# THE HIGH COST OF FREE HIGHWAYS

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## I. INTRODUCTION

It is widely, but not universally held that more roads mean more traffic.[1] In spite of this evidence we are continually seduced by the notion that we can zone for low density to preclude traffic from occurring, that we can move far enough away from traffic to avoid it, and/or that we can build our way out of traffic. This low density race to the

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1. Martin J. H. Mogridge, *The Self-Defeating Nature of Urban Road Capacity Policy: A Review of Theories, Disputes and Available Evidence*, 4 TRANSP. POL'Y 5, 5 (1997); ANTHONY DOWNS, STILL STUCK IN TRAFFIC: COPING WITH PEAK-HOUR TRAFFIC CONGESTION 52 (rev. ed. 2004); Susan Handy, *The Road Less Driven*, 72 J. AM. PLAN. ASS'N 274–75 (2006).

edge results in the ill-defined but expensive condition of sprawl.[2] In a counter vein, New Urbanists,[3] advocates of Transit Oriented Development (TOD),[4] and smart growth advocates[5] have embraced the notion that traffic has always been with us and it is here to stay,[6] but we can make the most of our activity spaces by concentrating development, arresting the creation of new roads, and investing wisely in high capacity transportation systems.

This sprawl versus anti-sprawl debate is represented at the extremes by two factions. The first group believes that the automobile and the auto-highway system are great equalizers and democratizers; they further maintain that the current land use and transportation system is the product of market forces and consumer preferences that should be respected. The second group maintains that we must find ways to break the auto dependence that is endemic to United States lifestyles, largely by planning for more transit and compact development. They maintain that our current land use and transportation system is not at all a product of market forces, rather a result of deliberate decisions based on particular normative beliefs.

Through an examination of how people and businesses make location decisions and how the transportation system mediates in those decisions, this paper attempts to dissect the two extremes of this de-

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2. William Fulton et al., *Who Sprawls Most? How Growth Patterns Differ Across the U.S.*, *in* SURVEY SERIES 3 (The Brookings Inst. Ctr. on Urb. & Metro. Pol'y, July 2001), *available at* http://www.brookings.edu/es/urban/publications/fulton.pdf; *see generally* ROBERT W. BURCHELL ET AL., SPRAWL COSTS: ECONOMIC IMPACTS OF UNCHECKED DEVELOPMENT (2005); ROBERT BURCHELL ET AL., THE COST OF SPRAWL-REVISITED (1998), *available at* http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_39-a.pdf.

3. *See* ANDRES DUANY ET AL., SUBURBAN NATION: THE RISE OF SPRAWL AND THE DECLINE OF THE AMERICAN DREAM (2000); PETER KATZ ET AL., THE NEW URBANISM: TOWARD AN ARCHITECTURE OF COMMUNITY (1994); PETER CALTHORPE, THE NEXT AMERICAN METROPOLIS: ECOLOGY, COMMUNITY, AND THE AMERICAN DREAM (1993).

4. *See* MICHAEL BERNICK & ROBERT CERVERO, TRANSIT VILLAGES IN THE 21ST CENTURY 103–33 (1997); DENA BELZER & GERALD AUTLER, TRANSIT ORIENTED DEVELOPMENT: MOVING FROM RHETORIC TO REALITY (2002), *available at* http://www.brook.edu/es/urban/publications/belzertod.pdf; HANK DITTMAR & GLORIA OHLAND, THE NEW TRANSIT TOWN: BEST PRACTICES IN TRANSIT-ORIENTED DEVELOPMENT (2004).

5. *See* Reid Ewing et al., *Measuring Sprawl and its Transportation Impacts,* 1831 TRANSP. RES. REC. 175 (2003); Robert Cervero, *Growing Smart by Linking Transportation and Urban Development*, 19 VA. ENVTL. L.J. 357 (2000).

6. Indeed, the first national conference on city planning and the problems of congestion was held in 1909. Michael Southworth & Eran Ben-Joseph, *Street Standards and the Shaping of Suburbia,* AM. PLAN. ASS'N J., Winter 1995, at 65, 71. As early as 1924 Sidney Waldon, an executive with Packard Motor Car Company, said in correspondence "We have seen [the automobile's] great efficiency for individual rapid transit defeated by the very number of persons trying to take advantage of this new medium of transportation." MARK FOSTER, FROM STREETCAR TO SUPERHIGHWAY: AMERICAN CITY PLANNERS AND URBAN TRANSPORTATION, 1900-1940, 60 (1981).

bate. The clear conclusion is that, in fact, neither land use-transportation arrangement is a natural outcome of market forces, but either could be an outcome of particular policy decisions. The paper concludes with an examination of three road pricing strategies and their possible effects on land use and other transportation mode options: free roads, pricing for congestion, and distributed cost or "un-congestion" pricing. By understanding the power of transportation policy decisions in shaping regions people in communities can plan and influence the character of cities, suburbs, and regions where they live.

## II. LAND USE AND TRANSPORTATION–SIAMESE TWINS

### A. The Value of Land and Transportation

Transportation has very little intrinsic value; indeed, it is primarily characterized as an economic good with a derived demand in that we seldom value a trip for its own sake, but instead we endure it in order to arrive at the place we want to be. Hence the demand for travel is derived from the demand to visit, shop, work, and so forth. Certainly there are situations where the trip itself is pleasurable, but by and large we travel to partake in activities that occur at a point other than where we are. Intuitively, to overcome distance, whether it is the movement of people or goods, simply for the sake of moving is meaningless. But our cities, suburbs, and rural hinterlands exist in space—space that must be overcome to get from location to location.

To overcome distance in order to engage in activities—whether essential or discretionary—*does* have value. This value adds to our survival and to our social, cultural, and economic enrichment. It is not the fact of our *mobility* that adds to our survival and betterment, rather it is the *accessibility* to activities that our transportation systems have provided that adds to our betterment. Mobility and accessibility are both measures of transportation well-being. Mobility, in some senses easier to grasp, has been the traditional performance measure of transportation. Measures of mobility are agent focused and tend toward questions of quantities of distance that can be covered per unit of time. For example, how many miles per hour can a vehicle go, and how much delay would that vehicle experience on a network? Thus, mobility measures the ability of a person to move or be moved across a transportation system. Accessibility, on the other hand, measures the number of activities that a person can reach within a certain amount of time. Accessibility is location focused. There are several measures of accessibility that sum the number of activities that can be reached from a set of locations. Increased mobility can lead to increased accessibility, but to the extent that mobility is achieved by increasing auto infrastructure at the expense of other land uses, it may also detract from accessibility.[7]

To be able to access a variety of land uses and activities, people make decisions about where to locate. A central location, for example, typically gives a household access to other residences (and their occupants), a variety of job opportunities, recreational opportunities, and more choice/variety in shopping. For these accessibility advantages the centrally located household may give up space, privacy, and access to nature. A suburban location typically gives a household greater opportunities for more affordable housing, larger living space for the same cost of housing, and private outdoor space, but potentially fewer opportunities to interact with others. Thus, we trade greater variety in shared amenities but less private space in dense locations for greater private space but less variety in other amenities in less dense locations and vice versa.

Regardless of the intrinsic value of travel, our investments in transportation, combined with land use regulation and real estate market responses, can be very powerful shapers of regions. It is in this way that transportation provision becomes a very key element in understanding sprawl and, not land use per se, but real estate or development response to the regulatory/government provided context of land use and transportation.

At the beginning of this section I attempted to convince the reader that transportation has little or no value in and of itself. I will now attempt to persuade the reader that land also has little or no value in and of itself but that land and transportation are co-dependent complements.

Since there have been organized economies, transportation infrastructure has been a relatively key determinant of location. The agrarian economy relied on shipping routes, typically waterways, to distribute products. Later, with the industrial revolution, manufacturers also relied on waterways, both for power as well as shipping. Local transportation was typically on foot, horseback, or by horse-drawn carriage. As new innovations in transportation were made settlements grew into cities following patterns dictated by the transportation technology. Walking cities tended to spread uniformly around the industrial hub, unless there were geographic barriers.

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7. For an excellent treatment on the mobility and accessibility measures of transportation well-being, see SUSAN HANDY, ACCESSIBILITY- VS. MOBILITY-ENHANCING STRATEGIES FOR ADDRESSING AUTOMOBILE DEPENDENCE IN THE U.S. (2002), *available at* http://www.des.ucdavis.edu/faculty/handy/ECMT_report.pdf.

