THE EVOLUTION OF LEGAL INSTITUTIONS WITHOUT EFFICIENCY: THE CASE OF ZONING

By

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To Ole Risom's and Richard Scarry's Nicholas.

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1 Introduction

This paper argues that law and economics has not come to grips with Arrow's limitation on social welfare economics nor with the evolutionary character of economic and legal institutions. Arrow's theorem makes the concept of a socially efficient economic institution dependent on a prior allocation of property rights. A socially efficient result is efficient only within the bounds of the initial allocation of property rights. A differing initial allocation would have resulted in a different efficient result. *The participants in economic and legal systems are aware of this fact.* They see that their positions can be improved both by market trades and by adjustments to property rights. This fact is the engine by which evolutionary law and economic change occurs. Furthermore, evolutionary law and economics has not recognized the fundamentally complex nature of evolution. Contrary to early arguments in law and economics, institutions do not evolve toward efficiency. They do not evolve toward a single point of any kind. Instead, they evolve in a complex and partially unpredictable way; driven by the actions of numerous participants and subject to path dependency and other evolutionary phenomena. The ideas that legal institutions form in an evolutionary manner and that social efficiency is a weak concept have been well-argued in the literature (for reviews see Barry 1991, Samuels 1991). However, the modern development of evolutionary economics has provided tools and metaphors that can strengthen the presentation (Roe 1996). I have chosen zoning as my illustration in part because of the numerous attempts by economists to analyze its efficiency and in part because it provides a compelling illustration of the evolutionary view.

This paper first discusses welfare economics and Arrow's theorem. It argues that the persistent focus on social efficiency is misguided and misleading. It is misguided because of its ignorance of the allocation issue; misleading because of its willingness to voice policy conclusions. The paper goes on to discuss evolutionary thought as an alternative to the traditional view. Finally, the paper recounts the development of zoning law as an illustration of the evolutionary phenomena that aggregate welfare economics overlooks.

Zoning is a central element of land use control in the United States. Virtually every city and town in the U.S. has a zoning ordinance. The major exception is Houston, the residents of which repeatedly defeat proposals for zoning.[1] The economics literature

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[1] It should be noted that Houston is not free of land use restriction. Apart from local government controls on housing construction, much of the housing in Houston and its suburbs is subject to private restrictive covenants. "Almost every acre of land in the city is subjected to private restrictions over use, size, or cost of house, yard requirements, height of building, and all the other baggage customarily found in our zoning ordinances" (Babcock 1966, p. 25). According to Babcock's classic study, the primary effect of Houston's lack of zoning has been the "invasion" by commercial buildings of *middle income* suburban neighborhoods. High income neighborhoods have been preserved by the employment of private covenants; low income neighborhoods have sought in-home commercial development (like a small repair shop) as a way to add value to otherwise low value homes (Babcock 1966, p. 28). The most recent Houston zoning battle occurred between 1991 and 1993, with voters again rejecting zoning (See Washington Post 1993).

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has taken an interest in zoning (Pogodzinski & Sass 1990). Apart from being an interesting economic problem,[2] zoning is an area of law that is particularly amenable to economic analysis and thus attractive to law and economics scholars (Fischel 1978).

The guiding question for welfare economists who study zoning has been the (social) economic efficiency of zoning laws as they now stand. In section 2, I discuss the significance and limitations of the concept of economic efficiency. As part of this discussion, I present the familiar but oft-ignored result that the standard of social efficiency does not determine a unique goal for society; it determines a set of goals which social efficiency itself cannot distinguish among. I also discuss welfare models of zoning specifically as an illustration of the limitations of welfare analysis. In section 2.4, I present a review of the use of efficiency in the law and economics literature.

A separate question from the welfare economists' efficiency question concerns the appearance of zoning laws in the first place: where did zoning come from and what affected zoning's changing form? This is an instance of the more general issue of how legal institutions are formed and change. One common answer to that general question is that legal institutions "evolve" to be efficient. This answer, which I discuss in section 3.1, is argued most strongly by the law and economics literature. In this essay, I argue that the answer, though headed in the right direction, is inadequate. It is true that legal institutions evolve. However, the selection pressure shaping zoning laws (and laws in general) does not stem from efficiency concerns and does not have efficiency-causing effects except incidentally. Instead, the evolution of legal institutions is driven by concerns of individual gain. And, just as in the familiar prisoners' dilemma from game theory, individual gain may not lead to social gain (even if the latter is uniquely defined). I present a more rich view of evolution in section 3.2.

As an illustration of this view of legal evolution, I present in section 4.1 a history of zoning and a discussion of its modern form. To preview, the forces which gave rise to zoning were the growth and industrialization of American cities and the desire by urban residents for quiet living. The first force relates to zoning's role as a controller of externalities like the effects of factory smoke on residents. The second force relates to zoning's role as preserver of the upper-class suburban single-family lifestyle against lower class encroachment. Zoning's development was strongly shaped by courts' ideologies. Zoning emerged from a tumult of private and public law devices that attempted to address the same two forces. Zoning has become entrenched as a legal and political tool for resolving or at least addressing land use conflicts. This discussion (the first step toward a formal model of zoning's evolution) provides a clear illustration of the personal gain motivation that drives legal evolution.

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[2]As Fujita (1989) observes, the assumptions of traditional economic theory need some reworking to apply to land use problems because of the inability of landowners to move easily, the presence of externalities among neighbors, the existence of local monopolies, and the physical durability of land-based infrastructure.

2 Efficiency

2.1 Defining efficiency

"Economic efficiency" is the touchstone of welfare economics. An economic system consists of individuals, an initial allocation[3] of resources (like land, structures, goods, or services) among those individuals, and a device for setting prices of the resources. In the stylized Walrasian economy, the market process, beginning from the initial allocation of resources, determines a set of prices based on the personal preferences of the individuals. The set of prices is brought forth by the interaction of individuals who express their preferences in buying and selling. This set of prices has associated with it an allocation of resources among individuals which is likely different than the initial allocation. Under any allocation, *individuals* obtain certain levels of personal welfare determined by their preferences for the various resources. An art lover will experience low personal welfare under an allocation which gives her an extensive collection of plastic trinkets but not a single French painting.

The question of *social* welfare is different. An individual evaluates her own welfare simply by consulting her preferences (which, in the stylized economy, are assumed to satisfy certain required axioms). However, there is no "agent for society" empowered to consult "societal preferences" in a like manner. Instead, welfare economics seeks to aggregate individual preferences into a social welfare function which will report the level of social welfare obtained at each possible allocation across individuals. In essence it seeks to use the preferences of agents themselves to unambiguously determine the appropriate allocation across individuals.

By way of illustration, consider an economy which consists of two individuals, A and B, and two goods x and y.[4] The total amounts of goods x and y are fixed as is an initial allocation of them (W). A and B may trade away from this initial allocation. This situation can be represented in an Edgeworth box (figure 1 on page 4). Each individual has preferences for the two goods which are represented by their indifference curves. The indifference curves through the initial allocation define a lens shaped area. Since every allocation within this area is preferred by both individuals, they will trade into this area. Note that a different allocation (Z) defines a different lense-shaped area and a different set of attainable Pareto efficient allocations. The set of Pareto efficient allocations (those allocations at which no individual can be made better-off without making the other worse-off) is a line (not necessarily straight) between the corners of the box.

The remaining question for welfare economists is whether a given final allocation can be improved upon in any sense. As is well known, the first and second theorems of welfare economics state that, in the stylized Walrasian economy, a market equilibrium allocation is Pareto efficient and any Pareto efficient allocation is a market equilibrium from some initial allocation (Varian 1992, pp. 323-329). In the figure, these theorems

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[3]In this paper, "allocation" is a term of art. Other authors may use terms like "distribution" to capture the same concept.

[4]These concepts apply to more generalized economic models with larger numbers of individuals, firms, and the other stuff of real economies.
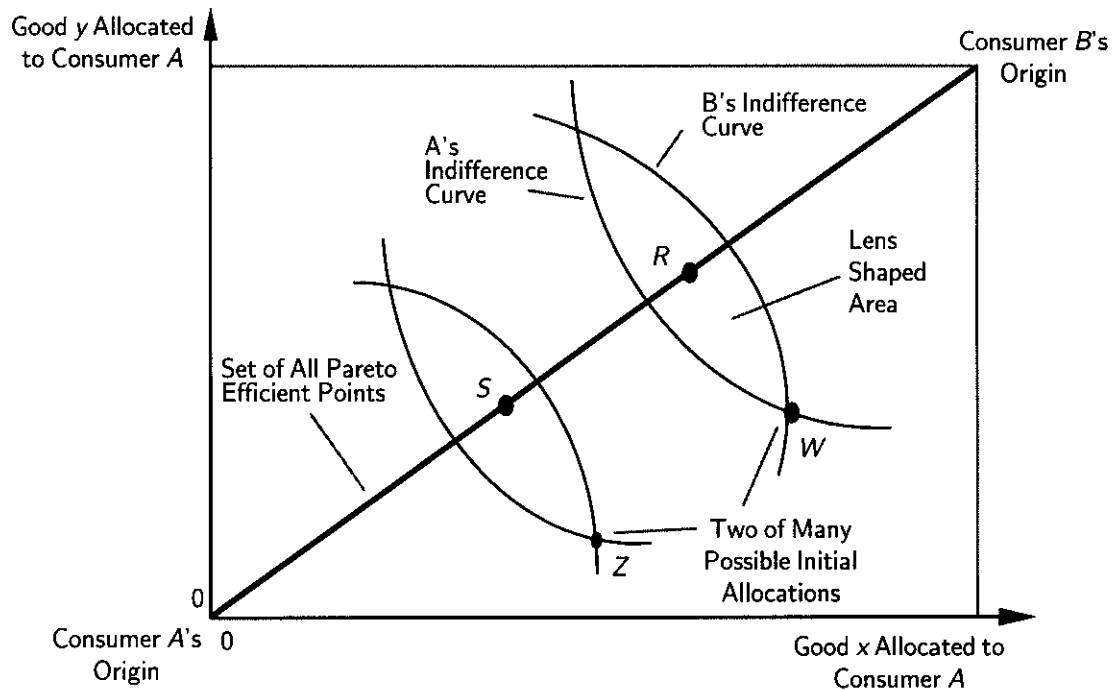
Figure 1: *A pure exchange Edgeworth box. The goods x and y are indicated on the axes; Consumer A is allocated increasing amounts of x and y at points further away from A's origin (lower left corner). Similarly, B is allocated increasing amounts of x and y at points further away from B's origin. An indifference curve is illustrated for A and B for each of two initial allocations, W and Z (there are an infinite number of possible initial allocations). Given each allocation, the consumers can trade to a new allocation. They will only do so, however if they are better off. Hence, all trades move into the lense-shaped area defined by the initial allocation and corresponding indifference curves. The Pareto efficient points are those allocations at which neither party can be improved without harm to the other. The points R and S are two possible.* ◇

Individual	Preferences
1	$A \succ_1 B \succ_1 C$
2	$B \succ_2 C \succ_2 A$
3	$C \succ_3 A \succ_3 B$

Table 1: *Preferences of three individuals (1, 2, and 3) for three policy options A, B, and C. The notation $x \succ_i y$ indicates that choice x is preferred to choice y by individual i.* $\Diamond$

Ballot	Victor	Social Ranking
A vs. B	A wins	($A \succ_s B$)
B vs. C	B wins	($B \succ_s C$)
A vs. C	C wins	($C \succ_s A$)

Table 2: *Social rankings for all three possible two choice elections. The preferences of individuals 1, 2, and 3 from table 1 yield the following social rankings of the three choices A, B, and C. The notation ($x \succ_s y$ indicates that choice x is preferred by the social ranking to choice y).* $\Diamond$

mean that the market mechanism will achieve a Pareto efficient allocation given any starting point (such as W or Z) and that any Pareto efficient allocation can be reached by the market from at least one initial allocation.

