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Measuring the Costs and Benefits of Urban Land Use Regulation: A Simple Model with an Application to Malaysia[1]

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Land use regulation *per se* is neither good nor bad. What matters is the cost and benefit of *specific* regulations in *specific* market conditions. This paper presents a straightforward cost–benefit framework for analyzing land use and related regulations in such a context, and presents an application of the method to Malaysia. We use these results to illuminate several important issues, namely the effects of such land use regulations on housing markets, how to use such analyses to suggest revisions to common land use regulations, and what changes in higher-order incentives facing regulatory authorities might be required to encourage an appropriate regulatory environment for urban land.

INTRODUCTION

Land use regulation *per se* is neither good nor bad. What matters is the cost and benefit of specific regulations under particular market conditions. This paper presents a straightforward cost–benefit framework for analyzing land use and related regulations in such a context, and presents an application of the method to Malaysia. In particular, we discuss the implications of the fact that with real-world data sets, we usually have better data on costs than on benefits. We use

[1]This paper is based on a larger study of the effect of government interventions on housing markets, which was carried out in collaboration with Stephen K. Mayo and Lawrence Hannah. We are also indebted to many government officials and private market participants in Malaysia. An anonymous referee provided useful comments. However, opinions expressed are solely those of the authors, and do not reflect official policy or views of the World Bank or any other organization.

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these results to illuminate several important issues, namely the effect of such regulations on housing markets, how to use such analyses to suggest revisions to common land use regulations, and what changes in higher-order incentives facing regulatory authorities might be required to encourage an appropriate regulatory environment for urban land.

The study we report on here was part of a joint research project, *Getting the Incentives Right*, carried out with our colleagues Larry Hannah and Steve Mayo, which was carried out in response to a request from the Malaysian government for a study to explain why formal housing costs appeared to be so high.[2] The study had three interlocking parts: (1) an analysis of aggregate market and macroeconomic data; (2) a detailed cost–benefit study of land use regulations; and (3) an analysis of the costs, benefits, and incidence of a wide range of government interventions (taxes, subsidies, and regulations). This paper is focused primarily on the second part. The other parts are discussed in a companion paper, Malpezzi and Mayo (1997).

The present paper completes the documentation of the original *Getting the Incentives Right*, but putting that study, much cited,[3] and sometimes controversial,[4] in the public domain is not our only motivation for this paper. Many previous studies have analyzed one or a few urban regulations in isolation, such as zoning (e.g., Pogodzinski and Sass, 1991), density and subdivision regulation (Real Estate Research Corporation, 1974), price controls (Malpezzi, 1993), or building codes (Muth and Wetzler, 1976). However, land markets operate under many specific regulations. As we will see below, the net effect of a large set of regulations can surprise those who have only considered the isolated effects of one or two. The general approach taken here is to analyze a large set of land use regulations in a comprehensive and integrated framework.[5]

Standards for land use are often established on the basis of an abstract minimum "need" for each service or facility. In isolation, each may seem reasonable when considering only the narrow purpose or specific objective to which the regulation is addressed. However, in practice standards often have unintended effects on developments, which may result in costly distortions. Our model clarifies some of the unintended consequences, and measures the size of the distortions. The model also permits an investigation of how land use regulations affect the type and location of housing ultimately produced. Such an analysis is the key to understanding the linkage between land use decisions, urban form ("sprawl"), and housing affordability.[6]

[2]Hannah *et al.* (1989).

[3]See World Bank (1991, 1993), Angel (2000), Dowall (1992), and Strassman (1991), for example.

[4]See Baken and van der Linden (1993), Malpezzi (1996), and Ward and Jones (1997).

[5]In a companion paper (Malpezzi and Mayo, 1997) we in turn consider the land use regulations analyzed here as a subset of total housing development regulation.

[6]These issues are highly topical in developed markets (e.g., Burchell *et al.*, 1998; Green, 1999; Chesire and Sheppard, 1989; Monk and Whitehead, 1999), developing countries (Dowall, 1989;

The approach taken in this paper is partial equilibrium; i.e., we take prices and costs as given, and ignore general equilibrium effects. Of course no single model of land use suits all purposes. Our model is particularly good at illustrating how actual and quite specific regulations affect costs (and hence land use and housing prices) if prices are initially taken as given. The model will therefore give good results for analysis of regulatory exceptions for specific development projects (a common occurrence in many developing countries). On the other hand, market-wide changes in land use regulations will often affect prices. This suggests a general equilibrium model of such changes in price can complement the model presented in this paper. We do not account for such effects explicitly in this paper, although we discuss their effects and how the model may be modified in light of them.

TWO SIMPLE MODELS OF LAND USE REGULATION

Fischel (1990) points out that most studies of land use regulation by economists are not cost–benefit studies, but rather cost studies. One of the central points of this paper is that studies of regulation should consider its benefits as well, for why else would one regulate? The reason that so many studies ignore such benefits, of course, is that they are so difficult to estimate.[7] We take a rough and ready approach to measuring benefits by comparing current regulation and practice to a baseline based on market comparisons and "international practice," which will be explained below. We think of this as an approximate or second best approach, compared to an exact method based on known demand for the public goods generated by regulation. Since we generally do not, and cannot, know these demands in practice, we suggest this approximate method will provide superior results to the real-world alternative of ignoring benefits entirely. Since a comparison of these approaches is so central to our purpose, we present a simple formalization of each in this section.

An Exact and Preferred Model

Figure 1 presents a simple model that underlies the rationale behind land use and related regulations. Consider a representative consumer who has a demand D_1 for some common use of land—say streets as an initial example.[8] D_1 his or her private willingness to pay, is determined by the consumer's private benefit

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Kim, 1993; Mayo and Sheppard, 1996; Green *et al.*, 1994), and transition economies (Bertaud and Renaud, 1997; Hegedus *et al.*, 1997; Mayo and Stein, 1995; Renaud, 1995a, b).

[7]Peterson (1974a, b) and Malpezzi (1996) are among studies that do explicitly consider benefits of regulation as well as costs.

[8]Extension to other common uses/externalities such as setbacks, land for community facilities, floor area ratio regulations, and so on, is direct.