Muller suggests four distinct periods of intra metropolitan growth and transport development.[8] His periods cover the Walking-Horse Car Era (1800–1890),[9] the Electric Streetcar Era (1890–1920),[10] the Recreational Automobile Era (1920–1945),[11] and the Freeway Era (1945–present).[12] A fifth period, the Post-Freeway Era, is added to Muller's typology. These periods are illustrated in Figure 1.

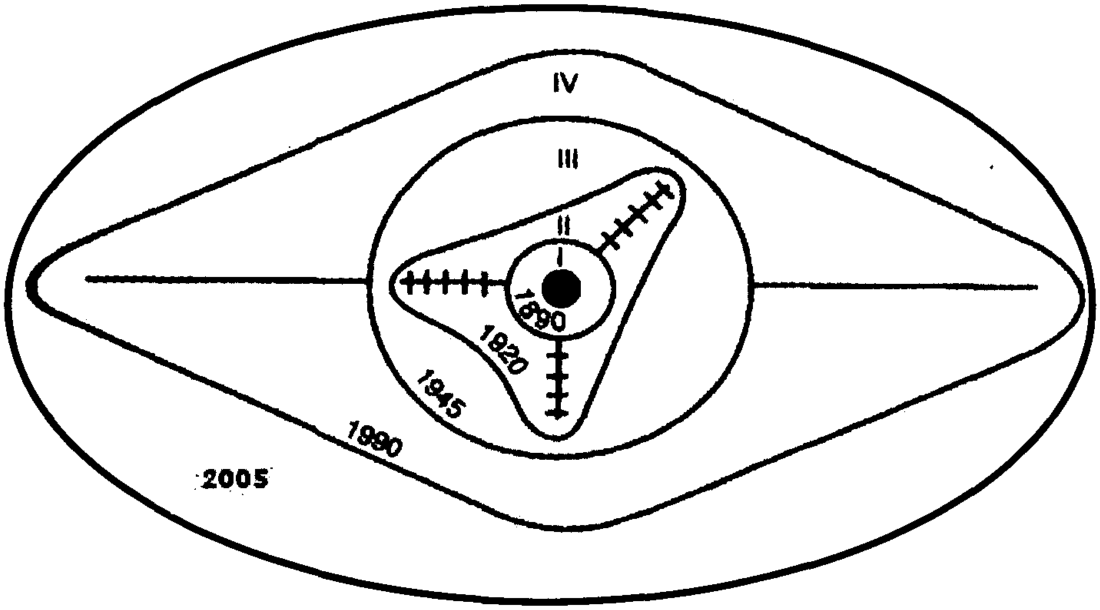


**Figure 1: Stages of Urban Development**[13]

The Walking-Horse Car Era is reflected in a relatively small and uniformly developed area around a central hub. In the Electric Street-Car Era, the city begins to expand along corridors. Next, in the Recreational Automobile Era low density development begins to spread between the corridors defined by the electric street-car lines. In the Freeway Era, land development begins to follow freeway corridors just as it had earlier followed street-car corridors.[14] In the Post-Freeway Era, development begins to fill in between the freeway links.

Each of these periods is characterized by an advance in technology and supporting national policy regarding transportation and/or housing. During the industrial revolution, cities gained a reputation

8. Peter O. Muller, *Transportation and Urban Form: Stages in the Spatial Evolution of the American Metropolis, in* THE GEOGRAPHY OF URBAN TRANSPORTATION 29 (Susan Hanson ed., 2d ed. 1995).

9. *Id.* at 31–33.

10. *Id.* at 33–36.

11. *Id.* at 36–42.

12. *Id.* at 42–47.

13. Adapted from Muller's illustration. *Id.* at 29.

14. *See id.* at 29–30.

for being unhealthful, and it was the goal of those who could to get a home in one of the streetcar suburbs.[15] Developers of suburbs like Shaker Heights, Ohio, Pasadena, California, and several enclaves in Westchester County, New York made fortunes by subdividing formerly valueless land that was now profitable because it was being served by streetcars.[16] Indeed, some of the developers ran the streetcar companies, understanding that the transportation was a required element of their land development strategy.[17] Eventually, the streetcars began to lose their cache, and the private car began to dominate the landscape.[18] Road building projects were the order of the day. From the end of WWI until the end of WWII, vehicle registrations climbed from around 5 million to 30 million.[19] However, the big boost came at the end of WWII with the United States Government facilitating growth of the automobile suburbs.[20] Between road construction projects, obligating lenders to invest in new home construction, insuring individual mortgages, and providing low interest loans to Federal Housing Administration and Veterans Administration clients, the path to our current land configuration was set firmly on its course.[21]

As urban areas began to expand with new transportation technology, so too have long distance transportation innovations changed the portfolio of developable parcels. When railroads began to crisscross the country, additional tracts of developable land were brought into the accessible land portfolio. Then highway corridors did the same. Business opportunities were made more abundant; business and population stretched out along these corridors following first the rail routes then the highway corridors. These innovations permitted access to vast new tracts of land that could not otherwise have been exploited for economic gain. New technologies in both road construction and modes of personal mobility have continued to give access to greater and greater tracts of land allowing additional businesses to find ways to operate profitably, increasing choice in location for these businesses, and allowing householders increasing choice in their location decisions.

Formalizing these observations into a coherent theory of transportation and land use interaction is the subject of the next section.

15. *Id.* at 27.
16. FOSTER, *supra* note 6.
17. *Id.*
18. Muller, *supra* note 8, at 37.
19. *Id.* at 38 fig.2.9.
20. *Id.* at 27.
21. *Id.* at 39.

## III. LAND MARKET THEORIES

Economic theory asserts that the value of an asset is equal to the net present value of the benefits and costs associated with owning it.[22] To fit land value to this model, real property must be viewed as a bundle of services, obligations, and rights. The value of land is a function of characteristics that include improvements on the land, potential improvements (what is feasible from an engineering perspective or allowed in zoning, for example), location (which serves as a proxy for accessibility to the land and accessibility to other complementary land uses), and other endowments. David Ricardo, the nineteenth century economist, is credited with the first formal treatment of a land rent model.[23] His articulation of "rent," a reflection of value, follows:

> If all land had the same properties, if it were unlimited in quantity, and uniform in quality, no charge could be made for its use, unless where it possessed peculiar advantages of situation. It is only, then, because land is not unlimited in quantity and uniform in quality, and because, in the progress of population, land of an inferior quality, or less advantageously situated, is called into cultivation, that rent is ever paid for the use of it.[24]

Ricardo makes his case based on the notion that certain parcels of land are naturally more fertile and therefore "worth" more for cultivation.[25] The theory is that a farmer will pay a higher rent for more productive land but only up to the value of the higher potential yield.[26] Ricardo goes on to discuss how improvements may be made to equalize the value such that two parcels, not originally equally endowed, can be made competitive with one another.[27] A shortcoming of Ricardo's model is that it takes no account of the cost in moving the crop to market. Thus, a very fertile piece of land in the far off hinterlands may have no real value. If the cost of bringing the product to market cancels its additional value relative to an inferior parcel that is better located geographically, there will be no demand for the more fertile plot.

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22. DENISE DIPASQUALE & WILLIAM WHEATON, URBAN ECONOMICS AND REAL ESTATE MARKETS 9 (1996).
23. DAVID RICARDO, PRINCIPLES OF POLITICAL ECONOMY AND TAXATION (1911).
24. *Id.* at 35.
25. *Id.* at 35–37.
26. *Id.*
27. *Id.* at 41–45.

Not much later, Thünen improved on Ricardo's model by explicitly including distance to market as a variable in land rent.[28] Thünen theorized that competitors for land would bid for proximity, driving land prices to an equilibrium level, which also implied a natural market sorting by commodity.[29] Producers of the most perishable commodities or the heaviest and therefore most costly to transport would bid most aggressively for the locations nearest to the "center."[30] Producers of each commodity would have a bid-rent curve for their product.[31] Each bid-rent curve would naturally decline with distance from the center, and each would have its own rate of decline.[32] The value of land from the center to the fringe would then follow the envelope of these curves, and the land area devoted to each use would be as illustrated in Figure 2.[33] In this example, Commodity A has a steeper bid-rent curve than Commodity B and therefore "wins" the land closest to the Central Market. Commodity A's area of production is more limited because it must be closer to the center than Commodity B.

