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Sustainable Transport in the United States:
From Rhetoric to Reality?

Editor: Gregory L. Newmark

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Institute of Urban and Regional Development
316 Wurster Hall # 1870
Berkeley, CA 94720-1870 USA

<http://iurd.berkeley.edu>

bpj@berkeley.edu

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Editor's Note

Welcome to Volume 19 of the Berkeley Planning Journal. As we embark on our third decade of publication, we are very pleased to present a themed issue entitled *Sustainable Transport in the United States: From Rhetoric to Reality?*

The primary purpose of this theme is to bring together, in a single volume, many strands of current planning research on the linkages between transportation and sustainability. The papers address a wide variety of topics and methods, all exploring the central theme from distinct and critical perspectives. Karel Martens proffers a social justice basis for sustainable transportation planning that challenges traditional approaches to transportation modeling and cost benefit analysis. Todd Litman delineates distortions in transportation markets that foster less sustainable behaviors. Eran Leck and Jennifer Dill each examine the interactions of urban form and travel behavior. Leck applies meta-analysis to clarify contradictory findings of the previous studies in the field. Dill examines a newly built New Urbanist community in Portland, Oregon, to assess whether the touted benefits of such land use are being fulfilled in reality. Lawrence Frank, Karen Glanz, Meg McCarron, James Sallis, Brian Saelens, and James Chapman innovatively expand the idea of sustainability to address access to nutrition for school children in Atlanta, Georgia. John Pucher and Ralph Bueler make a detailed and critical examination of Canadian cycling policies and trends. Alex Bond and Ruth L. Steiner explore the potential for universities to foster sustainable transportation on their campuses and in their communities through a case study from the University of Florida. Lynn Scholl reviews the existing research on contracting bus services in the US. Finally, Tristan Chevroulet explores the implications of "virtual elevator" programs that meld shopper reward schemes with smartcard transit use.

The secondary purpose of this theme is to re-emphasize concern for sustainable transportation planning in highly industrialized regions, particularly the United States. While this objective is addressed in different dimensions in the papers noted above, Melvin M. Webber, Jonathan Mason, and Richard Gilbert directly probe assumptions regarding sustainability policy in their respective essays.

During the course of preparing this special volume, two very significant events occurred in the transportation planning community at Berkeley. In January 2006, Martin Wachs retired from the University of California, where he had been inspiring students and researchers for 35 years. His colleagues, Elizabeth Deakin, Robert Cervero, and Lewison Lem offer short tributes in this volume, which together illuminate portions of

Professor Wachs' great impact on the field. In November 2006, shortly before publication, Melvin M. Webber, professor emeritus in the Department of City and Regional Planning where he had been a member of the faculty for over a half century, passed away. Professor Webber's heartfelt concern for planning education, for students, and for intellectual rigor was without peer. We are honored to publish a posthumous essay that he wrote expressly for this volume and to dedicate this special issue on transportation to his memory.

I would like to specifically acknowledge the critical contribution made to the production of this journal by Jennifer Yeamans and Chris Amado. Without their committed and consistent efforts, this issue would not exist in print. I would also like to thank Elena R. Aronson for providing a stunning photograph of a tram in Lisbon, Portugal, for our cover. As we look out from the campanile, we are always searching for creative and elegant planning solutions to realize a more sustainable future.

Thank you and enjoy,

Gregory L. Newmark, Editor
December 2006

Basing Transport Planning on Principles of Social Justice

Karel Martens

Abstract

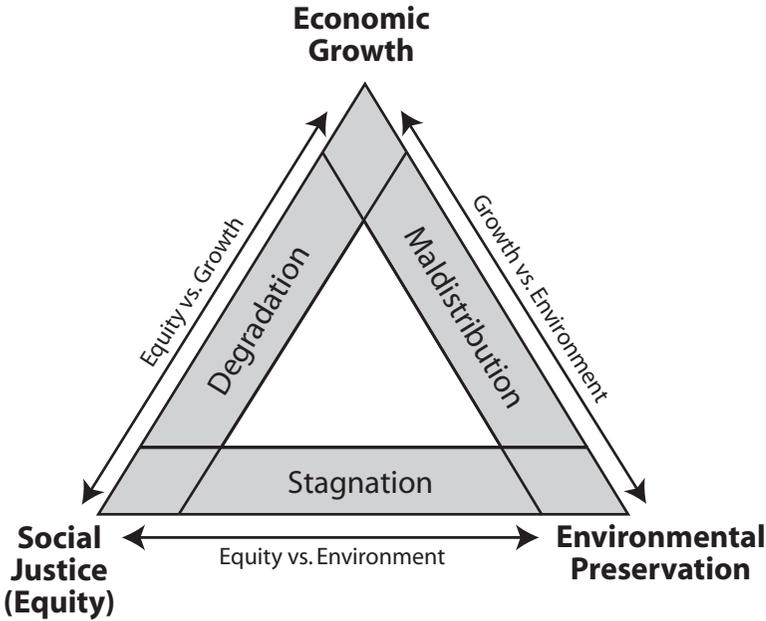
Transport modeling and cost-benefit analysis are two key tools used in transport planning. Both tools have been adapted substantially to cope with the challenges posed by the goal of sustainable development. However, the changes have primarily focused on the negative environmental impacts of the transport sector. Hardly any attention has been paid to another key dimension of sustainable development: social justice. This paper critically analyzes the two tools from this perspective. It concludes that transport modeling is implicitly based on the distributive principle of demand. Given the importance of mobility in current society, it is suggested to replace current demand-based approaches by transport modeling that is based on the principle of need. Likewise, cost-benefit analysis has a built-in distributive mechanism that structurally favors transport improvements for highly mobile groups. This problem could be solved by replacing travel time savings by so-called accessibility gains as the key benefit taken into account in cost-benefit analysis. If the suggested changes were realized, both transport modeling and cost-benefit analysis could become key tools for promoting sustainable transport.

Introduction

The concepts of sustainable development and sustainable transport have swept through the academic literature since the publication of the UN report *Our Common Future* (Brundtland 1987). The sustainability concept links three overarching policy goals to one another: economic development, environmental preservation, and social justice. Following Feitelson (2002), each of these three dimensions can be depicted as the corner of a triangle, with the trade-offs between the key dimensions demarcated along the triangle's sides, as shown in Figure 1. Using the figure, the search for sustainable transport can be reformulated as a search for solutions that address all three trade-offs simultaneously so as to avoid the three "faces"

of unsustainable development: environmental degradation, economic stagnation, and maldistribution of resources.

Figure 1. The Three Dimensions of Sustainable Development



Source: Feitelson 2002, 101.

The publication of the Brundtland report and the ensuing discussions have resulted in a new wave of policies and plans to reduce the environmental impacts of the transport sector. In the U.S., both the Intermodal Surface Transportation Efficiency Act (ISTEA) and the 1990 amendments to the Clean Air Act are, at least in part, an outcome of the renewed environmental awareness generated by the sustainability debate (Garrett and Wachs 1996). The environmental provisions in more recent U.S. transport legislation, such as TEA-21 (Transportation Equity Act for the 21st Century) and SAFETEA-LU (Safe, Accountable, Flexible, Efficient Transportation Efficiency Act: A Legacy for Users), suggest that the environmental dimension of sustainable development has become well institutionalized.

This emphasis on the environmental impacts of the transport sector contrasts sharply with the still limited consideration for the social justice dimension of sustainable transport. The recent literature on justice and transport is largely disconnected from the sustainability discourse, and the number of policy initiatives that address the gaps in mobility and accessibility between population groups has been limited. Much of the

literature deals with issues like accessibility poverty (Higgs and White 1997; Denmark 1998; Blumenberg 2002) and transport exclusion (Church et al. 2000; Hine and Grieco 2003), without exploring the broader implications for a comprehensive transport policy that integrates all three dimensions of sustainable development. Most policy initiatives, in turn, do not insert equity considerations into mainstream transport policy, but merely add auxiliary instruments to address the special needs of weak population groups. Such “stop-gap” policies include the U.S. Welfare to Work program (Blumenberg 2004), and the recent U.K. experiments with accessibility planning (Lucas 2006).

This narrow perspective is reflected in the development of two key tools of transport planning: transport modeling and cost-benefit analysis. Over the past two decades, both tools have been adapted so as to better address the environmental impacts of the transport sector. In contrast, the implications of the social justice component of sustainability for transport modeling and cost-benefit analysis have hardly been explored. This article aims to begin filling that void. It provides a critical analysis of both transport modeling and cost-benefit analysis from the perspective of social justice. Social justice is understood here as the morally proper distribution of goods and bads across members of society (Elster 1992; Miller 1999a). Although both transport modeling and cost-benefit analysis implicitly help determine the distribution of transport-related goods and bads, there has hardly been any explicit reflection on the distributional mechanisms that are currently built into both planning tools. The aim of this paper is to critically discuss these main distributional mechanisms and suggest possible alternatives. These alternatives, apart from promoting equity in the field of transport, are also expected to strengthen the trend towards a more sustainable transport system.

Transport Modeling

Transport modeling is a tool to forecast future demand for transport with the goal of generating information concerning the future performance of the existing or expanded transport system. The fundamentals of transport modeling were developed in the U.S. during the 1950s, in the context of the pioneering Detroit and Chicago Transportation Studies. Since then, this forecasting tool has gained widespread use in the industrialized world and is now an integral part of transport planning in virtually all motorized countries (Bates 2000).

The first generation of transport models consists of variations on the four-step model. While widely criticized as outdated and irrelevant, the four-step model is still in common use in industrialized countries includ-

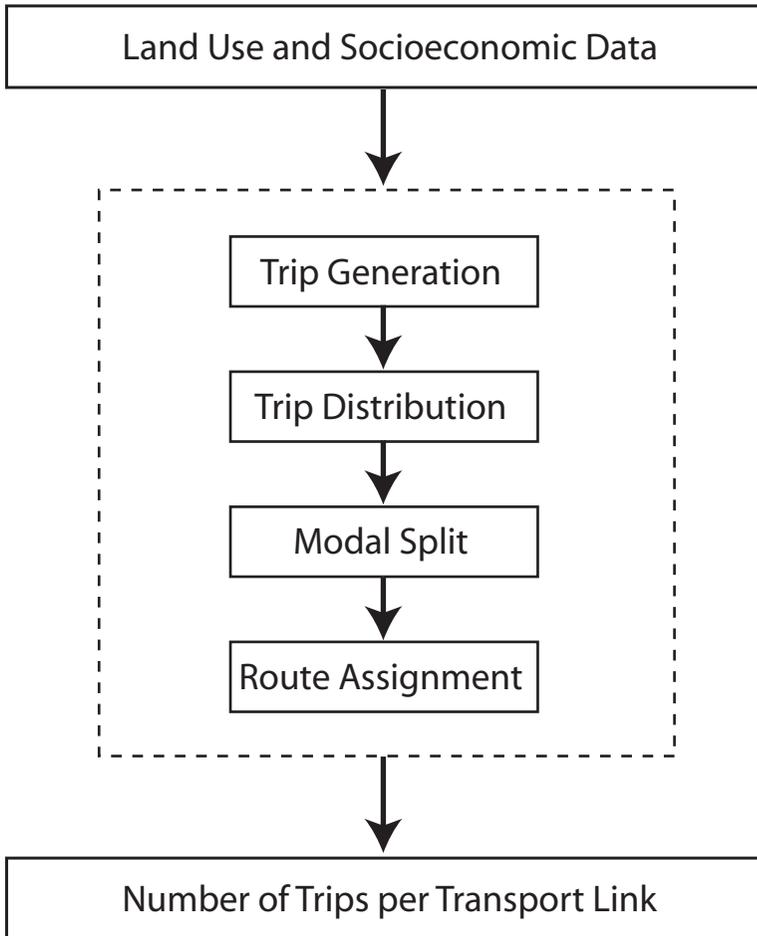
ing the U.S. (Bates 2000; McNally 2000b). As shown in Figure 2, the model forecasts future transport demand in four steps (see for example de Dios Ortuzar and Willumsen 2001; McNally 2000b; McNally 2000a). The first step, trip generation, estimates the number of trips originating in each transport activity zone, based on socio-economic and land use data. The second step, trip distribution, divides the total number of trips generated by each transport activity zone among destination zones, based on estimates of zonal attraction and travel impedance. The third step, mode choice, estimates the distribution of trips among the available modes (typically car and public transport). Finally, the fourth step, traffic assignment, allocates the trips between a specific origin and destination to the available roads or public transport links. The four-step model ultimately results in a forecast of future travel demand per transport link. These data are then used to assess the future performance of the existing transport system, to identify transport links in the region that lack sufficient capacity, and to forecast the impact of possible transport investments on the performance of the system.

In response to growing environmental concerns, transportation planners have both adjusted the traditional four-step model and developed a new generation of transport models. The most important adjustment, in the U.S. and elsewhere, has been the addition of a pollution emissions model. This additional step estimates the extent to which new transport infrastructures and the resulting future travel patterns will create concentrations of air pollutants at different locations (Garrett and Wachs 1996).

The inability of the four-step model to assess policies that may reduce the environmental impacts of car-based travel (McNally 2000a), such as parking fees and congestion charges, has strengthened interest in activity-based models (Ettema and Timmermans 1997). Because these models focus on activity patterns rather than trips, they are better able to forecast behavioral responses to car restraint policies. However, because activity patterns are complex, activity-based transport models have only been applied sporadically in practice.

The efforts to address environmental aspects in transport modeling have not been matched by similar attempts to address equity impacts. This oversight is remarkable, as demand-based models—whether they take the shape of a four-step or an activity-based model—have direct social justice implications. From a social justice perspective, both types of models are comparable in one crucial respect: both aim to forecast future travel demand based on current travel patterns. As Sheppard (1995) rightly points out, the concept of travel demand should be treated with care:

“Conventionally, it implies the notion that consumers have freely chosen one possibility over all others, which in turn suggests that the observed

Figure 2. The Four-Step Model

Source: Garrett and Wachs 1996, 8.

pattern of trips [on which modeling efforts are based] represents the best possible set of actions that individuals could have taken given their preferences and the spatial structure of the city" (Sheppard 1995).

However, as the activity-based approach rightfully stresses, current travel demand is as much the result of constraint as it is of choice. This assertion implies that transport modeling that starts from current travel patterns may actually reinforce the existing differences in mobility and accessibility between various population groups.

A further analysis of the four-step model augments this argument. From a social justice perspective, the first step of the model is of key importance.

In this step, the number of trips per household is predicted for some year in the future. Generally, households are distinguished according to a number of characteristics, the most important of which are household size, car ownership level, and household income. Then, for each household type, the average number of trips is calculated using large-scale travel data. These average trip rates, in turn, are used to forecast future trip generation levels at the level of transport activity zones. Table 1 presents a typical example of the trip rates used in transport modeling. The table shows, for instance, that a one-person household with a car is predicted to make more than seven times as many trips per day as a one-person household without a car. These differences in trip generation rates translate into the results of the transport model and, ultimately, into suggestions for major transport capacity improvements.

Table 1. Typical Example of Trip Rates Used in Transport Modeling

Household Size	Car Ownership Level		
	0 cars	1 car	2+ cars
1 person	0.12	0.94	--
2 or 3 persons	0.60	1.38	2.16
4 persons	1.14	1.74	2.60
5 persons	1.02	1.69	2.60

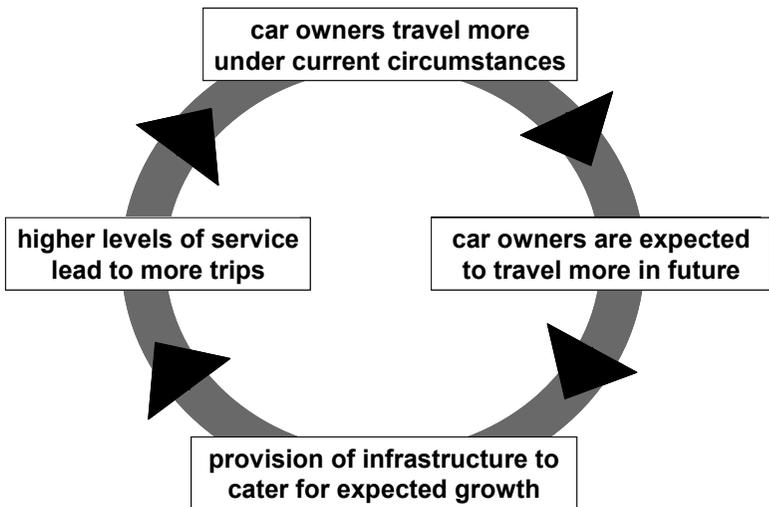
Source: de Dios Ortuzar and Willumsen 1994, 137.