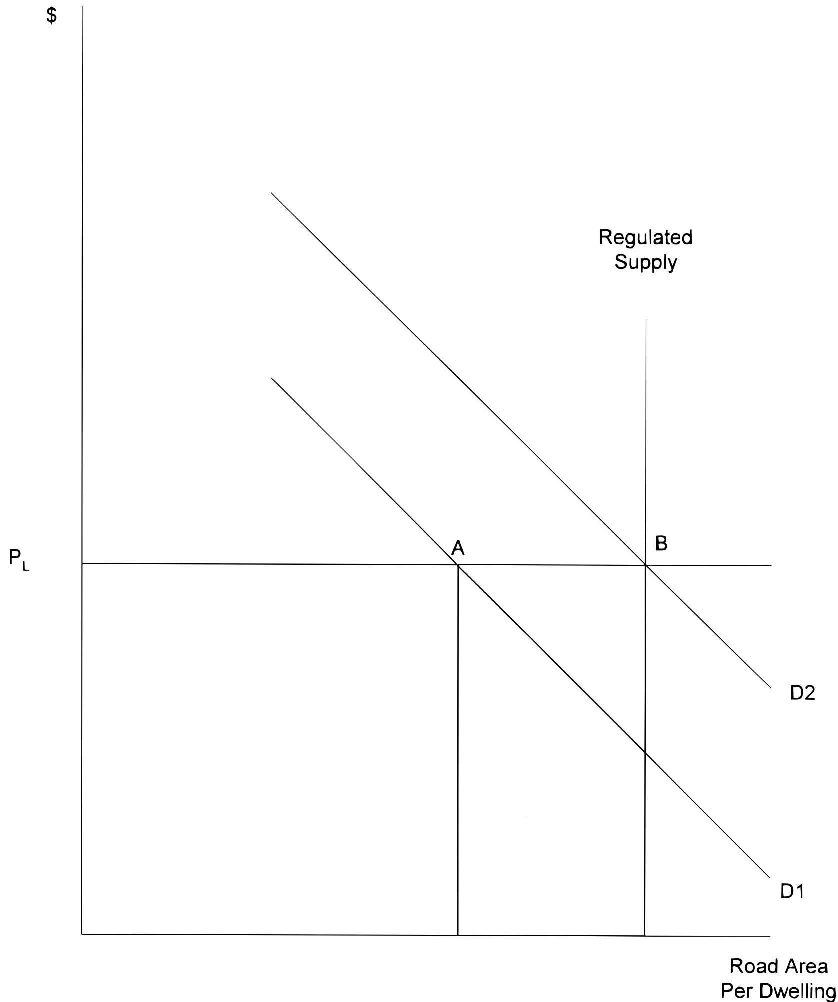

FIG. 1. Supply and demand for a representative common use of land.

from subdivision roads, and the consumer will demand roads built to the standard represented by *A*. If a positive externality exists—say because in the relevant range streets are congested, and most of those costs are born by others—social benefits of devoting land to streets exceeds private benefits. These are reflected in the social benefit curve, D_2.

Thus in our example the private market devotes too little land to streets, assuming developers respond to consumer demand. In principle, the government can correct this case of market failure by regulating more land devoted to streets, specifically to point *B*. We say in principle because arriving at the social optimum, *B*, assumes *inter alia* that the regulating authority knows both private demand and the size of the externality, that the authority has specific regulatory instruments available to them that they can use to reach *B* with reasonable precision and with low administrative cost, and that the regulating authority acts to maximize social welfare rather than (say) its own budget or some other objective function.

If, in addition, the demand curve is compensated for the income effect of changes in price, in principle this method can be used to measure exactly changes in welfare from land use regulation (or any other public intervention). If the demand curve is uncompensated—the so-called money–income–constant demand curve—the resultant measure is an approximation, but one whose bounds are well understood.[9]

An Approximate, Second Best Cost–Benefit Model

Many design characteristics must be considered in land development such as the amount of open space, plot sizes, type of clustering, type of sanitation, type of street surfacing, and engineering specifications.[10] Regulations affect each and every one of these. In principle the model just described could be applied to each in turn. In practice, this requires *inter alia* knowledge of the private and social demands for each. This is not practical, but we will show below that by relying on approximation and a willingness to seek bounds rather than exact results, it is possible to analyze reasonably quickly the implications of a large number of regulations and other interventions on many design standards.

The basic idea is a simple one. For each regulation, we first calculate the cost in terms of additional land, higher-cost infrastructure components, additional materials and labor, and so on. Then we net out any obviously measurable benefits that accrue to developers, consumers, or society at large. Conceptually, then, the model is quite simple. The value added is in the details, particularly (1) in clarifying the role of benefits as well as costs,[11] (2) roughly quantifying both costs and benefits rather than making even rougher judgments based on rules of thumb, (3) adding up the effects of many different regulations, each of which

[9]See Freeman (1979) for a lucid discussion of the details of such consumers surplus models, and Willig (1976) for the analysis of error bounds for the money–income–constant demand or “Marshallian” model.

[10]One well-known previous study that attempted to analyze a number of regulations simultaneously in a developed country was Real Estate Research Corporation (1974). That study focused only on costs, and ignored benefits, even in our approximate and heuristic fashion (as the authors themselves were careful to point out). In addition, Windsor (1979) and Altshuler (1977) point out that RERC focused on per-unit cost, and did not calculate the least costly pattern of housing development for a given population. In our study, unlike RERC’s study, unit floorspace is held constant across alternatives, so that per-unit and per-capita costs are proportional.

[11]It could be argued that by training and temperament many planners underweight costs of regulation, and many economists underweight benefits.

may by themselves have little effect but whose cumulative effect may be substantial, and (4) consider in at least a limited way the interaction of regulations.

Another advantage is more heuristic. A complete application of the model requires involvement from all the relevant land use professionals—planners, engineers, economists, financial analysts, housing market specialists—simultaneously during the various phases of the regulatory design process, instead of having them participate one after another in a succession of discrete unrelated tasks.

Let us examine such a simple accounting model in light of the cost–benefit framework above. In Fig. 2, let D represent the social demand curve for land for a particular use. Suppose for the moment that the regulator requires too much land for this use. The best measure of net cost is $P_L(L_R - L_S) - \int_0^{PL} D_S dP$, or ABCI − ACE. This requires knowledge of two pieces of information easily collected—regulated supply and the price of land. It also requires knowledge of the demand curve—level *and* elasticity—for every regulated use, which is not so readily obtainable.

Consider some alternative approximations. Suppose we know the level of land demanded for this use at P_L, but not the shape of the demand curve. $P_L(L_R - L_S)$ is not a very good approximation, at least as drawn, since benefit ACE is entirely neglected.

Suppose we (for the moment arbitrarily) shift the baseline to the right, to say L_β. Since ACGH is a wash, and neglected cost AFG is (approximately) offset by neglected benefit GHE, $P_L(L_R - L_\beta)$ = FBHI happens to approximate true net cost ABCI − ACE.

Of course this substitutes one difficult piece of information for another. However, we argue, firstly, that market participants know more about levels than elasticities, and that provided we choose L_β to be well to the right of L_S, we will more often *underestimate* net costs than overestimate them.

The only practical alternative to such approximations is to eschew cost–benefit analysis. Given our conservative approach to measuring benefits, our procedure is biased toward finding that a particular regulation has a favorable cost benefit. Thus, if we find regulations that are robustly costly (compared to benefits), we can confidently recommend their revision. For those near a net cost benefit of 0, we recommend further study. Other regulations, of course, will be found robustly favorable, and these should be retained, possibly strengthened and enforced. The method thus lends itself to what could be termed regulatory triage.