It would have been convenient for the field of welfare economics to have been able to rank the set of Pareto efficient points (that is, to determine whether R is "better" than S) but is unable to do so (MacKay 1980, p. 1). Despite the fact that the society is a collection of individuals, it is not possible to aggregate individuals' preferences into a social welfare function with nice properties (see below). Were such an aggregate social welfare function possible, one could analyze the social effects of various resource allocations and select the *one* which maximized *true* social welfare.

2.2   Arrow's theorem

The reason such aggregation will not work can be illustrated by some of the social aggregation procedures that are used in practice; such as voting rules. Voting rules also provide a simple illustration of why aggregation procedures often yield strange results. The so-called voting paradox can be illustrated as follows. There are three individuals $1, 2$ and 3 who are choosing from among three choices A, B and C. The individuals rank the choices as shown in table 1 ($x \succ_i y$ indicates that choice x is preferred to choice y by individual i).

If only two choices are included on the ballot the social rankings depicted in table 2 occur ($x \succ_s y$ indicates that choice x is preferred by the social ranking to choice y).

The social decision procedure which results has an interesting feature. It produces the ranking $A \succ_s B \succ_s C \succ_s A$ which is nontransitive (A winds up being preferred to

1 Votes A	2 Votes B	3 Votes A	$\rightarrow$ A Wins District	
4 Votes A	5 Votes A	6 Votes B	$\rightarrow$ A Wins District	A Wins All
7 Votes A	8 Votes B	9 Votes B	$\rightarrow$ B Wins District	
$\downarrow$	$\downarrow$	$\downarrow$		
A Wins District	B Wins District	B Wins District		
B Wins All				

Table 3: *The effects of districting on an election. Voters 1 through 9 choose between A and B. In a straight majority election, A would win five votes to four. If districts of three voters each are formed, A wins with horizontal districting but B wins with vertical districting.* ◇

itself if one follows the chain through). The final result of any vote depends critically on which choices are on the ballot.

Phenomena similar to this one are well known in politics. Consider, for another example, the effect of districting on an election. Let there be nine voters numbered one through nine and two candidates labeled A and B. The preferences of the voters are depicted in table 3. Voter one chooses candidate A, voter two chooses B and so on.

In a straight majority vote, A will win five votes to four. If the candidates must win districts rather than the overall vote, A will win if districts are horizontal in the table but B will win if districts are vertical. All three votes are aggregation procedures yet they do not yield the same results.

Similar phenomena are endemic to social decision procedures. Arrow's famous impossibility theorem demonstrated that *no* social decision procedure exists which satisfies four particular properties (MacKay 1980, p. 2).

1. *Unrestricted Scope.* The decision procedure is able to evaluate any set of choices presented to it.

2. *The Pareto Principle.* If a unanimously preferred option exists, the procedure will select it.

3. *Nondictatorship.* The procedure does not merely reflect the opinions of a single individual.

4. *Independence of Irrelevant Alternatives.* The procedure only considers the choices presented to it. It does not use information about what would have been preferred, had the choices been different.

All four axioms are extremely plausible, though the fourth can be criticized. Regardless of the exact construction of Arrow's theorem, the paradoxical behavior of common social decision procedures, like voting, is an observed fact. The issue is

whether all social decision procedures suffer from such problems. Certainly any procedure which attempts to satisfy all four of Arrow's axioms will fail. (see generally MacKay 1980, Kelly 1978).

2.3 Allocation ignored

Since there is no objective way to rank Pareto efficient points, the best that welfare economics can do is indicate whether the current allocation is efficient; if not, what can be done to move the economy toward one of the (many) efficient points available? (Note that the choice of initial allocation determines the set of Pareto efficient points that can be obtained. Only those efficient points within the lens-shaped area can be reached without harming one of the individuals.) Despite this problem, welfare economics seeks to employ an aggregate measure of welfare in the evaluation of resource allocations. In the case of welfare models of zoning, the aggregate measure typically takes the form of an assumed inverse demand function, a representative agent model, or a focus on removing externalities.

The externalities approach stems from the fact that the first and second theorems of welfare economics (that a market equilibrium allocation is Pareto efficient and any Pareto efficient allocation is a market equilibrium from some initial allocation) do not hold in the presence of externalities (Varian 1992, p. 432). Welfare models often note the presence of externalities as a barrier to attaining an efficient allocation, but fail to mention the issue of *which* optimal solution is not being attained. Such models concentrate on the elimination of the externality as an enhancement to welfare. Such it certainly is — but without consideration of the allocation problem.[5]

Welfare analysis often goes further and assumes a specific social welfare function; like a weighted sum of individuals' utilities (Varian 1992, p. 409). The choice of an arbitrary social welfare function rigs the game, if you will, and also has the effect of excluding certain allocations.

One way in which theorists select a social welfare function is the use of an arbitrary aggregate demand function. Under this approach, the existence of a relationship between quantity and price is postulated, but no information about allocation is used. Mills uses this approach by defining an (inverse) demand function which depends on the amount of undeveloped land in the community and the level of congestion within the community (Mills 1989, p. 2). Another way of assuming a social welfare function is the elimination of separate individuals from the economic model entirely. Under this approach, there is only one person in the model (or if you prefer, a large number of exactly identical agents). So-called "representative agent" models ignore the allocation question since if there is only one agent, or all agents are identical, there

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[5]Furthermore, the terminology "elimination" of externalities is inappropriate. As has been shown by Randall, there is no such thing as a Pareto-relevant externality in practice (i.e. an externality that the parties involved can negotiate to change without making any party worse off) (Randall 1983) — instead, markets will eliminate them. There may remain Pareto-*irrelevant* externalities owing to the nature of nonexclusive or nonrival goods. In this case, policy determines which of the parties involved bear the burden of the Pareto-irrelevant externality. Thus it is more accurate to speak of policies *shifting* externalities than removing them.

will be no variation in preferences and consequently no difficulty in "aggregating." However, the social welfare measure in a representative agent model is "aggregate" in name only since the addition of more individuals has no effect on the model's outcome.

2.4   Efficiency in Law

The notion of efficiency also has a long history outside of economics particularly in law and political philosophy. Hardin (1996) traces the development of the idea of efficiency from Hobbes to the present. He notes that Hobbes' discussion concerned the supramarginal change from no government to government. Unlike the marginalist philosophers and economists who succeeded him, Hobbes was only concerned with showing that the situation with government was better than the situation without government. He did not attempt to evaluate the multiple with-government possibilities. Furthermore, as has been emphasized in my economic discussion, efficiency is at its strongest when addressing mutually advantageous changes for individuals. When one attempts to extend the concept to the group level (by aggregation) one confronts the same issues raised in the preceding discussion.

Two authors in the law and economics tradition[6] addressed this problem head on: Ronald Coase (1960) and Richard Posner (1992). Coase's contribution was the argument that money could serve as a cardinal measure of utility. In Coasian trades, parties can determine and arrive at a superior allocation via trade. The money-mediated trades serves as a sort of implicit aggregation mechanism. However, for this device to work at all there must not be prohibitive transaction costs. For it to serve as a true measure of utility, the traders must not exhibit income effects. Money must be a universal indicator of utility.

Posner's argument is essentially that wealth (i.e. money) maximization is itself an adequate goal and that the law should act to overcome transaction costs by assigning the disputed right to whichever party would have bought it had transaction costs not intervened. Posner's argument has been well-criticised by the economist Donald Keenan (1981). Keenan makes essentially the same points made above; the changes in an economic system are made from a starting allocation and wealth maximization only provides a useful standard in cases of small changes from an already acceptable starting point. Wealth maximization cannot resolve conflicts over initial allocation.

2.5   The Distractions of Efficiency Theory for Zoning

What is the harm of a focus on aggregate efficiency? Certainly welfare economics can tell us if the present allocation of an economy is not Pareto efficient. Yet in so doing, it distracts our attention from what appears to be a more significant question: how are individuals faring within the system? As indicated by Arrow's theorem, economics cannot evaluate the positions of individual, it can at best describe them. By focusing

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[6]For a brief history of law and economics, see Minda (1995).

on aggregate measures to the exclusion of individual ones, welfare economics not only fails to instruct, but tends to mislead.

Furthermore, by ignoring the allocation issue, welfare economics is likely to be caught unawares. While an aggregate welfare analysis blinds itself to allocation, the participants in an economic system remain fully aware of it. Their awareness is a primary driving force behind economic change. This theme, that allocation is central to economic evolution, will be taken up below. In this section, I finalize the argument against aggregate welfare measures by presenting four welfare studies of zoning.[7] The models described below are representative of the larger literature. Indeed, most models surveyed by Pogodzinski and Sass (1990) make two key assumptions. First, consumers are identical in preferences and endowment (i.e. the different effects of zoning on classes are not modeled); And second, production is in long-run perfectly competitive equilibrium (i.e. the dispersal of profits among groups is not modeled). In other words, they are aggregate welfare studies. Despite the limitations of aggregate analysis, these studies are willing to voice policy recommendations that will influence allocation.

2.5.1 Mills' development limitation model

Mills models a development-limiting zoning plan (1989). There is only residential and undeveloped land; not industrial or commercial land. The model has the following elements.

1. There is a single community.

2. Land is fixed and homogeneous.

3. Land is either residential or undeveloped.

4. Congestion is an unwanted "public good" (Mills apparently intends the good to be interpreted as a nonexclusive and nonrival good; congestion affects all agents within the community and does not diminish through "use." The good is unwanted in the sense that the benefits of residence increase as density decreases).