By ignoring the fact that current travel patterns are a reflection of the way in which transport resources have been distributed in the past, transport models thus create an inherent feedback loop. The models use the high trip rates among car owners in the present to predict high trip rates among car owners in the future. These predictions favor policies that cater to this growth through improved services for car owners (e.g., road building or investment in costly rapid rail). These improved services, in turn, result in higher trip rates among car owners and the circle begins again, as shown in Figure 3.

This analysis can be translated into social justice terms. The fact that current approaches to transport modeling aim to forecast future travel demand suggests an implicit assumption that demand constitutes the just principle upon which to distribute new transport facilities. After all, the forecast of future travel demand is the basis for generating policy recommendations about future investments in transport infrastructure. While traditional transportation planning has thus focused on the overall performance of

the transport network, a social justice approach would focus on the distribution of transport investments over population groups and the related performance of the network for each of these groups. Since the criterion of demand encompasses current wants backed by a willingness and an ability to pay (Hay and Trinder 1991), the future distribution of a good based on this criterion will essentially reflect the current distribution of income in society. Transport modeling based on demand will thus tend to recommend transport improvements that serve the rich rather than the poor.

Figure 3. The Vicious Circle Underlying Transport Modeling



The importance of mobility and accessibility in contemporary lifestyles makes the distribution of transport facilities according to the criterion of demand difficult to defend. Access to efficient motorized transport systems is of key importance to fulfill the tasks that are expected from every ordinary citizen in contemporary society, such as work, study, or child care. The sprawling urban development that has accompanied the increase in car ownership has made motorized mobility a necessity rather than a luxury. Motorized accessibility to key destinations such as employment centers, schools, or medical facilities, has become, in the words of Dworkin (1985), a prerequisite for “a life of choice and value” (Frankfurt 1987). But if this accessibility has indeed become a prerequisite for such a life, and if we posit that each citizen deserves such a life, the provision of transport facilities can hardly be based on the criterion of demand. Rather, need comes to the fore as the just principle upon which to distribute key transport facilities.

This conclusion suggests that current transport demand models will have to be replaced by a whole new generation of models based on the criterion of need. The goal of such a need-based model would be to assess to what extent the existing or future transport network is able to secure a minimal level of accessibility for all population groups. Unlike demand-based models that apply a seemingly neutral methodology, the development of a need-based model will require an explicitly normative approach, as needs will have to be distinguished from wants and explicit accessibility standards will have to be set.

Classifying certain activities as needs and others as wants is not simple; however, such efforts can build on the extensive existing literature on basic needs (e.g., Braybrooke 1987; Thomson 1987; Doyal and Gough 1991). The resulting model would start from a matrix of basic transport needs for different population groups, rather than from the traditional matrix of trip generations and attractions based on current travel patterns. The activity set will include basic needs like health, education, work, and social contacts. The risk of an extremely paternalistic approach — in which planning institutions rather than people themselves determine which trips count as “needs” and which as “wants” — can be avoided to some extent, since groups with different needs (such as the young and the old, women and men) will often live together in one area or “transport activity zone.” The transport system will thus have to be robust to serve for all these needs, as well as for changes in population over time (Apparicio and Seguin 2006). At the same time, areas may differ in their transport needs, for instance, because of their socio-economic or ethnic composition, and the model will have to be sensitive to this.

The second challenge posed by a need-based model is the setting of accessibility standards. Without explicit standards it is impossible to assess the performance of a transport network in terms of its success or failure to provide minimal levels of accessibility to all population groups. Furthermore, without explicit accessibility standards, the model will be unable to assist decision-makers in setting priorities between possible transport investments. The accessibility standards will have to be defined in terms of travel time and costs, as well as in terms of the number of opportunities that are within reach of a specific area or transport activity zone. The latter condition is of key importance as the availability of alternatives (e.g., in terms of employment locations or educational opportunities) is a major element in ‘a life of choice and value.’ The need-based model could benefit from recent advances in the measurement of accessibility, largely inspired by activity-based transport modeling (e.g., Miller 1999b; Recker et al. 2001; Dong et al. 2006).

Paradoxically, the third component of a need-based transport model would consist of a demand-based model. Such a traditional model is necessary,

because accessibility depends on the level of congestion on transport links (roads or public transport), which, in turn, depends on the actual or predicted use of transport infrastructure. The need-based and demand-based models are thus complementary: the former identifies which transport links are needed, while the latter indicates the necessary capacity on these links. The combination of both models also avoids bias towards needs that ignores demands.

The development of a need-based transport model could benefit from recent experiments to provide accessibility to weak population groups, such as the U.S. Welfare to Work program (Blumenberg 2004) and the U.K. initiative to institutionalize accessibility planning (Lucas 2006). But where these experiments aim to identify accessibility needs of marginalized groups and generate solutions to solve their specific problems, need-based transport modeling would inform transport planning overall. This would avoid the paradoxical situation that mainstream transport modeling primarily serves the wants of the strong, while small-scale experiments and alternative financing schemes have to provide for the accessibility needs of the weak, whose problems were created by mainstream transport planning and the related maldistribution of resources in the first place.

Cost-Benefit Analysis

Cost-benefit analysis (CBA) is a procedure of identifying, measuring, and comparing the benefits and costs related to an investment project or program (Campbell and Brown 2003). It has become the accepted standard for evaluating transport projects since the early 1960s (e.g., Talvitie 2000; Quinet 2000). Early types of cost-benefit analysis applied in the transport sector generally included only a limited number of benefits and costs. Typically, the focus was on the costs of infrastructure construction and maintenance and on the benefits of travel time savings, reductions in vehicle operating costs, and — to some extent — improvements in road safety. The growing concern about the environmental impacts of the transport sector in general, and road building in particular, has resulted in a broadening of the approach in many countries over the past two decades (Morisugi and Hayashi 2000). Currently, many countries include a number of environmental impacts in the standard cost-benefit analysis, most notably air and noise pollution. In addition, cost-benefit analysis has been adjusted in several countries in order to enable a direct comparison of the costs and benefits of various transport modes (e.g., Vickerman 2000).

Social justice considerations have traditionally played a role in the development of cost-benefit analyses, most notably in the monetary valuation of travel time savings. Since time savings typically account for the vast

majority of benefits generated by a transport investment, the way in which the monetary value of these savings is calculated is of the utmost importance. In virtually all countries using CBA, the value of travel time savings is linked to wage rates, so the key question is which wage level to use in the calculation. The theoretical foundations underlying CBA suggest the use of market-based values and to differentiate the value of travel time savings according to differences in income levels of groups of travelers. The possible consequences of such an approach were recognized as early as the 1960s (Mackie et al. 2003). If market-based values were to be used, transport investments that primarily benefit higher income groups would score substantially better in cost-benefit analyses than alternatives that would serve poor population groups, all else being equal. In order to address this bias, the so-called "equity value of travel time" was introduced in virtually all cost-benefit analysis used in the U.S. and abroad (Morisugi and Hayashi 2000). The equity value of time is based on an average income level and is used for all travel time savings, independent of the income level of the traveler that benefits from the time saving. Currently, most cost-benefit analyses also use equity values for the calculation of the benefits related to improvements in road safety.

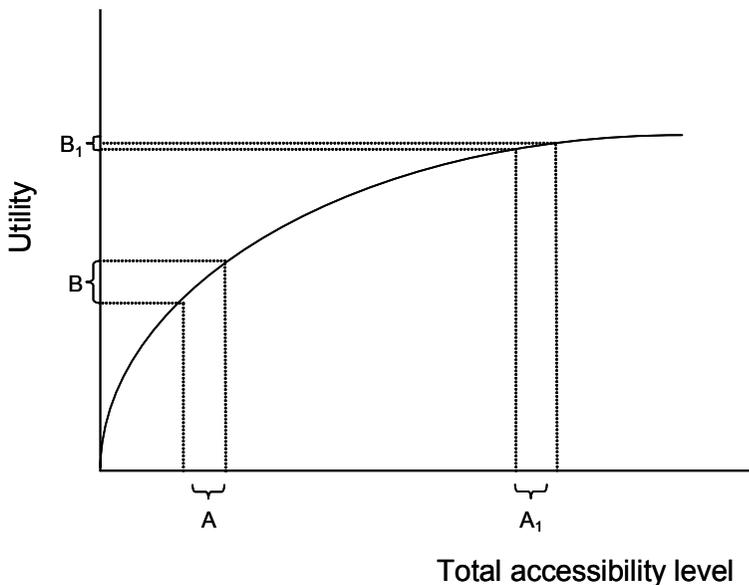
While the use of equity values is certainly to the benefit of weaker groups in society, the focus on these values hides another, even more powerful, distributional mechanism at work in cost-benefit analysis. This mechanism concerns the link between the total number of trips and the total benefits generated by a transport improvement. The more trips are forecasted for a specific link for a certain year in the future, the more travel time savings can be earned by improving that link, and the higher the total benefits related to that improvement. This principle works to the advantage of stronger population groups with high levels of car ownership, as they are characterized by substantially higher trip rates than weaker population groups with low levels of car ownership (see above). For instance, the improvement of the link between a well-to-do suburb and a large employment area will virtually always perform better in a cost-benefit analysis than an improvement in the transport link between a disadvantaged neighborhood and the same employment area. This is especially true in societies like the U.S., in which the spatial segregation of population groups is to some extent replicated in their use of particular infrastructures (Hodge 1995).

A reassessment of the impacts of improvements in the transport network challenges the existing approach to travel time savings in cost-benefit analysis. The current emphasis on time savings is implicitly based on the assumption that travelers will use higher travel speeds to reduce the travel time between fixed origins and destinations. Empirical research from around the world shows that this is a mistaken assumption (Levinson and Kumar 1994; Whitelegg 1997; Noland and Lem 2002; Harris et al.

2004; Mokhtarian and Chen 2004). A large number of studies show that higher travel speeds are not translated into shorter travel times, but rather into increases in travel distances. These increases in travel distances, in turn, reflect people's desire for an improvement in accessibility. People use higher travel speeds to access places that they were unable to access before. This suggests that the main benefit of a transport investment does not consist of travel time savings, but rather of accessibility gains generated by higher travel speeds.

The identification of accessibility gains as the prime benefit of transport investments has profound consequences for cost-benefit analysis. The monetary value of accessibility gains is not related to income group dependent wage levels, but in large part to the existing level of accessibility of a person. More specifically, the value of an additional destination that comes within reach due to a transport improvement will depend on the choice set of destinations already within the reach of an individual. Following the principle of diminishing marginal utility, an individual with a large choice set of destinations may be expected to attach a lower value to the addition of an extra destination, than a person with a relatively small choice set of destinations, all else being equal, as shown in Figure 4.

Figure 4. The Principle of Diminishing Marginal Utility Applied to Accessibility Gains



One unit of accessibility gain (A) for persons with low levels of accessibility will generate a larger improvement in utility (B) than the same unit of accessibility gain for population groups with high levels of accessibility (A_1 and B_1).

Following this analysis, it is now possible to distinguish two alternative approaches to correct the distributional flaw in current cost-benefit analysis. In the first approach, CBA calculations will continue to include travel time savings as the most important benefit generated by a transport project. However, the savings will only be used as an indicator of accessibility gains, and the monetary value attached to time savings will be based on the understanding that they reflect accessibility gains. Following the principle of diminishing marginal utility discussed above, the monetary value attached to a specific accessibility gain should differ between individuals or population groups in reverse relation to their current levels of accessibility. Using travel time savings as a proxy for accessibility gains, this means that time savings for the mobility-poor should be valued higher than travel time savings for the mobility-rich. Note that this argument is not based on considerations of justice, but solely on the concept of diminishing marginal utility as applied in the classical approach to welfare economics (Sen 1973).

The drawback of this first option is that the link between total number of trips and total benefits of a transport investment remains intact. Travel time savings will still be a result of the number of trips, the time savings per trip, and the value of travel time savings. The reverse relation between income and travel time value may correct the current situation to some extent, but will not solve the basic distributional flaw built into cost-benefit analysis.

The second option would be to disconnect total trip numbers and total benefits altogether by replacing travel time savings with accessibility gains as the key benefit of a transport project. The argument here would be that travel time savings are not an adequate proxy of accessibility gains generated by higher travel speeds, since the value of accessibility gains does not depend solely on the number of trips made. This is because accessibility has both a use value and an option value (Campbell and Brown 2003). Having accessibility to a wide number of jobs, shops, medical services, or educational facilities is a value in itself, even if no actual use is made of these destinations, as it increases choice and thus future options. The emphasis on option value rather than use value will strengthen the inverse relation between existing accessibility levels and the monetary values attached to accessibility gains. It would guarantee that transport investments that improve accessibility levels of the mobility-poor would perform well in cost-benefit analysis, independent of the low number of trips made by this group. The use of accessibility gains as the primary benefit of transport improvements would thus have two advantages from a social justice perspective. First, it would direct the attention in transport planning and cost-benefit analysis to equity in terms of accessibility and accessibility gains, rather than focus on the absolute size of travel time savings. Second,

it would disconnect the direct link between trip numbers and benefits, as the value ascribed to accessibility gains will be a function of both actual use and option value (Geurs and Ritsema van Eck 2001).

The challenge will be to develop a practically feasible method to ascribe monetary values to accessibility gains. Of all the accessibility measures developed since the early article of Hansen (1959), the measures that are based on economic theory and apply the concept of user benefits to assess accessibility offer the most potential (e.g., Ben-Akiva and Lerman 1985). But even these methods still fall short of translating accessibility and accessibility gains to monetary values (Miller 1999b). The development of a practically feasible method is further complicated by the conditions set by cost-benefit analysis. These conditions include an often limited data set with regard to travel and accessibility, which does not incorporate information on spatial or temporal constraints necessary for accessibility measures developed along the lines of time-space geography. This suggests the application of a relatively simple accessibility measure, which uses only data that are commonly generated within the framework of transport (demand) modeling and cost-benefit analysis. At the same time, the measure will have to be sophisticated enough to assess differences in accessibility between population groups, as defined, for example, by income or car ownership level. Classic accessibility measures that generate aggregate accessibility indices at the level of land uses or transport activity zones are thus not enough, as they do not provide the information necessary from the perspective of social justice.

Conclusions and Discussion

The increasing concern over the environmental impacts of the transport sector and road building in particular have substantially changed the features of two key tools of transport planning: transport modeling and cost-benefit analysis. The difficulties of applying the classic four-step transport model to assess the impacts of policy measures that are part of the sustainable transport planner's toolbox, such as parking fees and congestion pricing, have helped to stimulate the development of activity-based approaches. Likewise, the tool of cost-benefit analysis has been adapted to include key environmental impacts of transport.

The efforts to adapt transport modeling and cost-benefit analysis to the environmental challenge have not been paralleled by comparable attempts to address the social justice dimension of sustainable development. While both transport modeling and cost-benefit analysis implicitly help to determine how transport-related goods and bads are being distributed in

modern societies, there is hardly any explicit reflection on the distributional mechanisms that are built into both tools.

The analysis in this paper suggests that both transport modeling and cost-benefit analysis are driven by distributive principles that serve highly mobile groups, most notably car users, at the expense of weaker groups in society. Transport modeling is implicitly based on the distributive principle of demand. By basing forecasts of future travel demand on current travel patterns, transport models are reproducing current imbalances in transport provision between population groups. The result is that transport models tend to generate suggestions for transport improvements that benefit highly mobile population groups at the expense of the mobility-poor. Given the importance of mobility and accessibility in contemporary society for all population groups, this paper suggests basing transport modeling on the distributive principle of need rather than demand. This shift would turn transport modeling into a tool to secure a minimal level of transport service for all population groups.

The criticism of cost-benefit analysis is comparable. Like transport modeling, cost-benefit analysis has a built-in distributive mechanism that structurally favors transport improvements for the mobility-rich. The direct link between total trip numbers, travel time savings, and total benefits in cost-benefit analysis automatically favors transport investments that serve highly mobile groups in cost-benefit calculations over transport improvements that primarily serve less mobile groups. This paper suggests replacing travel time savings with the concept of accessibility gains. This shift would result in an inverse relation between the value of travel time savings and income levels and/or in a disconnection between the number of trips and the total benefits generated by a transport investment.