Students of elementary public economics will have found most of this discussion straightforward. What is less familiar, but only a little more difficult, is how to analyze land use regulations in practice. To this we will now turn, referring to a computerized version of the model developed by the first author.

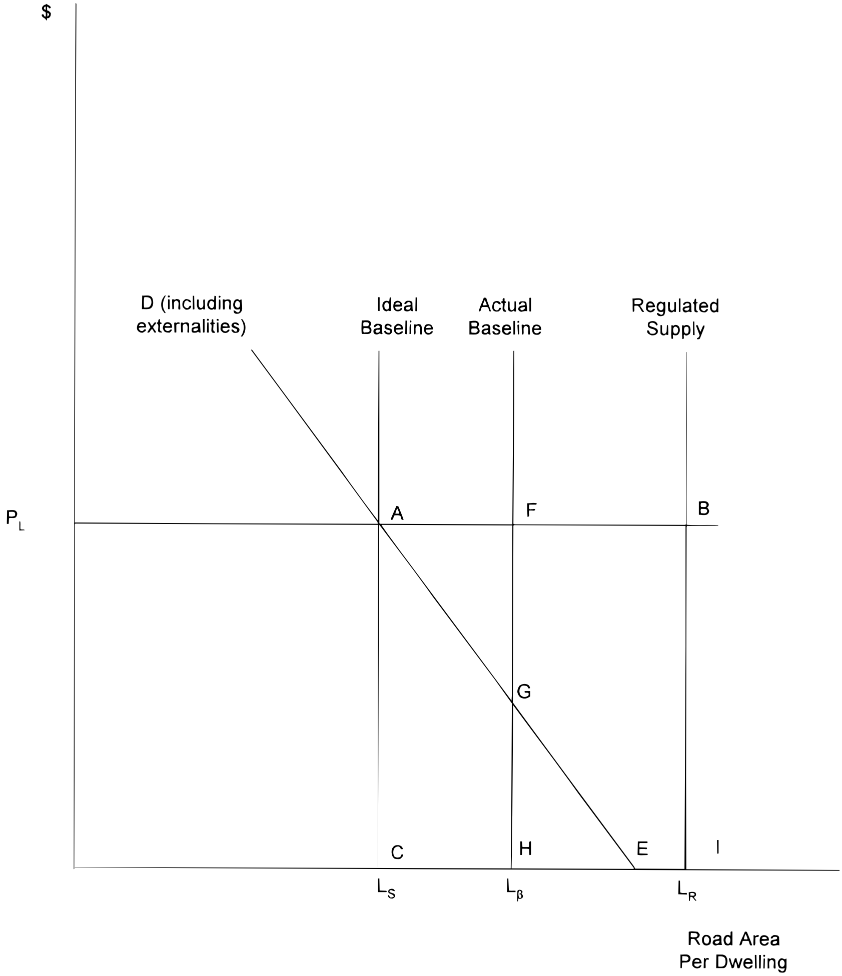

FIG. 2. Cost–benefit: Consumer's surplus and an approximation.

The "Bertaud Model"

The Bertaud Model is a model that is used to numerically compare the cost–benefit of alternative project designs, using the second best framework laid out above. In our example above, we considered the demand for road width. In fact, the Bertaud model costs out a proposed project design, simultaneously considering a wide range of design parameters, such as road width and design, floor area ratio (FAR), land required for public uses (e.g., schools and parks), infrastructure standards (off-site and on), minimum plot sizes and setbacks, site preparation costs, and design and administrative costs, among others.[12] A complete description of all inputs and calculations of the model is too lengthy to present here; details can be found in Carroll and Bertaud (1986), Bertaud (1981), and Bertaud *et al.* (1988). However, a simple example is sufficient to illustrate how the model works, and its value.

Consider the development of a plot for a housing unit with 10 m frontage, and assume the price of land is $10 per square meter. Suppose there is a requirement that the road in front of the house be 7 m wide. If the house in question faces an identical unit, we would say roughly that the land required for the road adds 0.5*7*10*10 or $350 to the unit cost of development. Of course there is an offsetting benefit provided by the road, but in order to set the "correct" road width, we wish to know the cost–benefit of a meter of required width, on the margin. The "exact" method above requires us to know household demand for roads, and not just in general, but by size of road. This is not easy to estimate, and not generally doable. The exact method cannot be employed.

Our approximate method proceeds as follows. Suppose that by studying the market in question we determine that, in fact, existing developments can be found where households similar to the target market for this development live and which have roads averaging, say, 5 m in width; that no evidence can be found that units with slightly wider roads command a higher price; and that no significant unpriced, external benefit of such wider roads can be established. Using one of the computer implementations of the Bertaud model,[13] the user would enter a 5-m road as a baseline case, and a 7-m road as an alternative for comparison. Under the assumptions above, changing to a 5-m road would yield a savings of $100 per unit. Of course, if it was determined that there was some offsetting (private or public) benefit for the wider road, the amount of offset can be readily entered.

The example above is so trivial that the value of a computer model for such calculations may not be readily apparent. In principle such calculations are quite simple, but in fact they quickly become more complicated in practice. Returning to our simple example of road width, narrower roads will also require less grading, engineering, and paving. Compared to a proposed 7-m standard, a network of 5-m residential roads will imply a denser overall development (given fixed plot sizes) and hence less area devoted to feeder roads. In rainy climates smaller road area overall leads to less runoff, and less required drainage infrastructure. Keeping track of all such interactions among design features, when many design parameters

[12]The floor area ratio is the ratio of floor area buildable under the regulations to the area of the plot.

[13]There have been several versions of the model, with the same underlying principles as described in this paper, but with increasing detail, and sophistication of output. Early versions were programmed for calculators; later versions were designed for spreadsheets. More recent versions are programmed in computer-aided design language (AutoCAD), which has the advantage of presenting results as a graphic site layout readily interpretable, by developers and planners.

are considered simultaneously, is one of the central features of the model. For example, in the Malaysian case study below, the standards issued for the Special Low Cost Housing Program comprised some 43 specific regulatory standards, and this complexity is by no means unusual. Computer implementation also has the advantage of translating design parameters implied by regulations into CAD representations of representative site layouts, as well as monetary amounts.

Of course comparing the costs and benefits of alternative project designs is a quite general problem, and the Bertaud model has application beyond the study of land use and related regulations, but its applicability to regulatory cost benefit is obvious. Binding regulations change project designs, and the Bertaud model permits a careful analysis of the costs and benefits of these changes. "Good" regulations generate (public and private) benefits that exceed their costs, "bad" regulations the reverse.

Thus the model calculates the cost of a given project design, subject to the land use and infrastructure policies in force. The model is used successively to compare alternative designs; i.e., it does not produce the optimal design as an output.[14] Most applications involve comparing a current or proposed design to one or more alternatives. The choice of alternatives involves some judgement, so the model is not a "black box" for designing optimal projects. One of several alternatives studied will emerge as the best alternative, but an unstudied alternative that is still better, at least on the margin, may and in fact usually exist. However, experience in numerous countries confirms that when used by or with the advice of experts in real estate development, exercises undertaken with the model consistently yield significant improvements in design, in the sense of more favorable cost–benefit.