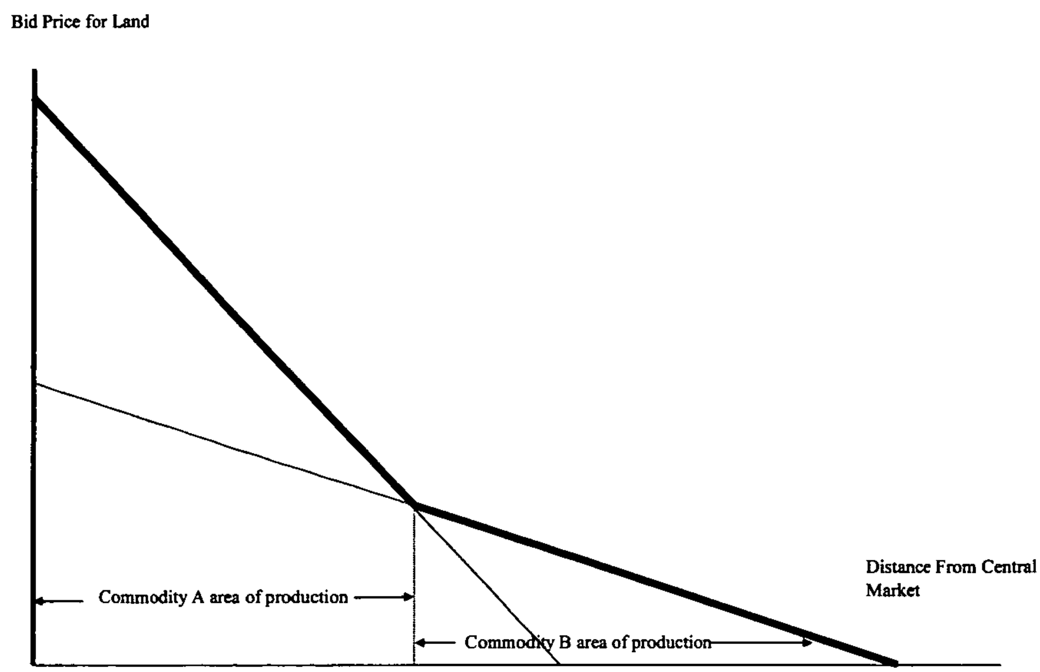


**Figure 2: Thünen's Bid-Rent Curve**

28. JOHANN HEINRICH VON THÜNEN, THE ISOLATED STATE (Peter Hall ed., Carla M. Wartenberg trans., Pergamon Press 1966) (1826).
29. *Id.*
30. *See id.*
31. *Id.*
32. *Id.*
33. A graphical depiction of Thünen's Bid-Rent Curve.

### A. Residential Location

In the Thünen model, residential location is relegated to the residual land beyond the edge of production.[34] The thread was picked up by Wingo and Alonso.[35] Keying off the hypothesis that other things being equal a household would trade housing costs for transportation in some proportion and by adapting the Thünen model from agricultural sorting to residential choice, the two came up with a virtually identical theory of residential location for a mono-centric city.[36] According to their work, people trade off accessibility to the central employment area and central business district (CBD) for housing amenities at some distance from the CBD.[37] As in Thünen's model, the bid-rent curve displays a distance-decay relationship between land, rent, and distance from the CBD.[38] This is illustrated in Figure 3.[39] The slope and intercept of the curve depend on the cost of transportation and the household's demand for space and neighborhood amenities. The exact relationship between land cost and transportation is variable and context dependent as factor substitution comes into play. However, steeper curves are characteristic of higher transportation costs and of greater demand for accessibility. Improvements to the model were made by Muth and Mills in which basic employment is fixed in space but local or non-basic employment is permitted to co-locate with the population.[40] In the Thünen class of models it is predicted that land value decreases from a hypothetical center, dictating the general shape of mono-nucleated cities and the shapes of nuclei in multi-nucleated ones.

Essentially, as with other consumer choices, residential-location outcomes reflect the household or householder's preference for a bundle of characteristics that define housing. These characteristics include differing levels of shelter, size of shelter, land, privacy, location (or proximity to work, schools, shopping, neighbors, other family, or other local destinations), and many other things. Households will bid for housing and housing locations that best satisfy their particular

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34. *See generally* THÜNEN, *supra* note 28.

35. LOWDON WINGO, JR, TRANSPORTATION AND URBAN LAND (1961); WILLIAM ALONSO, LOCATION AND LAND USE: TOWARD A GENERAL THEORY OF LAND RENT (1964).

36. KAZEM ORYANI & BRITTON HARRIS, ENHANCEMENT OF DVRPC'S TRAVEL SIMULATION MODELS TASK 12: REVIEW OF LAND USE MODELS AND RECOMMENDED MODEL FOR DVRPC (Sep. 1996), http://ntl.bts.gov/lib/7000/7500/7505/789761.pdf.

37. WINGO, *supra* note 35, at 92; ALONSO, *supra* note 35, at 18–35.

38. *See generally,* WINGO, *supra* note 35; ALONSO, *supra* note 35.

39. Fig. 3. Residential uses enter the model.

40. EDWIN S. MILLS, STUDIES IN THE STRUCTURE OF THE URBAN ECONOMY (1972); RICHARD F. MUTH, CITIES AND HOUSING: THE SPATIAL PATTERN OF URBAN RESIDENTIAL LAND USE (1969).

needs and desires. Subject to budget constraints, householders will pay higher prices for housing that best embodies the characteristics that they desire. The amount of their housing budget will depend on their income and other expenditures. If it is indeed the case that the housing and transportation costs are traded at some marginal rate, then it is unclear in the face of changing transportation costs whether households will accommodate their position by changing their distance from the center or by changing the quantity of "housing" they consume.