Mills introduced the following notation.

1. $L \in \Re^+$ is the number of units of land in the community.

2. $l \in [0, L]$ is the number of units of developed land.

3. $c \in \Re^+$ is the cost per unit of development.

4. $R \in \Re^+$ is the unit value of undeveloped land.

5. $g(l) \colon [0, L] \mapsto \Re^+$ is the level of congestion in the community.

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[7]The notation and organization of the models has been changed from the original articles in the interest of clarity.

6. $f\big(l, g(l)\big)\colon \{(0, L) \times \Re\} \mapsto \Re^+$ is the inverse demand for developed land (i.e. the maximum willingness-to-pay for the lth unit of land given g congestion.).

The model includes the following assumptions.[8]

1. $g(l)$ is continuous.

2. c and R are constant.

3. $f(l, g(l))$ is twice differentiable.

4. $f_l \leq 0$ and $f_g < 0$ for all $g(l)$ and l. In addition, $g_l > 0$ for all l. Together these imply

$$\frac{\partial f\big(l, g(l)\big)}{\partial l} < 0.$$

5. $f\big(L, g(L)\big) > 0$.

In the model as it stands, land will be developed as long as it is profitable (i.e. as long as $f\big(l, g(l)\big) \geq R + c$. Since $f\big(l, g(l)\big)$ is strictly decreasing (assumption 4 on page 10), there is a unique l^0 such that $f\big(l^0, g(l^0)\big) = R + c$.

Mills shows that l^0 is an inefficient level of development in the sense that l^0 is larger than the surplus-maximizing level of development l^*. Mills uses the surplus formula

$$B(l) := \int_0^l f\big(y, g(l)\big) dy - (R + c)l$$

for which $g(l)$ is held constant at the limit of integration l rather than depending on the variable of integration. Assuming $B(l)$ to be strictly concave, the first order condition for the surplus-maximizing level of development is

$$f\big(l^*, g(l^*)\big) + \int_0^{l^*} f_g\big(l, g(l^*)\big) \cdot g_l(l^*) \cdot dl = R + c$$

This defines

$$\theta(l^*) := -\int_0^{l^*} f_g\big(l, g(l^*)\big) \cdot g_l(l^*) \cdot dl$$

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[8]Mills mentions in passing the assumptions that municipal services are supplied with a constant return to scale technology and are financed by taxes equal to the marginal cost of the services for both the developed and undeveloped regions. These assumptions do not appear formally in his model but are acknowledged omissions from it.

which is the marginal social cost of a unit of developed land. The socially optimal price of land is $R + c + \theta(l^*)$ which exceeds the uncontrolled price of land $R + c$ since $f_g < 0$ and $g_l > 0$ (Mills 1989, p. 3). The inefficiency arises because of congestion.

For my purposes, the central element of Mills' model is his surplus formula.[9] That formula,

$$B(l) := \int_0^l f\big(y, g(l)\big) dy - (R + c)l,$$

depends on the inverse demand function $f(l, g(l))$ which is assumed in Mills' analysis. The inverse demand function $f(l, g(l))$ represents the price of land as a function of congestion. It is the price of any extra unit of land (regardless of its location or owner). It is furthermore a universal price. A price available to all individuals regardless of their identity. Because the effect of congestion is modeled as a direct effect on the price of all land, Mills' model is incapable of answering any questions about how the aggregate community values open land. The critical step from individual valuation to aggregate valuation has been skipped. In its place Mills provides a mechanical rule that ignores all questions of individual identity. For instance, because Mills' aggregate community is a single entity, there is no distinction between the buyers and sellers of land. Consequently, the model is unable to address the fact that some buyers and sellers have different interests and different rights in the exchange.

Despite these limitations, Mills is willing to voice normative criticisms of zoning. He argues first that the "rent" $\theta(l^*)$ created by zoning is "inequitably distributed" (Mills 1989, p. 3). This argument is presented despite the fact that Mills's analysis has no structure capable of distinguishing individuals. He argues second that the creation of those rents both moves society away from the optimal point and creates secondary costs to society such as rent-seeking. Mills recommends as a solution that zoning rights be saleable for cash (Mills 1989, p. 11). Whatever the merits of this proposal, his analysis does not support the argument since it is silent about the issue he focuses on: the allocative effects of zoning.

2.5.2 Crone's externality model

Crone presents a model of zoning which includes local productions externalities[10] (1983). His purpose is to show that under certain conditions, land use externalities may create nonconvexities in the firms' production sets which cause zoning to be a more efficient solution to the externalities problem than either the Coasian solution (more precise definition of property rights) or the Pigouvian solution (imposition

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[9]The bulk of Mills' paper concerns the inefficiencies of rent-seeking. Mills argues that the costs of rent-seeking can outweigh the benefits of zoning (Mills 1989, p. 10).

[10]The externalities are modeled as negative effects of the production of one good on the production of the other. Though Crone does not model Coasian trades, the externality is implicitly Pareto-irrelevant in the sense that the model does not allow for trades between the firms to eliminate or reduce the externality.

of taxes and subsidies).[11] For my purposes, a presentation of the model without the conclusions is sufficient. The concept of social welfare appears in Crone's model via his reference to externalities. His is a model which regards the presence of externalities as a barrier to the attainment of *a* Pareto efficient allocation but which does not consider *which* Pareto efficient allocation to select.

Crone makes the following assumptions.

1. Two goods x_1 and x_2 are produced at location S. Absent externalities, S is the most productive location available.

2. At least one good imposes a production externality on the other.

3. There are two inputs, land, which is in fixed supply $\bar{A}$, and another resource N. $\bar{A}$ can be set equal to one without loss of generality.

4. The prices $\bar{p}_1$ and $\bar{p}_2$ of the goods x_1 and x_2 are fixed and exogenous.

5. The price of input N, $\bar{p}_n$ is fixed and exogenous.

6. *Within* location S, both the total and relative supplies of land are fixed — the former by God, the latter by the zoning board. This allows the price of land which produces x_1 (denoted p_1^A) to differ from the price of land which produces x_2 (p_2^A).

Given these assumptions, the production functions for x_1 and x_2 are

$$x_1 = f(A_1, N_1, x_2)$$
$$x_2 = g(A_2, N_2, x_1)$$

where A_1 and N_1 are the the amount of land and the other resource used in the production of good one (similarly for good two).

The externality assumption can be written as

$$\frac{\partial f}{\partial x_2} < 0 \text{ or } \frac{\partial g}{\partial x_1} < 0. \tag{1}$$

Crone uses this model to investigate when the total value production functions, given prices, will be nonconvex. If the production functions are indeed convex, argues Crone, the Pigouvian and Coasian solutions will be blocked; leaving zoning as the next best alternative. However, as discussed in the text adjacent to figure 1 on page 4, the "solutions" under examination are limited to a narrow subset of possible efficient

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[11]Briefly summarized, the argument is that for the Coasian or Pigouvian solution to be efficient, it is necessary that production sets be convex. As Crone argues, production sets may be nonconvex if "output diminished at an increasing rate with the pollution level up to a point of relative saturation and at a decreasing rate thereafter" (Crone 1983, p. 169 note 1). The latter half of Crone's paper presents an empirical investigation of the convexity of production sets for Foster City, California.

allocations. That subset is delimited by the functional form of the model. In the Crone model, the negative effects of one production process on the other are modeled as in equation 1 on page 12. Because the form and extent of the externality are specified in Crone's model, under either the Coasian, Pigouvian or Croneian solution, the participants in the model have no personal say about the allocation of resources. Their voices have been co-opted by the functional form in equation 1. Despite this limitation, Crone concludes his paper by arguing that there may be a justification for zoning due to "equity" (i.e. allocative) concerns rather than efficiency concerns. This may be true, but the model presented does not shed light on the question.

2.5.3 Bogart's exclusionary zoning model

Bogart presents a general model of exclusionary zoning (Bogart 1993). Its main element is the presence of two different types of individuals: type A and type B. The model assumes the following.

1. There are J communities, indexed by the superscript j. The population of each community consists of α^j type A's and β^j type B's.

2. Individuals receive utility $U_A(Z, X)$ and $U_B(Z, X)$ where X is a private consumption good and Z is a locally provided "public" good. More precisely, Z is an excludable and rival good (i.e. an ordinary "private" good) which is "public" only in the sense that it is produced *by* the community government and provided to each resident individually.

3. X has a unit price of 1, without loss of generality.

4. Z represents the quantity of the public good consumed (as opposed to produced). Individual consumption of Z depends on the amount of inputs, the composition of the community (the ratio of A's to B's), and the type of the individual.

5. The composition of a community is represented by the fraction of type A individuals within it. The fraction of type A's within community j is denoted

$$\theta^j = \frac{\alpha^j}{\alpha^j + \beta^j}.$$

6. The cost of production of Z in community j for an individual i depends only upon the composition of the neighborhood and is denoted by $P_i^j(\theta^j)$.

7. The cost of producing Z declines as the fraction of type A's increases. This is denoted

$$\frac{\partial P_i^j}{\theta^j} \leq 0.$$

Bogart makes some additional extensions which are not relevant here (Bogart 1993, p. 1673) and some assumptions about how the municipality spends and taxes. The welfare problem is then to find the community composition (i.e the amount of type B individuals to admit) to maximize social welfare within the community.

The exact form of that problem is not relevant here but, roughly speaking, it is the maximization of the type A's welfare *subject to* the welfare of the type B's being at or above a certain level. In other words, the welfare level of the type B's is fixed at an arbitrary level. This has the effect of limiting the analysis to a particular region of the set of Pareto efficient points. In the Edgeworth box depiction (figure 1 on page 4), fixing the type B's utility at a particular level is equivalent to restricting the final allocation to along a particular type B indifference curve. The welfare problem is then slide along that curve to the point *on that curve* where the welfare is maximized. Though the Bogart model formally includes two types of persons. In fact there is only one type of person; the type A's. The second class of persons have no choice regarding their own actions. They are part of the background environment to which the type A's adjust their behavior. Furthermore, it should be noted that the type A's are all identical. Consequently, no allocation issues are considered among the type A's themselves. In short, Bogart's model, like the preceding two, is incapable of addressing the welfare question of allocation. Though it is formally a model with heterogeneous agents, it is in fact a model with only one agent.

2.5.4 Fischel's Coasian property rights model

Fischel emphasizes the property rights aspects of zoning welfare. His approach, based on the Coase theorem, differs from the Pigouvian approach by focusing on trade rather than on government taxation (Fischel 1985, 116–122).