The suggestions in the paper for change in both transport modeling and cost-benefit analysis can have far-reaching consequences for current transport planning practices. They imply the replacement of several deeply rooted beliefs of the goals of transport planning, most notably the goal to provide for future travel demand. So far, the sustainability agenda has not been able to make this shift. While the environmental concerns have led to a reluctant replacement of the "predict and provide" paradigm by a "predict and prevent" approach (e.g., Vigar 2002), the focus has remained on the demands of the highly mobile traveler. The only shift that has taken place is in how to provide for the "needs" of this mobile traveler: by building ever more roads (predict and provide) or by providing attractive public transport in combination with a rise in the costs of car-based mobility (predict and prevent). The social justice approach to sustainable transport promises to bring about a much more profound, if not revolutionary, change in the field of transport planning and policy.

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Karel Martens is a researcher and lecturer at the Institute for Management Research, Radboud University Nijmegen, the Netherlands. He has worked in the Netherlands and Israel on issues ranging from compact city development to modern wind energy parks. His research interests include transport and land use, interconnectivity in transport systems, and road safety. Currently, most of his research efforts focus on justice and transport, and in particular, how considerations of equity, fairness and justice could be integrated into key transport planning tools. The paper was written during his time as a research fellow at the Environmental Simulation Laboratory, Porter School of Environmental Studies, Tel Aviv University, Israel.

Transportation Market Distortions

Todd Litman

Abstract

Properly functioning markets efficiently allocate resources. Such markets must reflect certain principles, including consumer options, cost-based pricing, and economic neutrality. Transportation markets often violate these principles. This report examines these distortions and their implications for transport planning.

Transportation market distortions include various types of underpricing of motorized travel, planning practices that favor automobile travel over other modes, and land use development practices that create automobile-dependent communities. Although these distortions may individually appear modest and justified, their impacts are cumulative and synergistic, leading to economically excessive motor vehicle use. These distortions exacerbate many problems, including traffic congestion, facility costs, accidents, reduced accessibility (particularly for non-drivers), consumer transportation costs, inefficient energy consumption, and excessive pollution. Market reforms that reduce these distortions would provide significant economic, social, and environmental benefits. In a more efficient market, consumers would choose to drive less, rely more on alternative transport options, and be better off overall as a result.

Introduction

The French social critic Voltaire's 1759 comic masterpiece *Candide* ridiculed the "optimistic philosophy" (also called "metaphysical optimism"), which claims that "all is for the best in this, the best of all possible worlds." The book's hero tries to maintain the optimistic philosophy when faced with various problems and insults, but eventually realizes that the existing world is not really optimal. The optimistic philosophy can be harmful by discouraging critical thinking, innovation, and reform.

The optimistic philosophy reappears occasionally in various guises. For example, some people claim that current transportation and land use pat-

terns are optimal because they represent consumer preferences, and so efforts to change these patterns (called “mobility management” and “smart growth”) must be harmful (Dunn 1998; Mills 1999; “Evaluating Criticism of TDM,” VTPI 2005). There is much to be said for letting consumers make their own choices, but it is important to consider market conditions before concluding that the resulting consumption patterns are optimal. Love of markets must not be blind.

A properly functioning market is like a well-tuned machine: Consumers choose from various goods and make tradeoffs between factors such as quantity, quality, price, and location. Prices provide information about resource supply, production costs, and the value consumers place on goods. Profits give producers incentives to provide goods that consumers value, and competition encourages efficiency and innovation. The result tends to maximize societal benefits. But to be efficient, markets must reflect certain principles:

- Consumer options. Consumers need viable options from which they can choose and make trade-offs between factors such as price, quantity, quality and location.
- Cost-based pricing. Prices (what consumers pay for a good) must reflect marginal costs (what it costs to produce that good).
- Economic neutrality. Public policies (investments, taxes, subsidies, and regulations) should not favor one good or group over others, unless specifically justified.

Consumption patterns cannot be considered optimal if markets violate these principles. For example, current transportation patterns are not necessarily optimal if they result from market distortions. Reforms that shift the market toward efficiency could result in different transport patterns that make people better off overall.

This paper investigates the degree to which current transportation markets reflect market principles, and the degree to which current transport activity is socially optimal and economically efficient. Travel activity that exceeds this optimum can be considered economically excessive, which is travel that consumers would choose to forgo in a more efficient market. Because transportation is affected by the location of activities (housing, jobs, public services, etc.), this paper also investigates related land use market distortions.

Market Principles and Distortions

This section examines in detail individual market principles, the degree to which they are reflected in current transportation markets, and various types of market distortions.

Consumer Options

An efficient market offers consumers various options from which they can choose the combination that best suits their needs, as well as convenient information about available options.

Application to Transport Markets

An efficient transportation market offers various travel modes (walking, cycling, ridesharing, public transit, carsharing, delivery services, etc.), price and quality options (for example, being able to choose between cheap, basic public transport and more expensive, premium services). Similarly, efficient markets offer consumers options regarding the location of activities such as housing and shopping. Consumers also need convenient and accurate information about their options. Even people who do not currently use a particular transport or location option can benefit from having them available for possible use in the future, which economists call option value (Litman 2003). Improving non-automotive transport and location options tends to benefit physically and economically disadvantaged people in particular, and so increases equity.

Current Market Conditions

Although consumers have many options when purchasing motor vehicles and related services, they often have few options for non-automobile transport, and the options that do exist are often inconvenient, uncomfortable, expensive, stigmatized, and poorly integrated with other modes. Non-automotive transport generally has limited levels of service (for example, public transit users are seldom able to choose among various levels of service at different prices). Walking and cycling conditions are often poor, which can be a significant barrier since most public transit trips include nonmotorized links.

Similarly, there are often few options for housing and services in multi-modal locations. Those that exist are often either undesirable (located in older, degraded areas) or expensive (since so few exist, those that have a high level of neighborhood quality often command a high price). As a

result, many households choose more automobile-dependent locations than they actually prefer (NAR and NAHB 2002; Litman 2006). Anybody who doubts the inadequacy of current transport options should spend two weeks without using an automobile. With few exceptions, such as multi-modal neighborhoods in some cities and towns, non-drivers face significant problems meeting basic accessibility needs.

This is not to say that governments must provide unlimited transport services or housing options regardless of their economic viability, but it does indicate that policies which reduce transport and location options (discussed later in this paper) tend to harm consumers, and policies that improve these options, particularly affordable options suitable for use by physically and economically disadvantaged people, tend to benefit individual consumers and society overall.

Pricing

Economic efficiency requires that prices (what users pay for a good) equal marginal cost (the cost of producing that good), unless a subsidy is specifically justified. Efficient pricing tests consumer demand. For example, it would be inefficient for society to pay \$2 in road and parking facility costs to accommodate a vehicle trip that a motorist only values at \$1. Charging motorists directly for the road and parking facility costs they impose eliminates lower-value trips while improving mobility for higher-value trips.

Current Market Conditions

Motor vehicle travel imposes various costs, including vehicle ownership and operating expenses, roads and parking facility costs, traffic services, roadway land value, travel time, accident risk, congestion, and various environmental impacts (Delucchi 1996; Litman 2005). Figure 1 illustrates one estimate of these costs, including monetized estimates of non-market costs such as travel time, accident damages, and environmental impacts. These are categorized as External (imposed on other people), Internal Fixed (borne by the motorist as a fixed fee), and Internal Variable (borne by the motorist in proportion to how much they drive, which is equivalent to price).

In total, about a third of automobile costs are external and a quarter are internal-fixed, as illustrated in Figure 2. As a result, motorists perceive less than half the total costs imposed by their vehicle use when making individual trip decisions. Internal-fixed costs give motorists an incentive to maximize their vehicle travel in order to get their money's worth from their large fixed expenditures.

Put differently, motorists only receive part of the savings that result when they drive less. An efficient transportation system gives drivers the full savings produced when they reduce their mileage, providing more efficient incentive, as illustrated in Figure 3.

Figure 1. Per-Mile Costs of Automobile Use (VTPI, 2005)

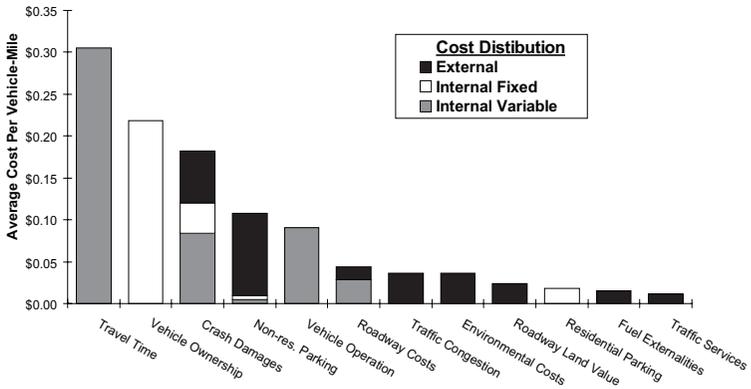


Figure 2. Average Distribution of Automobile Costs (VTPI, 2005)

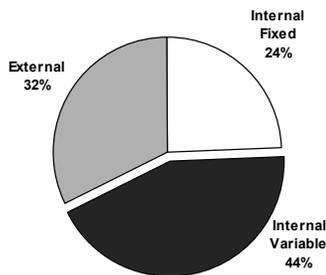
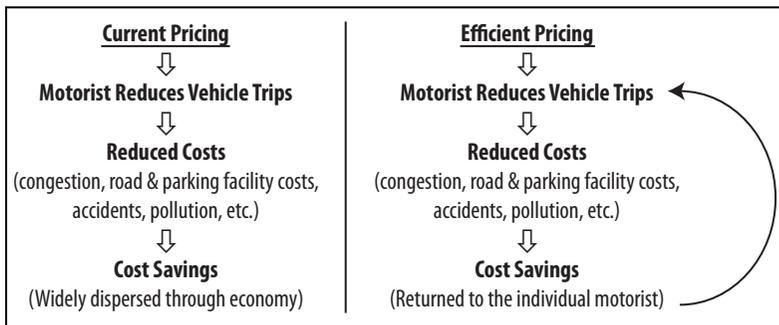


Figure 3. Efficient Pricing Rewards Motorists for Reducing Costs



Specific types of transportation underpricing are described below (Litman 2006).

Fixed Internal Costs

Most vehicle expenses are fixed costs, classified as ownership costs rather than operating costs. Vehicle depreciation is generally considered a fixed cost, although increased mileage reduces resale value and increases repair frequency. Vehicle insurance and registration fees are fixed, although the costs they represent (insurance claims and roadway expenses) increase with vehicle use. Residential parking is also an internal-fixed cost bundled with housing costs.

External Costs

Many motor vehicle costs are external. Although most people who bear these costs are themselves motorists (for example, most congestion delay and accident risk is borne by other road users), they are inefficient because individual consumers do not confront the costs they impose and so lack the incentive to reduce their impacts to optimal levels.

Parking subsidies are another significant external cost of driving averaging hundreds or thousands of dollars annually per motor vehicle (Delucchi 1996; Litman 2005; Shoup 2005). This cost is borne by governments and businesses, and therefore indirectly by consumers through higher taxes and retail prices and lower wages.

A portion of roadway costs is external. Roadway user fees, such as fuel taxes and tolls, fund about 70 percent of roadway expenses. This percentage drops when other related services, such as traffic policing, street lights, and emergency response, are included in the cost of providing roadways (FHWA 1997; DeCicco and Morris 1998). Vehicle charges would need to increase 40 to 100 percent to fund roadways and traffic services fully (Litman 2005). By convention, roadway users pay no rent or taxes for roadway land, although economic neutrality requires charging the same as on competing uses of the land. Failure to charge for roadway land underprices road transport relative to rail (which pays rent and taxes on rights-of-way), underprices transport relative to other goods (for example, housing and agriculture, both of which have high land costs), and results in overinvestment in roads (Lee 1998; Litman 2005).

Vehicle fuel production, importation, and distribution impose various external economic and environmental costs. Motor vehicle air pollution costs are estimated to average 1 to 5 cents per vehicle-mile, and more in

certain areas (Delucchi 1996; Litman 2005). Automobile use also imposes external accident costs estimated to range from 2 to 18 cents per vehicle-mile (Edlin and Mandic 2001; Blincoc et al. 2002).

Land Use Pricing

The costs of providing public services (utilities, roads, policing, schools, etc.), and environmental costs, tend to be lower in more compact, infill locations, but these savings are seldom reflected in utility rates, development fees, or taxes (Litman 2004). Efficient land use pricing would reward consumers who choose more accessible locations. Residents of such areas tend to own fewer motor vehicles and drive fewer annual miles than residents of more automobile-dependent locations.

Economic Neutrality

Economic neutrality means that public policies (planning, investments, taxes, regulations, etc.) are not arbitrarily biased to favor a particular good, activity, or group.

Application to Transportation Markets

Neutrality requires that transport planning and investment practices allocate resources equally to comparable modes and users, unless special treatment is justified for specific reasons such as equity (e.g., discounts for disadvantaged people), economic development (e.g., airport development), or other planning objectives (e.g., emergency vehicle priority). Because governments provide most transport facilities, regulate travel activity, control prices and taxes, and influence land use, public policies significantly affect transport markets. Even modest bias can leverage significant travel shifts. For example, if employee parking is income-tax exempt (an exemption worth about \$300 annually per employee), employers tend to provide free parking (a benefit worth about \$1,500 a year per employee), which typically increases automobile commuting by 15 to 25 percent, and creates more automobile-dependent transport systems and land use patterns.

Current Market Conditions

Current public policies tend to favor automobile use over other forms of accessibility in various ways described below.

Transport Planning

Current transport planning practices tend to favor automobile-oriented improvements, even when other solutions are more cost-effective and beneficial overall (“Comprehensive Transport Planning,” VTPI 2005). For example:

Performance Indicators. Conventional transport planning tends to evaluate transport based on mobility rather than accessibility, and so often results in planning decisions that reduce alternative travel options and land use accessibility (“Measuring Transportation,” VTPI 2005). For example, conventional transport planning tends to measure transport system performance primarily in terms of motor vehicle travel conditions, using indicators such as Roadway Level-of-Service, average traffic speeds, and congestion indices. Other modes are given less consideration. This skews planning decisions to favor automobile-oriented improvements, and undervalues walkability, multi-modalism, telecommuting, and land use reforms (e.g., more mixed development) as transportation improvements.

Defining “Travel Demand.” Conventional transport planning misdefines travel demand. In economics, demand refers to the relationship between price and consumption. It is a function. But transport planning often calculates demand at zero price, that is, free roads and parking. This creates a self-fulfilling prophecy: roads and parking planning decisions are made to satisfy unpriced demand, and demand grows to fill the underpriced roads and parking.

Generated Traffic. Conventional transport project evaluation often ignores the effects of generated traffic (additional traffic that occurs when roadway capacity is expanded), which tends to exaggerate the net benefits of roadway improvements and undervalue alternative congestion reduction strategies (“Rebound Effects,” VTPI 2005). One study found that transportation investment models that fail to consider generated traffic overvalued roadway capacity expansion benefits by 50 percent or more (Williams and Yamashita 1992). This skews planning decisions toward roadway capacity expansion and away from alternative solutions to traffic problems.

Limited Range of Objectives and Impacts. Conventional transport project evaluation tends to focus on a limited set of planning objectives and impacts (“Comprehensive Transport Planning,” VTPI 2005). For example, when comparing highway and transit improvements conventional evaluation often overlooks the additional downstream congestion, parking costs, accidents, and pollution that result from expanded road capacity, and similarly overlooks savings that result from shifts to alternative modes (see Table 1). Conventional evaluation often assumes that everybody (at least everybody who counts) owns an automobile that would simply

sit unused when they shift to alternative modes, and so ignores vehicle ownership savings from improved travel options. Similarly, conventional evaluation often ignores public health benefits of increased walking and cycling, community livability and walkability benefits from reduced automobile traffic, and benefits from reduced pavement coverage. These omissions skew transport planning decisions to favor automobile-oriented improvements.