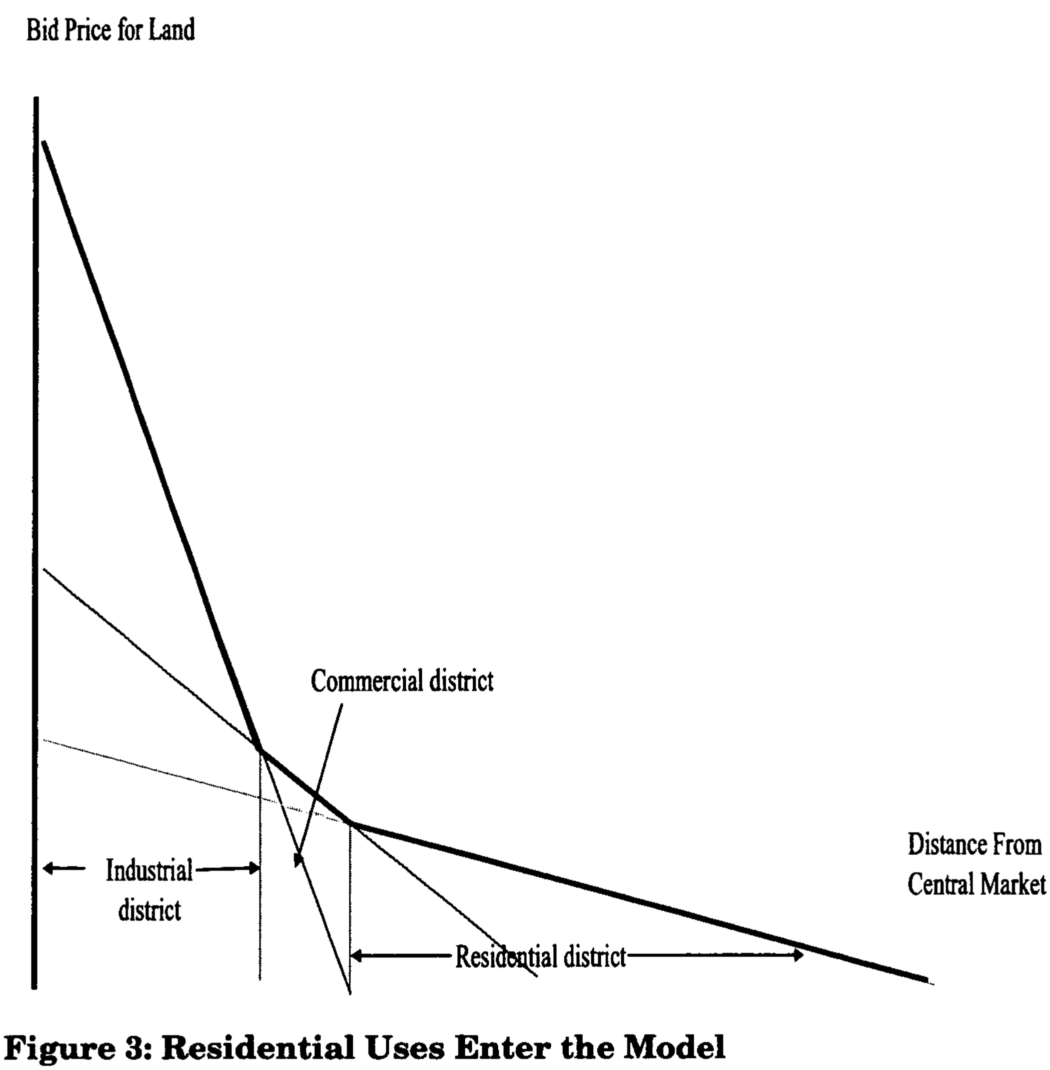


**Figure 3: Residential Uses Enter the Model**

### B. Business Location

On the question of business location, Weber articulated a comprehensive view of business location based on the business' need to minimize transportation and labor costs.[41] To do this, the business had to consider three things: the weight ratio of intermediate materials to the final product; whether it was cheaper to produce nearer the market or nearer the source of raw materials, the 'labor distortion,' at what point it was more economical to locate in a cheaper labor market but incur greater transportation expense; and finally, what might be the benefits of agglomeration.[42] Isard and Moses contributed the idea of input substitution to production functions.[43] As noted above, a business will substitute land, labor, capital, and material inputs to maximize profit; thus production inputs and outputs serve as determinants of business location.[44]

Subsequent models, based on Weber's line of reasoning, study the dynamic interactions of agents in an urban environment as explanatory variables in urban form.[45] Centripetal forces, derived from economies of scale, scope, and agglomeration, serve to concentrate spatial activities.[46] Linkages among agents serve to hold the agents and their respective activities in place.[47] A self-reinforcing cycle develops in which activities concentrate where the market is large, and the market is large because activities concentrate there.[48] These centripetal forces are countered by centrifugal forces that work to disperse the city.[49] When competition for land is too steep, some firms will be driven to seek other locations—frequently outside the main CBD. Diseconomies and negative externalities, such as congestion or the inability to find an appropriate site, are centrifugal forces and explicitly result in multi-nucleated cities.[50]

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41. *See* ALFRED WEBER, THEORY OF THE LOCATION OF INDUSTRIES (C.J. Friedrich ed. & trans., The Univ. of Chi. Press 1929) (1909).

42. *See id.* at 20–21.

43. *See* WALTER ISARD, LOCATION AND SPACE-ECONOMY: A GENERAL THEORY RELATING TO INDUSTRIAL LOCATION, MARKET AREAS, LAND USE, TRADE, AND URBAN STRUCTURE 19, 49, 172 (1956); Leon N. Moses, *Location and the Theory of Production*, 72 Q.J. ECON. 259 (1958).

44. *See* ISARD, *supra* note 43, at 49, 172.

45. *Id.* at 172–76.

46. *Id.* at 78 n.5.

47. *See id.* at 2.

48. *See id.* at 6.

49. See *id.* at 1–15.

50. *Id.*

### C. Some Shortcomings

The primary shortcoming of these models is that cities are much messier than any model can replicate. Assumptions include the characteristic that cities form on featureless plains, that there are no transaction costs, and that humans are continuously adapting their decisions to an underlying economic rationale. The most troubling notion is the theoretical expectation that, with the market clearing mechanisms, land uses will naturally sort themselves in concentric rings around a hypothetical center.[51] Modern market sorting, which has recently come under attack from many quarters, has been the product of zoning regulation much more than it has been a function of free market economics.[52] Indeed, many cities are focusing on increasing mixed uses and encouraging mixed use development as new understandings in urban planning favor. In spite of these shortcomings, the theoretical models are very accurate in their insights and provide clear direction with respect to what would likely happen under differing policy approaches. The next section discusses some of the issues that must be considered in tandem with the insights we gain from these models.

## IV. LOCATION DECISIONS IN REAL LIFE (HOW DO HOUSEHOLDS AND FIRMS MAKE LOCATION DECISIONS?)

### A. Households

When we understand the role of public policy, that is, provisions of sewerage, transportation infrastructure, access to economic opportunities, taxation, and so forth, we still only understand a small part of the question: "How do households make location decisions?" To parse the question further, we have to understand more about the actors. What motivates location choices depends on a variety of issues related to the households in question. People make location decisions typically at times of change:

(1) Maturing and leaving the parental home
  a. Going away to school
  b. Forming an independent household
(2) Job change (but not every job change)
(3) Joining two households (marriage, domestic partnership)

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51. *Id.* at 270–75.

52. *See generally* MUTH, *supra*, note 40, at 5; JONATHAN LEVINE, ZONED OUT: REGULATION, MARKETS, AND CHOICES IN TRANSPORTATION AND METROPOLITAN LAND-USE (2006).

(4) Splitting a household (divorce, separation)
(5) Growing family
(6) Buying a home
(7) Retiring.

What goes into the decision varies at each of these times. A single person will have different needs and likely be less risk averse than a couple. Someone looking for work after completing college may be more flexible about an interregional move than would someone looking for work who is established in a community but has just been laid off. Higher income households will generally have greater mobility, both inter- and intra-regionally, than will lower income households. Homeowners, with higher transaction costs, will be slower to make a location adjustment than renters. Some households will select a region, confident that job opportunities will materialize, and then select a neighborhood that satisfies their requirements for neighborhood amenities. Others will follow a job to a region, and then face the decision regarding neighborhood choices. A great many will remain in, or return to, the region where their family is. Sometimes it is a job that anchors the location choice and sometimes a location choice, made at an earlier time, limits the radius of the job search. It depends on social expectations, established social networks, housing needs, budget, access to a job—or at least job opportunities—and myriad other things.

The location amenities required at different stages in the life-cycle will also impact the decision. Adults without children—whether it is before they have them, if they decided not to have them, or after their children have grown—will have different priorities. Similarly, people with different philosophical orientations will make decisions based on their preferences. As noted earlier, people trade off more public amenities in the city, such as theater and museum opportunities, public playgrounds, more variety in retail and services, for more private amenities in the suburbs, such as their own yard, a bigger house, and greater anonymity.[53] Homeownership, an important priority for many Americans and an intensely rational economic path, dictates, to a large degree, where a family will live. Even while housing costs (the sum of land cost and improvement cost) may be relatively higher at some greater distances from the CBD, housing per acre may not.[54] The cost, then, is associated with the improvement on the land more than the parcel itself. Housing that is affordable to many lower middle class and working poor families is at a great distance from the

53. MUTH, *supra* note 40, at 37.
54. *Id.* at 9.

main employment centers.[55] The quality of local schools is also a very important factor. Families with school-age children will often make school quality a higher priority than journey-to-work travel time in their location calculus.

Each decision is rational in the context of the decision maker, but it has proven difficult to develop explanatory models that adequately take account of the complexity inherent in the decision. The earlier reference to homeownership bears repeating. For the middle class in this country and for those aspiring to the middle class, homeownership is an important step.[56] Certain housing types and tenure options are often available only in particular distance and density configurations. For example, single family homes may only be available beyond a ring of multi-family apartment complexes. Apartments, until recently, have generally been available only for rental, and therefore those seeking to own have had to move beyond the ring of apartments. To find affordable housing for purchase, then, a householder may well have to move beyond the first rings, thus increasing travel time to the center. In this scenario, housing available for purchase exists in greater abundance at that greater distance so the requirement of minimizing travel time to work must obtain a lower priority. Tying residential location (homeownership) to work trips, while one of the most available indicators of system performance, is a rather blunt instrument.