A "property right" is a legally enforceable right to control some or all aspects of resource. For example, a landlord owns the right to exclude persons from the rental property, sell it to others or rent it to others. The renter of the property owns a right to exclude others and to occupy the property during the rental term but does not own the right to sell or lease the property. Property rights are relevant to the zoning issue in two ways. First, zoning itself is viewed as a "collective property right" (Fischel 1985, p. xiii). By this it is meant that zoning provides the municipal government (and through it, the citizens of the municipality) limited rights to control property within the municipality. Second, a zoning ordinance provides selected residents with benefits that they would otherwise lack, like low density neighborhoods. These benefits can be viewed as property rights which the affected residents will be reluctant to relinquish (Fischel 1985, p. 231).

A central tenet of the economics of property rights is the Coase theorem (Fischel 1978, p. 66). The Coase theorem is applicable to situations where one party's use of a property creates a negative externality[12] for another party. One solution to the

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[12]More generally, the Coase theorem addresses the situation where one party's use of a good is incompatible with another person's use of that good. The term externality is one way of describing this situation. That term is commonly applied to situations such as air pollution where a polluting party's use of the air is incompatible with a breathing party's use of it but incompatibility is present

externality problem is to impose a tax upon the polluter for each unit of pollution. This is the so-called Pigouvian tax solution; the tax forces the polluter to consider the costs that pollution imposes on other users of the air. It is obviously necessary for the tax to match the actual costs born by others but this information gathering problem is prohibitively difficult to solve. The Coase theorem notes that given certain unrealistic assumptions — which happen to be the same as those underlying the Pigouvian tax and which include the absence of transaction costs — a tax is not necessary. Instead, one of two things can occur depending on the allocation of property rights. If the polluting party owns the right to pollute, the party which is harmed by the pollution will pay the polluter to abate the pollution — up to the point where the marginal cost of the payment matches the marginal benefit to the pollution-bearing party. If instead the pollution-bearing party owns the right to prevent pollution, the polluter will pay to be allowed to pollute — up to the pont where the marginal cost of the payment matches the marginal benefit to the polluter. The Coase theorem states that the final amount of pollution will be the same regardless of which party is given the initial rights. Note that the final wealth of the parties will differ; a different party pays in each situation.

The Coase theorem is unrealistic. It assumes, for example, that it does not cost the parties a cent to find one another, to bargain, or to enforce their agreements. However, the underlying idea, that parties may attempt to make trades when it is advantageous, has wide applicability.[13] Fischel applies it to the zoning problem.

Fischel describes the purpose of zoning as the regulation of "external effects among land uses so as to provide a more efficient allocation of activities." This is the familiar externality motivation for zoning. As noted, zoning provides a collective property right to the municipality. If the allocation of rights granted by zoning is inefficient, the Coase theorem indicates that the parties (the municipality and residents or developers) will bargain until the efficient allocation is reached. This does not occur in practice because the collective property right created by zoning is incomplete. In particular, municipalities lack three rights:

1. The ability to fully *exclude*, i.e. to completely prevent persons from using a particular parcel of land. The zoning variance, political intrigue and even the beleaguered takings doctrine prevent governments from entirely restricting use (Coyle 1993);

2. The ability to *lease* zoned parcels of land; and

3. The ability to *sell* the restrictions and development rights on zoned parcels of land.

See Hirsch (1988, p. 100) and Fischel (1978, p. 66).

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in mundane goods such as food.

[13]In particular, it results in the clarification of the term "externality" into two parts: Pareto-relevant externalities and Pareto-irrelevant externalities. The latter being external effects which are not subject to mutually advantageous bargaining because of barriers such as transaction costs (Randall 1983).

In Fischel's model, the inability of municipalities to sell zoning restrictions means that they face no opportunity cost by zoning land. By contrast, if a municipality purchased land, it would face the opportunity cost of not reselling that land. Furthermore, though municipalities can lower property values by zoning them for particular uses, the municipalities are not required to pay full compensation for this loss (in other words, they are not required buy the land *de facto*. The result is that zoning is a cheaper way for municipalities to control land use than direct purchase of land is.[14] The control is not total since, according to Fischel, the municipality lacks the right to compel particular development or to require public access to a part of the property.[15] At most, municipalities own limited rights to prevent certain actions on parcels of land. However, they are barred from selling these restrictions. Developers cannot simply pay to have zoning restrictions removed, nor can residents pay to have them imposed. This limitation stems from the rationale of zoning as an exercise of the police power. The police power is government actions for the benefit of the public. Were it to be sold that justification would be undermined. As Fischel notes, "To sell zoning would be analogous to selling elevator safety certificates or restaurant health inspections" (Fischel 1978, p. 67).

Using the idea of property rights, Fischel models a development-limiting zoning ordinance.[16] The model consists of a municipality with a growing population denoted by N. Residents maximize their individual utilities over two goods: a composite good and "residential quality" (denoted by Q). The quality good Q is provided by municipal services M where higher population requires a higher provision of services to achieve the same level of residential quality. The relationship between the amount of municipal services and population (for a given level of residential quality) is represented by the curved line depicted in figure 2 on page 17.

As population increases, the amount of open land decreases and the per capita cost of provision of municipal services increases.[17] Rather than continue to pay this

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[14]It was certainly the case that zoning was cheaper than purchase when Fischel wrote in 1978 and is most likely the case now. The strong claim that municipalities are not required to pay *any* compensation for land use restrictions has been weakened by recent case law. See for instance *Lucas v. South Carolina Coastal Council*, 112 S.Ct. 2886 (1992). In *Lucas*, the South Carolina Coastal Zone Management Act completely prohibited development on Lucas' two shorefront lots. The Court held this to be a *possible* compensable taking and remanded the case to the South Carolina supreme court for a determination. *Lucas* raised the possibility that government restrictions would be more likely to require compensation in future. However, the degree of restriction placed on the Lucas' property was extreme. It appears that Fischel's argument is not seriously weakened by *Lucas*.

[15]This claim must be tempered by reference to such practices as exactions in kind; whereby the municipality requires the dedication of a piece of the property for public use like for a bicycle path or a green buffer. This practice has been called into doubt by *Nollan v. California Coastal Commission*, 107 S. Ct. 3141 (1987). In *Nollan*, the Court required than there be an "essential nexus" between such restrictions and the development plans of the landowner.

[16]Though Fischel identifies the purpose of zoning as the control of externalities and discusses the Coase theorem (an analysis of externalities) he presents a model of development limiting zoning. The externality in such models is not that of incompatible uses — say between factory and residence — but the effect of congestion on individual quality of life. The distinction is not relevant here.

[17]This rise in per capita costs is due to the concavity of the residential quality production isoquants; a shape which Fischel assumes (Fischel 1978, p. 69).
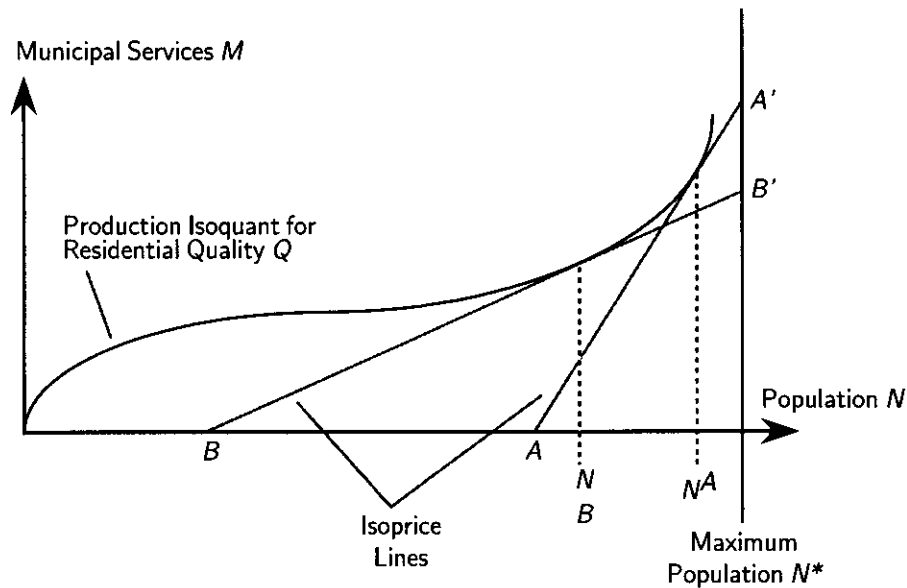
Figure 2: *Population densities under municipal land purchase and zoning. The line $A - A'$ indicates the cost of municipal land purchase. The line $B - B'$ indicates the cost of zoning. N^A indicates population use under municipal land purchase. N^B indicates population under zoning (Source: Fischel 1978).* ◊

amount, the municipality could limit population growth either by purchasing open land or by zoning. The line $A - A'$ represents the cost of purchasing land in terms of the provision of municipal services. Its slope is equal to the ratio of the market price of land and the cost of municipal services (Fischel 1978, p. 70). The line $B - B'$ represents the cost of zoning in terms of the provision of municipal services. Because the municipal government cannot sell zoning rights, it incurs less opportunity cost by zoning than by purchasing land. The resulting population level if the municipality purchases land is N^A. If it zones the level is N^B which is lower than N^A.

In short, because municipalities are not required to pay for the loss of value they impose upon property owners, they do not consider those costs when enacting zoning. The failure to consider those costs results in more zoning (i.e. stricter development limitation) than the market would provide (Fischel 1978, p. 71). Fischel's comparison to the market is a reference to the welfare economics concern with allowing the market to move to *an* efficient allocation. However, like the preceding models, there is nothing in Fischel's model that represents the conflicting choices of individuals. Here, the aggregate societal view of land is represented in the price of land (in terms of municipal services). The entire society is treated as a single entity and there is consequently no allocation question possible. The only issue is how much zoning the monolithic society will choose to have. In that sense it is odd to argue that this model demonstrates the inefficiency of zoning. Here zoning is inefficient only to the extent that it yields a level of open space different from what "the market" would have yielded. Yet there is no market modeled here. There is no opportunity for affected landowners to voice

opinions. The inefficiency of this model is Pareto-irrelevant within the context of the model since there is no opportunity for affected parties to bargain for any other result.

As did the others, Fishel departs from the bounds of his model to address the allocation question.

> It is important to note the advantage of zoning to existing residents. With it, municipal service expenditures are much lower than they would have been under some other system, so more disposable income is available to preexisting residents. ... Other systems of land use controls — private covenants, nuisance laws, and municipal acquisition of open land or development easements — all would require that land be purchased or owners otherwise compensated.