Various versions of the model have been applied to roughly 30 countries, as diverse as India, Thailand, Peru, Senegal, and Russia. To illustrate how this model can be used to analyze land use regulations in practice we examine late 1980s Malaysian land use regulation as a case study.[15] Before we undertake this analysis it will be useful to provide some background information about the study and the Malaysian market at the time of the study.

APPLICATION OF THE SECOND BEST MODEL

As noted above, the larger study of which this is a part (Hannah *et al.*, 1989) was carried out in response to a request from the Malaysian government for a

[14]In principle a goal-seeking version of the model that optimizes is possible. However, given the magnitudes involved, and variation in inputs such as the price of land, as well as imperfect knowledge of demand, it is unlikely that such a model would yield true optima, or for that matter significant improvement over the current "expert" approach.

[15]We chose to illustrate the model with the Malaysian case study for several reasons. First, presenting results from a middle-income developing country has some advantages; the case is in the middle of

study to explain why formal housing costs appeared to be so high; in this paper we focus on the effect of land use regulations. It is important to note that as the study was carried out in 1989, specific figures presented in this paper are dated, and much has changed in Malaysian land and housing policy. However, in a general sense the issues raised are still "live" in Malaysia as in many other countries (including, as noted above, the United States).

Background: Urban Land and Housing Markets in Malaysia

As already noted, the Malaysian Government was concerned about high formal housing costs, despite the existence of a Special Low Cost Housing Program (SLCHP) designed to induce private developers to build low-cost housing. That program was innovative in that virtually all the units were to be built by private developers on both private and state-owned land. Developers were permitted to build 60% of their units to high standards with high profit margins in order to subsidize the remaining 40%. For the low-cost units, reduced infrastructure standards and streamlined regulatory approvals were envisioned, but these proved to be insufficient. In its first year, the SLCHP fell well short of the target number of low-cost housing units it had hoped to build.

When the Special Low Cost Housing Program was launched at the end of 1986, existing land use standards made it difficult to reach the M$25,000 per dwelling target envisaged in the program. As a result, the Ministry of Housing and Local Government (MHLG) prepared guidelines that should have been used by local authorities for SLCHP projects. The new guidelines contained provisions to streamline the land development approval process, and to reduce minimum standards to make them more affordable. In particular, the new guidelines established the minimum plot size at 68 m^2 and the minimum floor space at 42 m^2. Service back lanes were reduced to 4.50 m. However, a number of road standards and setback regulations were still very costly in comparison with their corresponding benefits,[16] and local authorities resisted applying even these modestly relaxed standards.

To anticipate results below, even after these changes land development standards, as enforced by local authorities, were found to be major constraints on development, particularly for low-cost housing. Even before the study, many public and private developers, architects, planners, and government officials shared this opinion, but lack of quantification and little specificity about just which regulations were causing the problem hampered discussion. Our land use analysis of low-cost residential projects (developed by private and public

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the income distribution of cases to date. Second, the Malaysia case study has been widely cited, as noted above, but this aspect of the work has never been documented in a published paper. Third, for those with an interest in details beyond this paper, much supporting documentation exists (contact the second author for further information).

[16]The new guidelines and their cost implications are reviewed in detail in Hannah *et al.* (1989).

developers) showed that some standards and practices verged on the extravagant. For instance, the area per household provided for roads is up to four times larger than the area for roads in projects in other countries of Asia, Europe, and America with a similar plot size. Using international practice as a yardstick, about 25% of the land developed for residential purpose was wasted. This waste was shown to be due in large part to excessive road areas, arbitrary setback regulations, and in lesser part to redundant community facilities.

Such waste is a serious issue, as it not only raises housing costs, but also reduces the supply of land and, consequently, raises land prices. Additionally, it reduces densities and, therefore, increases the cost per dwelling of providing and maintaining infrastructure. Indirectly, lower densities result in higher transport costs and a reduction in overall urban efficiency.

Cost–Benefit Analysis and Results

As described above, the model estimates the effects of changes in regulations on cost and market value through intervening design characteristics: plot frontage, block length, street width, and infrastructure standards. Again, we emphasize that the object is not to demonstrate a single “correct” regulatory solution. The optimal solution will usually be different from case to case. However, these examples show the importance of careful analysis of regulatory options.

Measuring costs is often time-consuming but straightforward work. For example, increasing required road widths from 5 to 7 m consumes a straightforwardly calculable amount of land, materials, and labor. The model facilitates this work; once land prices, road construction costs and standards, and so on are entered, the marginal cost of different standards is easily calculated. The model also facilitates the investigation of simple interactions between regulations; for example, the cost of a change in required road widths will vary with many other design parameters affected by regulation (e.g., road construction standards, minimum lot sizes, and floor area ratios).

Choosing the baseline remains partly judgmental and the most difficult part of the exercise. We generally rely on a combination of information on local markets, ranging from middle-income neighborhoods to privately developed illegal subdivisions. For instance, we found that the minimum plot area of 68 m^2 was very close to the average encountered in new illegal subdivisions catering to precisely the same income group targeted by the SLCHP program; therefore we kept the plot area constant throughout the exercise. For roads, we compared the standards of tertiary roads with those of middle- and even high-income settlements.[17] In addition we cross-checked with international practice in other part of Asia, Europe, and Latin America for this segment of the market.

[17]We concentrated on the tertiary roads standards that benefit only residents and which have no externalities on traffic flows outside the subdivision itself. The construction of numerous speed breakers at practically every intersections confirmed that the width of the tertiary roads were not

Although market rents or prices usually provide the best available indicator of the value beneficiaries would place on design characteristics, it is sometimes necessary to adjust market information for external costs that may not be fully reflected, such as safety, long-term maintenance costs, and the need to protect the environment. The value of amenities such as clean air and groundwater or reduced maintenance costs to local government may not always be reflected in the rents that beneficiaries would be willing to pay. These externalities can be measured using hedonic pricing (see Freeman (1979)) and/ or contingent valuation (see Mitchell and Carson (1989) and Whittington *et al.* (1993)).

Using one or all of these methods, we can measure corresponding benefits and enter them in the model. The advantages listed in the cost side—quantification, adding up, limited interaction—are also obtained. Thus we end up with a balance sheet as in Table I,[18] which presents a summary cost analysis of alternative land use standards from an application of the Bertaud Model. Three cases are studied: a middle-income project of the type done by private sector developers before the issuance of the special low-cost housing guidelines permitted a legal move downmarket, a similar development undertaken under the SLCHP guidelines, and a development undertaken under our suggested alternative land use standards, further downmarket than the SLCHP permits.