Table 1. Conventional Evaluation (“Comprehensive Transport Planning,” VTPI, 2005)

Usually Considered	Often Overlooked
Traffic congestion Parking problems Vehicle operating costs Per-mile accident rates Per-mile pollution emission rates	Downstream congestion Parking facility costs Vehicle ownership costs Mobility options for non-drivers Public fitness and health Per capita crash risk Per capita energy consumption Per capita pollution emissions Community livability Barrier effect Reduced impervious surface and associated stormwater management costs and heat island effects

Limited Range of Transportation Improvement Options. Conventional transport planning tends to focus on engineering solutions and gives less consideration to management solutions, particularly those that involve new approaches, institutional changes, and complex partnerships, such as pricing reforms, marketing programs, and multi-sector cooperation.

Undervaluing Nonmotorized Transportation. Nonmotorized travel tends to be undervalued in planning and investment decisions because most travel surveys ignore or undercount short trips, travel by children, off-peak travel, and nonmotorized links of motorized trips (for example, a bike-bus-walk trip is often coded simply as a bus trip, and an auto-walk trip is coded as an auto trip, even if the nonmotorized link involved takes more time than the motorized link). Nonmotorized travel is actually two to six times more common than conventional data indicate (“Nonmotorized Evaluation,” VTPI 2005). Since most transit and rideshare trips involve walking links, this reduces the viability of these modes too.

Transport Investments

Current investment practices are biased in ways that favor automobile transport relative to alternative modes or management solutions, even when those alternatives are more cost-effective and beneficial overall (Dittmar 1998; Lee 2000; Beimborn and Puentes 2003). Although some transport funds are now flexible (they can be shifted from highway to transit and mobility management programs), a significant portion may only be used for roads (about half of all U.S. states have constitutional provisions that dedicate fuel taxes to roadways, and many Canadian provinces fund highways but not transit). Local matching rates are often lower for road project grants than for alternative modes. The availability of external roadway funding encourages transportation planners to expand highways and makes road pricing politically difficult to implement (Roth 1996). Similarly, parking facilities often have dedicated funding that cannot be used for management programs (such as including parking costs in building budgets). There also tends to be more funding for motorist safety than for pedestrian and cyclist safety (STPP 1998).

Tax Policies

Many federal, state, and local government tax policies are biased in favor of motor vehicle use. Fuel is exempt from general taxes in many jurisdictions, land devoted to public roads and parking facilities is exempt from rent and taxes, and petroleum producers are given significant tax exemptions and subsidies (Litman 2005). Business and income tax policies tend to encourage companies to subsidize automobile parking as an employee benefit, since a parking space would cost a typical employee nearly twice as much in pre-tax income as what it costs their employer to provide. Mileage reimbursement and tax exemption rates are usually higher than marginal vehicle operating costs, so employees perceive financial incentives to maximize their business driving.

Automobile-Oriented Land Use Development Policies

Many current zoning codes and development practices favor automobile-oriented land use patterns (Moore and Throsnes 1994; "Smart Growth Reforms," VTPI 2005). These include minimum parking requirements, density restrictions, single-use zoning, and automobile-oriented street designs. The result is a self-fulfilling prophecy: more automobile-oriented land use, reduced travel alternatives, more driving.

Potential Market Reforms

Various reforms can help create more efficient transportation markets.

Pricing Reforms

Various reforms can increase transport system efficiency by making prices more accurately reflect marginal cost (Litman 2005; Litman 2006). These reforms and their travel impacts are summarized in Table 2.

Table 2. Transportation Price Reforms

Reform	Typical Fee	Travel Impacts
Convert currently fixed insurance and registration fees into distance-based fees.	5–10¢ per vehicle-mile.	10% mileage reduction per affected vehicle.
Charge motorists directly for using parking facilities.	\$1–5 per trip, or 10–20¢ per vehicle-mile.	10–20% mileage reduction.
Charge motorists directly for all roadway costs, including rent and property taxes on roadway land.	5–10¢ per vehicle-mile.	10% mileage reduction.
Charge individual motorists for congested delays they cause other road users.	5–25¢ per vehicle-mile in congested conditions.	10% urban-peak, 2% total vehicle travel reduction.
Environmental fees (additional fees for air, noise and water pollution).	2–5¢ per vehicle-mile.	2–5% mileage reduction.
Fuel taxes (internalize currently external fuel production and distribution costs).	0.5–3¢ per vehicle-mile.	1–2% mileage reduction.

Transportation Planning Reforms

Least-Cost Planning (or Integrated Planning) is an approach to resource planning that implements demand management solutions whenever they are more cost effective than capacity expansion, taking into account all significant impacts (“Least Cost Planning,” VTPI 2005). This approach tends to increase investment in alternative modes and mobility management strategies for addressing transportation problems such as congestion, accident risk, and pollution emissions. Where these reforms are implemented they would probably reduce long-run per-capita automobile travel by 5 to 10 percent.

Land Use Planning Reforms

Various smart growth land use reforms include reduced and more flexible parking requirements, support for more compact and mixed land uses, public investment practices that favor infill over sprawled development, more accessible and walkable roadway design, location-based utility pricing and tax rates, and encouragement for urban infill development ("Smart Growth Reforms," VTPI 2005). These reforms could probably shift about 20 percent of households and worksites to more accessible locations where per-capita vehicle travel is 20 percent lower, resulting in a 4 percent reduction in total vehicle travel.

Summary

Table 3 summarizes the various categories of transportation market distortions.

Table 3. Summary of Transportation Market Distortions

	Description	Potential Reforms
Consumer Options and Information	Markets often offer limited alternatives to automobile transportation and automobile-oriented location.	Recognize the value of alternative modes and more accessible development in planning decisions.
Underpricing	Many motor vehicle costs are fixed or external.	As much as feasible, convert fixed costs to variable charges and charge motorists directly for the costs they impose.
Transport Planning Practices	Transportation planning and investment practices favor automobile oriented improvements, even when other solutions are more cost effective.	Apply least-cost planning so alternative modes and management strategies are funded if they are the most cost-effective way to improve transport.
Land Use Policies	Current land use planning policies encourage lower-density, automobile-oriented development.	Apply smart growth policy reforms that support more multi-modal, accessible land use development.

These categories are not mutually exclusive. There is considerable interaction and overlap among them. For example, planning and funding biases that favor roadway investments lead to automobile underpricing (i.e.,

free roads and parking) and more automobile-oriented land use patterns, which reduce travel options. As a result, it is inappropriate to simply add up the effects of individual distortions or reforms.

It is not possible to predict exactly how travel would change under a more optimal market, but automobile travel would probably decline significantly. International comparisons indicate that transport market conditions significantly affect travel patterns. For example, compared with the U.S., per-capita automobile travel is about 35 percent lower in wealthy European countries and 50 percent lower in Japan (“Transportation Statistics,” VTPI 2005), although some market distortions are still common in these countries, including fixed vehicle insurance and registration fees, free parking, and significant pollution and accident externalities. This indicates that a comprehensive set of market reforms could reduce per-capita vehicle travel even in those countries.

Possible Justifications for Distortions

Various arguments that have been presented to justify the transport market distortions identified in this paper are discussed below (Dunn 1998; Mills 1999; “Evaluating TDM Criticism,” VTPI 2005).

Consumer Preferences

Some people argue that automobile-oriented policies and high levels of vehicle travel reflect consumer preferences. But true consumer preferences can only be determined in an efficient market. Excessive vehicle travel resulting from market distortions is inefficient and harms consumers overall. Skeptics may question whether market reforms that reduce vehicle travel make society better off overall. They may ask, “Since driving provides benefits, how can reforms that reduce vehicle travel increase benefits?” The answer is that reforms give consumers more of the savings that result when they drive less. Consumers would only forgo vehicle travel that they value less than these savings. Higher-value vehicle trips would continue. The travel patterns that result from a less distorted market would reflect true consumer preferences.

External Benefits

Some people claim that external transportation costs are offset by external benefits, such as economic benefits from vehicle expenditures. But there is no reason to expect large external benefits, since rational consumers and businesses try to internalize benefits and externalize costs. For example,

businesses that provide jobs generally try to obtain concessions such as subsidies and tax discounts. Many claimed external benefits, such as jobs and tax revenues, are economic transfers rather than true economic benefits. As a result, it would be a mistake to expect external costs to be offset by external benefits.

Economic Development Benefits

People often claim that automobile-oriented policies support economic development, but most examples they cite reflect economic transfers (one group benefits at another's expense) rather than net productivity gains. When the roadway, vehicle, and petroleum industries were first developing (from 1900 until about 1950) underpricing may have helped achieve economies of scale (i.e., you benefited if your neighbors drive more because this reduces your costs), but such economies no longer exist; there are now diseconomies of scale, at least for urban peak travel (you now benefit if your neighbors use alternative commute modes because this reduces your congestion costs). Mobility management tends to support economic development ("Economic Development Impacts," VTPI 2005).

Cost Uncertainty

Critics of transport market reforms sometimes argue that motor vehicle costs (particularly non-market environmental impacts) are difficult to quantify and so it is impossible to determine optimal prices ("Criticism of Transportation Costing," Litman 2005). However, many of the proposed reforms reflect well-studied economic costs (insurance, roads, parking, land values), and have been endorsed by professional organizations.

Transaction Costs

Some degree of underpricing is justified due to transaction costs (costs to governments and businesses of collecting fees and costs to motorists of paying fees). It may not be cost effective to charge motorists for small fees, or at dispersed destinations, or to disaggregate fees into small increments. However, new electronic pricing systems can greatly reduce transaction costs and allow more precise and flexible fees (for example, rates that vary by time, location, and vehicle type, with special need-based discounts).

Equity and Affordability

Motor vehicle underpricing is often justified to make driving affordable to lower-income households. User fees such as road tolls, parking fees, and

higher fuel taxes are considered regressive. But the equity impacts of such charges actually depend on available travel options and how revenues are used. If consumers have good alternatives to driving and revenues benefit lower-income households (they replace regressive taxes, fund services that benefit the poor, or provide cash rebates), higher user charges can be neutral or progressive overall (“Pricing Evaluation,” VTPI, 2005). Transportation market distortions tend to be regressive because they reduce travel options for non-drivers and force people who drive less than average to subsidize others who drive more than average. For these reasons, distortions that favor automobile travel are inappropriate ways to increase equity.

Other Subsidies

Some people argue that automobile subsidies are justified to balance public transit subsidies (Cox 2004). Although transit subsidies may appear large, a significant portion are justified on equity grounds (to provide basic mobility to disadvantaged people) and efficiency grounds (as a second-best solution to reducing problems such as traffic congestion, and to take advantage of economies of scale). Because motorists travel more miles than non-drivers, and automobile transportation imposes so many costs, motorists tend to impose larger external costs than non-drivers when measured per capita. When properly evaluated there is little evidence that transit travel is subsidized more than automobile travel (“Transit Evaluation,” VTPI 2005).

These arguments do not appear to justify current transport market distortions. Although it may not be possible to create absolutely perfect transportation markets, it is possible to reform current markets to significantly increase efficiency. To the degree that efficient market reforms are not implemented and distortions continue, blunter strategies to control vehicle travel and reduce sprawl may be justified on second-best grounds. For example, without efficient pricing, it may be appropriate to limit vehicle travel with regulations, to subsidize otherwise unjustified public transit services, and to impose urban growth boundaries.

Conclusions

Efficient markets create harmony between individuals and society. Such markets internalize costs so society is not harmed when consumers increase their motor vehicle travel. Market distortions spoil this harmony. Current transport and land use markets are distorted in various ways that lead to economically excessive vehicle travel, impose external costs, and create conflicts. Although motorists directly benefit from the additional mileage, it imposes indirect costs that makes most people worse off overall.

These impacts are cumulative and synergistic (total impacts are larger than the sum of individual impacts). For example, underpriced parking not only increases parking facility costs, it also increases traffic congestion and accident costs, while underpricing road space increases parking costs and pollution emissions. Transport market distortions reinforce a cycle of increased automobile dependency, reduced consumer options, increased sprawl, and increased total costs.

Market reforms can lead to more efficient transportation and land use patterns. Many transport problems are virtually unsolvable without reforms. Such reforms tend to be particularly beneficial to physically and economically disadvantaged people, who experience constrained options and high costs due to automobile-dependency.

Analyzing market distortions can be difficult and is somewhat subjective. Many distortions appear justified to individual decision-makers. Zoning laws, planning practices, and tax structures were created to achieve certain social objectives. Pricing incurs transaction costs. It is not possible to provide all travel options everywhere. Whether a particular distortion is a “significant problem” depends on perspective and assumptions. As a result, it may be infeasible to eliminate all transport market distortions, but efficiency can improve significantly with certain reforms that convert currently fixed costs into variable charges, internalize currently external costs, apply least-cost planning and investment practices, and create more multi-modal, accessible communities.

These reforms would not eliminate automobile travel. Much driving provides benefits that exceed costs and so would continue in an efficient market. But a significant portion of driving consists of lower-value vehicle travel that consumers would willingly forgo if they were offered better transport options and demand were tested with prices. In a more efficient market, consumers would drive less, rely more on alternative modes, and be better off overall as a result.

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Todd Littman is founder and executive director of the Victoria Transport Policy Institute, an independent research organization dedicated to developing innovative solutions to transport problems. His work helps to expand the range of impacts and options considered in transportation decision-making, improve evaluation techniques, and make specialized technical concepts accessible to a larger audience. His research is used worldwide in transport planning and policy analysis.

Mr. Litman is author of the Online TDM Encyclopedia, a comprehensive Internet resource for identifying and evaluating mobility management strategies. He has worked on numerous studies that evaluate the costs and benefits of various transportation services and activities. He authored *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*, a comprehensive study of transport impacts, which provides cost and benefit information in an easy-to-apply format.

Todd is active in several professional organizations, including the Institute of Transportation Engineers, the Transportation Research Board (a section of U.S. National Academy of Sciences) and the Centre for Sustainable Transportation. He is a member of the Editorial Advisory Board of *Transportation Research A*, a professional journal.

The Impact of Urban Form on Travel Behavior: A Meta-Analysis

Eran Leck

Abstract

A common viewpoint held by many New-Urbanist and Neo-Traditional planners is that characteristics of the built environment, such as population density, mixed land use settings and street configuration, exert a strong influence on travel behavior. The empirical evidence for this relation, however, as portrayed in many primary studies, is somewhat mixed. This paper offers an application of statistical meta-analysis in an attempt to settle the contradictory findings reported in the single studies. The findings reaffirm the role of residential density as the most important built environment element influencing travel choice. The findings also reinforce the land use mixing component of the built environment as being a strong predictor of travel behavior. The findings do not, however, support the most controversial claim of the New Urbanism regarding the role of street pattern configuration in influencing travel behavior.

Introduction: The Built Environment–Travel Connection

Over the past two decades, many communities, cities and metropolitan areas across North America have embraced new design approaches [New Urbanism (Katz 1994), Neo-Traditional Development (Duany and Plater-Zyberk 1992), and Transit Oriented Development (Calthorpe 1993)] in an attempt to reduce the negative social, economic, and environmental impacts of urban sprawl. These planning concepts can be summed up as an effort of reorienting fringe development toward patterns reminiscent of U.S. communities prior to World War II (Ryan and McNally 1995). The key design strategies employed by the Neo-Traditional, New Urbanism and Transit Oriented Development (TOD) approaches include:

- Compact and dense residential and employment development.
- Diverse mix of activities and housing options.
- Concentration of residences and jobs in proximity to transit stations and commercial businesses.

- Design of smaller buildings, blocks and narrower roads at the neighborhood scale.
- Highly connected roads (grid layout), sidewalks and paths, allowing relatively direct travel by motorized and non-motorized modes.
- A clearly defined center with public space, public buildings, a transit stop, and retail businesses.
- Public open spaces in accessible locations (Calthrope 1993; Katz 1994; Bernick and Cervero 1997; Niles and Nelson 1999; Lund 2003).

The main argument put forward by the proponents of these design approaches is that the characteristics of the built environment have a direct impact on the scope of travel (e.g. vehicle miles traveled, vehicle hours traveled, travel frequency) and on mode choice (walking, cycling, using the private car, or riding transit).