This statement notes, correctly, that zoning provides a benefit to *selected* individuals (i.e. the beneficiaries of zoning) which those individuals may not be willing to give up. Yet, Fischel's analysis does not provide any method for studying the question.

3 Evolution

The models presented in the preceding section (and others like them) are incapable of addressing the allocative effects of zoning. Despite this, the authors allow themselves to make policy recommendations and predictions that transcend the models. Such statements are both misguided and misleading. They are misguided because they are unsupported by the models. They are misleading because they speak with authority while hiding the allocation issues from view. In order to conduct a more reasoned study of the allocation questions and the development of economic and legal systems, it is necessary to pursue a larger approach. Several approaches have been employed including the impact analysis approach of institutional economics (Schmid 1987). In this section, I will introduce the evolutionary approach. Because it focuses on the actions of individuals, it is well-matched to the concern for individuals' positions under a given allocation. It has threads in both law and economics.

3.1 Evolution in Law

3.1.1 Early Evolutionary Thought

The idea that the law "evolves" in some sense has an old history (Elliott 1985, p. 38). Elliott's study considers jurisprudence that explicitly draws upon the metaphor of *biological* evolution. By "biological" Elliott means the ideas of selection of fit individuals from among a population. He does not mean the entire body of biological evolutionary thought (such as the important distinction between genotype and phenotype). As noted by Hodgson (1993) , the term evolution can also connote "unfolding" of a set plan. Under this meaning of the term, Marxian history is evolutionary since

it envisions an unfolding of society through necessary stages. Elliott reports that the idea of legal evolution extends back to the 18th and 19th centuries but that, curiously, 20th century scholars seem to feel that they are discovering the concept for the first time (Elliott 1985, n. 5). (There has, however, been a qualitative change in the way evolutionary models are constructed in biology and economics; the subject has become significantly more mathematical and comprehensive.)

According to Elliott, early scholars such as Friedrich Karl von Savigny and Sir Henry James Sumner Maine viewed legal evolution as a mechanical process of development through prescribed stages (the "unfolding" sense of the term evolution; see below at page 21). John Henry Wigmore and Albert Kocourek developed an evolutionary theory with a more modern flavor that emphasized the continual struggle of underlying societal forces. In Wigmore and Kocourek's view, these forces allow no more than a temporary equilibrium and provide no inherent direction to the development of law (Elliott 1985, pp. 46–50).

Elliott distinguishes these early theories (which he calls "social theories" because they address the evolution of entire societies) from doctrinal theories derived from the work of Oliver Wendell Holmes, Jr. Doctrinal theories address the changes in specific legal doctrines. They are thus more precisely addressed to changes within a given legal system such as the developments of the common law of tort.

3.1.2 Evolutionary Law and Economics

Evolutionary legal thought declined noticeably during the first half of the 20th century (Elliott 1985). Its recent resurgence began in 1977 with Robert Charles Clark who proposed the idea that statutory law evolves (Elliott 1985, p. 63). However, the 1970s saw the more interesting development of evolutionary theories occur in the field of law and economics. The law and economics movement had an evolutionary component from its inception, claiming that the common law has evolved to be "efficient."[18] However the exact nature of the process by which efficient legal rules survive and inefficient ones perish was not specified. In adjacent articles, Paul Rubin (1977) and George Priest (1977) proposed that the decisions of individual litigants determine the set of cases from which judges may rule. Furthermore, litigants will be more likely to go to court if the existing legal rules are inefficient. They are more likely to litigate because inefficient rules impose higher costs upon litigants and thus increase the benefits available from litigation[19] Other law and economics articles of the period include Goodman (1978), Terrebonne (1981), Clark (1981), and a Note in the Yale Law Journal (1983).

The idea the the common law evolves *to be efficient* has been criticised. Balkin (1987), for instance, presents an extended criticism of a later work by Landes and

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[18] "Efficiency" in this context means maximizing of total social wealth. The emphasis on cash wealth is a significant difference from the general theory of welfare introduced earlier. This difference is often ignored.

[19] Rubin and Priest differ over the question of how inefficiency motivates litigants. Rubin's version is subject to a barrier in that the benefits of relitigation must exceed its costs. Priest argues that the fact that inefficient rules are more likely to be litigated is sufficient to create a selection pressure.

Posner (1987). Among other things, Balkin argues that the evolutionary mechanism can at best tend toward efficiency in some cases but that other general evolutionary concepts (such as the idea of vestigial components — features that served a purpose at one time but no longer) must be included in the theory for completeness. Of particular interest is a note in the 1983 Yale Law Journal which argued that the common law is not efficient in the first place (Note 1983). The Note studied liability rules and found that they are becoming increasingly "reckless" over time (requiring too little care by potential accident victims). (The Note also comments that efficiency itself is a relevant standard only to the extent that "society" has the goal of wealth maximization (Note 1983, note 39).)

3.1.3 Recent Developments

In 1981 Robert Clark proposed a methodology for what he called the interdisciplinary study of legal evolution (Clark 1981). His proposal called for systematic, interdisciplinary, and scientific study of legal evolution. In particular, his program depends on the hope that general patterns can be found to explain legal evolution. Perhaps not patterns as simple as Law and Economics's evolution toward efficiency claim, but general enough to do better than merely reciting the facts of historical change.

Despite Clark's call, after the flurry of articles between 1977 and 1985, there did not appear to be continuing published work in evolutionary law and economics. The relative silence of the late 80s and early 90s was broken by two works: A book chapter by economists Warren Samuels, Allan Schmid, and James Schaffer and an article in the Harvard Law Review by Roe. Roe proposed incorporating some of the most recent ideas from the mathematical modeling of complex evolving systems (Roe 1996).[20] Roe addresses a fundamental problem with evolutionary theories of law and economics. In their quest to demonstrate that the (common) law is efficient, scholars between 1977 and 1985 employed a highly mechanical conception of evolution that owes more to the equilibrium models of neoclassical economics than it does to a general theory of evolution. Roe adds three concepts to the discussion: path-dependency[21], sensitive dependence on initial conditions[22], and the distinction between global and

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[20]The study of evolving complex systems is an exploding endeavor in many academic disciplines including physics, computer science, biology, sociology, economics, political science, and meteorology. Popular works in complexity include Waldrop (1992), Pagels (1988), and Coveney & Highfield (1995). Economics works include Anderson, Arrow & Pines (1988) and Saari (1995). See also the periodical *Complexity* .

[21]Path-dependency is the notion that evolving systems have a difficult time innovating entirely new structures and processes. Instead, they generally build upon their current situation. Consequently, evolving systems are limited to a particular "path." Even if a superior solution is theoretically obtainable, if the existing structures cannot be readily modified, the superior solution may not be reached. Stephen J. Gould, that great popularizer of evolutionary ideas, gives the example of the Panda's Thumb (Gould 1980). The Panda's sixth "thumb" (used to strip leaves from bamboo) is in fact an elongated wrist bone. Speaking anthropomorphically, the Panda found itself in need of a sixth digit but was not able to revise its existing hand structure to create a sixth jointed digit with functionality similar to the existing five. Instead, it settled for an elongated wrist bone that serves adequately though not as well as a jointed digit.

[22]Sensitive dependence on initial conditions is a phenomenon where small changes in the initial

local optima[23].

Samuels, Schmid & Schaffer (1994) list twelve elements that an evolutionary theory of law and economics should satisfy. Among them are the interrelation of the legal and economic processes in society, the nonlinearity of the legal/economic system, the fact that "power, ideology, and institutions...are endogenous" to the legal/economic system, and the the fact that the legal/economic system is constantly changing (its "principle characteristic [is] *process*" (p. 98, emphasis in original).

It should be noted that one article in the early period, Kooter & Kornhauser (1980), did criticise the mechanical approach. Cooter and Kornhauser constructed a particular mathematical model of legal evolution and found that though there is a trend selecting for efficient rules, the trend does not culminate in a fully efficient system nor does it prevent multiple rules from existing together.

3.2 Evolution in Economics

3.2.1 History of Evolutionary Economics

The modern incarnation of evolutionary economics is in its infancy (Hodgson 1993). However, as in law, evolutionary concepts have been present in economics for many decades (Hodgson 1994). The field ranges from primarily prose accounts of institutional formation to mathematical descriptions of, for instance, the spread of technology standards through an economy.

As Hodgson notes, the term "evolution" has many meanings within economics. Hodgson labels the two major branches of the term as the "developmental" branch and the "genetic" branch. The developmental view of evolution connotes the concept of unfolding or unrolling and so hearkens back to the latin root *evolvere*. Associated with this view are the concepts of progression and development. Thus, Marx's view of the economy as progressing through inevitable stages, culminating in the overthrow of the capitalist system, is evolutionary in this sense. The genetic view is akin to the current view of biological evolution. It connotes change of the components of a complex system such as an ecosystem or an economy. The change occurs through some sort of selection pressure, though in the modern view of biological evolution, there is no sense of progression or inevitable improvement (Gould 1993).

Many authors in economics attempt to base an evolutionary theory on biological principles, beginning, of course, with Alfred Marshall's oft-quoted statement that

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state of a system have strong effects on the future of the system. A system that does *not* exhibit sensitive dependence on initial conditions is a firing cannon. *Small* changes in the volume of gunpowder, height of the barrel, or weight of the shot have only small effects on the path of the shot. By contrast, a ball balanced on the top of a hill may come to rest in widely separated valleys depending on slight changes in its initial location.

[23]The distinction between global and local optima can be illustrated by the analogy of a hilly landscape. The highest hill is the global optimum, surrounding small hills are local optima. Obviously, if one climbs a small hill, one cannot get to the highest hill without first going back down. For a hiker, this initial descent may be a small price to pay but for an evolutionary system (where the participants likely are unaware of the highest hill in the first place) the descent may not be taken even though it would lead to improvement in the long run.

"the Mecca of the economist lies in economic biology..." (quoted in Nelson 1995) (see also Bresson 1987). Nelson argues that a biological foundation is inadequate and misleading (Nelson 1995). Indeed, there is a general mathematical theory of *adaptation* which formalizes Darwinian evolution and many other variants (Holland 1992).[24]

Though the term "evolutionary" is used widely in economics, I intend it to refer to modern research pioneered by Richard Nelson, among others (Nelson 1982, Nelson 1995). This type of evolutionary economics is, roughly, concerned with the economy as a complex system consisting of numerous independent agents who (to some extent) seek their own gain[25] but do so in the face of severely limited information and in an ever-changing context.

3.2.2   Elements of an Evolutionary Model

A modern (in the sense just described) complex evolutionary model of law and economics must include the following elements.