## B. Firms

Decisions for firms are less complex as there is less emotional context for the decision, but the aggregate location decision for firms remains non-trivial. How national firms choose to locate differs from the choices of local firms. Retail firms, service firms, and manufacturing firms will all have different requirements. But each has a production function, or at least an heuristic thereof, in which the production inputs are land, capital, and labor.[57] To the extent that these inputs can be traded off against each other to increase profit or productivity, they are. In terms of transportation and urban form, firms require access to three markets: their supplier markets, the labor market, and their customer market. They locate to take adequate advantage—if not optimal advantage—of those three markets.

55. *Id.*

56. Home ownership generally provides added stability—as the owner is less susceptible to market changes; the home, as a vehicle in which to accrue equity and tax benefit, often makes it a good investment for those in a position to make it.

57. WEBER, *supra* note 41, at 20–21, 25.

The models of urban form discussed above argue that locations that, for one reason or another, are endowed with greater profit potential, that is, a transportation advantage, should command a higher price. The next section reviews hedonic price models, a class of empirical studies that demonstrates the veracity of this theory. The section on hedonic models is followed by a discussion of empirical studies on journey-to-work travel time behaviors that add additional insight into the way people interact with transportation systems and how, in turn, regions are shaped.

## V. HEDONIC PRICE MODELS

There is rich literature on the effects of transportation infrastructure on land value.[58] This section reviews only a small sampling of those studies that come under the heading of hedonic price models. Hedonic models are regression models that estimate the value of a commodity as a function of its characteristics. First applied in the automotive industry to estimate how the public would value a car as a function of its horsepower, interior materials, and other design features, hedonic price models are now a favorite of people who study real estate markets, measuring housing and commercial property value as functions of square footage, location, improvements (that is, number of bathrooms or presence of fireplaces for houses), and other features and amenities essential to the property. When they include transportation-specific variables, they are valuable for adding insight to urban and transportation systems.

The studies reviewed in this section are of hedonic models that include the amenity of proximity to rail transit in the real estate value function. By including the transit variable, these studies make comparisons of how markets value transit plus street access over street access alone. Most of the early studies are of commuter or heavy rail, and they analyze changes in home prices based upon either distance to the transit station, or commute cost savings associated with the transit improvement, or both.[59]

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58. *See* William Huang, *The Effects of Transportation Infrastructure on Nearby Property Values: A Review of the Literature,* INST. OF URB. & REG. DEV., Aug. 1994, at 2–3; Kaveh Vessali, *Land Use Impacts of Rapid Transit: A Review of the Empirical Literature,* 11 BERKELEY PLAN. J. 71 (1996), *available at* http://www.dcrp.ced.berkeley.edu/bpj/pdf/bidl1105.pdf.

59. *See, e.g.,* DAVID E. BOYCE ET AL., IMPACT OF RAPID TRANSIT ON SUBURBAN RESIDENTIAL PROPERTY VALUES AND LAND DEVELOPMENT: ANALYSIS OF THE PHILADELPHIA-LINDENWOLD HIGH SPEED LINE (1972); Frederick W. Davis, *Proximity to a Rapid Transit System as a Factor in Residential Property Values,* 38 THE APPRAISAL J., Oct. 1970, 554; RICHARD R. MUDGE, THE IMPACT OF TRANSPORTATION SAVINGS ON SUBURBAN RESIDENTIAL PROPERTY VALUES (1974) (discussing a study examining both

For the most part, researchers attempted to control for characteristics of the unit; characteristics of the neighborhood; locational features, such as distance to the central business district or distance to rail; and, for multi-year studies, for economic cycle variables. Though data quality and methodologies varied, almost all of these studies found some benefit capitalized into land value that could be associated with the proximity to the rail system.

### A. Residential Property

In their study of neighborhood effects, Lewis-Workman and Brod looked at neighborhoods in three cities, specifying separate models for each city.[60] In general, their models included variables accounting for home size and age, lot size, distance to the transit station, and distance to the nearest highway.[61] In two cases they conclude that transit provides "large and measurable benefits" from proximity to transit.[62] Their Bay Area Rapid Transit (BART) and New York City Transit (NYCT) results suggest that the benefit exceeds the value of transportation savings, thus implying an added neighborhood value, such as attraction of desirable retail stores, et cetera.[63] Their Portland models were more equivocal.[64] In contrast to other studies of Portland in which a clear benefit was shown,[65] they showed a negative correlation between proximity to light rail and house values for Portland.[66] Two explanations they provide for these anomalous results are that benefits of heavy rail are likely more pronounced than benefits of light rail, and that the effects may be somewhat confused as the Portland system is located in the right-of-way of a major arterial street.[67] Along with the benefit of proximity to rail, Lewis-Workman and Brod

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measures of accessibility); Arthur C. Nelson, *Effects of Elevated Heavy-Rail Transit Stations on House Prices with Respect to Neighborhood Income*, 1359 TRANSP. RES. REC. 127 (1992) (discussing studies measuring distance); W. Bruce Allen et al., *Value Capture in Transit: The Case of the Lindenwold High Speed Line,* 28 J. TRANSP. RES. FORUM 50 (1987) (discussing studies measuring commute cost savings). For additional discussion on land capitalization of employees' commute time, *see* Jeffrey S. Zax, *Compensations for Commutes in Labor and Housing Markets,* 30 J. URB. ECON. 192 (1991).

60. Steven Lewis-Workman & Daniel Brod, *Measuring the Neighborhood Benefits of Rail Transit Accessibility*, 1576 TRANSP. RES. REC. 147 (1997).

61. *Id.* at 148.

62. *Id.* at 153.

63. *Id* at 148–51.

64. *Id.* at 151–52.

65. *See, e.g.,* Hong Chen, Anthony Rufolo & Kenneth J. Dueker, *Measuring the Impact of Light Rail Systems on Single-Family Home Values: A Hedonic Approach with Geographic Information System Application,* 1617 TRANSP. RES. REC. 38 (1998); Musaad A. Al-Mosaind et al., *Light-Rail Transit Stations and Property Values: A Hedonic Price Approach*, 1400 TRANSP. RES. REC. 90 (1994).

66. Lewis-Workman & Brod, *supra* note 60, at 152.

67. *Id.* at 151–52.

showed a negative correlation between house value and proximity to highway.[68] In a case like that of Portland, where rail proximity and highway proximity are concomitant, there will be a confused result.

Shortly after the Portland system opened, Al-Mosaind et al. developed two hedonic models to explain home prices in an area served by MAX light rail.[69] Their second model, limited to properties within the ¼ mile band but using a continuous distance measure, showed a negative correlation, implying the distance decay function described above.[70]

A study of BART attempted to separate the nuisance effect from the accessibility effect using a distance-to-highway and distance-to-rail variable along with a highway and rail adjacency variable.[71] Landis et al. found no statistically significant relationship between "adjacency" (a dummy variable defined for properties within 300 meters of a transit line or highway) and home price.[72] They did find a correlation between home sale price and the continuous network distance to transit or a highway access point.[73] These findings imply the potential negative value of being near a transit line was not reflected in land value capitalization, but the accessibility advantage of being near a transit station or highway interchange is.

### B. Commercial Property

Commercial property is not as well studied as residential. Another work by Landis et al. also studied the relationship between transit (BART and San Diego Trolley) and the value of commercial properties, but they found it difficult to apportion price differentials into a "quality" component and a "transit accessibility" component.[74] The issue arose because commercial properties near BART and the San Diego Trolley were found to be bigger, newer, and better than more distant properties.[75] Landis et al. noted that the number of sales observations that they collected was small, and suggested that given a richer dataset, results might be different.[76]

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68. *Id.* at 150.

69. Al-Moisand et al., *supra* note 65.

70. *Id.* at 92.

71. John Landis, Subhrajit Guhathakurta & Ming Zhang, *Capitalization of Transit Investments into Single-Family Home Prices: A Comparative Analysis of Five California Rail Transit Systems*, INST. OF URB. & REGIONAL DEV., July 1994.

72. *Id.* at 10–11.

73. *Id.* at 11.

74. Robert Cervero & John Landis, *The Transportation-Land Use Connection Still Matters,* 7 ACCESS 2 (Fall 1995).

75. *Id.* at 8.

76. *Id.* at 3.