Past Research on the Impacts of Urban Form on Travel

A considerable body of literature now exists on the impacts of urban form on travel behavior. Crane (1996) argues that creating a typology of the impact of the built environment on travel could be useful in understanding the subject. According to Crane, studies on the influence of urban form on travel behavior can be usefully organized by:

- Compact and dense residential and employment development.
- Travel purpose (journey-to-work, shopping, trip chaining, etc.)
- Analytical method (simulations, regressions, etc.)
- Choice of explanatory variables (travel costs, travel opportunities, socio-economic characteristics, etc.)
- Nature and level of detail in the data (aggregated, disaggregated).
- Characterization and measures of urban form (street layout, composite measures of density, mixed use, pedestrian features, etc.)

The typology presented below, follows Crane's latter proposal. This type of classification is especially suitable for the empirical method chosen in this paper (meta-analysis), since it provides a simple framework for identifying and understanding the relationship between the various components of the built environment (independent variables) and travel behavior.

Residential and Employment Densities

The significance of population and employment densities as predictors of travel behavior is almost undisputable. Many studies dealing with the

impact of urban form on travel have found the density measure to be, by far, the strongest predictor of travel behavior amongst all of the other built environment measures. One of the earliest studies on the effects of urban form on travel was conducted by Levinson and Wynn (1963), who find that neighborhood density substantially reduces vehicle trip frequency. Pushkarev and Zupan (1977) confirm that population density is a decisive factor in justifying investments in heavy rail transit systems. To support high-frequency light rail service, for instance, Pushkarev and Zupan conclude that densities of at least nine dwelling units per acre within a 15 mile radius of a downtown would be required (Cervero and Radisch 1996). A study in Portland by 1000 Friends of Oregon estimates that an increase in 20,000 jobs within a 20-minute commuting distance by car will reduce daily household vehicle miles traveled (VMT) by half a mile while increasing the number of daily auto trips by one-tenth of a trip. The same increase in jobs within a 30-minute commuting distance by transit was estimated to reduce daily VMT a bit more, to six-tenths of a mile, and the number of daily car trips by one-tenth of a trip (1000 Friends of Oregon 1993). A similar study to that of the 1000 Friends of Oregon report was conducted by Holtzclaw (1994). Using the 1990 U.S. Census of Population and Housing for 28 communities in California, Holtzclaw measures the influence of neighborhood characteristics on auto use. The reported regression coefficient on density in his study was 0.25, suggesting that doubling the density will reduce both the number of cars per household and the VMT per household by about 25 percent.

A small number of studies, however, find the impact of density on travel to be fairly weak. A study by Schimek (1996), which used data from the 1990 Nationwide Personal Transportation Survey, finds that density matters, but not by much. A 10 percent increase in density was projected to lead to only a 0.7 percent reduction in household automobile travel. By comparison, a 10 percent increase in household income was projected to contribute to a 3 percent increase in automobile travel. Studies conducted at the neighborhood level by Cervero and Kockelman (1997) in San Francisco and by Greenwald and Boarnet (2001) in Portland find that density has a modest and only a local effect on travel. Higher densities only marginally reduced the probability for commuting by car and slightly increased the probability for walking and riding transit.

Land Use Mix

The assertion that land-use mixture, that is the intermingling of offices, shops, public open spaces, and other consumer amenities amongst one another, yields some transportation benefits is almost undisputable in the literature. The assumption is that in mixed used settings people will be less likely to drive and more likely to walk to their destinations. This behavior

presumably should be reflected in lower vehicular trip generation rates and higher non-motorized modal splits.

Many studies show that mixed land use settings have a significant impact on the travel choices of individuals. However, the nature of this relationship is much more complex than other urban form factors, such as population or employment densities, and the results reported in various studies with regard to the influence of land use mix on travel tend to be subject to much larger variation. The main reason for this variation is that there is neither a simple way to define what a "mixed environment" is nor a clear-cut method of how to quantify it. Although some progress has been made in recent years to address this issue [see for example the dissimilarity index proposed by Kockelman (1997)], the inherent subjectivity of what represents mixed land use will likely result in continued variation in approaches to its quantification.

Recent research by Cervero (2002), conducted in Montgomery County, Maryland, finds that mixed land use settings exert a strong influence on travel behavior. His study shows that intensities and mixtures of land use significantly influence decisions to drive-alone, share a ride, or patronize transit. A previous study, also by Cervero (1996), which examined the impact of mixed land use on travel choices at a more aggregated level (i.e., the 44 largest U.S. metropolitan areas), finds that having grocery stores and other consumer services within 300 feet of one's residence tends to encourage commuting by mass transit, walking and bicycling, while controlling for such factors as residential density and vehicle ownership. Contrary to these findings, Crane and Crepeau (1998) find little role for land use mixture in explaining travel behavior. Mixed use settings were not found to be significantly correlated with fewer car trips or lower car mode splits.

The unanswered question in the built environment - travel studies (as in any other statistical study investigating the relationship between independent and dependent variables) is that of causation. Although many studies show strong correlations between the two elements, it is not clear whether attributes of the built environment, such as high residential densities and mixed land use settings actually contribute to lower VMT and higher slow mode and transit shares. It is possible that this relationship is due to the fact that people choose to reside in high density and mixed environments because they prefer to drive less.

Street Pattern

The street pattern plays a key role in many of Neo-Traditional and Transit-Oriented Development plans. The assumption is that designing smaller

blocks, continuous sidewalks and highly connected roads (grid layout) will reduce automobile trips, automobile frequencies and VMT, and will generate greater pedestrian traffic (Crane 1996; Ryan and McNally 1995; Plaut and Boarnet 2003). This assumption however is probably the most controversial and highly debated hypothesis of the urban form-transportation connection. The empirical evidence collected from many studies draws indecisive conclusions with regard to the impact of street pattern designs on travel behavior.

Perhaps the most typical transportation feature of Neo-Traditional and New Urbanist plans is a grid street layout, in contrast to the looped cul-de-sac pattern. Calthorpe's (1993) assertions about the transportation benefits of his suburban designs depend heavily on the study of Kulash et al. (1990) that traditional grid circulation patterns reduce VMT by 57 percent as compared to VMT in other street networks. The more complex simulation studies of McNally and Ryan (1992) similarly report less driving in a rectilinear grid street system (Crane 1996). A simulation study conducted by Gat et al. (2005), in a highly auto dependent urban district near Tel Aviv, Israel, has predicted that a "pre-emptive TOD styled design initiative," characterized by a highly connected grid network and mixed land usage, could shift slow mode splits to a 40 percent share, as compared to a 5 percent share in the "business as usual" alternative.

The results of the simulation studies conducted by Kulash et al. (1990) and McNally and Ryan (1992) have come under sharp criticism. Crane (1996) claims that the evidence concerning the transportation benefits of the grid pattern is weak at best, and contradictory at worst. He argues that those studies supportive of the proposition that "grid patterns reduce car use" tend to have serious flaws, such as assuming that trip frequencies do not vary from one design to another, or failing to isolate the independent influence of the street pattern on travel behavior.

Other commonly investigated features of the street pattern include sidewalk and cycling path ratios. The assumption is that higher shares of these indicators will contribute to higher rates of slow mode trips. Cervero (2002), in a study conducted in Montgomery County, Maryland, finds that neighborhoods with fairly well developed sidewalk infrastructure appear to have influenced mode choice to some degree, seemingly by providing more attractive settings for taking a bus or joining a vanpool. Contrary to these findings, a study by Rodriguez and Joo (2004), which examined the relationship between travel mode choice and the attributes of the street pattern (sidewalk availability, presence of walking and cycling paths) in areas which were in close proximity to the University of North Carolina at Chapel Hill, finds the influence of these attributes on mode choice to be fairly weak.

The empirical evidence on the impact of urban form on travel is mixed. Although a considerable consensus has been reached with regard to the impact of population and employment densities on trip generation and mode choice, a great deal of ambiguity is still left concerning the influence of street pattern characteristics and land use mix on travel behavior. This issue of inconclusive and inconsistent studies is problematic, but solvable. In the past three decades, a number of statistical techniques have been formulated in order to resolve the apparent contradictions in research findings. The best known technique was developed by Glass (1976), who introduced a method of translating results from different studies to a common metric. He coined the term "meta-analysis" and distinguished it from primary analysis and secondary analysis.

Meta-analysis: Main Principles and Procedures

Meta-analysis is a package of statistical procedures designed to accumulate and integrate experimental results across independent studies that address a related set of research questions. Unlike traditional research methods, meta-analysis uses the summary statistics (correlation coefficients, P values, Z Scores, t values, sample size, etc.) from individual primary studies as the data points. These procedures allow one to determine the strength and direction of associations between the independent and dependent variables. Meta-analysis is particularly suitable in cases where research outcomes are to be judged or compared (Lyons 2003; Hunter and Schmidt 1990; Hedges and Olkin 1985). In this context, standard regression methods or, in the case of categorical data, discrete choice methods are often employed (Nijkamp and Pepping 1998).

There are two main methods for conducting a meta-analysis. The first method involves the combination of probability values, Z scores or correlations. In this procedure the correlation coefficients are either combined by the use of simple average, or by "weighted" average according to the sample size of each primary study (Lyons 2003). An alternative approach for this method is Fisher's transformation. In this statistical procedure, the correlation coefficients are first transformed to Z scores. This step ensures the normality of the distribution sample.

Glass (1976) and Cohen (1977) have developed a second method of meta-analysis that does not rely on the combination of Z-scores or probability values as the common metric. Instead, this method uses standardized differences between mean scores (effect size – d) as the combinatorial statistic. The effect size is a quantitative index, equivalent to the difference between means, used to measure the magnitude and direction of relations between independent and dependent variables.

The Application of Meta-analysis in Transportation and Urban Planning

Over the span of three decades, meta-analysis has grown from a fairly unknown statistical method, used only in few research fields (e.g. education, clinical psychology, medical sciences), to a very common technique for conducting empirical research in many of the social science disciplines.

In recent years, more than a dozen studies have applied meta-analytical methods in an attempt to settle contradictory findings in the urban and transportation planning fields. Nijkamp and Pepping (1998) have offered an application of meta-analysis for analyzing the critical success factors of urban energy policies and sustainable city initiatives. Debrezion et al. (2003) have used the method in an attempt to measure the aggregated impact of railway stations on residential and commercial property values. The database for their research was based upon 70 underlying cross-sectional studies that varied in their geographical settings (United States, Canada, and Europe), and time scale (early 1970s through 2002). Results of the meta-analysis show that commuter railway stations have a consistently higher positive impact on property values than light and heavy railway/metro stations. Other applications of meta-analysis in regional science and urban and environmental economics can be found in Van den Bergh and Button (1997), Button and Kerr (1996), and Button and Nijkamp (1997).

It appears that only two studies have used meta-analysis in an attempt to reach a more clear-cut conclusion regarding the built environment–travel connection. In a form of meta-analysis, Ewing and Cervero (2001) estimated elasticities for VMT and vehicle trips based on the results of published studies. Four measures of the built environment were used: density, diversity, design and regional accessibility. The results of the meta-analysis showed a statistically significant, but rather weak connection between urban form variables and travel behavior. A 10 percent increase in local density and local design, for example, was associated with a 0.5 percent decline in vehicle trips, and a 10 percent increase in local diversity was associated with a 0.3 percent fall in vehicle trips and a 0.5 percent decrease in VMT. The authors note that although these elasticity values are not large in absolute terms, they are significantly different from zero, and the cumulative effects of regional accessibility, density, diversity, and design are actually quite large.

Ewing (2005) examines the effect of the built environment on physical activity levels and health related issues (e.g. Body Mass Index, obesity). His research investigated the association between compact development patterns and the use of active travel modes such as walking and transit, after controlling for the amount of reported leisure time walking. In the final stage of his research, Ewing conducted a meta-analysis of travel

elasticities with respect to land use density, diversity, and design. The elasticities derived suggest that for every 1 percent increase of measures of density or design, the percentage of trips made on foot rises by approximately 0.45 percent.

Potentials and Pitfalls of Meta-analysis

One of the great advantages of meta-analysis is that it provides the opportunity to view the 'whole picture' in a research enterprise. It keeps the researcher from relying on the results of a single study in attempting to understand a phenomenon. Meta-analysis allows a more objective appraisal of the evidence than traditional narrative reviews and may explain heterogeneity or the similarities and differences among the methodologies and the results of various individual studies (Egger and Smith 1997).

Another major benefit of meta-analysis is that by accumulating results across studies, one can enlarge the sample size of the research, gain a more accurate representation of the population relationship and a higher statistical significance than one achieved in a single underlying study. In this context, Rosenthal and DiMatteo (2001) argue that pulling together the results of only two studies, even if they are less statistically significant, provide much more powerful evidence against the null hypothesis than the results of a single study that is more statistically significant. Meta-analysis thus provides the opportunity for even smaller and less significant effects to contribute to the 'overall picture' of the research.

Meta-analysis has been criticized in a number of ways. First, it has been argued that published findings are highly selective and do not represent the "state of the art" accurately. Researchers are inclined to report findings that are statistically significant and to neglect those that are not. Journal editors tend to reject submitted manuscripts which do not include statistically significant findings due to the high competition for journal space. Second, meta-analysis has been criticized for "garbage in and garbage out," that is the mixing together of "good" and "bad" studies (Hunt 1997). Third, meta-analysis has been reproached for mixing "apples and oranges." This claim is due to the fact that the procedure involves summarizing results from studies that vary in their modeling techniques, in the measurement of independent and dependent variables, and that employ very different types of sampling units to achieve answers to questions that are similar, though often not identical (Schwarzer 1989; Hunt 1997).

Research Design

In light of the problem of mixed empirical evidence, this research attempts to settle the contradictory findings reported in the single studies and reach

more robust conclusions with regard to the outstanding questions of the effects of density, land use mix and street pattern configuration on travel behavior.

The Application of Meta-analysis in Light of the Main Critiques

Before specifying the research approach, it is appropriate to explain the justification of using meta-analysis in this research in light of the three main critiques of the method. The first criticism suggests that meta-analysis is prone to publication bias either because journal editors tend to reject insignificant results or since authors are likely to report only significant findings. This constraint, known as the “file drawer problem,” has much more to do with publication ethics than with the actual “problematic nature” of the procedure itself. Any evaluation tool, be it meta-analysis or a different method, can only make inference on what is known and reported. The “file drawer problem” is even less relevant within the particular context of the land use–travel connection due to the raging debate within the planning community regarding the impact of the built environment on travel behavior. As can be seen from the literature review section, highly critical studies, which show insignificant relationship between built environment characteristics and travel behavior indicators, are almost as abundant as studies that show strong and robust connection between the two elements.

The second critique contends that meta-analysis mixes together “good” and “bad” quality studies. This criticism is more relevant to medical or clinical studies, where the methodological quality of the study is determined by the method of allocating the population to treatment or control groups (random allocation is considered to be of high quality and non-random allocation of low quality). Glass, McGaw, and Smith strongly disagree with the “garbage in, garbage out” critique and argue that proper meta-analytic procedures do not prejudice the quality of studies for selection purposes: “The influence of study quality on findings should be regarded as an empirical a posteriori question, not an a priori matter of opinion or judgment used to exclude large numbers of studies from consideration” (Glass, et al. 1981). This meta-analysis research has avoided the use of simulation studies, which were often criticized for exaggerating the effect of built environments characteristics on travel behavior. Concurrently, studies which did not control for socio-demographic effects were also excluded from the meta-analysis.

The third main critique of meta-analysis is that the procedure “mixes apples and oranges.” This claim is true in a sense because the various primary studies used in the meta-analysis often employ different statistical procedures and measure their independent and dependent variables in a

dissimilar manner. In many of the meta-analyses conducted in the social sciences, as in the case of this particular research, the underlying studies are also drawn from different populations and vary in their geographical settings and scale. An answer to the “apples and oranges” criticism can be quite simple. It can be argued, as Rosenthal and DiMatteo (2001) correctly note, that it is a good thing to mix apples and oranges, particularly if one wants to generalize about fruit (density, land use mix and street pattern configuration), and that studies that are exactly the same in all respects are actually limited in generalizability.

Any statistical procedure can be misused, and meta-analysis is no exception. Today there is no longer serious criticism that rejects meta-analysis methodology. In the context of the transportation and urban planning fields, Nijkamp and Pepping (1998) note that “meta-analysis has clearly demonstrated its validity and usefulness as a methodological tool for comparative study in the field of transport science and environmental science.”

