5 (0.007)		9.11 (0.000)	
Variable	**Coefficient (Std. Error)**	***t*-ratio**	**Coefficient (Std. Error)**	***t*-ratio**
Constant	3226.26** (1003)	3.22	3268.7** (803.8)	4.07
ln (Pub goods)	53.41 (104.4)	0.51	78.36 (62.29)	1.26
ln (External)	84.28 (255.8)	0.33	–68.3 (182.9)	–0.37
Tax	53.16 (53.23)	1.01	25.29 (24.06)	1.05
Income	–14.94 (52.54)	–0.42	–31.46* (16.26)	–1.93
FSI-1.33 (dummy)	3394.20** (1422)	2.39	3278.7** (951.6)	3.45
FSI-0.75 (dummy)	257.57 (1747)	0.15	1300 (1117)	1.16
Time (dummy)			63.5 (699.8)	0.09
W-Transp (dummy)	617.11 (1253)	0.49	1752.8** (809.7)	2.16

** significant at 95% confidence level
* significant at 90% confidence level

The results of regression analysis have four major important observations:

- First, the dummy variable FSI-1.33 is statistically significant in explaining land values within the construct of model, which implies that density regulation impact is significant in those areas that are already highly dense. As most of the highly dense areas are in the CBD, it reflects that the effect of density controls is stronger in already dense city centres, wherein the demand for land as well as built space is high. It also implies that besides residential property the commercial property would be influenced by density regulation (although the latter

[6] Here, markets are also assumed to be under no cyclical changes (booms and busts).

is not included in the study). Moreover, the density regulation dummy for extended suburbs i.e., FSI-0.75, is not significant, which implies that the density regulation dummy for suburbs i.e., FSI -1.0, is significant. This reflects that the impact of density regulation is also stronger in those areas where the demand for housing is very high. This is somewhat consistent with findings of other studies (e.g., Bertaud and Brueckner, 2003; Green, 1999; Monk and Whitehead, 1999; Bramley, 1993; and Cheshire and Sheppard, 1987). But, in other studies the effect on suburban residential property and beyond has also been high, which is, however, not the case here, i.e., the relation is strong but not statistically significant.

- Second, the results indicate that the provision of public goods and the existence of externalities might not significantly influence urban land prices. This is surprising as it suggests that the role of public goods (community infrastructure) and externalities is statistically insignificant in the explanation of land prices, which is contrary to general belief expressed in theory. One possible explanation might be that as demand for land increases very high (as evident by the rapid population growth) and when supply is restricted in many ways[7], urban land prices are determined in narrow (or, thin) markets, and, hence, the provision of public goods as well as the presence of externalities may have little (marginal) effect on land prices. Further, access to transportation system ('W-Transp' dummy variable) is another important determinant of land prices in the pooled analysis, which is true in many cities across the world (e.g., FTA, 2002).

- Third, a large value of constant term and its statistical significance in determining land price could possibly imply that the model is perhaps incomplete. Partly, this is true as the model do not have financial variables such as mortgage interest rate, trade and financial investment, as well as other macro-economic variables which might also be determining land prices. However, this problem could not be overcome with the given limited data available and econometric problems of losing degrees of freedom by including too many variables when there were fewer records in cross-sections data. The tax variable is statistically not significant and takes a positive sign, as taxation seems to raise the demand for land (Harvey, 2000). The prevalence of high tax rates in commercial areas of CBD, where the intensity of

[7] For example, physical form and structure of the city itself (a peninsular city surrounded by sea with limited developable land) present one such constraint. Several past interventions through legislation e.g., Urban Land Ceiling Act (ULCA) and Rent Control Act (RCA) shall also impose constraints on the operation of land and housing markets in Mumbai. Further, legislations like the Coastal Regulation Zone (CRZ) act also impose restriction on any new development of land within 500 m of coastline (Nallathiga, 2005).

commercial activities is higher, also perhaps supports this. The income variable is statistically insignificant in cross-sectional analysis, but significant in pooled analysis, whereas its sign is different from that anticipated which is quite puzzling. One possible explanation is that most of the working population is resident away from station, whose current incomes are modest; whereas in the CBD most of the residents have more wealth rather than income.

- Last, the model appears to do not have any major statistical problems, but there are some limitations to the study. The prevailing diagnostics of R^2 and *t*-ratios do not suggest any multi-collinearity problem in the analysis, which is also confirmed by the correlation matrix of independent variables. Although the degrees of freedom are less, the explanatory power of the models stands out somewhat good, particularly in case of primary data. Further, an examination of the residuals gives an impression that heteroskedasticity might have been prevailing in the model constructed, but the Park test suggests that heteroskedasticity does not affect the model in both cases. However, spatial autocorrelation could be prevalent with data pertaining to spatial units. Although a visual examination of plots of residuals does not suggest the presence of any spatial autocorrelation, a thorough examination of its presence is beyond the scope of current study. However, besides density regulation a host of other legislations also influence the operations of land markets, such as rent controls in the case of old properties in the island city (or, CBD) and ceilings on urban land possessions (ULCA). Although they could not be modeled in the study, which when done will lead to a realization that the compound impacts of regulations might be much higher. Yet, in the study, the data might have avoided the rent control effects, given that most of the property prices data was coming from the new property built after the rent control legislation came into force. The impacts of ULCA might be akin to the effects of large lot zoning effects in the USA.