1. Economic systems are "complex" in the sense that they have many independent agents each pursuing some degree of optimization or satisfaction. The large number of agents and their interactions means, among other things, that the possible states of the system cannot be systematically tested. [26]

2. The agents in the system are boundedly rational, both due to their own cognitive constraints, to the unknown future behavior of other agents in the system,[27] and to the extremely large number of possible structures involved in the economy.

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[24]Holland gives an example of a nonbiological adaptive system. This system is a device for recognizing patterns projected onto a screen. It consists of a number of sensors which can be either on or off depending on whether they are receiving light or not. The number of states of this sensor array is vast and practically unsearchable. The adaptive plan begins with a weighted sum of the signals gathered from a given image. Roughly speaking, the sum procedure partitions the set of images into two pieces. A good set of weights results in one piece matching the actual pattern reliably. The adaptive plan is a rule for adjusting the weights in response to correct or incorrect attempts to recognize successive patterns. Rather than having the programmer attempt to determine rules for pattern recognition, this procedure allows the machine to develop a test on its own in response to repeated attempts.

[25]Evolutionary economics does not exclude the possibility that individuals seek the gain of others who are close to them. It only requires that individuals do not seek the gain of everyone in society. The social capital literature addresses the question of whether individuals seek the welfare of others. See Robison (1996).

[26]By way of illustration, consider an organism with a 100 gene chromosome, each of which can be in two states. Since the genes can vary independently, there are 2^{100} possible states of the chromosome. To test these states at the rate of one gene per second would require considerably more time to complete than the universe has yet existed (Holland 1992). A system with 100 people each of whom can choose from two options is equivalently complex.

[27]The fact that agents in the system are responding to other agents, who are in turn responding to other agents, creates a coevolutionary system. In such a system, a given agent may find that by choosing a superior option, that option *becomes* inferior due to the counter moves of other agents. For instance, the producer of a new product may find that abandoning that product becomes preferable to producing it when new competitors enter the market.

3. There is an environment that includes space information (distance, direction, and costs to movement) and communication information (how far and in which places can communications occur).

4. Agents within the system are able to communicate with one another in various ways, to affect one another's well-being, and to process information from such communication and from the environment.

5. The system exhibits nonlinear dynamics of various forms with the central result that the system does not possess optimal states. Of course, even if an optimum exists, the complexity of adaptive systems means that determining whether a given solution is indeed optimal is impossible, rendering the concept less useful.

6. The system evolves in the sense that the agents change in response to information they receive from the environment and the process of change generates novelty. Change can either be through learning by individual agents or through the generation of new agents and the loss of old.

These elements are central to evolutionary models that employ only low levels of interaction between agents. Two such models include the functioning of an ant colony (Ferber 1994) and the spread of culture (Axelrod 1995). To model higher level interaction such as the formation of contracts, more is required. This is discussed in more detail in section 4.3.

The central question for a complex evolutionary system is what high level behavior emerges from low level components. This is the concept of "emergence." A property of a system is emergent if it could not be predicted from the individual components of the system alone and indeed is not a part of the individual components alone but of their joint interactions. A simple example of emergent behavior is the flocking behavior of birds. This behavior can be modeled in a computer by giving each computer bird brief rules about how close to fly to its neighbors. In a model reported by Waldrop (1992), Craig Reynolds specified three rules. Each computer bird tried to (1) maintain a minimum distance from all other objects in the simulation; (2) match velocities with neighboring birds; and (3) move toward the center of any mass of birds near it. When each bird follows these rules, the result is a flock which appears to function with a mind of its own. Flocking behavior emerges even if no individual bird is granted the power of leader. (Numerous implementations of this idea are available on the World Wide Web.)

The economic models presented in section 2.5 do not exhibit any emergence because all behavior within the model is fully specified. This is because they are "top-down" models composed of global equations. The study of emergent behavior, by contrast, requires a bottom up approach including the elements listed above. Such a model is only practical when constructed in computer that can perform the calculations for each agent quickly. Because only the agents and their environment are defined, high-level behavior is the unknown result that is the subject of study. Using such a model, one can experiment by varying the parameters for each agent and

for the environment and observing the resulting effects on high-level behavior. See Hillebrand & Stender (1994).

The idea of emergent behavior appears in the game-theoretic literature on the emergence of institutions. Here it has been referred to as the *Smith-Menger-Hayek conjecture* that institutions spontaneously emerge without planning by any single leader (Witt 1989, p. 155). How can actions of individual agents affect the development of higher-level social institutions? It has long been recognized that the individual gain seeking behavior of agents within the economy is important to the development of the economy and of legal systems. This idea is well represented in the Chicago school of law and economics and elsewhere. Samuels et al. (1994, p. 97) identify "the continuing contest over the distribution of income and wealth" as one of the two "driving forces of legal economic behavior." This continuing contest is blocked by the aggregation approach to welfare modeling that was criticized in section 2 on page 3. The concept of efficiency as it was presented earlier focused exclusively on mutually advantageous exchanges between agents. In the Edgeworth box terminology, agents that find themselves at a Pareto suboptimal allocation will trade with one another and thus move toward a Pareto optimal allocation. They do so because *both* agents benefit from the trade. But what if this trade is blocked by a transaction cost or one of the parties wants to move to an allocation that benefits itself at the expense of the other? The traditional economic model excludes these possibilities; both by ignoring the uniqueness of individuals and by assuming low transaction costs and nonattenuated property rights.

It is the role of government to, among other things, specify the ownership rights of individuals. The market trade, which is one way in which individuals seek to alter an allocation, requires that the owner of property be able to prevent others from using that property (exclusion), be able to collect money for the use of that property (rent), and be able to transfer these rights to another (alienation). In other words, the world must be divided into *sellers* and *buyers* vis à vis a given piece of property (Schmid 1994).

In practice, what happens when a buyer wishes to change an allocation but does not wish to pay for the change? One option is the direct appropriation of property without payment (commonly referred to as stealing). Another is the *redefinition* of buyer and seller in law. The latter method, the redefinition of property rights, results in a transfer as surely as the first but, if done discretely, may escape the social stigma of the first method.

This illustrates one major motivation for changes in legal systems. Those who are dissatisfied with a given allocation *and its associated ownership law* will seek to change both the allocation (via the market) and the law.[28] Zoning is a just such a change in law. It restricts property owners' rights to use their properties and benefits neighboring owners who were unable to buy the use restrictions in the market.

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[28]Both market transactions and changes in law can be costly. Dissatisfied individuals will consider whether trade or legal change are worth these costs in a given situation.

4 Zoning

With the list of evolutionary concepts presented, it is possible to apply them to zoning. I first present a summarized history of zoning that identifies the most important actors and forces. Following the summary, I will identify the similarities between the history and the evolutionary concepts developed above.

4.1 The History of Zoning

Zoning in the United States is a recent phenomenon. The first comprehensive zoning ordinance was adopted by New York City in 1916 (83 Am. Jur. 2d Zoning and Planning 1995, § 1). Less comprehensive "building zone laws" began around 1901 (*Euclid v. Ambler Realty Co.*, 272 U.S. 365, 386 (1926)). Before the 20th century, conflicts between neighboring land users were addressed by the common law of nuisance and by building restrictions. Legislative control of land use was limited to building and fire codes and prohibitions on noxious uses (Anderson 1976, § 1.02). These controls proved inadequate to address the mid 19th and early 20th century's great technical and social changes. These changes, which included the development of large industry and intercity rail and intracity horsecar transportation, attracted many people to the nation's large cities. Chicago's development is in many ways typical and will be used as an example throughout this section. The Chicago history material is due to King (1986).

4.1.1 The setting

During the period following the Civil War, between 1850 and 1870, Chicago and many other American cities began their transformation into the suburban form of today. This form was and is characterized by new subdivisions composed of relatively large lots, building setback requirements, quiet streets, trees, and the absence of racial minorities and less wealthy classes. Suburban lots in Chicago in the 1870s were wider than earlier city lots and were built with detached homes rather than the row house design which had prevailed in eastern cities (King 1986, p. 29). The setback requirement and the placement of trees between houses and their fronting roads was gaining popularity in the east and was recommended by a report to Chicago area developers (King 1986, p. 28–29). The segregation of minorities and the less wealthy was an inevitable result of the high cost of large lots, large homes, and other suburban amenities. Ultimately, the suburban idea was meant to provide comfortable living separate from the working areas of the central city; though the term "suburb" did not originally connote the total separation from the central city that it does today (King 1986, p. 27). For this separation to succeed required ready transportation from suburbs to city. This transportation was initially provided by horses, then rail, and later by the automobile.

During the same period of 1850 to 1870, manufacturing expanded and rail and horsecar routes were constructed in Chicago. As the city developed after the Civil war, commerce and industry located at the city center and along the new transporta-

tion routes. At the city's edge, the suburban lifestyle became established. Subdivision construction expanded quickly. Between 1865 and 1872, one third of the city's land area was platted by real estate developers. The early suburbs were a ring, connected to the city, with middle class homes further out than the working class and ethnic neighborhoods. When street rail was developed, the middle class moved further out. Between 1871 and 1893 the urban fringe moved about five miles out (King 1986, pp. 26–28). Meanwhile, the city center formed into separated manufacturing and wholesale sections interspersed with residential areas characterized by the newly invented apartment houses (initially fashionable for the wealthy). As the city grew, manufacturing and multifamily dwellings moved outward, bringing with them congestion, sanitation problems, traffic, dirt, noise, and racial and class dislike on the part of suburban residents. The cities were now subject to what King calls "the cycle of invasion and succession" (King 1986, p. 34). By this cycle, the suburban residential areas were "invaded" by apartment houses or industry, the suburbs moved outward and the cycle began again. As mentioned, this phenomenon of invasion had strong racial and class elements. Suburbanites were leery not merely of apartment houses, but of the lower class and racial groups which apartment houses represented.

Suburban residents and the land developers who served them sought to fix the suburban way of life against the separate encroaching forces of industrialization and population influx. The former was addressed with nuisance law, the latter with private building restrictions.

4.1.2 Nuisance law

From the early days of English common law, the action in trespass was available to remedy physical invasion of land like dumping of soil on land, drainage of water across land, or personal entry onto land. Nuisance law was available to cover conflict between landowners where physical invasion of land was lacking. The two remedies available for a nuisance action are money damages to compensate for harm and the injunction to block the offender from causing further harm. Unlike trespass, where the invasion itself was considered demonstrative of the defendant's ill will, nuisance cases required a determination of the reasonableness of the defendant's conduct.

