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WELFARE CONSEQUENCES OF BUILDING HEIGHT CONTROLS

Hafiz A. PASHA*

This paper sets up general equilibrium model of building heights, which can be used for determining the short- and long-run optimal (profit maximizing) heights at various locations in a city in the presence and in the absence of a maximum height limit respectively. This model is applied to Makkah (with a seasonal peak in housing demand due to pilgrimage) in Saudi Arabia. Welfare consequences of height deregulation on property owners (producers of housing) and on the permanent and temporary residents (consumers) are quantified. The basic conclusion is that the direct welfare cost of building height controls is relatively small.

I. Introduction

Building heights controls constitute one of the instruments available to city governments to regulate the intra-urban distribution of housing stock and population. Such controls could take various forms. On the one hand, the objective behind fixing a maximum height (usually in terms of number of floors) limit in the central area of the city is to contain externalities in the form of congestion and environmental pollution due to high residential densities. On the other hand, specific neighbourhoods at the urban periphery may be designated as areas of high rise construction and a minimum height prescribed for structures. The motivation in this case is to limit the extent of urban sprawl and increase the effectiveness in provision

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of public goods (fire, police protection, etc.), costs of which are related to city size.

The objective of this paper is to analyse the welfare consequences of the first type of height controls and to identify the nature and magnitude of benefits and costs which accrue in the short as well as in the long run to different groups in society as a result of deregulation of building heights.

II. The Institutional Setting

The implications of building height regulation are analysed in the context of the city of Makkah in Saudi Arabia. This city is the focal point of pilgrimage for Muslims from all over the world. It is estimated that currently during the month of *Dhul Hijjah* in the Islamic year the resident population of the city almost trebles from 0.5 million to over 1.3 million due to the arrival of foreign nationals for pilgrimage. Some of the religious rites constituting the pilgrimage are performed at the *Haram Al-Shareef*, located at the centre of the city. In view of the importance of this structure for prayer and worship and because movement to it has been pedestrianised[1] bulk of the pilgrims have a strong preference for locating in close vicinity to it.

However, building heights in the central area of the city have been restricted in order to preserve the primacy of the Haram in the environment and to control the level of congestion. Originally, a height limit of six floors had been imposed in order to ensure that buildings did not rise above the parapet wall (height of 26 meters) of the Haram. This has recently been relaxed to a maximum of ten floors[2] along the main roads in the central area. The criterion now being used is a more liberal one in that building heights should be such that the top of the minarets (height of 95 meters) of the Haram are visible.

However, in view of the high rents commanded by properties in the central area an influential lobby of landlords of Makkah has been agitating for complete withdrawal of building height limits. This is being resisted by those who want to preserve the traditional architecture and sanctity of the religious character of the environs of the Haram. In the heat of the debate, the economics of high rise construction appears to have been lost. The advocates of skyscrapers perhaps do not realise that precisely for the reason that there is a high value to increments to the housing stock near the

[1] During the period of pilgrimage, the area within a distance of ½ kilometers approximately from the Haram has been pedestrianised in order to minimise noise and congestion due to motorised vehicles.

[2] In some instances, for example, to hotels, case-by-case exemption has been granted for construction upto twelve floors.

Haram, a major building boom in the central area of the city could lead to a significant fall in rents and property owners may not make large profits or even incur losses on new construction. As such, it might be in the interest of landlords not to overstate their case for building height deregulation.

The basic task in this paper is to determine the short-run and long-run building heights in Makkah at varying distances from the Haram in the absence of building height controls. The implications of this relaxation on welfare levels of producers and consumers of housing are then highlighted. The approach adopted is similar to that of Arnott and Mackinnon (1977). It consists of quantifying only the direct welfare gains from deregulation of heights from the original height limit of six floors. Such benefits result from the associated increment in housing stock in the central area and the fall in rents. The indirect implications on welfare due to changes in the level of congestion and in the quality of the environment around the Haram are not possible to measure being in the nature of unpriced externalities. Following quantification of the former a subjective judgement can be made as to whether they are large enough to compensate for the latter.

The paper is organised as follows: Section 3 develops the framework for study of optimal building heights. In section 4 we set up a general equilibrium model of seasonal housing markets within which the consequences of building height deregulation can be analysed. The nature of extension required to the model to incorporate periodic variations in housing demand are explicitly identified so as to indicate the structure of a somewhat simpler model that can be used to study the economics of building height controls in the more general case of cities with, more or less, short-run fixity in population and housing demand.

Section 5 presents the empirical application of the model to Makkah. This is followed in sections 6 and 7 by estimation of the changes in building heights and direct welfare gains in the short run and long run respectively. Section 7 also highlights the changes in the spatial distribution of net housing investment within the city as a result of withdrawal of height controls.

III. Theoretical Framework

For the purpose of defining the optimal height at a particular distance from the centre of a city we designate the following: k = distance, R(F,k) = annual rent from the Fth floor of a representative property[3] located at distance k, C(F) = annual amortised structural cost plus maintenance cost

[3] At the stage of empirical analysis, the representative property is defined as having a plot size of 640 square metres. The built up area is assumed to be, more or less, the same as the current practice in Makkah is to provide very little garden or parking space.

of representative property of height F floors, MC(F) = marginal cost[4] of the Fth floor, L(k) = land rent at distance k, $\bar{F}$ = existing height in the central area, F* = optimal height.

The case of high rise structures has been justified either on the basis of total cost minimisation per floor or profit maximisation from construction on a given plot of land. For example, Arnott and Mackinnon (1977) have derived optimal building heights in the city of Toronto in Canada which achieve the former objective. In their formulation, households not only demand structures but also recreational land. They have assumed, however, that there is no preference by floor of residents.