A detailed exposition of this application of the model and its results can be found in Bertaud *et al.* (1988) and Hannah *et al.* (1989). Here we focus on the main points. The first subsection of the summary table presents three key price measures: the market price of land, the price of construction, and the price of infrastructure. The price of construction is per square meter of structure, and the other two are per square meter of land.[19]

The next section of the table summarizes the effects of various regulations on plot geometry. The key summary statistic is the last line of this section, the *plot* FAR. Note that under the low-cost SLCHP guidelines, a standard plot's FAR is almost identical to the middle-income plot's FAR, and a corner plot, due largely to high setback requirements, actually has a FAR only half that of the middle-income plot.

Figure 3 shows a typical site plan for a new housing development under SLCHP guidelines. Under these regulations, public uses take up 56% of land; only 44% is saleable, and the overall floor area ratio is a mere 0.23. Some potential areas for savings, which show up in Fig. 3, include:

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expected to improve traffic flows. The calculation of cost–benefits of primary and secondary roads are much more complex than those of tertiary roads as they involve city-wide traffic, and the method proposed here cannot be used for this purpose. Many Malaysian residential subdivisions were small, from 50 to 300 plots, and therefore hardly included any secondary roads.

[18]This is an aggregated output from the actual computer model, but the level of detail is sufficient to illustrate the method.

[19]If a general equilibrium analysis is carried out to predict the effect of (say) market-wide regulatory changes on the price of land, it is a simple task to incorporate the estimated price change here.

TABLE I
Developer Profitability and Land Use Standards

		Middle-income plot	SLCHP guidelines		Revised standard, Lb	
			Standard plot	Corner plot	Standard plot	Corner plot
A. Unit sale price	(units)					
Sale price of construction	M$/m^2	225	200	200	200	200
Sale price of land	M$/m^2	30	30	30	30	30
Infrastructure cost	M$/m^2	45	40	40	40	40
B. Regulation-induced plot geometry						
Plot area	m^2	139.0	68.0	**142.4**	68.0	**99.9**
Plot frontage	m	6.0	4.3	**8.9**	4.3	**6.3**
Plot length	m	**23.2**	**15.9**	**15.9**	**15.9**	**15.9**
Front setback	m	5.0	4.7	4.7	4.7	4.7
Back setback	m	3.0	2.5	2.5	2.5	2.5
Side setback	m	0.0	0.0	4.7	0.0	2.0
Maximum ground buildable area	m^2	**91.0**	**37.4**	**37.4**	**37.4**	**37.4**
Actual built area	m^2	82.0	21.0	21.0	26.5	30.0
Number of floors		1	2	2	2	2
Floor space/plot	m^2	**82**	**42**	**42**	**53**	**60**
Plot floor area ratio		**0.59**	**0.62**	**0.30**	**0.78**	**0.60**
C. Site land use regulations						
Percentage of corner plots				15%		15%
Percentage of salable land		**45%**		**44%**		**55%**
Site floor area ratio		**0.27**		**0.23**		**0.41**
D. Costs per dwelling unit						
Cost of superstructure	M$	**18,450**	**8,400**	**8,400**	**10,600**	**12,000**
Cost of land	M$	**23,167**	**10,755**	**22,517**	**8,655**	**12,708**
Total cost per dwelling unit	M$	**41,617**	**19,155**	**30,917**	**19,255**	**24,708**
E. Profit assumptions						
Profit rate, construction		15%		15%		15%
Profit rate, land		10%		10%		10%
F. Average profit/ha by site						
Profit/ha	M$	**164,595**		**140,453**		**192,541**
Profit incentive (disincentive)	M$	Baseline		**(24,142)**		**27,946**
Compared to middle income unit		Baseline		**−15%**		**17%**
G. Additional indicators						
Profit per plot	M$	**5,084**	**2,335**	**3,512**	**2,455**	**3,071**
Number of plots/ha		**32**	**48**	**8**	**64**	**11**
Total number of plots/ha		**32**		**56**		**76**
Average household size		5	5	5	5	5
Population density (people/ha)		**162**		**280**		**378**

Note. Calculated outputs are shown in bold.

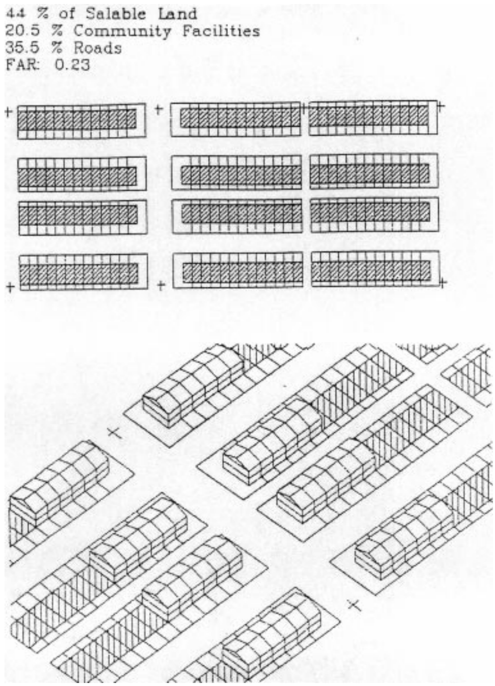

FIG. 3. Site plan corresponding to SLCHP guidelines.

• Roads are wide: internal roads (shown horizontally on Fig. 3) are 8 m wide; distributor roads (shown vertically on Fig. 3) are 12 m wide.

• Back alleys 6 m wide are required.

• Large setbacks are required on corner plots. Setback requirements of 4.5 m along vehicular roads when applied to the minimum plot size of 67 m^2 imply that corner plots would have an area of at least 140 m^2. However, because of setback regulations, only 38 m^2 of the total 140 m^2 of the corner plots are buildable.

Figure 4 is a typical site plan for a new housing development with our suggested changes:

- Reduction of internal roads to 7 m, and distributor roads to 10 m.
- Elimination of back alleys.
- Reduction in corner setbacks to 2 m.
- No reduction in regular setbacks.

Under these regulations, saleable land rises to 55%, and the overall floor area ratio rises from 0.23 to 0.41. This means that to build the same 1000 m^2 of floor

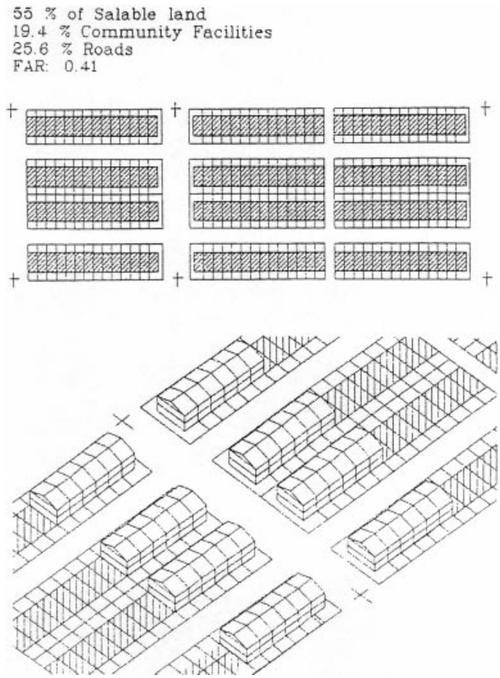

FIG. 4. Site plan corresponding to a conservative baseline.

space, a developer needs to acquire 2440 m^2 of raw land instead of 4350 m^2 under the SLCHP guidelines. This implies a reduction of 44% in raw land demand to build the same amount of housing. The plot FAR rises from 0.62 to 0.78 because of the increase in the amount of floor space that can be built for about the same ceiling price. In other words, the reduction of roads standards allows an increase in floor space of 11 m^2 per unit, the equivalent of an additional room.