The nuisance action was ineffective in controlling land use changes for four reasons. In land use cases, mid nineteenth century courts typically limited the damage remedy by stressing the need for objective measures of the damages to the plaintiff. Courts were hesitant to grant damages to plaintiffs in urban land use cases where the injury was to non economic and subjective values. (Indeed, with rising land values from urban encroachment, plaintiffs would often be *better off* financially as a result of nearby nuisances (King 1986, pp. 82–83).) Courts also limited the injunction remedy by allowing the damage remedy to act as a "purchase" of rights by the invading land use. In other words, the plaintiff, suing over encroaching manufacturing or apartment housing, would be paid damages and left to suffer the encroachment — or more likely, sell out. Another barrier to the nuisance remedy in land use cases was the courts referral to the "reasonable man" standard for determining whether a defendant's conduct was bad enough to warrant a remedy. Unfortunately for suburban dwellers,

their standards of quiet and serenity tended to be more strict than the reasonable man's were (King 1986, pp. 85–87). Finally, courts refused to enjoin threatened nuisance; i.e. nuisances which do not yet exist but may exist. Thus the construction of an apartment building would not be enjoined because it was not clear before the fact that the apartment building would prove to be a nuisance.

4.1.3 Building restrictions

The building restriction (also referred to as a restrictive covenant) was "the leading private device to control another person's land use" after the Civil War (King 1986, p. 1). Building restrictions took the form either of an easement on the plat or of a covenant in the deed or some other document. In Chicago, building restrictions were primarily established by subdividers. Most restrictions covered at least one city block. Restrictions typically established setback lines, prohibited apartments and businesses, set minimum house costs, and required early house construction (to prevent speculative holding of the restricted land) (King 1986, pp. 35–36). Restrictions were generally struck down by the courts which heard challenges to them. The Illinois Supreme Court, for instance, rejected restrictions which did not clearly manifest a contractual agreement (*Eckhart et al. v. Irons et al.*, 128 Ill. 568, 581 (1889)). In particular, courts rejected covenants which placed restrictions on broad categories like "nuisances" or which used inclusive language (language permitting certain uses and thereby excluding others) (King 1986, pp. 41). A practical limitation of the effectiveness of building restrictions was their limitation to the wealthy, who alone could afford the litigation necessary to enforce them (King 1986, p. 65).

4.1.4 Early zoning

Though Chicago had its own development history, the five forces of industry, multifamily dwellings, ethnic groups, expanded transportation, and city expansion were active in other cities as well (Burgess 1994, pp. 19, 29, 35–59). It was the change inherent in this early industrial situation, and the inadequacy of the two private law devices, which zoning arose to address (Steele 1986, p. 714).

According to Anderson,

> [t]houghtful persons concluded that the [blight and decay of urban areas] was intolerable and that it would grow even worse unless municipal governments mounted a broad assault on existing conditions, and moved to prevent further uncontrolled development ... (Anderson 1976, § 1.02).

Several public law tools were applied to the problem before the advent of zoning. Building codes in Chicago became more detailed and covered a broader range of buildings, particularly after the Chicago fire of 1871 (King 1986, pp. 161, 215). The doctrine of public nuisance[29] developed from a little-used side light of English common law to a significant facet of municipal police powers (King 1986, pp. 161–228).

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[29]A public nuisance is distinct from a private nuisance in that it affects the public interest in some way. Merely affecting a large number of private individuals is insufficient to constitute a public nuisance.

Of particular interest in a discussion of zoning is the development of the frontage consent ordinance, which emerged in the 1870s. Under frontage consent, the city delegated some of its authority to the property owners of a block. Construction in a frontage consent area required a city permit which would only be granted if a certain percentage of the block's residents approved of the project. Frontage consent originally emerged to regulate railways but spread to cover saloons and business activities and finally to homes. It's use against businesses and homes reflected the two things property owners sought to protect: property values (against business, industry and rail) and amenities (against apartment dwellers and other encroaching residents). Chicago employed a variety of frontage consent ordinances tailored to different property uses like saloons, railways, stables and carousels; but in 1914, the Illinois courts blocked the extension of the frontage consent method by limiting is use to activities which were recognized nuisances. Many activities of concern to urban residents were not legal nuisances. Apartment buildings are a prime example. In addition to its limitation by the courts, the frontage consent method was rejected as a tool by professional city planners like Edward Bassett because it depended on the "social solidarity" of residents of an area (see King 1986, pp. 312 and following). The planning profession[30] preferred comprehensive city-wide plans over "block-oriented" controls (King 1986, p. 350).

According to King, planners rejected private controls like restrictive covenants for similar reasons. Private controls were only available to the wealthy and they were locally tailored and lacked a city-wide plan (King 1986, p. 64). A zoning plan, by contrast, would act city-wide to simultaneously benefit the real estate market by stabilizing land values, and stabilize the social order by preventing the formation of slums and preserving a nucleus of the "leader classes" within the city (King 1986, pp. 350–352) (quoting Carol Aronovici, secretary of the Suburban Planning Association of Philadelphia, 1914).

In Chicago, the choice between comprehensive zoning and partial zoning of pieces of the city was debated at length but ultimately the comprehensive and planned approach was adopted. The comprehensive approach triumphed in Chicago and elsewhere partly due to the efforts of planning advocates like Herbert Swan, Robert Witten, and Harland Bartholomew. These experts spoke to civics groups, wrote newspaper articles, and advised city planners. Their theme was that comprehensive city planning was scientific and would therefore succeed in solving city problems (King 1986, pp. 383–385).[31]

Early zoning ordinances emerged in cities around 1910. They were modeled on concepts drawn from private and public nuisance and public law controls like frontage consent. In Illinois, it took six years of legislative wrangling to obtain the first Illinois

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[30]The planning profession in Chicago was bolstered in 1908 with the publication of the Commercial Club of Chicago's *Plan of Chicago*, written by Edward Bassett and Daniel Burnham (King 1986, p. 313). As a result, the mayor of Chicago and the city council formed a 328 member city planning commission.

[31]As Professor Schmid observed on reading this work, there is an amusing parallel between the scientific aspirations of early urban planners and the scientific aspirations of latter-day welfare economists. It appears that neither group has attained its goal.

zoning enabling act.[32] Eventually, zoning became common in large cities. It became so common that in 1926, the U.S. Department of Commerce drafted the Standard Zoning Enabling Act (SZEA). The SZEA was widely adopted and served as the model for nearly every state's zoning enabling statute (Fischel 1985, p. 29). Its main elements, together with those of the Standard Planning Act remain central to modern zoning.

The SZEA is a broad and vague grant of powers to local governments. The purposes cited by the SZEA for municipal zoning address the ills of the era's cities. Note that the SZEA advocates comprehensive planning, the opposite of block-oriented controls.

> Section 3. Purposes in View. — Such regulations shall be made in accordance with a comprehensive plan and designed to lessen congestion in the streets; to secure safety from fire, panic, and other dangers; to promote health and the general welfare; to provide adequate light and air; to prevent the overcrowding of land; to avoid undue concentration of population; to facilitate the adequate provision of transportation, water, sewerage, schools, parks, and other public requirements. Such regulations shall be made with reasonable consideration, among other things, to the character of the district and its peculiar suitability for particular uses, and with a view to conserving the value of buildings and encouraging the most appropriate use of land throughout such municipality. (Standard Zoning Enabling Act, reprinted from Mandelker 1993, § 4.17)

In addition to its rather broad purposes, the SZEA provides authority for districting a community and for the regulation of construction, alteration and repair of buildings within the districts (Mandelker 1993, § 4.18). Third, the SZEA authorizes the local legislative body to adopt and amend zoning regulations and requires public notice and hearings for zoning ordinance adoptions and amendments. (Mandelker 1993, § 4.19). A central feature of the SZEA was "adjustment." The Board of Adjustment, created under the act, is empowered to hear appeals from interpretations of the zoning ordinance, grant special exceptions to the ordinance, and grant variances from the ordinance. Though the terms are confused in practice, a special exception connotes a use that is authorized by the zoning ordinance but requires confirmatory approval before being undertaken. A variance is granted for a use which violates the ordinance but which is necessary to avoid "unnecessary hardship" to the restricted party (Mandelker 1993, § 4.20).

Because the SZEA preceded the Standard Planning Act (also developed by the U.S. Department of Commerce), the SZEA includes a provision for a zoning commission which has authority to recommend zoning districts and regulations (Mandelker 1993, § 4.16). The Standard Planning Act removed the need for a zoning commission by providing for a planning commission. "The planning commission

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[32]Cities are political subdivisions of their states and consequently derive their powers from the states. Cities exist by virtue of enabling legislation which specifies the powers cities may exercise. Zoning was not originally one of the powers granted and had to be added by zoning enabling legislation.

[now] carries out the functions of the zoning commission in almost all communities" (Mandelker 1993, § 4.16).

4.1.5 *Euclid v. Ambler Realty Co.*

The case which is often cited as having "allowed" municipal zoning is *Euclid v. Ambler Realty Co.*, 272 U.S. 365 (1926), though zoning was widespread before *Euclid* was decided. In that case, the village of Euclid, a suburb of Cleveland, enacted a comprehensive and detailed zoning ordinance. It divided the village into six classes of use districts, three classes of height districts and four classes of area districts.[33] The ordinance gave enforcement power to the building inspector, allowed appeals to the zoning board, and gave the board rulemaking authority. In short, it was a modern zoning ordinance. The ordinance was struck down by the U.S. District Court and the village appealed to the U.S. Supreme Court.

The Court was not the first to hear a zoning case. Indeed, the Court emphasized the litany of pro-zoning cases that had been decided by state courts.

> The decisions of the state courts are numerous and conflicting; but those which broadly sustain the [zoning] power greatly outnumber those which deny it all together or simply narrowly limit it; and it is very apparent that there is a constantly increasing tendency in the direction of the broader view.

The specific issue before the Court was whether the village's zoning ordinance violated the due process clause of the first section of the 14th Amendment to the U.S. Constitution and similar provisions of the Ohio Constitution. However, the Court did not address the constitutional issue. Instead, it focused on whether the ordinance was a valid exercise of the police power (*Euclid*, 272 U.S. 365, 387 (1926)).[34] In focusing on the police power, the Court merely had to verify that the zoning restrictions bore a "rational relation to the health and safety of the community" (*Euclid v. Ambler Realty Co.*, 272 U.S. 365, 391). The Court found that they did and so upheld the ordinance.

In support of its decision, the Court argued that the advent of zoning ordinances was a result of the increasing complexity of modern life and that constitutional provisions can stretch in their application (*Euclid*, 272 U.S. 365, 387 (1926)). The Court also compared the zoning ordinance to nuisance law in that both nuisance law and the ordinance sought to resolve land use disputes among neighbors (*Euclid*, 365,

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[33]The use districts segregated residential, commercial and industrial uses in great detail, including restrictions on the number of horses in wagon sheds. The height districts restricted building heights. The area districts restricted lot sizes for residential locations.