Pollard (1980) analyses the effect of location-specific amenities on the supply of housing, measured by height of buildings. He finds that profit maximising developers take into account the premium on rents due to access and view of Lake Michigan in the city of Chicago in the USA in determining the optimal height of buildings at different locations.

Therefore, under the two different objectives, the problem of determination of optimal building heights can be stated as follows:

Cost Minimisation

The objective is $\underset{F}{\text{Min}} \left[\frac{L(k) + C(F)}{F} \right]$

This implies that F* is given by

$$MC(F^*) = \frac{L(k) + C(F^*)}{F^*} \tag{1}$$

That is, with the cost minimisation criterion, F* is the floor which equates the marginal cost with the average cost per floor.

Performing comparative statics on (1) leads to

$$\frac{\partial F^*}{\partial k} = \frac{\frac{\partial L(k)}{\partial k}}{F^* \bullet \frac{\partial MC(F^*)}{\partial F^*}} \tag{2}$$

If $\frac{\partial L(k)}{\partial k} < 0$ and $\frac{\partial MC(F^*)}{\partial F^*} > 0$ then $\frac{\partial F^*}{\partial k} < 0$.

[4] This is defined as the difference in the annual amortised structural plus maintenance cost between a building of height F floors and that of height F-1 floors.

Land values generally fall as distance from the centre of the city increases and the second condition has to be satisfied if costs per floor are to be minimised at F*. Therefore, the optimal height F* declines with an increase in k.

Profit Maximisation

In this case, the objective is $\underset{F}{\text{Max}}\ [\int^{F} R(F,k)\,dF - C(F) - L(k)]\,dF$ and F* is given by, $R(F^*,k) = MC(F^*)$. (3)

Differentiating (3) yields

$$\frac{\partial F^*}{\partial k} = \frac{\dfrac{\partial R\,(F^*, k)}{\partial k}}{\dfrac{\partial MC\,(F^*)}{\partial F^*} - \dfrac{\partial R\,(F^*, k)}{\partial F^*}} \tag{4}$$

If $\dfrac{\partial R\,(F^*,k)}{\partial k} < 0$ and $\dfrac{\partial MC\,(F^*)}{\partial F^*} - \dfrac{\partial R\,(F^*,k)}{\partial F^*} > 0$ then $\dfrac{\partial F^*}{\partial k} < 0$.

The former condition has to be fulfilled if households in the city are to attain locational equilibrium and the latter has to be satisfied if F* is to represent the profit maximising height. Therefore, in this case also F* declines with the distance from the centre of the city.

Optimal building heights have been analysed in the paper in a profit-maximising framework. Given the assumption of perfect competition in land markets it is assumed that the difference between structure rents and costs accrues to land. It is empirically observed in Makkah, as described later, that the rent function exhibits a pronounced decline for higher floors due perhaps to socio-cultural factors and because of heavy congestion on lifts during the movement of pilgrims five times a day to the Haram for prayer. The situation in Makkah is depicted in Figure 1.

Given the profit-maximisation criterion, landlords in the vicinity of the Haram perceive that if building heights are deregulated then their profits could increase by BEC. However, if building heights rise from $\bar{F}$ to F* then, given the associated expansion in the housing stock, the rent function shifts downwards. The change, $\Delta\pi$, in profits is actually given by

$$\Delta\pi = B'XC - (AA'BB' + EXE') \tag{5}$$

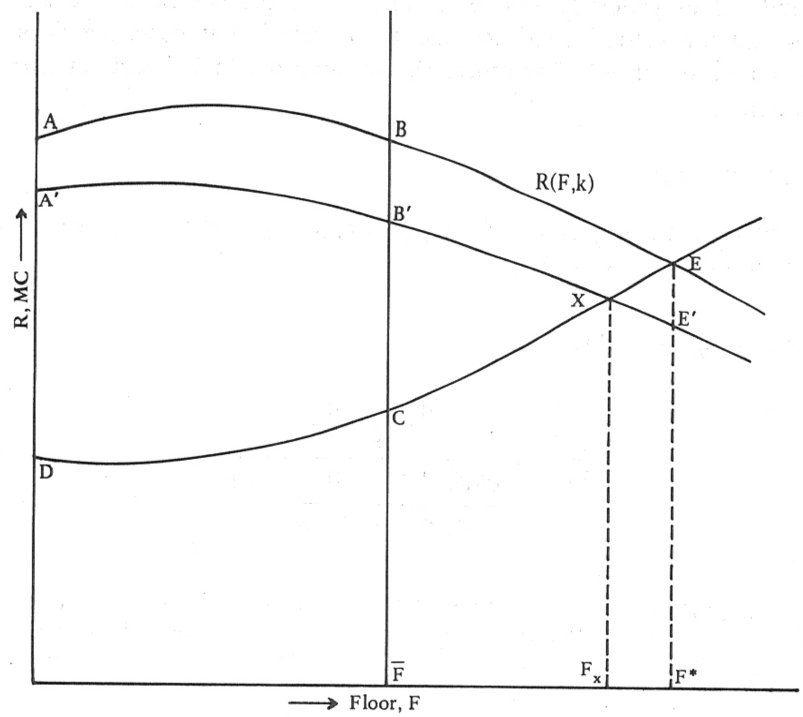

Figure 1

Annual rent and costs per floor of a representative property

Therefore, while there are profits from the additional floors, $\overline{F}+1$ to F_x, there is some reduction in the profits up to $\overline{F}$ and a possible loss on higher floors beyond F_x • *Ex post*, $F^* - F_x$, represents the extent of 'over-construction', as losses would actually be incurred on these floors.

Clearly, $\Delta\pi$ is ambiguous. The likelihood of higher profits depends, first, on the difference between F*and $\overline{F}$, second, on the degree of slope of the rent function beyond $\overline{F}$, third, on the extent to which additional construction takes place following the withdrawal or liberalisation of height controls, and, fourth, on the magnitude of impact on rents of the increment in the housing stock.