The Bertaud Model also adds up land required for roads, schools, parks, and other required common uses under the land use regulations in force. The *site* floor ratio is the FAR with each plot's share of common land uses taken into account. Because of high requirements for common areas, the SLCHP site FAR is actually less than the supposedly higher-cost middle-income plot standard:

- Certain types of community facilities must be provided only when a population threshold is reached. For instance, a primary school must be provided in schemes with populations of over 5000 persons. Each one of the nine types of community facility required has its own threshold.[20]

[20]These create their own distortions. If a given area was developed through a number of small schemes, below about 500 plots each, the land to be used for community facilities would be purchased by the local authority using general taxation revenue. If the same area was developed through a few

• The cost of redundant street area is very high, as it has the triple effect of consuming additional land, increasing civil works cost, and increasing the speed and quantity of storm water run-off, thus requiring higher design standards for the whole downstream drainage network.

Because community facilities must be provided on the basis of population thresholds by projects, developers tend to build in phases so that each individual phase is below most applicable thresholds. For this reason we have not made any tradeoff on community facilities in Table I. Only land required for primary schools is included, and the increase in salable land is entirely due to a decrease in road area, back alleys, and setbacks, but the same method could be applied to community facilities as well as to roads.[21]

The next section of Table I summarizes the all-in cost for each dwelling unit. The first line is the cost of the structure, and the second is the cost of land, including both the plot and the units share of common land. Note the particularly striking result that under SLCHP guidelines, a corner unit has a developed land cost almost identical to the middle-income unit; of course with a smaller structure, the all-in cost of the unit is smaller by about 25%. However, clearly market pressures would mitigate against building small units on plots the size of middle-income plots.

How does this affect developer profitability? At market prices we estimate that profit per hectare for the middle-income development would have been about $165,000 at the time of the study. We estimated that developing a similar plot under the Special Low Cost Housing Program guidelines would have yielded a profit of $140,000, or about a 15% decline in profit per hectare. Overall density of the low-cost project under the SLCHP guidelines is similar to the density of the middle-income project, around 280 people per hectare.

Now contrast the results for our suggested low-cost standards with the middle-income and the SLCHP guideline standards. We have deliberately kept key indicators such as plot size the same, but we have reduced setbacks, and some common land uses described above, primarily the elimination of back alleys. These comparative modest reductions in standards lead to an increase in plot floor area ratio to 0.78 for standard plots and 0.6 for corner plots, a significant increase over both comparators. The overall site floor area ratio increases to 0.41. Perhaps most importantly, with the higher FAR the estimated profit per hectare rises to $193,000, a 17% increase over the base line middle-income alternative development. Thus, it becomes clear that changes in the regulations can tilt

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large residential schemes, about 2000 plots per scheme, the cost of land for community facilities would be borne by the developer and therefore passed on directly to the future plot owners in the initial price of the dwelling.

[21]Land use standards for community facilities tend to be extravagant. It is understandable that they would be so, as those are national standards to be applied to every project, irrespective of market segment or location.

profitability back toward the bulk of the market. Density is increased to 378 people per hectare.

EFFECTS OF STANDARDS ON LOW-INCOME HOUSING SUPPLY

Land use results are of course of interest *per se,* but, from the economic point of view, ultimately land is primarily an input to other productive processes, residential and nonresidential. To this we now turn. At the time of the study, the public and private sectors were able to provide units below the M$25,000 official ceiling for low-income housing only in areas where the land cost was low (between M$10 and M$20 per square meter). However, most of the demand for low-income units was in more centrally located areas where the price of land is between M$20 and M$60 per square meter.[22] The present land use practice implied that about 170 m^2 of raw land was required to develop the minimum plot of 68 m^2. At least one-third less, or about 110 m^2, would be sufficient if land use standards were in line with those used outside Malaysia.[23] In other words, the land use standards precluded densities above 60 plots per hectare (densities of existing schemes are in general even lower as many plots are above the minimum sizes) where densities of about 90 plots per hectare are common for areas within the range of the minimum plot sizes used in Malaysia.

Because the standards, and implementation practices, require a relatively large quantity of land and substantial expenditure for infrastructure per housing unit, the cost of land becomes the main determinant of site selection for lower-priced housing projects. Areas where the cost of land is low enough to make such developments financially viable tend to be remote. As a result, private developers are inclined to increase space and finish standards in response to what they perceive to be weak demand for low-cost, higher-density housing in those less convenient locations. Although building costs and recently revised land use standards would permit considerably cheaper units, it was unusual to find many units for sale for much less than the M$25,000 regulated ceiling price.

Private developers were reluctant to move to higher-priced land (a) because for every additional dollar paid for raw land they would have to reduce floor space to stay under the M$25,000 cost ceiling, and (b) because their profits are directly linked to the amount of floor space built per unit of land. The public sector, on the other hand, responded to different financial incentives. It selects sites where land is available at lower cost or where it is already in government

[22]Land cost includes the land purchase price, land use conversion premium, and contribution fee for off-site infrastructure. Malaysia does not have a land-price map. The numbers reported here were supplied to the Bank mission by public and private sources.

[23]In Indonesia, for instance, the public mortgage bank (BTN) would not finance plots in developments where the salable area is less than 60% of the total area. This would correspond to a raw land area of 113 m^2 for a minimum plot of 68 m^2.

hands. The public sector is more likely than the private sector to attempt to sustain the financial cost implied by the slow sales or large inventories of plots in distant locations where demand is sluggish. The various subsidies in public sector housing allow a certain disregard for consumers' preferences. Equivalent inattention to demand characteristics would be fatal for a private firm.[24]

Any revision of land use standards should not aim at reducing costs by indiscriminately changing all standards. The revisions should be designed to increase the supply of low-cost units by responding, as closely as possible, to market preferences and by removing the cost distortions created by some of the legal minimum standards. The removal of those distortions stimulates developers to produce more low-income plots where the demand is the greatest and not necessarily where land is the cheapest.[25]

If land use standards were revised, private developers would likely build more units below the M$25,000 ceiling because: (a) they would be able to develop land in more expensive areas where the demand for low-cost housing is greater; and (b) they would be able to build a larger area of floor space per unit of land, and therefore low-cost housing would become more profitable. Developers will use the new standards for low-cost housing when (a) those standards allow the highest return possible per unit of land, and (b) when the "housing bundle" corresponds to the perceived demand in that location, and therefore reduces the risk of slow sales or large inventories.