[34]The "police power" is a general label for the regulatory power that is inherent in every sovereignty. It does not derive from state constitutions and indeed is not mentioned in most of them (16A Am. Jur. 2d Constitutional Law § 361). It is distinct from eminent domain and the power to tax (§§ 365, 366). The police power is commonly described as the power to legislate for the protection of the public health, safety, morals, and welfare (§ 363). The village of Euclid exercised the police power as a political subdivision of the state of Ohio.

387–388). This has led some to argue that *Euclid* is an *application* of nuisance law (Hirsch 1988). But in its own words, the Court referred to nuisance law, "not for the purpose of controlling, but for the helpful aid of its analogies in the process of ascertaining the scope of, the [police] power." (*Euclid*, 365, 387–388). The Court noted that the police power, like the law of nuisance, is situation-dependent. What is undesirable varies with time and place. Thus congestion and other growth-related disturbances were properly subject to village control in the modern, crowded, era (*Euclid*, 365, 391).[35]

The Court's choice of nuisance law as support for zoning must be credited to the counsel for the village of Euclid (King 1986, p. 417). In preparing their brief, they realized that zoning was a new form of property regulation and needed grounding in some established legal idea like nuisance law. This choice of analogy has affected the evolution of zoning doctrine. For one thing, the nuisance analogy limited the uses of zoning to situations that were like nuisances; i.e. which featured some unpleasant activity. Planning for planning's sake has not been fully available under zoning. On the other side of the coin, the nuisance analogy also severed zoning from planning since planning was not required for the correction of nuisances. It should be noted that zoning was not equivalent to nuisance law since the latter was subject to case-by-case determination. Zoning sought to decide what activities constituted nuisances legislatively and uniformly rather than in the courts.

4.1.6 Modern Zoning

In 1975 the American Law Institute published *A Model Land Development Code* which has not been as popular as the SZEA of 1926 (Fischel 1985, p. 29). Several states have revised their zoning legislation but the changes "do not change the basic structure" of the SZEA (Mandelker 1993, § 4.22). Though the structure of modern zoning legislation is similar to what existed in the 1920s and 1930s, the practice is somewhat different. The role of planning is diminished in the modern practice, the role of citizen participation and negotiation is enhanced, and the uses of zoning have expanded to include goals like historic preservation.

Notice that section 3 of the SZEA states that zoning regulations "shall be made in accordance with a comprehensive plan." The vision of early planners was that the comprehensive plan would be a document setting forth the design of the city with specificity and, in particular, *before* zoning regulations were enacted. In practice, the comprehensive plan generally follows zoning ordinances and may not be drafted at all (Fischel 1985, p. 31). This trend began early because of passage of the SZEA *before* the Standard Planning Act (Mandelker 1993, § 4.16). In addition, planning was viewed as a technical enterprise done by trained city planners who were to have been above local politics. On the contrary, zoning is now very political (Fischel

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[35]The Court noted that both nuisance law and the police power refer to the maxim *sic utere tuo ut alienum non laedas* (so use your own that you do not injure that of another). (*Euclid*, 365, 387; *See also* 16A Am. Jur. 2d Constitutional Law § 368). A central element of police power regulations and nuisance law is the protection of persons from the *legitimate* actions of others; hence the balancing between the use of one's own and injury to others.

1985, 33). "According to zoning and planning theory, land development was to be guided by comprehensive public land-use plans. In practice ... formal comprehensive plans have had almost no influence. Instead, development has been determined by the interaction of private developer pressures and the exercise of neighborhood and community zoning rights" (Nelson 1977, p. 84).

The role of private developers and citizens in zoning decisions is strong. The SZEA requires public notice and hearings before the adoption of, or amendments to, zoning ordinances. Neighbors in particular are given strong voice in zoning issues. For instance, the SZEA has a "20 percent protest" clause. This provides that a petition by 20 percent of the neighbors of a tract for which rezoning has been proposed forces a three-quarters vote by the local legislature for passage (Fischel 1985, p. 34). Typically, there are several procedural stages at which affected parties may review development proposals or zoning changes. These stages include the planning commission, the Zoning Board of Adjustment, and the local legislative body like the city council.

Both variance and special permit proceedings have an *ad hoc* character. In some instances, Zoning Boards of Adjustment grant variances for seemingly any cause (Fischel 1985, 35).

The purposes of modern zoning are generally extremely broad. Including control of externalities, modern zoning can have four broad purposes:

1. *Segregation of types of land use.* Zoning which segregates land uses (as industry and residences) addresses the problem of externalities. Land use segregation is one aspect of zoning's history and the element most commonly modeled by economists.

2. *Exclusion of groups of persons.* Zoning excludes certain groups of people addresses the problem of suburban amenities. Exclusion is the second aspect of zoning's history and less frequently modeled.

3. *Limitation of development.* Though zoning originally focused on land use segregation and exclusion, it has more recently been applied to halt or slow the growth of cities entirely.

4. *Preservation of structures or land.* Zoning has also been applied to preserve structures or land. Historic preservation commissions and historic districts are two devices for preservation (which may or may not be explicitly linked to the zoning power). Historic buildings, agricultural land, wetlands, and floodplains are often subject to preservation efforts.

Modern zoning plans typically include statements on environmental quality, historic preservation, the provision of low cost housing, reduction of congestion, reduction of sprawl, and many others (Fischel 1985, p. 32). Several of these provisions are inconsistent. Where early zoning's "purpose" was mere preservation of the suburbs, modern zoning seeks to solve a broad range of social ills.

4.2 Zoning's Evolution

The elements of an evolutionary model can be identified in the history of zoning. First, there are multiple independent agents with heterogeneous preferences and abilities who are boundedly rational. Some of the ways these agents differed from one another included their choices for spacious versus low cost housing, their incomes, their employment, their racial views, and their circles of communication (with whom do they regularly interact?)

Second, there is an environment that influences the well-being of the agents and their abilities to communicate with one another. The environment associated with the development of zoning was complicated but included some prominent forces. These included the development of progressively faster transportation, the natural physical tradeoff between housing density and visual amenities, the benefits to commerce from clustering, and the physical effects of commerce and living upon neighbors (noise, crowding, etc.)

Third, agents affect one another through communication. This communication was central to the spread of ideas about zoning (what forms should be tried?) and to the maintenance of the social structures that supported land use institutions.

Fourth, the history showed significant path-dependencies. The courts influenced the development of zoning by restricting some institutions because of legal precedent. For instance, the use of restrictive covenants and frontage consent were all restricted. In addition, the *presence* of zoning proposals and zoning advocates fostered the development of zoning. Had other land use options been supported, and land use advocates put their support behind them, the pressure for zoning would have been lessened.

Fifth, the land use options and attitudes of people changed in response to the successes and failures of the past. Many land use options were available and attempted. Some of these failed, others remained.

4.3 Toward an Evolutionary Model

It is simple to identify the elements of the evolutionary view within the history of zoning. The more difficult question is whether these elements are adequate to explain the development of zoning. Can an evolutionary model recreate the pattern of zoning's development? By the nature of evolutionary modeling, one does not expect to recreate the particular development of zoning law within a jurisdiction. Instead, one identifies potential significant forces to include in the model and looks for general behavior similar to zoning. Does the model pass through stages similar to the private law, frontage consent, and zoning stages? Do agents within the model use similar criteria for zoning (lot size, set backs etc.)? How important are random events such as the actions of a single advocate? How does the political process (e.g. voting) affect the development of zoning law? It is beyond the scope of this paper to program a full model of the evolution of zoning. Instead, I will close the paper by sketching the structure of such a model. Following the list of elements of an evolutionary model given in section 3.2.2, a model of zoning should include the following elements.

First, the model should be set in Euclidian space. In other words, agents in the

model should be located at specific locations, there should be costs to movement between locations, and interactions between agents should depend to some extent on their relative locations. This obviously parallels the situation involved in land use.

Second, the model must include a large number of independently acting agents. At the very least, the agents must make separate decisions (i.e. not be represented as a collective body by a single equation). In addition, it is desirable to include variable parameters to describe the agents. For instance, parameters relating to wealth, tolerance for crowding, and occupation can be included (manufacturing and housing supply would be particularly important). It may also be desirable to differentiate agents by roles with some having more power over social or investment decisions. Such differentiation could reflect the facts that government is in fact a subset of the population and that land use proposals originate from and are proposed by a small number of agents (e.g. the professional land use planners).

Third, agents must affect one another. In particular, local population density and external effects of manufacturing can be included. The population density can simply be a count of the number of agents in a given location and would be adequate to model pure exclusionary zoning. Modeling of manufacturing would also require the specification of a manufacturing operations.

Fourth, agents' decisions must be represented by heuristic decision processes and not be overly complex perfect information rules. For instance, agents could be restricted to consider only their immediate neighborhood. In particular, agents would not be given any information about the decision processes of other agents.

Fifth, agents must be assigned costs and benefits related to their situations. For instance, agents can be given an income (probably variable across agents), suffer a cost of moving to a new location, and suffer disutility from crowding.

An important issue is the way in which zoning rules are formed and enforced. In evolutionary models with the elements listed in section 3.2.2, it is possible to generate a division of labor within the population (with agents residing in different areas and pursuing different occupations). But the development of rules that bind the population requires additional structure. This structure need not be imposed at a high level (an exogenous court system for instance). It requires three elements: the ability for agents to communicate (already present in the general structure), the ability of agents to make executory contracts, and the ability of agents to punish other agents in some way (either for violation of a contract or for other reasons). With this approach, larger scale rules, such as zoning, emerge from the gathering of certain individuals (via contract) who then punish certain actions. This approach follows the bottom-up spirit of evolutionary modeling.

5   Conclusion

As indicated in section 2 much of welfare economics views the difficulty of aggregating individual preferences as merely an annoying limitation on an otherwise solid edifice. In this view, the concept of social welfare is retained and employed even though a particular form of social welfare function can only be chosen arbitrarily by the

researcher. This view leads welfare economists to employ models that are incapable of addressing the individual preferences of agents with the model. The evolutionary view of economics and law argues on the contrary that the behavior of individual agents is central to the development of economies and laws. The interaction of these separate agents forms and changes the higher level phenomena such as law. Even a result that is efficient in some sense, may remain unpopular and therefore unstable in the evolutionary sense. Because the losers in a politico-economic system will seek to change that system (as has occurred in zoning) any welfare policy suggestions may be thwarted by those losers. This is not to say that the concepts of welfare economics are useless or incorrect. Rather, that an *incomplete* analysis which ignores the change-prone nature of the system is weak.

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