Given the sensitivity of the impact of withdrawal of building height regulation on land values in the central area to the response of peak and off-peak period rents to changes in housing stock we proceed to set up a general equilibrium model of building heights in a seasonal housing market of the type prevailing in Makkah to analyse this relationship.

IV. A General Equilibrium Model of Building Heights

The model is based on the assumptions that as a result of competitive forces, firstly, conditions of locational equilibrium [Alonso (1964), Mills (1967), Muth (1969)] are fulfilled for permanent residents (the Makkans) and pilgrims respectively, and, secondly, that spatial equilibrium between demand and supply is attained throughout the year, both during the seasonal peak and otherwise. A basic version of the model is presented in Pasha (1984).

The utility function for the permanent resident is specified as

$$U_1 = (1-\theta)U_1\ (q_o, x_o, v_o) + \theta U_1\ (q_1, x_1, v_1)$$

and given that part of the income to him accrues from engaging in subleasing arrangements with pilgrims during the peak period his budget constraint[5] is

$$y_1 = (1-\theta)x_o + (1-\theta)p_o q_o + (1-\theta)t_o v_o + \theta x_1 + \theta p_1 q_1 + \theta t_1 v_1$$

where y_1 = monthly income, x_o, x_1 = non-housing expenditure during the off-peak and peak period respectively, q_o, q_1 = consumption of housing services during the two periods, v_o, v_1 = number of daily visits to the Haram during the two periods, p_o, p_1 = unit prices of housing services during the two periods, t_o, t_1 = transport costs in the two periods, and θ = length of the peak season as proportion of the year, with $0 < \theta < 1$. It may be noted that in the utility function postulated visits to the Haram actually confer utility.

The housing demand functions are

$$q_o = q_o\ (p_o, p_1, y_1, t_o, t_1, \theta) \tag{6}$$

$$q_1 = q_1\ (p_o, p_1, y_1, t_o, t_1, \theta) \tag{7}$$

and the amount of housing q_s, supplied by the permanent resident to pilgrims during the peak season is given by

$$q_s = \phi q_o - q_1 \tag{8}$$

[5] If a permanent resident engages in sub-leasing arrangements with pilgrims, his budget constraint is:

$$y_1 + \theta p_1 (q_1 - q_o) = [(1-\theta)p_o + p_1]\, q_o + (1-\theta)\, x_o + \theta x_1 + (1-\theta)t_o v_o + \theta t_1 v_1$$

which transforms to the equation given for the budget constraint.

where ϕ is the relative valuation of the same physical structure in the peak period as compared to the off-peak season.

The overall indirect utility function, V_1, for the permanent resident can also be derived as

$$V_1 = V_1 (p_o, p_1, y_1, t_o, t_1, \theta)$$

The locational equilibrium condition can then be expressed as

$$\frac{\partial V_1}{\partial k} = 0 \qquad (9)$$

Turning to the temporary resident his utility function, U_2, is

$$U_2 = U_2 (q_2, x_2, v_2)$$

and his budget constraint is

$$y_2 = \theta (p_1 q_2 + x_2 + t_2 v_2)$$

In this case, the housing demand function is

$$q_2 = q_2 (p_1, y_2, t_2, \theta) \qquad (10)$$

and the indirect utility function, $V_2 = V_2 (p_1, y_2, t_2, \theta)$. The locational equilibrium condition for the pilgrim is

$$\frac{\partial V_2}{\partial k} = 0 \qquad (11)$$

Spatial housing market equilibrium during the off-peak period requires that

$$N_1 (k) q_o (k) = S_1 (k) \qquad (12)$$

where $N_1(k)$ and $S_1(k)$ are the number of Makkans and the housing stock (measured in some standard housing units) respectively at distance k from the Haram.

Similarly, during the peak season

$$N_1 (k) q_1 (k) + N_2 (k) q_2 (k) = S_2 (k)$$

From (8) and assuming that on the average, $\phi(k) = \frac{S_2(k)}{S_1(k)}$, yields

$$N_2(k)q_2(k) = S_1(k)\frac{q_s(k)}{q_o(k)} \tag{13}$$

In the short run, with fixed housing stock, given existing building height regulation, the following consistency conditions can also be defined. Firstly.

$$\int_{k_o}^{k^*} N_1(k)\,dk = \overline{N}_1 \tag{14}$$

where $\overline{N}_1$ is the existing population of Makkans. k_o and k^* are the minimum and maximum distances of location of housing stock currently in the city. Secondly,[6]

$$\int_{k_o}^{k^*} N_2(k)\,dk = \overline{N}_2 \tag{15}$$

Equations (6) to (15) constitute a ten equation model for determining $q_o(k)$, $q_1(k)$, $q_s(k)$, $q_2(k)$, $p_o(k)$, $p_1(k)$, $N_1(k)$, $N_2(k)$, and the magnitudes p_{oo} and p_{10} at the minimum distance of k_o from the Haram given exogenously the magnitudes of θ, y_1, y_2, $\overline{N}_1$, $\overline{N}_2$, shape of the utility functions, U_1 and U_2, transport cost functions, $t_o(k)$ and $t_1(k)$, and housing stock $[S_i k)$, $i=1, 2; k_o \leq k \leq k^*]$ in the short run.

In the general case, $\theta = 0$, implying no seasonality in housing demand. The basic model then collapses into equations (6), (9), (12) and (14). The endogenous variables are $q_o(k)$, $p_o(k)$, $N_1(k)$ and the magnitude of p_{oo} at the minimum distance of k_o from the centre of the city.

The next stage is incorporation of the impact of relaxation of building height controls into the model. We first take up the short-run impact.