Research Approach

This meta-analysis research aggregates the findings of various primary studies in an attempt to estimate the overall impact of built environment characteristics on travel behavior. Five urban form variables (residential density, employment density, land use mix, sidewalk ratio, and grid percentage) and seven travel variables (VMT, VHT, vehicle trips, non-work vehicle trips, probability of commuting by automobile, transit, or by walking) were included in the meta-analysis.

The main problem encountered in the design of the research involved the characterization of the independent variables. Many of the built environment variables used in the various primary studies were defined and quantified in a dissimilar manner. Some studies, for example, have defined density as “the number of households per acre,” and others have defined it as “the number of residents per squared mile.” The variation in the measurement of the land use mix was even greater, since every study used a different index to measure it. Due to the fact that there is no simple way to overcome this problem, the decision was made to focus only on the nature and direction of the relationship (significance and coefficient sign). The treatment of the dependent (travel) variables was easier since all of the studies have used common measurements such as vehicle trip frequency, or VHT. Other travel variables such as VMT and VKT (both of which denote travel distance) and the probability of commuting by a certain mode and the percent of trips made by a certain mode (both of which represent mode choice) were pooled together in order increase the sample size.

The meta-analysis method used in this research to estimate the combined effect of the various urban form components on travel behavior involved the aggregation of probabilities according to the weight (sample size) of each underlying study. Summary statistics, containing data such as correlation coefficients, P values, Z values, t values and sample sizes were collected from each primary study. The reported Z (probit models) and t values (OLS multiple regression, logit models) in each study were used to calculate normal distribution probabilities. In some cases, the Fisher's r to Z transformation was used in order to translate the correlations coefficients into Z scores and obtain the normal distribution probability.

Research Data

The research is composed of 17 different primary studies, which supplied a total of 32 unweighted data points to the meta-analysis, as shown in Table 1. It is important to note that preliminary search revealed over 40 published studies on the impact of urban form on travel behavior, but because of statistical and methodological constraints only half of them were used in the final analysis. This paring was primarily due to the exclusion of key summary data (which serve as inputs for the meta-analysis) and socio-demographic factors used as control variables in the underlying studies.

Most of the primary studies were located using electronic databases. The very thorough and comprehensive synthesis study by Ewing and Cervero (2001), which explored the effects of the built environment on key transportation outcomes, has also aided in identifying relevant data. Studies were included in the meta-analysis if they were published in the last fifteen years in the United States and assessed any of the three characteristics of the built environment (density, land use mix, and street pattern configuration) in relation to travel behavior. The original seventeen studies were carried out at the neighborhood, urban or regional levels, and their statistical information was drawn from census tract data (CT), transportation/traffic analysis zone data (TAZs), or from specifically-tailored surveys. Although the various primary studies differ from each other in many respects, there is still considerable logic in combining their results. Cervero and Ewing (2001) supply this rational in their synthesis study. They report that built environment–travel elasticities obtained from studies conducted by “different methodologies in different geographic areas for different time periods” tend to cluster around common values.

Table 1: Summary of the Primary Studies Used in the Meta-Analysis

Author(s)	Study Area	Estimation Method	Sample Size	Dependent Variable	Independent Variables
Cervero, 1994a	San Francisco	OLS regression	27	Percent of trips by rail transit (mode split)	Station distance (feet), density (DU per acre), land use mix, continuous sidewalks
Cervero and Gorham, 1995	Los Angeles	OLS regression	1,636	Percent of work trips by transit (mode split)	Gross residential density (HH per acre)
Cervero, 2002	Montgomery County, Maryland	Binomial logit	427	Mode choice: drive alone, work trips	Gross density (squared miles) origin and destination, land use diversity - origin and destination, ratio of sidewalks - origin and destination
" "	" "	" "	1,960	Mode choice: transit, all trips	" "
Frank et al., 2000	Seattle	OLS regression	1,700	Vehicle miles traveled	Gross residential density origin (HH per acre)
" "	" "	" "	" "	Vehicle hours traveled	" "
" "	" "	" "	" "	Vehicle trip frequency	" "
Ewing, 1995	Palm Beach County	OLS regression	548	Vehicle hours traveled	Gross residential density origin (HH per acre), gross employment density (jobs per acre), origin and destination
Schimek, 1996	Different US cities	OLS regression	15,916	Vehicle trip frequency	Gross population density (persons/sq km)
" "	" "	" "	" "	Vehicle miles traveled	" "
Cervero, 1991	Different US cities	OLS regression	52	Percentage of work trips by private car	Mixed use
" "	" "	" "	39	Percentage of work trips by mass transit	" "
" "	" "	" "	" "	Percentage of work trips by walking	" "
Kockelman, 1997	San Francisco	OLS regression	8,050	Total vehicle kilometers traveled	General mixed use
" "	" "	" "	6,311	Non-work VKT	" "
" "	" "	MNL	52,650	Mode choice: personal vehicle choice	Gross residential density (HH per acre) - origin and destination, gross employment density (employees per acre) - origin and destination
Boarnet and Sarmiento, 1998	Southern California	Ordered probit	432	Number of non-work automobile trips	Percent grid, population density (1,000 persons/sq mile), retail density (retail jobs/sq mile), service density (service jobs/sq mile)

Table 1: Summary of the Primary Studies Used in the Meta-Analysis (cont'd)

Author(s)	Study Area	Estimation Method	Sample Size	Dependent Variable	Independent Variables
Sun et al., 1998	Portland	OLS regression	300	Trip frequency	Employment density
" "	" "	" "	" "	Vehicle miles traveled	Land use balance
1000 Friends of Oregon, 1993	Oregon	OLS regression	2,223	Vehicle miles traveled	Number of households per zonal acre, employment per zonal acre, percent of commercial buildings
Crane and Crepeau, 1998	San Diego	Ordered logit	1,336	Household car trip frequency	Connected street pattern (grid), mixed street pattern (grid + cul de sac)
" "	" "	Ordered probit	" "	Car mode choice	" "
Greenwald and Boarnet, 2001	Portland	Ordered probit	1,083	Non-work walking trips	Zip population density per square mile, zip retail employment density
" "	" "	OLS regression	1,089	Non-work walking trips	Block population density, percent grid, census tract retail employment density
Cervero, 1994b	Different cities in California	OLS regression	17	Percent of work trips by rail	Employment density
Frank and Pivo, 1995	Washington state	OLS regression	1,000	Percent of trips by private car	Employment density, population density, mixing of uses
" "	" "	" "	" "	Percent of trips by transit	Employment density, population density, mixing of uses
" "	" "	" "	" "	Percent of trips by private car	Employment density, population density, mixing of uses
Cervero, 1996	11 US metropolitan areas	Binomial logit	9,823	Probability of commuting by automobile	Residential density, mixed land use
" "	" "	" "	15,258	Probability of commuting by public transit	" "
" "	" "	" "	9,805	Probability of commuting by walking or bicycling	" "
Cervero and Duncan, 2002	San Francisco	Nested logit	7,836	Probability that a trip will be made by walking	Land use diversity, origin and destination

Research Findings

The results of 18 meta-analysis tests, sorted according to the three main built environment characteristics discussed in the literature review section, are summarized in Tables 2 through 4. Each column represents an explanatory built environment variable and each row represents a dependent travel variable. Four summary statistics are presented for each of the 18 meta-analyses. They include the number of primary studies used in each test (# Studies), the total sample size (N), the coefficient sign (Sign), and the significance (Sig.) of the association between the urban form and travel variables. The number of primary research projects used in each meta-analysis ranges between two to six studies. Although this number seems to be quite small, it is important to remember that the combination of only two studies in the meta-analysis procedure provides much more powerful evidence against the null hypothesis than the results of a single study (see Rosenthal and DiMatteo 2001). A final comment is related to the question of causation. The conclusions in this section follow the supposition made in all primary studies, assuming that the characteristics of the built environment influence travel behavior and not vice-versa.

Residential and Employment Densities

Table 2 presents the meta-analysis results for the linkage between densities and travel behavior. The reported findings reaffirm the role of residential density as being the most important built environment element which influences travel choices. Residential densities were found to be overwhelmingly significantly and negatively correlated with VMT/VKT, VHT, total vehicle trips, and with the probability of commuting to work by automobile. The density element was also found to be statistically significant and positively correlated with the probability of commuting to work by transit, or by walking and cycling.

Employment density was found to exert a strong influence on travel behavior. Higher employment densities were found to be significantly connected with fewer VMT/VKT and total vehicle trips, and with a lower probability of commuting to work by automobile. Higher employment densities were not, however, found to be significantly linked with lower Vehicle Hours Traveled. This may be due to the fact that VHT is a more sensitive variable, in a sense that it does only reflect traveled distance, but also takes into account travel time or congestion conditions. Thus, in highly congested regions, the linkage between density (at trip end) and VHT may be less clear.

High employment densities were found to be significantly associated with higher probabilities of commuting to work by transit or by slow modes.

The main reason for the strong influence that employment density has on mode choice is due to the fact that the clustering of jobs, especially in close vicinity to bus or rail stations, allows people to either use transit or car pool to work. In areas which are characterized by high employment densities as well as by other mixed land uses (especially residential use), there is also a much greater chance for commuting by slow modes of walking and cycling.

Table 2. Meta-Analysis Results for the Relationship between Density and Travel Variables

	Gross Residential/Population Density (Origin)		Gross Employment Density (Destination)	
	N	#Studies	N	#Studies
VMT/VKT	19839	3	3923	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	P<0.001	-
VHT	2248	2	2248	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	NS	-
Vehicle Trips	17616	2	2000	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	P<0.05	-
Vehicle Trips (non work)			N	#Studies
			864	2
			Sig.	Sign
			NS	-
Probability of Commuting by Automobile / Percent of Trips by Automobile	73296	4	53650	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	P<0.001	-
Probability of Commuting by Transit / Percent of Trips by Transit	35139	6	1017	2
	Sig.	Sign	Sig.	Sign
	P<0.001	+	P<0.001	+
Probability of Commuting by Walking / Percent of Trips by Walking	21693	4	2083	2
	Sig.	Sign	Sig.	Sign
	P<0.001	+	P<0.01	+

NS – not significant at the 5 percent level

Mixed Land Use

If any doubts exist with regard to the influence of land use mixing on travel behavior, they are repudiated in this study. As can be seen from Table 3, the influence of mixed land use on travel was found to be overwhelmingly significant.

Table 3. Meta-Analysis Results for the Relationship between Land Use Mix and Travel Variables

	Land Use Mix	
	N	#Studies
VMT/VKT	10573	3
	Sig.	Sign
	P<0.001	-
Probability of Commuting by Automobile/ Percent of Trips by Automobile	N	#Studies
	10875	3
	Sig.	Sign
	P<0.001	-
Probability of Commuting by Transit/ Percent of Trips by Transit	N	#Studies
	18284	5
	Sig.	Sign
	P<0.001	+
Probability of Commuting by Walking/ Percent of Trips by Walking	N	#Studies
	18641	3
	Sig.	Sign
	P<0.001	+

NS – not significant at the 5 percent level

Land use mix is negatively associated with VMT and with the chance of commuting by automobile, and positively linked with the probability of commuting to work by transit or by slow modes. This finding is mainly due to the fact that the intermingling of residences, jobs, shops, and recreational facilities in a compact urban environment induces people to carry out their daily activities within a much smaller geographical area, thus on the one hand reducing VMT while on the other hand increasing the probability of traveling by slow modes.

Street Pattern

Table 4 shows the relationship between two street pattern elements (grid percent coverage and sidewalk ratio) and travel behavior. It is important to note that relatively few non-simulation studies have investigated the

impact of street pattern configuration on travel behavior. The linkage between these two elements was found to be insignificant.

Table 4. Meta-Analysis Results for the Relationship between Street Network Configuration and Travel Variables

	Ratio of Sidewalks		Percent Grid	
			N	#Studies
Probability of Commuting by Automobile/ Percent of Trips by Automobile			3025	3
			Sig.	Sign
			NS	+
Probability of Commuting by Transit/ Percent of Trips by Transit	N	#Studies		
	1987	2		
	Sig.	Sign		
	NS	+		

NS – not significant at the 5 percent level

The existence of a higher sidewalk ratio in an urban environment was not found to be related to higher probability of commuting by transit. The New Urbanist assumption that a larger sidewalk ratio will encourage walking to transit stations and thus boost transit use does not seem to hold water. The effect of grid percent coverage on the probability of commuting by automobile, although not significant at the 5 percent level, was somewhat surprising. The coefficient is positive, suggesting that higher grid percent coverage raises the probability for commuting by car, and does not lower it. This finding clearly contradicts the results of few simulation studies (e.g. Kulash et al. 1990; McNally and Ryan 1992), showing significant and negative association between the two elements.

Conclusions

This paper has analyzed the impact of urban form on travel behavior by the use of meta-analysis statistics. Several important lessons can be learned from this investigation. First, it is clear that two elements of the built environment, population density and employment density exert a strong influence on travel behavior, even when controlling for socio-demographic variables such as income or age. Second, the effect of land-use diversity on travel turned out to be even stronger than expected. The mix of offices, shops, and public facilities in urban settings does exert a

particularly strong influence on mode choice. Residents who live in more diverse urban environments are more likely to commute to work by transit or by slow modes. Third, the claim of many New Urbanists and Neo-Traditional planners concerning the advantages of a grid layout and continuous sidewalks design does not seem to have merit. The impact of these design features on travel behavior was found to be not significant. In the case of the grid network design, it may well be that the superior accessibility created by this type of network actually works in the opposite direction — that is, it might be actually contributing to a higher probability of commuting by car.

The results of this meta-analysis research have clarified some of the outstanding questions dealing with the effects of density, land use mix and street pattern configuration on travel behavior. The main shortcoming of the study is its inability to account, as Ewing and Cervero (2001) did in their synthesis study, for urban form-travel elasticities. This dearth is mainly due to the dissimilar definition and quantification of the explanatory variables in the various underlying studies. Deriving elasticities under these constraints could have led to biased and skewed results.

One of the main strengths of this particular study is the inclusion of seven travel variables in the meta-analysis. As a comparison, Ewing and Cervero (2001) included only two travel variables (vehicle trips and Vehicle Miles Traveled) in their analysis. They have also made quite a hard supposition in the estimation of vehicle trips and VMT, assuming overall trip rates to be constant (slow modes and transit trips were substituted for auto trips). This meta-analysis study has taken a much more cautious approach. It has avoided the generalization of travel variables, and separately investigated the relationship between urban form variables and various travel measures, including VHT, non work vehicle trips and mode choice. This caution, however, came at the expense of obtaining smaller sample sizes for each of the meta-analyses. Future meta-analysis research on the built environment-travel connection could incorporate some elements from the two methodologies. Prospective synthesis research should account for elasticities that represent relationships between built environment and travel measures beyond vehicle trips and VMT (e.g. VHT, mode choice). Concurrently, the validity of the explanatory built environment variables should be enhanced in order to avoid biased elasticities. This enhancement can be achieved by constructing a normalized index for the density, diversity and design attributes used to measure the built environment that is aimed at narrowing the discrepancies caused by the different methodologies and quantification methods used in the various primary studies.

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Eran Leck is a doctoral candidate in Urban and Regional Planning at the Technion–Israel Institute of Technology. His main research interests include transportation and land-use planning, efficiency and equity impacts of transportation improvements, and core-periphery relations in Israel. He is currently writing his dissertation which investigates the effect of transportation and human capital improvements on regional economic growth.

Evaluating a New Urbanist Neighborhood

Jennifer Dill

Abstract

New Urbanist neighborhoods aim to improve sustainability by reducing automobile use, increasing walking and cycling, increasing the diversity of land uses and people, and increasing social capital, through strengthened personal and civic bonds. With more New Urbanist communities being constructed, it is now more feasible and necessary to evaluate their success. Much of the existing research uses older, traditional neighborhoods as a proxy for New Urbanism. This research compares a New Urbanist development with two conventional subdivisions and finds that some of the objectives are being fulfilled, in both direct and indirect ways. While New Urbanist residents are walking more, they may not be driving less as a direct result of the New Urbanist design features. Demographic factors appear to explain much of the differences in overall driving.