Work by Bollinger et al. examines the determinants of office rents in the Atlanta region.[77] Their research seeks to demonstrate how rents are affected by differing concentrations of employment types.[78] They included accessibility variables that represent access to highways and access to transit.[79] They show a positive correlation between rent and proximity (within one mile) to a highway access point, but they estimated a negative coefficient for proximity to transit.[80] In this case, the transit access is to the Metropolitan Atlanta Rapid Transit Authority (MARTA).[81] They conclude that the finding with respect to MARTA is consistent with other research that shows MARTA has thus far had a negligible impact on transit ridership.[82] Their study is of ten counties only two of which are served by MARTA, and they postulate that the MARTA areas are perceived as high crime areas and are therefore dismissed as less desirable than some of the other areas.[83]

A series of hedonic models estimated on effective rent for a large sample in Santa Clara County, CA showed a small but unequivocal rent premium for property within ¼ mile of a light rail station, and from there a declining but still significant rent premium out to about ¾ of a mile.[84]

While there is some mixed evidence and impacts are frequently small, the preponderance of research shows that parcels with the added bonus of being near rail transit have a price premium consistent with that predicted by the economic theory suggested. Highway/street access is a minimum requirement for value, transit access can add an additional premium.

## VI. TRAVEL TIME AS A PREDICTOR OF URBAN VERSUS SUBURBAN LOCATIONS

Peter Gordon, Ajay Kumar, and Harry Richardson demonstrate that travel times are declining as a result of increasing dispersion.[85] Based on two sources—data collected in the Nationwide Personal Transportation Survey (NPTS) and from the 1990 Census—they pre-

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77. Christopher R. Bollinger, Keith R. Ihlanfeldt & David R. Bowes, *Spatial Variation in Office Rents Within the Atlanta Region*, 35 URB. STUD. 1097 (1998).

78. *Id.*

79. *See id.* at Parts 2, 4, 5.

80. *See id.* at Part 5.

81. *Id.*

82. *Id.*

83. *Id.*

84. Rachel Weinberger, *Light Rail Proximity: Benefit or Detriment in the Case of Santa Clara County, California?*, 1747 TRANSP. RES. REC. 104, 108 (2001).

85. Peter Gordon, Ajay Kumar & Harry W. Richardson, *Gender Differences in Metropolitan Travel Behavior*, 23 REGIONAL STUD. 499, 499–510 (1989).

sent a two minute decrease in average travel time as a major triumph of suburban living.[86] Additionally, in a different study, Levinson and Kumar looked at household surveys in the Washington, D.C. metropolitan region and demonstrated that by moving among the inner, center, and outer rings commuters were able to keep their travel times consistent over the 20 year period between 1968 and 1988.[87] These studies use automobile travel time to work as the key indicator of preferred spatial distribution.[88] Neither study accounts for additional travel that dispersion implies for shopping and other activities.

Contrary findings are shown in Chapple and Weinberger who studied travel times of commuters in the San Francisco Bay Area.[89] The primary research objective was to understand the differences in travel time across gender.[90] Nevertheless, the findings show that the journey to work (JTW) for workers living in the five-county Bay Area is higher for people living in suburban parts of the county.[91] Weinberger further counters the Levinson and Kumar and Gordon and Richardson findings by showing that workers in the Philadelphia region have increased their travel times by dispersing to the suburbs.[92] Even at a time of job loss for the region, the dispersal that once took advantage of free road space for shorter commute times has now caused an overwhelming of the auto highway system.[93]

Another travel time approach, taken by Giuliano and Small, looks at whether JTW travel time is explained by urban structure.[94] Looking at the Los Angeles region they find that people spend much longer commuting than would be predicted by location models.[95] Their finding is consistent with several other studies undertaken in the United States and Japan that show 'excess' commuting.[96] Not surprisingly, in and near central Los Angeles they find a resident workers per job ratio of .78 (the only sub-region in the study with a ratio less

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86. *Id.*

87. David M. Levinson & Ajay Kumar, *Why Travel Times Have Remained Stable*, 60 J. AM. PLAN. ASS'N 319 (1994).

88. *Id.*

89. Karen Chapple & Rachel Weinberger, *Is Shorter Better? An Analysis of Gender, Race, and Industrial Segmentation in San Francisco Bay Area Commuting Patterns*, WOMEN'S TRAVEL ISSUES, PROC. FROM THE SECOND NAT'L CONF., Oct. 1996, at 408.

90. *Id.* at 409.

91. *Id.* at 424.

92. Rachel Weinberger, *Men, Women, Job Sprawl, and Journey to Work in the Philadelphia Region*, 11 PUB. WORKS MGMT. & POL'Y 1, 3 (2007).

93. *Id.* at 1.

94. Genevieve Giuliano & Kenneth A. Small, *Is the Journey to Work Explained by Urban Structure?*, 30 URB. STUD. 1485 (1993).

95. *Id.*

96. *Id.* at 1487.

than one), and a longer than average commute.[97] But the models for housing location, as discussed above, include multiple factors that utility-maximizing households are trying to satisfy, of which travel time to work is only one.

The travel time studies are somewhat unsatisfying because they only tell us the difference in travel times between urban dwellers and suburbanites. An interesting exchange, focused on the question of whether the transportation land use connection is weakening to extinction, appeared in the pages of *Access* magazine where Giuliano posits that it is.[98] Her analysis follows from the work with Small that was referenced earlier.[99] The inquiry begins with the question of why people have longer commutes than standard theory predicts and proceeds to look at examples of transportation projects—both highway and transit—that have had little effect on the region.[100] Giuliano concludes that it is largely the fact that people prefer low density living aided by the fact that transportation costs have decreased dramatically over the past 100 years.[101] She finds that transportation investments show little or no gain in travel time savings or mode choice.[102] In a mature and dispersed region such as Los Angeles it stands to reason that even a large investment in a highway improvement will affect only a very small proportion of regional traffic.[103] However, Cervero and Landis counter that the transportation-land use connection continues to matter, and they offer other examples to both back up their claim and refute the alternate claim. The question is far from settled.[104]

Ironically, though, the argument that the transportation-land use connection no longer matters contradicts itself, prima facie. Essentially the idea rests on the notion that transportation is ubiquitous to the point of being irrelevant to land use and location decisions. Approaching the question from another angle, findings in Santa Clara County support the ubiquitous highway perspective.[105] That research showed that the relatively ubiquitous highway system offers the same price advantage to parcels throughout the county, for example, there was no location advantage for business, as reflected in rent premiums

97. *Id.* at 1492.

98. Genevieve Giuliano, *The Weakening Transportation-Land Use Connection*, ACCESS, Spring 1995, at 3, 11 (1995).

99. *See* Giuliano & Small, *supra* note 94.

100. Giuliano, *supra* note 98.

101. *Id.* at 5.

102. *Id.* at 8.

103. *Id.* at 6.

104. Cervero & Landis, *supra* note 74.

105. Weinberger, *supra* note 84.

for locating proximate to a highway interchange.[106] On the other hand, holding other things equal, commercial property within walking distance to transit stops did command a higher rent than other properties in the county. In a mature, congested system, there is evidence to suggest that value can still be created by introducing high capacity systems.

## VII. TRANSPORTATION INVESTMENTS

The Alonso-Mills-Muth and Weber framework allows us to make some observations and inferences about transportation investments and urban form.[107] The world has gotten more complex since Thünen posited his model, but it is nearly universally accepted that transportation improvements can affect the value of land. We now believe that by providing access to a parcel, transportation investments can increase its potential value. By providing access to other parcels, particularly in the case of creating a by-pass, transportation investments can negatively impact the value of a parcel. During construction of a transportation improvement a parcel is likely to be negatively impacted. Further, negative externalities of a transportation improvement can negatively impact a parcel, and this would usually be recognized as a taking.

Urban economic theory, as described in the preceding section, asserts that if a particular property has the ability to yield greater profit than other properties (or if the profit potential increases), demand will be higher and competitors for the land will bid higher, thereby driving the price up. The review of hedonic price models demonstrates this principle. Assuming profit-maximizing industrialists will wish to keep their cost as low as possible, and that utility maximizing households will do the same, public investment will change the value of real property if the investment produces benefits for, or imposes additional financial burdens on the property. Finally, given that transportation is a necessary ingredient in their production cycle, one way that both households and businesses can decrease the cost of transport is to locate near well-connected transportation facilities. Origins farther away imply a more costly trip to access the central desired location. As transportation becomes less expensive (a smaller part of the production budget) the demand for that specific central location will decrease. Transportation improvements that reduce the cost of movements have the effect of making the parcels that are affected by the transportation 'closer' and, thus, those locations become more highly

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106. *Id.* at 111.