Short-run supply responses are assumed to be restricted only to the central area of the city on which the height legislation is applied. Housing stock in the rest of the city is unaffected in the short run by this change. However, within the central area there are hardly any vacant plots. Therefore, bulk of the supply response will occur through demolition of some of

[6] It is possible that the pilgrims only stretch out to a distance k_1 where $k_1 < k^*$. However, given the relatively large number of pilgrims, the level of their housing expenditure in Makkah, etc., it has been demonstrated by Pasha (1984) that $k_1 = k^*$

the existing housing stock and its replacement by higher structures.

For demolition of an existing property of height F_e and its replacement by a structure of height F* to be profitable

$$\int^{F*} R(F,k)dF - C(F^*) > \int^{F_e} R(F,k)dF - VC(F_e) \quad (16)$$

where F* is given by (3) and VC is the variable cost component in building cost [see Bender (1979), Hufbauer and Severn (1974)].

If $s_1(f)$ and $s_2(F)$ are the number of standard housing units[7] for a representative property on the Fth floor during the off-peak and peak periods respectively then

$$\int^{F} R(F,k)dF = 12\ [(1-\theta)p_o\ (k) \int^{F} s_1\ (F)dF + \theta p_1\ (k) \int^{F} s_2\ (F)dF] \quad (17)$$

where $p_o(k)$ and $p_1(k)$ are the unit prices per month of housing services prevailing at the time of building height deregulation. The use of these prices for deriving the profitability of demolitions implies myopic expectations on the part of property developers.

From (16) it can be seen that the probability of demolition tends to be higher the smaller F_e is. However, for the demolition to be attributable solely to the withdrawal of building height controls it should not have occurred anyway. That is

$$\int^{\overline{F}} R(F,k)dF - C(\overline{F}) < \int^{F_e} R(F,k)dF - VC(F_e) \quad (18)$$

where $\overline{F}$ was the building height limit prior to deregulation.

From (16) and (18) and given the existing building height distribution in the central area it is possible to determine the proportion of the existing housing stock that is destroyed and the height of the structures by which it is replaced. The increase in housing stock can then be computed. Given the new magnitude of $S_1(k)$ the model can be used to derive the new equilibrium values, $p_o'(k)$, $p_1'(k)$, and so on.

We turn now to the long-run implications of withdrawal of building height controls. In the long run, of course, the level and distribution of housing stock in the entire city is variable. We first derive the long-run solution to the model in the presence of height controls.

7 The standard housing unit is defined later in the section on Empirical Application.

If k_c is the radius upto which the building height limit is operative then the stock of housing within this radius is given by

$$S_i(k) = \frac{2\pi k U(k)}{X} \int^{\bar{F}} s_i(F)dF \text{ for } k \leq k_c, \; i = 1, 2 \qquad (19a)$$

where X is the plot size of the representative property, U(k) is the proportion of land devoted to residential land use at k. k_c is given by

$$R(\bar{F}, k_c) = MC(\bar{F}, k_c) \qquad (20)$$

Beyond k_c, buildings have height F*(k), given by (3), and the long-run stock of housing is

$$S_i(k) = \frac{2\pi k U(k)}{X} \int^{F^*(k)} s_i(F)dF, \text{ for } k > k_c, \; i = 1, 2 \qquad (19b)$$

The city stretches out to a distance k_m where

$$\int^{F^*(k_m)} R(F, k_m)dF - C[F^*(k_m)] = L_m . X \qquad (21)$$

L_m is the land rent per unit of space at the urban periphery corresponding to the opportunity cost of land in other uses like agriculture.

Therefore, in the long run we have a fourteen equation model with four additional variables, k_c, $F^*(k)$, $S_i(k)$ and k_m. An additional exogenous parameter influencing the equilibrium is L_m. The four additional equations required to close the model are (3), (19a and b), (20) and (21). These four

$$U_2 = \alpha_2 \log X_2 + \beta_2 \log q_2 + \gamma_2 \log v_2 .$$

The housing demand functions then are

$$q_o = \frac{\beta_1}{\alpha_1 + \beta_1 + \gamma_1} \bullet \frac{y_1}{p_o}, \quad q_1 = \frac{\beta_1}{\alpha_1 + \beta_1 + \gamma_1} \bullet \frac{y_1}{p_1},$$

$$q_2 = \frac{\beta_2}{\alpha_2 + \beta_2 + \gamma_2} \bullet \frac{y_2}{\theta p_1}$$

implying that

$$\frac{q_s}{q_o} = \phi - \frac{p_o}{p_1}$$

The transport cost functions are specified as

$$t_o(k) = T_1 k^{\mu_1}, \quad t_1(k) = T_2 k^{\mu_2}$$

with $\mu_1, \mu_2 < 1$ in the event of congestion near the Haram.

Given the locational equilibrium conditions (9) and (11), $p_o(k)$ is given by

$$p_o(k) = p_{oo}(k/k_o)^{-\epsilon_1}, \quad \epsilon_1 = \frac{\gamma_1}{\beta_1}\mu_1 - \frac{\theta\mu_2}{1-\theta}\left[\frac{\gamma_2}{\beta_2} - \frac{\gamma_1}{\beta_1}\right]$$

This rent function derivation is given in detail in Pasha (1984). Also,

$$P_1(k) = p_{10}(k/k_o)^{-\frac{\gamma_2}{\beta_2}\mu_2}$$

Based on the above specifications it can be shown that [see Pasha (1984)],

$$\int_{ko}^{k^*} S_1(k) p_o(k) dk = E_1^R, \quad \int_{k_o}^{k_*} S_2(k) p_1(k) dk = E_1^R + E_1^H \qquad (22)$$

$$\text{where } E_1^R = \frac{\bar{N}_1 y_1 \beta_1}{(\alpha_1 + \beta_1 + \gamma_1)} \quad \text{and } E_1^H = \frac{\bar{N}_2 y_2 \beta_2}{\theta(\alpha_2 + \beta_2 + \gamma_2)}$$