Introduction

New Urbanism is often proposed as a more sustainable form of urban growth at both the neighborhood and regional scale. The concept shares many characteristics with other popular ideas, including transit-oriented development (TOD) and the broader concept of smart growth. The principles behind New Urbanism are set forth by the Congress for the New Urbanism in their *Charter for the New Urbanism* (2000). The *Charter* includes 27 principles, nine of which apply to neighborhoods, districts, and corridors. These principles cover three broad intended outcomes: (1) reduced automobile use and more walking and cycling; (2) increased diversity of land uses and people; and (3) increased social capital, through citizens taking responsibility and strengthened personal and civic bonds. These outcomes are consistent with many definitions of sustainability, which usually incorporate the three legs of environment, economy, and equity. Crane and Schweitzer (2003) examined the sustainability of New Urban-

ism with respect to transportation. They asserted that in order for New Urbanism to satisfy both the environmental and equity objectives of sustainability, the developments must decrease auto use and increase access to opportunities among disadvantaged urban residents. They proceed to point out that even if people living in New Urbanist communities walk or bike more (perhaps because of the design features of New Urbanism), they may not drive less. In addition, they question whether transit access, often a component of New Urbanism, can ever equal the access provided by automobiles.

Given the growing support for New Urbanism, there is a need to carefully and empirically examine whether New Urbanist communities meet their intended objectives. Early research on the travel behavior impacts of New Urbanism relied largely on older urban neighborhoods that exhibited many of the design features of New Urbanism — except for the “new.” Some of the initial research on other aspects, such as sense of community, used the first examples of New Urbanism, including Seaside, Florida, which may not be representative of the majority of projects now and in the future. As more developments are completed based upon New Urbanist principles, there are now opportunities to evaluate the associated outcomes. This paper presents an evaluation of a New Urbanist neighborhood in the Portland, Oregon, region in relation to the three intended outcomes of New Urbanism, outlined above, with a focus on transportation and sustainability. The evaluation uses survey data of residents from the neighborhood and two nearby subdivisions that do not have New Urbanist features.

Existing Research

The literature examining the diversity of New Urbanism is sparse. Critics of New Urbanism often contend that the developments are predominantly upper-middle class and lack diversity (see Ellis 2002 for a review). Talen (1999, 1373) notes that early New Urbanist developments are “dominated by affluence” and that “it is possible that this status rather than town design creates an economically based sense of community.” Podobnik (2002b) finds that Orenco Station was dominated by affluent white professionals with few children. Since his survey was conducted, apartments were completed that undoubtedly increase the range of income levels in the neighborhood. Podobnik’s survey did note a “moderately exclusionary attitude” among some of the original Orenco Station residents (Podobnik 2002a). Fewer residents of Orenco Station indicated that they wished for a more diverse neighborhood, compared to a more typical, and also predominantly white, suburban neighborhood in Portland. Brown and Cropper (2001) asked residents of a New Urbanist and standard subdivision a series of questions assessing whether the residents believed neighborhoods should provide

diverse housing opportunities. While New Urbanist residents favored housing diversity more, the difference was not significant.

There is far more research on the travel impacts of New Urbanism and related land use strategies. The principles of New Urbanism directly or indirectly aim to reduce automobile use by mixing land uses, having activities within walking distance, providing well-connected streets and paths, increasing accessibility to transit via design and increased building density, and providing a safe, comfortable, and interesting pedestrian environment. Many planners and policy makers support New Urbanism on these grounds. The logic is straightforward and, therefore, appealing. However, the empirical evidence supporting this idea is limited and mixed. In a review of the research linking travel and land use, Boarnet and Crane (2001, 58) conclude that “the wide range of outcomes . . . reveals little about whether a particular land-use pattern or urban design feature can deliver the reported transportation benefits.” By contrast, in their review of research focusing on walking and bicycling behavior, Sallis et al. (2004, 257) conclude that “there is a sizeable transportation research literature that demonstrates consistent associations of neighborhood environmental variables with walking and cycling for transport.” Ewing and Cervero’s review (2001) finds that the built environment is more closely related to trip lengths and to a lesser degree to mode choice and trip frequencies when compared to socioeconomic characteristics.

With respect to evaluating New Urbanism in particular, most of the early research uses pre–World War II suburbs as a substitute for New Urbanist neighborhoods. Some studies do this on a large scale using regional travel survey data (e.g. Crane and Crepeau 1998; Greenwald 2003), while others use paired (or multiple) neighborhood comparisons (e.g. Cervero and Radisch 1996; Handy 1996; Nasar 2003). The validity of using pre–World War II neighborhoods to examine the outcomes of New Urbanism, however, is questionable. Travel behavior is influenced by a number of factors beyond urban form, including income and other demographics and attitudes (Kitamura et al. 1997). The people who live in a New Urbanist neighborhood may be different from those living in older, traditional neighborhoods, even after controlling for income. Differences in the quality of schools, the age and style of the homes, and the location relative to the region may lead to differences in other demographics, such as age and household structure, and attitudes.

There is some recent research that uses actual New Urbanist developments. In a survey of six Portland neighborhoods, Lund (2003) finds that having shops within walking distance was associated with higher rates of “destination” (versus strolling) walking trips. Some of these neighborhoods were new, developed in the 1990s with New Urbanist features, while others were older, traditional suburbs. A survey of residents of Orenco Station, a New

Urbanist, transit-oriented development in the Portland region, found that nearly 70 percent of the residents claimed to use transit more than in their previous neighborhood (Podobnik 2002b). Comparing a neo-traditional to a conventional neighborhood in North Carolina, Khattak and Rodriguez (2005) find that residents of single-family homes in both cases made a similar number of total trips. However, after controlling for demographics, residents in the neo-traditional neighborhood made fewer auto trips and fewer trips outside the area and, therefore, fewer miles traveled.

One of the issues surrounding the debate over whether New Urbanism reduces auto travel is self-selection. The argument centers on how urban form influences travel behavior — *directly*, by changing people's behavior, or *indirectly*, by attracting residents who already walk, bike, or use transit. In a study of five different neighborhoods, Kitamura et al. (2003) find that attitudes, such as being pro-transit or pressed for time, were more strongly associated with travel behavior than land use characteristics. Lund (2003) finds that the most significant variable associated with walking behavior was the residents' attitudes about walking. She concludes that self-selection provided only a partial explanation for the higher rates of destination walking in neighborhoods with New Urbanist features. Greenwald (2003) also concludes that the substitution of walking for vehicle trips in neighborhoods with New Urbanist features was not fully explained by self-selection (2003). Krizek (2003) uses panel survey data to see how travel behavior changed when households moved to neighborhoods with different urban form features. He finds that households that moved to more accessible neighborhoods did drive fewer miles, but Krizek raised cautions about drawing strong conclusions from the findings. For example, the data used did not measure changes in preferences towards travel. Khattak and Rodriguez (2005) use two-stage regression models to control for self-selection. Levine (1999) argues self-selection should not matter — that the more important issue is whether communities are providing neighborhoods that meet people's preferences. If there are people who want to live in a place where they can walk, bike, and ride transit, but cities are not providing those environments, that is a problem. His research indicates that there is an unmet demand for New Urbanist-style neighborhoods (Levine et al. 2002).

As with travel behavior, the research on the effects of New Urbanism on social capital, sense of community, and personal bonds finds mixed results. Methodological issues, including self-selection, also confound findings here. New Urbanist developments highlight the design and community-friendly aspects of the neighborhood in marketing materials, which may result in a higher portion of civic-minded people who want to interact with their neighbors (Sander, 2002). Sander also warns of the "Hawthorne effect" — where New Urbanist residents may want to show that the "experiment"

works, thus confusing research findings. Talen (1999) stresses that while New Urbanism may not directly influence “sense of community,” it can increase resident interaction, which is one aspect of strengthening the social life of neighborhoods.

In his survey of Orenco Station, Podobnik (2002a) finds that most residents thought people in their neighborhood were more friendly and there was more of a sense of community than where they used to live. However, the author raises the self-selection caution flag — some people moved to Orenco Station because they wanted a more interactive community. In a comparison of Kentlands, a well-publicized New Urbanist development in Maryland, to a conventional suburb nearby, Kim (2000) finds a higher level of attachment to community and a higher sense of community identity in Kentlands. In contrast, Nasar (2003) finds no significant difference in sense of community, though his Ohio survey used an older traditional neighborhood rather than a New Urbanist neighborhood. Brown and Cropper (2001) find no significant difference in an index of “sense of community” between residents of a New Urbanist neighborhood and a standard subdivision. But residents of the New Urbanist neighborhood did report more neighboring behaviors, such as knowing and socializing with neighbors. This could be related to the finding that the New Urbanist residents spent more leisure time outside, including walking in the neighborhood. Lund (2003) specifically tried to link walking behavior to neighboring activities and finds a significant, positive relationship between the number of walking trips and both the frequency of unplanned interactions with neighbors and the number of local social ties. She notes, however, that the relationship was stronger for strolling trips, whereas the destination trips were more influenced by New Urbanist design features. In addition, the walking behavior was not related to supportive acts of neighboring.

Setting and Methods

The New Urbanist development selected for this research is Fairview Village, located in the city of Fairview, just east of Portland, Oregon. The project is listed in the Congress for New Urbanism’s database as a “traditional neighborhood” on a greenfield. As part of the “Village Story” on the project’s website (<http://www.fairviewvillage.com>), the developers explain that project features many ingredients of New Urbanism, including that “some of the primary planners and architects involved in designing the Village — including one of Fairview’s town architects, William Dennis, and town planner, Bill Lennertz, both worked for the founders of the New Urbanist town planning movement.” A brief excerpt of its description includes most of the key elements of New Urbanism:

Not quite a city, yet decidedly not a suburb, Fairview is a town in the classic sense — a cohesive network of individual neighborhoods built around community shopping, anchored by civic buildings and public parks, and scaled to people rather than to their cars. We wanted Fairview to be a community with the warmth and security of a small town and the energy and convenience of an urban area — a good place to live and work. A place to call home.

For comparison, two conventional subdivisions nearby (Neighborhoods A and B) were chosen. The neighborhoods were selected to help reduce the likelihood that income and other demographic differences might explain outcomes. All three neighborhoods are within three miles of each other, about 15 miles east of downtown Portland and were built at about the same time. The single-family home values are also similar, as shown in Table 1. The major differences between Fairview Village and the conventional subdivisions stem from the New Urbanist features.

Fairview Village is more diverse in terms of housing types and land uses. Construction of Fairview Village began in 1996. By the time of this survey, nearly all of the residential units were completed. These include detached single-family houses, attached townhomes and rowhouses, duplexes, and apartments. Some homes have garages on back alleys. Most include front porches and small setbacks. Neighborhoods A and B are exclusively single-family detached homes with garages in the front and larger setbacks. Fairview Village includes some neighborhood retail, a post office, library, city hall, and a Target store. Land planned for office and additional retail is still vacant, largely due to an economic slowdown. About half of the residential land area is within a quarter-mile walking distance of the central commercial area and nearly all is within one-half mile. Neighborhoods A and B are exclusively residential, but about half of the homes in Neighborhood A are within a quarter-mile walking distance of a strip-mall that includes a grocery store and small shops. The remainder of homes are within about a half-mile walking distance. The mall is across a major street at a signalized intersection. Residents in Neighborhood B are within walking distance of a park, but no retail activity. Neither conventional subdivision has a post office or library within walking distance. All three neighborhoods have large parks adjacent; Fairview Village also has several pocket parks.

Fairview Village is denser, with a net residential density of 11.4 units per acre, including the apartments, and 8.4 units per acre without the apartments. Neighborhood A is 5.0 units per acre, and Neighborhood B is 7.5 units per acre. Other characteristics of the homes in the neighborhoods are shown in Table 1. All three neighborhoods have good pedestrian features. All three have sidewalks along all residential streets, which are 32-foot wide, and few cul-de-sacs. These similarities are likely a result of policies in the region regulating residential streets, requiring high levels

of connectivity. None of the neighborhoods have particularly good transit service. Bus stops are on major arterials that surround the neighborhoods (less than a quarter-mile walk for most residents). The associated routes provide local service and connections to the region's light rail system. For example, a transit trip to downtown Portland (15 miles away) would take 50 to 60 minutes during commute hours for residents of Fairview Village. The buses run every 15 to 20 minutes during peak times and 20 to 30 minutes at other times.

Table 1. Features of Single-Family Homes (Attached and Detached) in the Neighborhoods

	Fairview Village (New Urbanist)	Neighborhood A (Conventional)	Neighborhood B (Conventional)
Lot size (square feet)	range: 900 – 15,132 median = 5,132	range: 7,012 – 44,093 median = 7,756	range: 2,541 – 10,491 median = 5,813
Home size (square feet)	range: 1,151 – 3,309 median = 1,734	range: 1,305 – 2,781 median = 1,833	range: 1,296 – 2,867 median = 1,809
Assessed value (land and building)	range: \$89,500 – 386,370 median = \$190,690	range: \$162,800 – 338,510 median = \$201,605	range: \$148,030 – 300,270 median = \$209,310
Net residential density	11.4 units/acre overall 8.4 units per acre excluding apartments	5.0 units per acre	7.5 units per acre

Source: Metro Regional Land Information System (RLIS), 2003.

The survey was hand-delivered or mailed to every housing unit within all three neighborhoods in May 2003, with follow-up surveys sent to non-respondents in June 2003. The survey packet included two forms to be completed by adults. First, the "Household Survey" was to be filled out by the "head of household." Along with basic information about the household (e.g. income and number of people, including children), it asked respondents a series of questions rating the importance of specific factors in deciding to purchase or rent their current home, such as price and proximity to shopping. These questions aimed to assess issues of self-selection. Second, there were three copies of the "Adult Survey," so that up to three adults could respond. Along with demographic information (gender, age and ethnicity), the adult survey asked for the number of trips made *from home* to various places by mode (personal vehicle, bike, walk, transit) for the previous week. There were also a series of questions gauging the adult's level of agreement with statements about their neighborhood. These questions aimed to gauge the person's sense of community.

A total of 628 survey packets were delivered, 352 in Fairview Village and 276 in the other two neighborhoods. Removing packets returned as undeliverable (vacant units) from the calculation, 45 percent of the Fairview

Village household surveys were returned and 29 percent of the conventional neighborhood surveys were returned. There were 185 valid adult surveys from Fairview Village and 136 from the conventional neighborhoods. The surveys were almost equally split between May (53.6 percent) and June (46.4 percent). Moreover, the split between May and June was almost identical for each neighborhood. Therefore, any differences in travel behavior between the two months should not influence the results when comparing the two groups.

Findings

The findings from the surveys are presented here, under the three topics of diversity, travel behavior, and sense of community. The survey results indicate that this New Urbanist neighborhood is fulfilling many, but not all, of the objectives of New Urbanism and transport sustainability.

Diversity

There are some significant demographic differences between the residents of the New Urbanist and conventional neighborhoods. There are large differences in terms of age and household structure. There were more older adults in the New Urbanist neighborhood; 11.4 percent of the adult respondents were over 65, compared to 5.3 percent of the conventional neighborhood respondents. These shares are similar to the 2000 U.S. Census figures for the neighborhoods (11.7 percent and 7.8 percent, respectively). The share of adults over 65 was even higher in the Fairview Village detached homes (17.8 percent), indicating that the smaller lots available in the development may attract more retirees. At the other end of the age range, the New Urbanist neighborhood had far fewer children, as shown in Table 2. There were also more households with one adult. The housing mix in Fairview Village does not explain these differences. Fairview Village households living in detached single-family homes also had fewer adults and children. In fact, of the 26 households that responded from the apartments, over 26 percent had children — a higher rate than the detached homes. Residents in the rowhouses and townhomes were the least likely to have children. According to the 2000 U.S. Census, the average household size in the conventional neighborhoods was 3.35 compared to 2.21 in Fairview Village. These numbers are higher than those reported by the survey respondents, which are 2.73 and 1.82, respectively. This may indicate that households with children were less likely either to respond to the survey or to report the number of children in their household.