107. ALONSO, *supra* note 35; MILLS, *supra* note 40; MUTH, *supra* note 40; WEBER, *supra* note 41.

demanded. In this respect, transportation and location can be thought of as imperfect substitutes for each other. The ultimate effect is that a wider area will have been brought into the shed or catchment area of a particular center.

Transportation investments along corridors that serve desired locations will tend to have two effects. Locations along the corridor become more accessible and should, therefore, increase in value. Absent zoning restrictions, and in the presence of market demand, the land would become more densely developed. This latter effect occurs because more people wish to capitalize on the transportation savings, and because denser development can generate more income, which is used to pay the higher land costs. The market value for the land will re-equilibrate at a point equal to the savings from the transportation improvement and the additional capital that can be gained from the higher density development.

## VIII. COST OF TRANSPORTATION

Transportation has both a money cost and a time cost.[108] The money cost is made up of the shared infrastructure, that is, streets and highways, railroad tracks, bridges, and so on, and private costs such as vehicle ownership, insurance, gasoline, and other operating expenses. The time cost is, of course, the amount of time a trip requires. Transportation improvements that decrease the time cost of travel essentially decrease the total cost of travel. This section examines the results of three transportation pricing strategies: free roads, congestion pricing, and distributed cost or un-congested pricing.

### A. Free Roads

In 1956, with the passage of the Federal-Aid Highway Act,[109] commonly known as the Eisenhower Highway Bill, it became the explicit objective of the United States Federal Transportation Program to make highway transportation as close to free as possible. Building the interstate system led to a decrease in time cost of highway transportation. The bill, which provided a $9 to $1 match for highway construction and expressly prohibited toll roads from the federal interstate system, removed the direct burden of the infrastructure cost

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108. Transportation also has many externalities associated with it. These are costs borne by society rather than individual drivers. While externality costs such as noise, greenhouse gas emissions, criteria pollutant emissions, destruction of natural habitat, and so on are very important considerations, they will not be considered in great detail in this paper.

109. Federal-Aid Highway Act, ch. 462, 70 Stat. 378 (1956) (current version at 23 U.S.C. § 101 (2000 & Supp. III 2003)).

from users.[110] The access to such generous matching grants led to an explosion in highway building, a much needed lift for our national economy, and produced the engineering and transportation marvel that is our national highway system. The transcontinental mobility afforded by the system dramatically altered the American way of life, permitting us to live farther and farther from our activities and to import our food and other essentials of life from ever greater distances without increasing perceived cost.

The system was almost entirely planned and built in a centralized way with the state departments of transportation following federally set policy. The use of the highway system, however, is subject to the decisions of millions of individuals and hundreds of thousands of business interests. The systematic under-pricing of the system has resulted in an extreme reliance on driving, a land use system that is dependent on individual mobility, an erosion of other transportation infrastructure—including walking environments—and near ubiquitous congestion in and around the nation's spreading population centers. The "price signal" sent by the road being virtually free meant, and continues to mean, that people consume more road use than they would had the price to users been more truly reflective of the cost involved in usage.

Further, the idea that transportation costs balance against land costs in location decisions, as described in the previous section, suggests that people have a transportation land use budget which they spend within a particular time-distance of the center. Through this balancing the urban boundary is defined. Figure 4 shows a hypothetical bid-rent curve that depends on a hypothetical attractor (central market) and a given set of transportation costs. It further shows the savings at the center to be expected by transportation investments or policy decisions that decrease travel time or cost. With the transportation improvement, more land falls within the particular time-distance, in essence, the supply of land in the core has been increased. This shift causes a drop in the price of the most highly valued land and confers value to land that had previously existed beyond the original time-distance boundary.

110. *Id.*

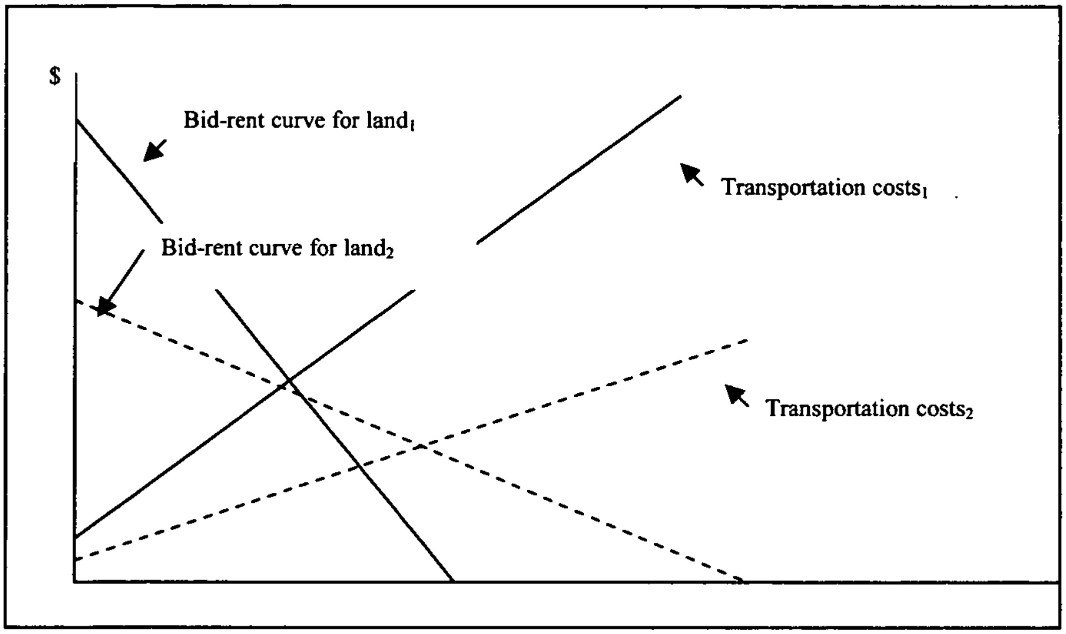


**Figure 4: The Impact of Transportation Investments on the Bid-Rent Curve**

In the case of households, some of the transportation savings are absorbed and put into other goods. Businesses either invest these savings into other factors of production or simply keep them as additional profits. It is conceivable that the decrease in transportation costs would free-up capital to be invested in land, thus making the bid-rent curve steeper, but with additional land now within the same time-distance shed, the more common market response is to consume additional land for the same level of productivity. The x-axis intercept of the bid-rent curves one and two of Figure 4 show the distance diameters of a hypothetical city with time-distance boundary before and after transportation investments. From this we see that the under pricing of transportation leads to over consumption of both transportation and land.

When general transportation costs are higher, cities are more compact and have higher densities. When local transportation costs are high (for example, when time costs increase due to congestion, and sufficient centripetal forces are not in place), cities can lose competitive advantage to neighboring jurisdictions. As transportation costs decrease and cities develop at lower density, the array of transportation options declines. Mobility may increase but accessibility to activities decreases. In compact cities people can walk, bike, drive, or ride a variety of transit modes to reach their activity destinations. However, as cities become more spread out, walking and biking become unfeasible. At low densities transit becomes impractical, leaving the automobile as the only viable transportation alternative.

As the cycle plays out and auto dependence becomes prevalent, the available transportation capacity becomes overwhelmed and the time cost begins to increase. To correct this distortion, William Vickrey, a Nobel prize-winning economist, suggested introducing a congestion charge, which would serve to manage demand.[111] Vickrey's suggestion is discussed in depth in the next section.

### B. Congestion Pricing

In 1952 William Vickrey proposed the notion of peak hour pricing for transit systems.[112] Vickrey noted that maintaining a fleet size and complement of drivers sufficient to serve the period of peak demand would be wasteful because that equipment and personnel would be relatively idle the rest of the day. Just as with peak telephone charging, his pricing idea would encourage some users to use the system at the "cheaper" times of day, thus spreading demand more evenly. This would allow the system to serve the daily demand without over building the system to accommodate the relatively short peak period.