The equations in (22) can be used to derive the impact on prices of housing services during the two periods of a change in the housing stock. The existing[8] housing stock is specified as

$$S_i(k) = Ak^{1-\lambda} \text{ for } k_o \leq k \leq k^*, \ i = 1, 2$$

Hedonic rent functions have been estimated separately for the pilgrimage and for the off-peak season with the help of data[9] collected in 1981 in Makkah. A large number of variables were initially incorporated in the regressions [see Kain and Quigley (1970), Berry and Bednarz (1975)]. The relatively significant variables are as follows: FLOOR = floor on which the pilgrim/permanent resident lived, FLOORSQ = floor squared, HRS WATER = average number of hours for which water was supplied daily during the stay of the pilgrim in Makkah or throughout the year to the permanent resident, DGRAD = dummy variable which assumes a value of one when the pilgrim/permanent resident lived in a property situated on a steep gradient[10] or two if very steep gradient, and zero otherwise, DEXTCOND = dummy variable which assumes a value of one when the external condition of the property was rated as good or very good, and zero otherwise, DAIRCOND = dummy variable with a value of one when the property was air-conditioned, and zero otherwise, DPAINT = dummy variable when the condition of paint was reported as fair or good, and zero otherwise, RMSIZE = average room size (in square metres) within the property, k = distance (in metres) of location of the property from the Haram. The dependent variable is RENT, rent per square metre per month.

[8] It is assumed that the valuation of the existing physical housing stock does not differ significantly between the two periods. As demonstrated earlier, the largest difference in valuation during the peak and off-peak season arises in the case of high-rise properties, which do not account for sizeable proportion of the housing stock currently.

[9] The process of data collection was organised by the Hajj Research Centre, Ummal Qura University, Makkah, Saudi Arabia. Two surveys were undertaken in 1401 A.H. (1981). The first was carried out during the period of pilgrimage. Information was collected on 1208 properties in Makkah. The questionnaire was administered on a randomly chosen pilgrim in each property. This survey of pilgrim housing was supplemented three months later in December 1981 by a smalier survey of 412 rented properties occupied by permanent residents.

[10] Makkah lies amid a complex of mountains and a series of alluvial valleys flanked by bare, steep-sided granite hills. Construction of housing has taken place along some hill slopes particularly near the Haram.

The initial regressions revealed that a quadratic specification of variation in rents with respect to floor did not work very well. There was a systematic tendency with this specification for rents on higher floors to be understated. Therefore, a spline function of the following form has been used

$$S = \text{MAX}\ [0, e^{F/\overline{F}} - e]$$

where $\overline{F} \geq \hat{F}$ and $\hat{F}$ is the floor at which the maximum rent is attained. Initially, a linear spline was used. However, the exponential form performed significantly better. $\hat{F}$ corresponds to the third floor during the peak period and to second floor during the off-peak period. The best value of $\overline{F}$ appears to be four in the former period and three in the latter.

Results of the regressions are presented in Table 1. A comparison of the estimated hedonic rent functions during the two periods highlights some

TABLE 1

Estimation of the Hedonic rent[a] functions for the peak and off-peak period

Independent Variables	Peak Period		Off-Peak Period	
	β	t-ratio	β	t-ratio
FLOOR	0.201	4.050*	0.121	2.683*
FLOORSQ	−0.033	−2.783*	−0.031	−1.952
S	0.106	2.386*	0.035	1.684
DGRAD	−0.261	−4.383*	−0.358	−4.167*
DEXTCOND	0.080	1.656	0.168	2.011*
DAIRCOND	0.100	1.777	0.088	1.342
DPAINT	0.090	1.576	0.148	1.908
HRSWATER	0.006	2.031*	0.002	1.089
ln (RMSIZE)	−0.023	−0.412	−0.103	−1.976*
ln (k)	−0.371	−11.879*	−0.125	−5.932*
INTERCEPT	7.870		4.378	
R^2	0.367		0.203	
F	61.234		21.671	
Degrees of Freedom	1096		348	

[a]The dependent variable is ln (Rent).

*Significant at the 5 per cent level.

important differences in housing preferences between temporary and permanent residents. First, the premium on home improvements, viz., DEXTCOND, DPAINT, etc., is lower. Second, the value of living space is greater during the peak period as indicated by the fact that there is no perceptible decline in rent per square meter with increase in size of the room and the rent differential during pilgrimage between properties situated on mountain slopes in relation to those located on flat terrain is smaller during this period. Further, the spline function has a significant positive coefficient only for the peak period implying that the decline in rent on higher floors of properties is less pronounced. Third, the stronger preference for centrality of pilgrims is established. The rent gradient is substantially greater during the peak season.

Based on the relevant coeffecients of the regression equations, p_{oo} = 931 Ryals per Standard Room Unit (SRU),[11] p_{1o} = 17,222 Ryals per SRU and $(\gamma_2/\beta_2)/\mu_2 = 0.13$, $\epsilon_1 = 0.37$. Values of other parameters, according to Pasha [1984], are as follows: $\mu_1 = 0.90$, $\mu_2 = 0.68$, $(\gamma_2/\beta_2) = 0.55$, $(\gamma_1/\beta_1) = 0.17$, $\beta_1/(\alpha_1 + \beta_1 + \gamma_1) = 0.25$, $\beta_2/(\alpha_2 + \beta_2 + \gamma_2) = 0.14$, $\bar{N}_1$ = 487,000, $\bar{N}_2$ = 800,000, y_2 = 442 Ryals, k_o = 30 metres, k^* = 8000 metres, and $\theta = 0.083$ in 1981. The housing stock parameters are A = 73.98 and $\lambda = 1.15$.