HIGHER ORDER INCENTIVES AND THE POLITICAL ECONOMY OF LAND USE REGULATION

The local authorities, up to the time of the study, had been reluctant to follow the guidelines. Most of the site plans that were prepared under the new rules were rejected. Under Malaysian law, housing matters and land use control are strictly a state and local authority responsibility, and there is no direct legal mechanism to enforce the new guidelines drafted by the Ministry of Housing and Local Government. However, a number of arguments could be developed to convince the local authorities to reverse their position on standards, once the

[24]In addition to the superior financial ability of the public sector builders to hold inventory, the objectives facing managers may be quite different in the public and private sectors. Many public programs are judged on an output or "need fulfilling" basis and poor sales can be dismissed as a problem of affordability on the part of those who really need the housing. No private developer could stay in business on this basis.

[25]For example, while it is clear that buyers highly value interior floor space, additional setback on corner lots or extra wide back alleys may have little utility. The most efficient and responsive supply of housing will occur when developers are able to make tradeoffs among a number of standards to meet the mix they perceive is wanted by buyers. In such circumstances, one would expect the developer to be rewarded by quick sale and good return on the project.

reasons for their present opposition are well understood. The local authorities' reluctance to allow the standards suggested under the new Ministry of Housing and Local Government guidelines can be explained by the following higher order incentives.

Most local authorities do not accord high priority to the provision of low-income housing in their territory. Maintaining high local land development standards is often considered to be in the best interests of the local community. The subsequent growth of squatter settlements and illegal subdivisions within the local authority boundary is perceived as a law enforcement problem rather than the direct consequence of a lack of affordable land development standards.

Lowering road standards would result in a loss of Federal grant money. Local authorities receive a grant from the Federal Government for road maintenance. The amount of the grant is based on the length of streets for any right of way wider than 30 ft or a pavement wider than 20 ft. This grant is fungible and does not have to be spent on road maintenance; hence it is an attractive local source of income. When a new area is being developed, the local authority has a strong vested interest in ensuring a maximum street width of at least 30 ft. This financial incentive probably explains some of the excessive amount of street space encountered in residential projects in Malaysia as illustrated by Fig. 3.

From the local authority's point of view, any amount of capital cost (spent by the developer) is justified to reduce maintenance cost (borne by the local authority). Local authorities have a strong incentive to reduce maintenance costs of infrastructure to a minimum, even if to do so requires a disproportionate capital expenditure. For instance, local authorities often require that service back lanes be designed to handle truck traffic. This practice is a typical example of unreasonable tradeoff between maintenance and capital costs. The mandatory service back lane alone was using about 10% of the residential land in a typical site.

Several additional administrative bottlenecks increase the risks to developers and therefore increase the cost of low-income housing. These are: (i) lack of coordination with the water authority for site connections to the water main; (ii) a complex and time-consuming beneficiary selection system which contributes to keeping a large inventory of completed houses vacant for months,[26] and (iii) uncertainty, arbitrariness, and fragmentation of the site plan approval process, which cause delays in construction works, generates additional design costs, and discourages innovation.

[26]Because of the quota system in plot allocation, beneficiary selection is not made by the developer but by the local authority. The criteria for selection by the local authority are based primarily on ethnic origin rather than credit worthiness. The list of beneficiaries provided by the local authority has commonly to be revised several times when the mortgage bank rejects candidates because they fail to meet credit criteria. The increase in interest cost during construction incurred because of delays in plot allocation can become a significant part of the final cost to the developer, and discourage him from producing more units subject to allocation quotas.

GENERAL LESSONS FOR REVISING STANDARDS FROM THE MALAYSIA CASE STUDY, AND OTHER APPLICATIONS

The application of the model to the Malaysia case study yielded a number of lessons that were broadly consistent with applications to some 30 other countries alluded to above. We believe these lessons have general applicability.

Land use standards and related regulations should be designed to ensure a responsive supply of housing and real estate, including low-income housing. Often the legislator's or regulator's intention in establishing minimum standards is to protect the consumer and the community. However, when standards are so restrictive that they stifle supply, they do not, on balance, benefit the community or the consumer. If minimum standards are unacceptable or unaffordable to many consumers, net cost–benefit will generally be unfavorable.

Standards should reflect the financial ability of those who pay for them. Good standards generally correspond to the most attractive housing quality/price alternative for the target group, and constitute the best alternative use of land for the developer. Once these two basic requirements are met, it is possible to look for additional tradeoffs that would further increase benefits to consumers and society.

The cost of the total package of standards should be considered. Land use standards establish geometric rules that are simple when considered individually, but complex in the way they interact with each other in determining land development costs.[27] To reform standards, it is therefore necessary to consider the whole range of parameters that are to be regulated. For instance, in the Malaysia case study it was necessary to simultaneously consider 43 land use parameters controlled by the guidelines. The computerized model takes all the regulated parameters into account to calculate the effect on cost of changing one or two parameters at a time.

Experience in many applications suggests that FAR and the percentage of salable land are the most important indicators that should be monitored when modifying standards. Those two indicators are directly linked to the developer's profitability. Table I showed an example of the difference in profit per hectare when building at minimum low-cost standards and medium-cost standards. Profits for medium-costs standard were 14% higher than for low-cost standards in the case study. This higher profit was directly related to the site floor area ratio, which was 0.27 for medium-cost housing and 0.23 for low-cost. If the percentage of salable land authorized by the regulations for low-cost housing were raised to 55% (even 65% is common in other countries), the profit per hectare of land

[27]For instance, a service back lane increases circulation area by the sum of its own area plus the area equal to the product of its width by the width of streets perpendicular to it. The development cost of a service back lane is therefore not limited to the cost of providing the back lane, but also includes the increase in cost for land and civil works in adjacent streets.

would increase by 25%, and profit per housing unit would be 10% higher than that for medium-cost housing, since the floor area ratio would be raised to 0.41.

The target values for the floor area ratio and for the percentage of salable land should be selected before deciding on the value of the other parameters. The most appropriate values are those that would ensure that low-cost housing would have a safe profit margin over alternative residential uses in areas where the demand is high. When these values are established, say 60% for salable land and 0.37 for the floor area ratio, it is possible to set detailed standards for roads, utility areas, and community facilities. Tradeoffs would have to be made among various standards, and an infinite combination of values is possible, the only constraint being that the sum of the nonresidential use should not be more than 40% (in the case where 60% has been selected for salable area). Hard choices might have to be made in allocating land between parks, schools, and roads, but those choices would also stimulate the use of innovative designs for site layout. The new guidelines have already shown the way in that direction in advocating that part of the area for school sites and buffer zones of oxidation ponds should be designed to allow their use as public recreational space.