Conclusions

Land use regulations, when implemented without careful thought of intended objectives vis-à-vis anticipation of their implications, result in unintended effects on urban economic growth (Staley, 1997) and only benefit those who have already occupied the urban land (Harrison, 1977). This occurs primarily due to the operation of regulations restricting the supply of land and built space, thereby increasing land/property prices. The current study found that the effect of density regulation on the operation of land markets appears to be stronger, which in turn would influence the housing availability, accessibility, and affordability. In particular, it observed that the impact of these regulations is very high in commercial areas and residential suburbs, but not in the suburbs beyond the city limits. The density regulation impacts in association with other regulatory policy impacts could be taking away the major pie of the land price, making it highly unaffordable to the sections of population whose incomes are low. The recent attempts of obtaining variances in density regulation in the case of public rehabilitation schemes and in the provision of public amenities proves that the costs of density regulation are now acknowledged and variances are given, but, from a broader welfare perspective, it is necessary to extend such relaxation to all other areas.

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Appendix: Review of Past Studies on Land Use Planning/Regulation Impacts

S. No.	Authors and year	Main hypothesis	Methodology	Data and Model	Results
1	Cheshire and Sheppard (1989)	Planning system creates scarcity rents for land in different uses by acting as a constraint on land supply through use allocation as well as development control	Comparative study using multivariate analysis	Survey of 242 and 132 households respectively in Reading and Darlington	Planning restrictions resulted in a price rise of between £ 1000-4000 (or 6%-8% increase); when the effects of space consumption are incorporated it leads to about £ 2,000 (or 3%-5% increase)
2	Bramley (1993)	Planning system affects volume of housing and its prices through the lags in market responses	Analysis of simulta-neous equations of equilibrium with multivariate approach	Cross-sectional data of 90 districts over time period of 1986-1988	An increase in planning policy targets by about 75% would result in the increase of output and price by 23% and 11-12% respectively at the begin of the period and 8% and 5% at the end
3	Monk et al. (1996)	Differential effects of planning constraints prevails at local level depending upon the extent of substitution effect between the areas	Comparative study	Regional data of 13 counties and local data of one county	Impact on house prices restricted land supply was greater in the South-East England by 35%-40%
4	Monk and Whitehead (1999)	Land use planning system reduces the total supply of land for housing, and, therefore, increases the cost as well as price of housing; it also affects the supply of land for housing by narrowing the range of location, by restricting the ways it is developed and by changing the timing of development	Case study	District level data of Cambridgeshire and Hertfordshire counties in the UK	Tight constraint on land supply for housing in both the counties during 1980s resulted in unprecedented rise of land house prices; at local level, planning regulation reallocated the output that was built, while also affecting the densities by constraining them towards an average that remained constant over time
5	Pollakowski and Wachter (1990)	Land use restrictions will have a positive effect on the price of developed land and negative effect on the price of undeveloped land	Multivariate analysis	Reduced form model of demand and supply functions using a data set of 17 cross-sections and for time period of 1982-1987	Restrictive zoning and low development ceilings raise land and house prices by increasing demand, due to amenity effects, as well as spill over form adjacent zone restrictions

(Continued)

S. No.	Authors and year	Main hypothesis	Methodology	Data and Model	Results
6	Green (1999)	Land use regulation increases the cost of housing, thus, limits the supply of land therefore increases its price	Multivariate analysis	Reduced form model of demand and supply functions using 160 observations	Minimum lot width and frontage show strong effects on prices e.g., 10 ft minimum frontage requirements reduce housing values by $ 75,000, on an average one-fourth the price of house
7	Thorson (1997)	Zoning restrictions on urban land significantly increase the value of developed land and reduce the value of undeveloped land; whereas, agricultural zoning increases the value of agricultural land	Multivariate analysis	Demand-supply equilibrium model based on stock-flow framework using Pooled cross-sectional data of 11 cities and over 25 years	Increasing minimum lot size leads to significant decrease in the number of building permits issued; but, it occurs with a lag
8	Asabere and Huffman (1999)	Existence of nearby non-residential uses causes buyers lower prices due to locational obsolescence of interior areas and boundary effect of hierarchial zoning	Multivariate analysis	Hedonic model using the data of sales of 372 apartment buildings	Down zoning resulted in 16% lesser values in boundary areas than interior areas
9	Mayo and Sheppard (1996)	Different planning systems result in different supply elasticities with the lower supply elasticities associated with those imposing greater risk to developers	Multivariate analysis using both OLS and recursive least squares	Reduced form urban economic model	Low supply elasticity that was constant over time for Korea; high supply elasticity constant over time for Thailand; and fluctuating but low level of elasticity for Malaysia were observed
10	Bertaud and Brueckner (2003)	Floor area restrictions impose constraint on operation of land markets resulting in welfare costs on society	Multivariate analysis with equilibrium in multiple stages	Urban economic model with transactions data on house prices	Floor area restriction would have contributed to 5-6% house price rise and thus an equivalent welfare loss