The implied $s_i(F)$ from the hedonic rent equations are presented in Table 2. In addition, the MC(F)[12] function is given for a representative property. From this table the increase in profits (area BEC in Figure 1) under partial equilibrium assumptions from the representative property as a consequence of withdrawal of building height controls can be determined. It appears that even with unchanged level of rents, the scope for additional floors is not very substantial. The maximum value of F* is thirteen floors in the immediate vicinity of the Haram. The potential rise in profits is also not so dramatic, at a maximum of 28 per cent. It certainly

11 A Standard Room Unit (SRU) is taken to correspond to housing consumption by a group of five pilgrims at a, more or less, minimum level of quality. For the unit, variables determining the level of rent have the following magnitudes: FLOOR = 2, HRSWATER = 10, DGRAD = 0, DPAINT = 1, DAIRCOND = 0, DEXTCOND = 1, RMSIZE = 15 square metres.

12 The following costing assumptions for Makkah were provided by the architects and engineers of the Hajj Research Centre, Ummal Qura University, Makkah:
Foundation Cost: 1500 Ryals per square metre (m^2) for the first floor, and additional cost (Ryals/m^2) for second floor, 300; third floor, 350; fourth floor, 400; fifth floor and above, 500.
Structure Cost: 1200 Ryals/m^2 of built-up area for each floor for average quality construction.
Lifts Cost: Number: one lift per 400m^2 at the fourth floor, increasing by 10 per cent for each subsequent floor.
Cost per lift: 200,000 to 250,000 Ryals per lift with capacity to carry ten persons.
Life of Building: Forty years.

TABLE 2

Existing rent level[a] and marginal cost per floor in the central area of Makkah for a representative property[b]

('000 Ryals)

	FLOORS												
	1[c]	2	3	4	5	6	7	8	9	10	11[e]	12[e]	13[e]
$s_1(F)$	27.0	27.8	26.9	25.4	22.8	19.7	16.4	13.5	11.0	9.0	7.9	7.5	7.2
$s_2(F)$	25.1	27.8	28.8	28.0	27.6	26.0	23.7	21.0	18.3	15.9	14.0	12.9	12.6
R(F, k)													
FLAT TERRAIN													
First Ring	926.9	617.9	622.4	598.1	568.8	519.3	458.9	397.0	338.9	289.2	254.4	236.5	229.8
Second Ring	725.4	483.6	484.9	465.1	439.6	399.1	350.6	302.0	256.7	218.3	–	–	–
Third Ring	592.8	295.2	394.5	377.2	355.9	321.8	283.1	242.5	205.7	–	–	–	–
Fourth Ring	503.2	335.5	333.9	318.9	299.7	269.9	236.6	202.1	–	–	–	–	–
MOUNTAIN SLOPE													
First Ring	–	–	–	–	–	–	–	–	–	–	–	–	–
Second Ring	297.7	319.9	321.5	308.2	293.3	267.7	237.4	204.6	–	–	–	–	–
Third Ring	231.8	248.0	248.2	237.6	224.9	204.1	180.1	–	–	–	–	–	–
Fourth Ring	196.1	209.3	208.8	199.6	188.2	170.1	–	–	–	–	–	–	–
$MC^d(F)$	172.8 (202.8)	96.0	99.2	137.6	144.0	151.0	159.0	169.0	180.0	191.0	203.0	216.0	229.0
VC(F)	43.2	24.0	24.8	34.4	36.0	37.8	39.8	42.3	45.0	47.8	50.8	54.0	57.3
FC (F)	129.6	72.0	74.4	103.2	108.0	113.2	119.2	126.7	135.0	143.2	152.2	162.0	171.7

[a]Rental income has been computed upto F* for each location.

[b]With a built-up area of 640 square metres.

[c]This floor is assumed to be devoted for commercial purposes in the case of properties situated on flat terrain, with rental income about 50 per cent more than on the second floor.

[d]The cost function is assumed to be the same at all locations, except that the initial foundation cost for properties situated on mountain slopes is taken as higher.

[e]Derived by extrapolation of the rent functions.

does not appear as large as would be expected given the intensity of lobbying efforts. This may be because property owners are not fully anticipating the extent of decline in R(F, k) after $\bar{F}$ or the increase in C(F) after this height.

VI. Short-Run Impact

As mentioned earlier, bulk of the supply response in the central area to building height deregulation is likely to take the form of demolition of existing properties and their replacement by higher structures. In addition, most properties with heights up to the previous maximum are of a structural condition that it is possible to raise the height by one floor with minor reinforcement work. This will happen almost immediately if

$$R(7, k) > MC(7)$$

with R(F,k) evaluated at $p_o(k)$ and $p_1(k)$ just prior to deregulation.

This condition appears to be satisfied for all locations within the central area except for properties located on mountain slopes at a distance of half to one kilometre from the Haram.

Turning to the scope for demolitions, on the assumption that variable costs are 2.5 per cent of the capital cost, the following types of demolitions satisfy the conditions (16) and (18).

	Location[a]	Height (F_e) of Existing Property	Height (F*) of New Property
1.	First Ring	7	13
2.	First Ring	6	13
3.	Second Ring	5	10
4.	Fourth Ring	4	8

[a]The central area has been broken up into four rings as follows: first ring, 30 to 100 m; second ring, 101 to 250 m; third ring, 251 to 500 m; fourth ring, 501 to 1000 m.

The overall supply response in the short-run represents an increase in the housing stock in the central area of 11.8 per cent during the off-peak period and 14.2 per cent during the peak period. This implies a decline in the rent level of 0.91 and 1.73 per cent in the two periods respectively.