By 1963 Vickery had adapted the idea of peak hour pricing to street traffic.[113] To build bigger roads that would lie mostly underutilized throughout the day simply to serve the peak unconstrained demand had a certain wastefulness to it.[114] Thirteen years elapsed from the time Vickery first introduced his idea until it was put into practice. Many more years passed before the idea took hold. The best known examples are Singapore, where a peak hour pricing scheme was implemented in 1976, and London, where a congestion pricing program was implemented in 2003.[115] Stockholm also implemented such a program but, ironically, in spite of voter support, has since suspended it.[116]

Almost 30 years after the idea of peak hour pricing was first published, demonstrating a marked shift in federal policy, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) opened the

111. William Vickrey, *Pricing in Urban and Suburban Transport*, AM. ECON. REV., Mar. 1963, at 452.

112. WILLIAM VICKREY, THE REVISION OF THE RAPID TRANSIT FARE STRUCTURE OF THE CITY OF NEW YORK 4, 11, 13 (1952).

113. *See* Vickrey, *supra* note 111.

114. *See id.*

115. Matthew Beard, *Livingstone Predicts 'Difficult Few Days' as Congestion Charge Begins*, THE INDEPENDENT, Feb. 19, 2003, *available at* http://news.independent.co.uk/uk/transport/article119308.ece.

116. *Stockholm Votes 'Yes' to Congestion Charging,* TRANSP. & ENV'T BULL., Sept. 28, 2006, *available at* http://www.transportenvironment.org/Article219.html.

door to re-examine the notion of pricing for the country's street and highway system.[117] ISTEA provided funds for congestion pricing experiments and government grants and loan guarantees eligible for use in new toll road finance.[118] Since then, a number of new toll roads are being constructed and a few "value-priced" corridors have been established. The change in federal policy has also lead to consideration of other possible pricing strategies. The general classes of pricing are described in the next paragraph; following that is a discussion of how the model predicts these pricing policies would affect urban form.

The three primary road pricing strategies that have been implemented around the world are corridor pricing, cordon pricing, and other use charges such as fuel taxes. Corridor pricing imposes a charge on the use of a particular stretch of road. Cordon pricing imposes a charge to enter a specific area. Other use charges, such as fuel tax, add a price on mobility regardless of what part of the system is in use. Corridor pricing in the form of tolling roads and bridges is a well known and common practice. A newly evolving corridor pricing scheme is value pricing where the tolls are variably adjusted according to demand, as Vickery had proposed. High Occupancy Toll, or HOT lanes, also come under this classification, permitting drivers to "buy-in" to use a lane otherwise reserved for high-occupancy vehicles, for example, buses and carpools. Cordon pricing in cities like Singapore, London, and for a time Stockholm, set up a cordon line around a heavily congested area, vehicles crossing the cordon are charged an entry fee. To have any effect, the cordon must be set up around an area that is experiencing greater demand for street travel than its current allocations can accommodate.

The intent of congestion pricing is to discourage discretionary, or non-essential, trips from being made at the busiest time thereby preserving the road space for what are considered to be the highest value trips. In fact, it is rather difficult to predetermine a high value trip. In many commercial instances it can be a straightforward cost accounting. When "buying" a vehicle's way out of congestion allows a vehicle's driver to make additional service calls rather than spending time in congestion, then, for that individual business or service provider it is a good deal. It is less clear when a discretionary trip by a person of greater means displaces a work trip by someone of more modest income, or when a visiting trip displaces a shopping trip. The regressive nature of congestion pricing is thought to be off-set by investing the

117. 49 U.S.C.A §§ 5501–5506 (2000).
118. 49 U.S.C.A. § 5504 (2000).

proceeds from such a program into lower priced transportation alternatives such as enhanced public transportation.[119]

Pricing to rationalize road use yields four possible decision outcomes. Some trips will be made at the cheaper and less congested times; some trips will be made via alternative modes; some trips will be made to alternate destinations; and, others will not be made at all. Ideally, to protect the economy of the cordoned zone, trip-makers will choose from among the first two choices. But, the trips to alternate destinations and those that are frustrated (for example, not made at all) must be carefully considered. The nature of travel as a derived demand introduces peculiar outcomes in a congestion pricing scheme, and just as transportation investments have land use implications, a change in pricing will likewise have land use implications.

In the short term, in a system with alternative means of travel and excess capacity in the off peak, some trips will be made in the off-peak, and some will shift mode. If there is continued growth in the area the off-peak periods will begin to fill in until there is no additional off-peak capacity.[120] At the same time, frustrated trips mean less economic activity and lowered utility for those who have foregone the trip.

In the long term, trips that are shifted to alternate destinations are a more serious matter. As increasing numbers of trips are made to alternate destinations, destinations along un-congested or un-priced roads, there is increasing demand for activities outside of the original congested core. Once the new areas become congested, pricing would be put in place parlaying traffic once again to the less congested "free" parts of the network, and so the cycle is predicted to repeat and development spread over a greater and greater area.

If the highway and street system represented the only resource whose use was affected by congestion pricing, it would be easy to argue for universal implementation. Because there are serious land consumption issues and other externalities associated with both congestion and congestion pricing, alternative approaches are warranted.

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119. *See generally* EDWIN S. MILLS & BRUCE W. HAMILTON, URBAN ECONOMICS (3d ed. 1984); J. P. Franklin, Non-parametric Distributional Analysis of a Transportation Policy: The Case of Stockholm's Congestion Pricing Trial, presented at the Transportation Research Board 84th Annual Meeting, Washington, D.C., 2005.

120. Capacity gains can be had by re-allocation as well as by additional construction. For example, if there is sufficient corridor demand, cities can gain great capacity increases from reallocating auto lanes to exclusive bus lanes. A single well used express bus lane can replace 25 lanes of highway auto traffic (HCM), hence the definition of both peak and off-peak capacity limits must be carefully examined.

### C. Distributed Cost or Un-congestion Pricing

In reality, most urban places currently have an implicit congestion price structure in place. To the extent that time is included in travel costs, and to the extent that people tolerate delay, travelers essentially pay for the privilege of making a trip with their time rather than with money. In that sense, congestion can lead to sprawl as well. The functioning of congestion pricing relies on the assumption that a price would be set according to an optimal level of use.[121] An alternative way to price the highway and street system is on a distributed cost basis. A road that is little used and experiences little congestion would be expensive to use, as the cost of building and maintaining the road would be shared among the few users. A road that is heavily used would be relatively inexpensive to traverse—but subject to congestion delays—because the cost of that road would be shared among the many users.

The higher money cost of the less used roads would represent a deterrent to low density development or sprawl. The push to the center would result in residential and commercial densities that could support multiple modes of travel and high levels of accessibility. If multiple modes are well supported these dense centers could be characterized by high levels of mobility as well.

## IX. CONCLUSION

The dominant thrust of transportation infrastructure policy over the past 100 years has been auto/highway oriented. For much of the past 50 years the policy has been to have highway travel be free or nearly free. While some condemn public transit subsidies and others wax nostalgic for the no longer profitable streetcar systems, it is worth noting that private operators stopped building and maintaining what we call public transportation systems when the government entered into the business of road building. Not surprisingly, the service provided by under-priced roads has been consumed at a rate that most economists define as excessive. Given the nature of travel as derived demand, the over-consumption of transportation has led to an over-consumption of land as well.

For a time this policy seemed unproblematic. Automobiles changed the landscape, redefining the terms of the American Dream. From an environmental point of view, autos were an improvement over the horses they replaced. They were effective at moving people out of crowded urban conditions that existed at a time when the coun-

121. An argument can be made that the optimal price would be the marginal social cost. *See* MILLS & HAMILTON, *supra* note 119.

try had neither the physical nor social infrastructure in place to ensure basic health. While the automobile provided new freedom and many associated benefits, the auto-highway system, by increasing the acreage within commute sheds of existing cities, allowed the relatively unchecked spread of development. As development spreads reliance on the automobile increases, but as more and more people take to the roads, the roads are increasingly congested.

For many years communities zoned low densities to prevent congestion and they built more roads to escape congestion. Some cities are now experimenting with pricing strategies that will manage demand for road space as a way to mitigate congestion. The most common idea, congestion pricing, will catalyze additional dispersion, exacerbating the problem. To maximize long term accessibility we will have to cultivate higher density nodes that are distributed throughout our regions. One way to do this would be reflecting the cost of transportation more directly to the users.