The reduction of unit cost would also require a systematic review of all engineering design standards, to ensure that no unreasonable tradeoff is made between capital cost and maintenance costs. Local authorities should be encouraged to explore ways to improve the productivity of their maintenance tasks. For instance, the use of modern equipment for the maintenance of sewer pipes can result in important savings in land (reduction in the width of back lanes) and civil works. If necessary, a program should be set up to help finance the modernization of maintenance tasks.

If appropriate land use regulations are to be developed, it is important that appropriate higher-order incentives be created for local authorities. The development of new low-income areas within a local authority's boundary should produce additional resources, not be a drain. Those additional resources can come from (a) a modified road grant system, (b) property tax, and, eventually, (c) a maintenance fee. To ensure the support of local authorities, low-income areas should produce the same amount of revenue per unit of land as middle-income areas, while the amount of tax collected per household should of course be smaller. This would be possible if the density in low-income areas were significantly higher than in middle-income areas, i.e., if the percentage of salable area and the floor area ratio were higher. The formulas through which the road grant system is calculated and the property tax collected should be reviewed. It would be necessary to ensure that the formulas for the grant and the tax result in the same revenue whether the area is low income or middle income.

The financing of land for large community facilities (schools, main places of worship, etc.) should not depend on scheme size, but on a development tax on all land in the process of being developed. All residential developments should pay a fair share of the cost of community facilities irrespective of their size or density. This would avoid the penalization of residential schemes where low-income plots are dominant. In effect, this is what a well-designed impact fee does. If desired, the tax could be made progressive by taxing the larger consumers of land at higher rates. This method would have the added benefit of giving a higher cost to raw land and therefore to encourage the use of innovative site design techniques to save land. Cost recovery and the provision of land for small community facilities, such as parks, playgrounds, and places of worship, could be made using existing formulas.

SUMMARY

Lessons Learned About Modeling Costs and Benefits of Land Use Regulation

Many studies of land use regulation focus on costs but ignore benefits. First-best models of regulation generally have impossible data requirements. We present and advocate a second-best approximation, where costs are carefully calculated and benefits are roughly estimated by comparing the regulatory practice under study to a baseline. The baseline is developed using local market information, and international standards, and can be adjusted to incorporate estimates of the willingness-to-pay for public goods provided through regulation, where such estimates exist.

Over the past decade and a half this conceptual model has been incorporated in a series of computer models developed by the first author, and known as the Bertaud Model. Among other advantages, the computerized version permits the user to keep track of many regulations, to compare alternative regulatory regimes, to account for interactions among regulations, and to graphically display results.

Lessons Learned About Malaysia's Land Use Regulations

This paper illustrated the use of the model with an example from Malaysia. We examined how project-level standards and practices in Malaysia affect the cost and output of housing. The analysis demonstrated that land use standards and practices in place at the time of the study led to inefficient use of land. In turn, these standards increased the risk of low-cost projects and reduced their profitability. These standards and practices not only increased the cost per dwelling by using more land than necessary, but also increase the capital and maintenance costs of infrastructure and ultimately drive up the price of urban land for all users.

In identifying the standards that need to be changed, the key factor was not floor space or minimum lot size, both of which were highly valued by prospective buyers. Instead, this study found road space and setback regulations to reduce the proportion of salable land, which in turn determined developer costs and ultimately profits. High infrastructure standards in respect to maintenance and the threshold system of financing community facilities also reduced incentives for provision of low-cost housing for poorer households.

While the revised standards issued for the SLCHP were in some ways a step in the right direction, since local authorities did not allow the standards to be widely implemented, their benefits were moot. Based on the analysis summarized above, we made the following recommendations. First, make it at least as profitable for developers to build low-cost housing as other types of housing by allowing more flexibility in the regulations. Second, set standards using two general criteria, the percentage of salable land and the floor area ratio, rather than use over 40 separate standards. Third, provide incentives to local authorities through the Federal Government's system of grants to encourage the approval of projects with appropriate standards. Fourth, finance community facilities in an equitable fashion so as not to distort the housing market.

General Lessons Learned

This paper has demonstrated how many land use regulations, each of which is seemingly reasonable and innocuous in isolation, can when taken together impose larger taxes on developers and, ultimately, consumers. We have also shown how these taxes are often proportionately larger for lower-income consumers.

The case study example was from Malaysia, but the model—and some of the lessons learned—are quite portable to other markets, developed as well as developing. The methods described herein are of particular interest in countries that are currently moving from a command and control approach to a more market-oriented approach to land use, including South Africa and reforming formerly socialist economies.

For example, in Russia and in all countries that were part of the former Soviet Union, very detailed master plans allocate land between various land uses and include a street design layout often including the tertiary level. The model has been used to test the consistency of permitted land use with current market price for each type of construction included in the plan. The model can be used to then "back out" the value of undeveloped land. When assuming land uses based on portions of the master plan, using current construction and market sale price, the calculated value of land is often negative. Using the model the plan can be iteratively adjusted to reach positive land values.

As Russian municipalities simultaneously control land use and sell land, they have an incentive to adjust standards to maximize land value. Parameters that can be readily improved upon include type of land use, road right of ways, infrastructure standards, and standards for community facilities. Politically, it is often easier to amend the current plan to make it consistent with market prices and customer preferences, rather than recommending discarding the plan because it is inconsistent with market forces. The amended master plan is thus progressively transformed into a zoning plan, allowing much more land use flexibility, and reducing the sort of costly infrastructure overdesign described above for Malaysia.

Current market price per square meter of housing, offices, and commercial facilities in different locations are of course one of the most important inputs of the model. The municipalities willing to use this method thus will put considerable effort into monitoring land and property markets. This monitoring has in turn a positive effect on the market itself, by disseminating real estate price information. Previously such price data were often only reluctantly shared by the various government entities in charge of land sale and lease.

Future Research

We have noted above that our model is designed to estimate actual and quite specific regulations-affected costs (and hence land use and housing prices) if prices are initially taken as given. One way to interpret this is that the model predicts what would happen to costs and prices at, say, the individual project level (where the project is "price taking"). If, for example, regulations were changed market wide, land prices could and would change, and numerical results modified accordingly. General equilibrium models in the spirit of Aaron (1975) and Sullivan (1986) could complement the work herein. We note in passing that under plausible conditions the effect of relaxing land use standards that affect the supply of land *in toto* will be to reduce land prices, and the effect of relaxing standards that discourage density will be to increase land's productivity and hence its value.

While we have noted the difficulty of estimating the demand for all public goods provided by regulation, certainly the use of the model can be better informed by more work on the demand side. In many respects, we believe one of the largest benefits of such an exercise is the implied requirement that planning agencies monitor markets, especially prices, in a detailed manner. Applied well, the model implies that regulations should always be market tested. This implies that regulators know their markets.

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