In general equilibrium terms, the net profit from reconstruction is given by

$$\Delta\pi = \int^{F^*} R'(F,k)\, dF - C(F^*, k) - FC(F_e, k) - \left[\int^{F_e} R(F, k)\, dF - C(F_e, k)\right]$$

implying,

$$\Delta\pi = \int^{F^*} R'(F, k)\, dF - \int^{F_e} R(F, k)\, dF - C(F^*, k) + VC(F_e, k) \qquad (23)$$

where R′ is the rent function evaluated at the new prices.

For any other representative property the loss in value is given by

$$\Delta\pi = \int^{F} [R'(F, k) - R(F, k)]\, dF \qquad (24)$$

The gain in utility to consumers of housing, viz., Makkans and pilgrims, is evaluated in terms of the compensating variation. For a permanent resident it is given by H_1 where

$$\log\left[\frac{y_1 - H_1}{y_1}\right] = \frac{\beta_1}{\alpha_1 + \beta_1 + \gamma_1}\left[(1-\theta)\log\frac{p_o'(k)}{p_o(k)} + \theta \log \frac{p_1'(k)}{p_1(k)}\right] \qquad (25)$$

where $p_o'(k)$ and $p_1'(k)$ are the new equilibrium prices following the supply response in the two periods respectively.

Similarly, for a pilgrim, it is denoted by H_2, where

$$\log\left[\frac{y_2 - H_2}{y_2}\right] = \frac{\beta_2}{\alpha_2 + \beta_2 + \gamma_2} \log \frac{p_1'(k)}{p_1(k)} \qquad (26)$$

The estimated short-run impact is shown below. It may be noted that landlords in the Central Area as a group actually lose in the short run following deregulation.

	(Million Ryals)
Change in Differential Land Rents in Central Area	-- 4.7
Change in Differential Land Rents Outside Central Area	−14.4
Income Equivalent of Change in Utility of Pilgrims	+10.2
Income Equivalent of Change in Utility of Permanent Residents	+11.7
Net Change	+ 2.8

VII. Long-Run Impact

1. *Building Heights*

In line with the methodology developed in section 3, F*(k) in the long run, with and without the regulation, can be determined. However, the actual computation required the development of a fixed point algorithm. This algorithm works with the prices, p_{oo} and p_{1o}, the unit prices of housing services during the off-peak and peak periods respectively, at the minimum distance of k_o from Haram. These prices are used to derive the annual rent, R(F, k). From (20), (3) and (21), k_c, F* (k) and k_m respectively are determined. Following this, $S_i(k)$ is quantified from (19a) and (19b). A consistency check is then applied to see if the particular values of p_{oo} and p_{1o} satisfy (22). If it appears that the implied value of services from the housing stock in the city is greater/smaller than total housing expenditure in a particular period then an appropriate downward/upward adjustment is made in these values until equilibrium is attained.

The analysis has been carried out under the following assumptions:

a) The city has been broken up into concentric rings, with width of rings increasing with distance from the Haram. As mentioned earlier, four rings have been defined in the central area, viz., 30 to 100 m, 101 to 250 m, 251 to 500 m and 501 to 1000 m. There are two reasons for doing this. Firstly, the first ring is in the immediate vicinity of the Haram and it is important to see what heights of buildings are likely to be in the long run at this location. If it turns out that the structures are too high and tend to dominate the Haram then the case for regulation of heights in the central area of the city becomes stronger. Secondly, rents fall significantly in the first kilometre, especially during the peak season and, therefore, building heights could change significantly within this distance.

   The other rings are as follows: 1001 to 1500 m, 1501 to 2500 m, 2501 to 4500 m, 4501 to 6500 m, 6501 m and above. For the purpose of facilitating calculation it is assumed that all properties within a ring are located at its mid-point.

b) Housing expenditures, E_1^R and E_1^H, are assumed to remain at present levels. The reasons for making this assumption are, firstly, to determine what the scope for new construction is at current levels of housing demand and, secondly, to identify locations within the city which are likely to witness greater construction in the long run in the presence and in the absence of height controls. Of course, it is possible to undertake a similar exercise of determining long-run optimal heights if major increase is anticipated in housing expenditure levels.

c) The assumed pattern of residential land use, U(k), in the long run is based on a number of considerations. Firstly, in the immediate vicinity of the Haram a substantial portion of the land is likely to remain reserved for prayer space and for motorised traffic and pedestrian movement areas. Secondly, the extent of residential land use away from the central area of the city is limited by the presence of mountains. As such, U(k) is assumed to attain a peak in the third ring and then decline continuously in subsequent rings.

d) It is assumed that bulk of the properties located on flat terrain (essentially along main roads) up to a distance of 2.5kms will have the first floor devoted primarily to commercial uses. This is because of the importance of Makkah as a shopping centre for religious souvenirs, consumer durables and groceries for pilgrims.

e) The city boundary is defined as the distance at which land values fall below 3000 Ryals per square metre.

f) The length of the peak season is assumed to remain approximately one month in the long run.

The magnitude of p_{oo} and p_{10} obtained by solving the model in the absence and in the presence of height controls in the long run are as follows:

(Ryals per SRU per month)

	Existing	Long Run: Absence of Height Controls	Long Run: Presence of Height Controls
p_{oo}	931	808	820
		(–13.2)	(–10.8)
p_{10}	17222	13522	14340
		(–21.5)	(–16.7)

Figures in brackets represent percentage change from existing level.

It may be noted that rent levels fall somewhat more in the long run in the absence of height regulation primarily because of the availability of more housing near the Haram.

The derived values of F* under the two long-run scenerios are presented in Table 3. A number of conclusions can be reached from the table. First, the difference in building heights is most pronounced in the immediative vicinity of the Haram. For example, structures in the first ring

TABLE 3

Long-run optimal building height in the absence and in the presence of height controls at varying distances from the Haram

Distance/Location	Long-Run Building Height (FLOORS)	
	In the Absence of Height Controls	In the Presence of Height Controls
Flat Terrain		
First Ring	11	7[a]
Second Ring	9	7[a]
Third Ring	8	6
Fourth Ring	7	6
Fifth Ring	7	7
Sixth ring	6	7
Seventh Ring	6	6
Eighth Ring	5	5
Nineth Ring	5	5
Mountain Slopes		
First Ring	—[b]	—[b]
Second Ring	8	6
Third Ring	6	6
Fourth Ring	5	5
Fifth Ring	4	4
Sixth Ring	3	3

[a]The average is taken as seven and not six floors because of the case-by-case exemptions given to some properties, e.g., hotels.

[b]There are no mountain slopes in this ring.

could go up to eleven floors whereas in the presence of controls they would be limited to an average height of seven floors. The recent upward revision of building height limits appears to be less than the optimal height only in the immediate vicinity of the Haram. For the third and fourth ring it represents over-adjustment as long run optimal heights are lower. Second, heights in the presence of controls are actually higher outside the central area, for example, in the sixth ring. Third, the slope of heights on flat terrain after, say, the fifth ring is not likely to be pronounced in Makkah. The minimum height is five floors. This reflects the relatively small decline in rental value as demonstrated by the hedonic rent functions and the modest rise in building costs up to this floor.

Fourth, it is of interest to note that the city boundary is further away in the presence of controls by 1.25km at 9.25kms. The restriction of construction in the centre of the city clearly makes investment more profitable at the periphery and, as a result, the city stretches out more.

Also, it appears that at present levels of demand for housing services there exists scope for net increase in the housing stock of about 22 to 24 per cent. This is an indication of the fact that the pace of construction activity in Makkah is going to remain relatively high in the next few years. In the absence of height controls there are likely to be major changes in the spatial distribution of housing stock over time. Bulk of the development is likely to be concentrated in the first six rings upto a distance of 2.5kms. In fact, long-run simulations of the model reveal that the presence of height limits in the central area has led to some overconstruction in the periphery. If heights are deregulated then there could even be a decline (−3 per cent) in housing stock after 6.5kms.

2. *Impact on Welfare*

Applying the same methodology as in the short-run case we can derive the welfare implications of the difference in the long-run outcomes in the housing market of Makkah, one in the presence and the other in the absence of height controls. These are presented below:

	(Million Ryals)
Change in Differential Land Rents in Central Area	− 3.6
Change in Differential Land Rents outside Central Area	−33.5
Income Equivalent of Change in Utility of Pilgrims	+23.4
Income Equivalent of Change in Utility of Permanent Residents	+20.3
Net Change	− 6.6

A number of important conclusions emerge from the welfare analysis for both the short and long run. First, contrary to the expectations of landlords in the central area, land rents are always lower in the absence of height controls. Dramatic increases in land values are not likely to be realised. It appears that the presence of height limits exerts a kind of monopoly output restriction effect and raises rents. The ambiguity of $\Delta\pi$ in (5) is clearly established and the results demonstrate that the general equilibrium consequences of height deregulation are to make $\Delta\pi$ negative. Therefore, the lobby of landlords which is agitating for such a relaxation may actually be working against its interest. In fact, landlords suffer somewhat bigger losses in the short run as they are unable to benefit fully in this period from withdrawal of regulation.

Second, the real losers in terms of the order of magnitude are landlords outside the central area. The presence of height controls, as highlighted earlier, has served to artificially raise profitability of investment in housing in the rest of Makkah city.

Third, the net welfare cost of height controls appears to be very small. The welfare gain from their withdrawal to consumers of housing just about compensates the loss of producer surplus.[13] In per capita terms, the net welfare gain per resident is only 2.2 Ryals in the short run and 5.2 Ryals in the long run. It is clear that the recent upward adjustment in maximum permissible heights is unlikely to have conferred significant benefits particularly if the direct welfare gains of the type quantified in the paper are traded off against the welfare cost of the deterioration in the environment around the Haram. In fact, a case could even be made for reversion to the original height limits. If however, this is politically and administratively infeasible then perhaps a policy decision could be taken not to relax the controls further in the foreseeable future.

Applied Economics Research Centre
University of Karachi

[13] A similar conclusion was reached by Arnott and Mckinnon (1977) in the context of height controls in Toronto, Canada.

References

Alonso, W., 1964, Location and land use, Cambridge, Mass: Harvard University Press.

Arnott, J., and J.G. Mckinnon, 1977, Measuring the costs of height restrictions in a general equilibrium model, Regional Science and Urban Economics, 7: 359–375.

Bender, B.A., 1979, The determinants of housing demolition and abandonment, Southern Economic Journal, 46: 131–144.

Berry, B.J.L., and R.S. Bednarz, 1975, A hedonic model of prices and assessments for single family homes: Does the assessor follow the market or the market follow the assessor?, Land Economics, 51: 21–40.

Hufbauer, G.C., and B.W. Severn, 1974, The economic demolition of old buildings, Urban Studies, 11: 349–351.

Kain, J.F., and J.M. Quigley, 1970, Measuring the value of housing quality, Journal of the American Statistical Association, 65: 532–548.

Makky, G., 1981, Pilgrim accommodation in Makkah, Unpublished Ph.D. thesis, Michigan: Michigan State University.

Mills, E.S., 1967, An aggregate model of resource allocation in a metropolitan area, American Economic Review, 58: 197–210.

Muth, R.F., 1969, Cities and housing, Chicago: The University of Chicago Press.

Pasha, H.A., 1984, Seasonal housing markets: A model of pilgrim housing in Makkah, Unpublished Ph.D. thesis, California: Stanford University.

Pollard, R., 1980, Topographic amenities, building height and the supply of urban housing, Regional Science and Urban Economics, 10: 181–199.