Table 2. Household Composition

	Percent of Households		
	New Urbanist (all homes)	New Urbanist (detached homes)	Conventional A and B
Number of adults in household			
One	37.6%	29.4%	12.5%
Two	53.0%	57.4%	63.9%
Three or more	9.4%	13.3%	23.6%
Number of children (under 17 years old)			
Zero	82.3%	80.1%	57.0%
One	11.5%	13.3%	21.5%
Two or more	6.2%	6.6%	21.5%
n	130	75	79

Fairview Village may be more economically diverse, but is not more ethnically diverse, as shown in Table 3. While there was no statistically significant difference in the overall income distribution between the two groups, a significantly higher share of the New Urbanist neighborhood residents had incomes under \$40,000. In addition, the mean income in the New Urbanist neighborhood was significantly lower. However, the share of households in the highest income category is the same. The respondents in all three neighborhoods are generally white and well educated. There was no significant difference between the respondents in race/ethnicity; 89 percent of the New Urbanist neighborhood and 88 percent of the conventional neighborhood adult respondents were white. However, according to the 2000 U.S. Census, 73 percent of the adults in the conventional neighborhoods were white and 21 percent were Asian. This finding may indicate that Asian households did not respond proportionately to the survey; only 8 percent of the respondents in the conventional neighborhoods were Asian. The New Urbanist neighborhood 2000 U.S. Census figures indicated that 95 percent of the adults were white. The census was administered before the apartment buildings opened, which may explain the difference between the census and the survey results. In addition, both the survey and the 2000 U.S. Census indicate that the New Urbanist neighborhood is less diverse than the county; 79 percent of Multnomah County residents in the 2000 U.S. Census were white.

Table 3. Demographics of Respondents

	New Urbanist	Conventional A and B
Household Income (from surveys)		
Median	\$65,000	\$75,000
Percent under \$40,000	26%	10%
Percent \$90,000 or higher	31%	33%
n	91	49
Race		
Percent white/Caucasian (from surveys)	89%	88%
n	176	131
Percent white/Caucasian (2000 Census)	95%	73%
Education		
Mean # of years of school completed	14.8	14.2
n	146	93

Travel Behavior

The adults in the New Urbanist neighborhood walk more and drive less than in the conventional subdivisions. However, the New Urbanist features of Fairview Village likely contribute to only part of this difference. Demographic and attitudinal differences between the neighborhoods are also important factors. The households in the New Urbanist neighborhood had fewer vehicles and drove them fewer miles per week than the conventional subdivisions, as shown in Table 4.¹ The smaller household size and lack of children seems to account for much of the reduced auto use. A linear regression model found that the number of children under five years of age had a significant, positive relationship with total weekly vehicle miles traveled (VMT), as did the number of vehicles; being in the New Urbanist neighborhood was not a significant explanatory variable.

The surveys collected information about trips taken the previous week from home. There were significant differences between the neighborhoods. Adults in the New Urbanist neighborhood made fewer vehicle trips and more trips on foot and bicycle, as shown in Table 5. Residents in all three neighborhoods made very few transit trips. The difference in walking trips is most significant and results in the New Urbanist neighborhood adults making more total trips. The adults in the New Urbanist neighborhood reported that about 30 percent of their trips were made walking,

¹ Note that for the findings related to travel results for the conventional neighborhoods are shown separately because of the difference in access to destinations within walking distance. Neighborhood A has some retail within walking distance, while Neighborhood B does not.

Table 4. Difference in Vehicle Ownership and Weekly Vehicle Travel

Mean	New Urbanist	Conventional A	Conventional B	sig.
# of vehicles in household	1.7	2.4	2.2	0.00
# of vehicles per adult	1.0	1.1	1.1	0.07
Total weekly vehicle miles traveled (VMT)	200	316	289	0.00
Total weekly VMT per adult	122	148	155	0.19
Total weekly VMT per person	108	119	111	0.82

compared to 9 percent and 8 percent for the adults in neighborhoods A and B, respectively.

The New Urbanist neighborhood residents made significantly more walking trips to shopping, restaurants/cafes, the library, the post office, parks, health clubs, and recreation. Some of these differences are explained by the lack of destinations within walking distance to the conventional subdivisions. For example, only Fairview Village has a library, post office, and health club within walking distance. However, all the neighborhoods had parks within walking distance, and residents in all neighborhoods could walk for recreation/exercise, which does not require a destination.² In addition, residents in Neighborhood A had similar access to shopping, but made an average of 0.27 walking trips to the store, compared to 0.45 in the New Urbanist neighborhood.

The New Urbanist neighborhood residents are not walking more because they feel safer than residents from the other neighborhoods. About 90 percent of the residents from both groups agreed or strongly agreed with the statement "I feel safe walking or biking in my neighborhood." The availability of destinations, as discussed above, seems to be a major factor, along with the New Urbanist design features. Residents in both groups said that they walk more in their current neighborhood than where they used to live — 53 percent for the conventional subdivisions and 71 percent for the New Urbanist neighborhood. The survey had an open-ended question asking why they walked more in their current neighborhood. 40 percent of the New Urbanist neighborhood residents that walked more and stated why said that it was because there were places to walk to, compared to 21

² Entertainment/movie/show was included as a separate category, but it is not shown in the table because no walking trips were made by respondents for this purpose. In addition, "health club" was included as a separate category. Finally, the survey form gave the example of walking or jogging in the neighborhood as "recreation/exercise." Therefore, the "recreation/exercise" category should include primarily walking as the activity, rather than walking to recreation.

Table 5. Number of Trips by Mode and Purpose by Neighborhood

Mean for Survey Week	New Urbanist	Conventional A	Conventional B
Total trips reported	19.7	15.7	18.3
# Transit trips	0.3	0.3	0.3
# Bike trips	0.4	0.0	0.4
# Personal vehicle trips	12.4	13.9	15.7
Work	3.3	3.0	3.5
Personal business	1.9	1.9	2.4
Shopping	2.0	2.5	2.4
Restaurants/cafes	1.0	1.4	1.5
Visit friends/relatives	1.2	1.3	1.8
Library	0.1	0.2	0.2
Post office	0.5	0.4	0.3
Health club	0.4	0.5	0.9
Park	0.1	0.1	0.2
Recreation/exercise	0.3	0.4	0.4
# Walking trips	6.6	1.5	2.0
Work	0.2	0.0	0.0
Personal business	0.2	0.0	0.0
Shopping	0.4	0.3	0.0
Restaurants/cafes	0.7	0.1	0.1
Visit friends/relatives	0.2	0.1	0.0
Library	0.5	0.0	0.0
Post office	0.7	0.0	0.0
Health club	0.6	0.0	0.0
Park	1.0	0.2	0.4
Recreation/exercise	1.9	0.6	1.3

Means that are significantly different ($p < 0.05$) between the three groups are in **bold**.

percent for the conventional neighborhoods. Residents in the conventional neighborhoods were more likely to be walking more for lifestyle reasons, such as wanting to improve their health or getting a dog. The New Urbanist neighborhood residents were also more likely to give a reason related to the aesthetics of the neighborhood, such as “cute,” “cleaner,” or “nicer scenery” (compared to their previous neighborhood).

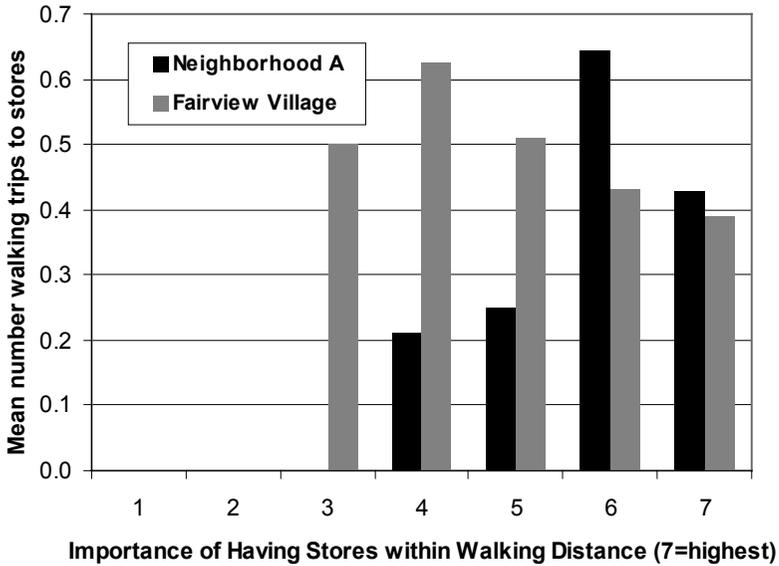
Self-selection may be an important, but perhaps not the only, factor explaining the higher levels of walking by residents in the New Urbanist neighborhood. The New Urbanist neighborhood residents clearly ranked having destinations within walking distance much higher than the residents of the conventional subdivisions, as shown in Table 6. But, there is some indication that the New Urbanist design may have an impact beyond allowing people who wanted to walk to do so. Figure 1 shows the mean number of walking trips to a store by the level of importance the person placed on having stores within walking distance when choosing his or her neighborhood. Only residents from the New Urbanist neighborhood

and Neighborhood A, which have similar access to stores, are included. In both cases, people who rated walking access to shopping very low did not walk to a store. But, for the New Urbanist neighborhood, the number of walking trips does not vary significantly for people rating that factor three or higher. The New Urbanist neighborhood residents who only rated walking access a three or four are walking as much as, or more than, those who placed the highest importance on it. On the other hand, the importance of walking access seems to be a more important factor in the number of walking trips for Neighborhood A residents.

Table 6. Ranking of Importance of Factors in Choosing Home

Factors in home decision 1 = Not at all important 7 = Extremely important	New Urbanist		Conventional A		Conventional B	
	Mean	Rank	Mean	Rank	Mean	Rank
Neighborhood safety	6.3	1	6.3	1	6.4	1
Style of the neighborhood	6.2	2	6.0	2	5.9	3
Price/rent	5.9	3	6.0	3	6.1	2
Having sidewalks in my neighborhood	5.8	4	5.7	7	5.1	9
Style of house/apartment	5.8	5	5.7	8	5.6	5
Sense of community	5.7	6	5.6	9	5.6	7
Amount of car traffic on my street	5.8	7	5.9	4	5.6	6
Size of house/apartment	5.6	8	5.4	12	4.9	11
Quick access to the freeway	5.6	9	5.9	5	5.7	4
Layout and size of the neighborhood streets	5.3	10	5.3	13	4.9	12
Neighborhood parks	5.2	11	4.4	15	4.1	15
Having stores within walking distance	5.2	12	4.5	14	3.4	18
Having a library within walking distance	5.1	13	3.1	21	2.3	22
Having a post office within walking distance	5.0	14	2.9	23	2.1	23
Having cafes/restaurants within walking distance	4.7	15	3.3	20	2.9	20
Size of the yard	4.6	16	5.8	6	5.0	10
Having bike lanes and paths nearby	4.5	17	3.4	19	3.7	17
Location relative to work	4.5	18	4.1	16	4.7	13
Property taxes	4.5	19	5.6	10	5.2	8
Quality of schools	4.2	20	5.6	11	4.6	14
Being close to public transit	4.1	21	3.0	22	3.0	19
Location relative to family/friends	4.1	22	4.0	17	4.0	16
Having schools within walking distance	3.3	23	3.7	18	2.8	21
n	129					

Means that are significantly different ($p < 0.05$) between the three groups are in **bold**.

Figure 1. Importance of Having Stores Nearby and Walking Trips to the Store

Relying on respondents to remember the number of trips they took from home by purpose and mode for the previous week does have limitations. People may not accurately remember all of their trips. There is no reason to believe that residents of the New Urbanist neighborhood would be more or less forgetful than people in the other neighborhoods. However, the Hawthorne effect may account for some of the difference in reported walking trips. But, the difference is so large that this does not seem to explain it all. In addition, if the Hawthorne effect were the main cause, one would expect to see a more positive correlation in Figure 1. People rating walking access high would be more likely to overstate their behavior. Another limitation to the survey is that residents may not accurately remember the factors that were important in choosing their home. Moreover, residents of the New Urbanist neighborhood may value features of the neighborhood, such shops within walking distance, now more than before because they are experiencing the benefits of the accessibility. However, there was no correlation between the accessibility ratings and length of time living in the New Urbanist neighborhood.

Sense of Community

The survey did not find any consistent evidence that residents of New Urbanist neighborhoods have a greater sense of community, neighborliness, or residential satisfaction. Sense of community was equally important

in the household's neighborhood location decision, as shown in Table 7. Overall, both groups of residents are satisfied with where they live. About 60 percent of the adults from both groups strongly agreed with the statement "I think my neighborhood is a good place for me to live" and over 30 percent agreed with that statement. The vast majority of adults from both groups also felt at home in their neighborhood.

There were some differences between the neighborhoods regarding their attitudes about their neighborhood, as shown in Table 7. Residents were asked whether they could recognize most of the people who lived on their street. Residents in Neighborhood A agreed the most with this statement. Residents from the New Urbanist neighborhood and Neighborhood A residents felt about equally that they had influence over what the neighborhood is like. However, residents of the New Urbanist neighborhood felt more strongly that people in the neighborhood could solve neighborhood problems.

Table 7. Adults' Attitudes about their Neighborhood

Factors in home decision, mean score 1 = Strongly disagree 4 = Strongly agree	New Urbanist	Conventional A	Conventional B
I think my neighborhood is a good place for me to live	3.6	3.7	3.4
I can recognize most of the people who live on my street	2.9	3.3	3.0
I feel at home in this neighborhood	3.5	3.6	3.4
Very few of my neighbors know me	2.4	2.3	2.4
I care about what my neighbors think of my actions	2.9	3.1	3.0
I have influence over what this neighborhood is like	2.7	2.7	2.2
If there is a problem in this neighborhood people who live here can get it solved	3.0	2.9	2.4
It is very important to me to live in this particular neighborhood	2.8	2.8	2.4
People in this neighborhood get along with each other	3.2	3.2	3.2
I expect to live in this neighborhood for a long time	2.9	3.0	2.5
n	175	77	54

Means that are significantly different ($p < 0.05$) between the three groups are in **bold**.

Walking behavior seems to be a factor in whether residents of the New Urbanist neighborhood know their neighbors. After controlling for the length of time in the residence, there was a significant positive correlation

between the number of walking trips and whether the resident recognized most of the people on their street — but only in the New Urbanist neighborhood. One explanation is that residents in Neighborhood A and B are seeing and meeting their neighbors in other contexts, perhaps through schools or just spending time in their front yards.

Policy Significance and Future Research

The survey results provide insight into whether the New Urbanist neighborhood examined is fulfilling the intended objectives of New Urbanism. Overall, the results show that this New Urbanist development is fulfilling many of the neighborhood objectives expressed in the *Charter* (CNU 2000). However, the features of New Urbanism may not always be the direct cause of meeting the objective. People in the New Urbanist neighborhood are definitely walking more in their neighborhoods, a key objective of New Urbanism. The higher rates of walking are due, in large part, to the proximity of destinations — stores, a post office, the library, parks, cafes, and other services. This convenience is a direct effect of New Urbanism. In addition, the walkable features of the neighborhood attracted people who wanted to walk — an indirect effect. Households in the New Urbanist neighborhood also drive less, but this appears to be an indirect effect of New Urbanism. The neighborhood attracted smaller households, particularly households without children, and more older adults. These factors will reduce vehicle travel. Therefore, it is unclear whether this New Urbanist neighborhood meets Crane and Schweitzer's (2003) test for transportation sustainability — decreasing auto use. Without data from the residents on their travel behavior before they moved to these neighborhoods, we do not know whether they have reduced their driving. However, the comparison to the other neighborhoods indicates that the lower rates of driving are largely due to differences in demographics and not the substitution of walking for driving.

The location of the New Urbanist neighborhood — in a lower density, auto-oriented suburban area without high levels of transit service — may make substitution more difficult. The residents can only reasonably walk to the destinations within the development, which are limited. Once the vacant commercial parcels are developed, more substitution may be feasible. In addition, the lack of good transit service reduces the potential to substitute transit for driving, particularly for work trips. The fact that the development does not have good transit service could be a criticism. However, the *Charter* (CNU 2000, 101) does not specifically mandate levels of transit service. Rather, it recognizes that levels of transit service are not necessarily controlled by the developer or planning agency. The principles state that “appropriate building densities and land uses should be within walking

distance of transit stops, permitting public transit to become a viable alternative to the automobile.” The authors identify 12 units per acre as a minimum for areas within one-quarter mile of bus stops. Fairview Village was close to this target when the survey was conducted. If the project is completed as envisioned, residential and commercial density will be higher in the future, perhaps warranting improved transit service.

There is some self-selection occurring. Residents of the New Urbanist neighborhood placed greater importance on having destinations within walking distance when choosing where to live. However, self-selection does not explain all of the differences in travel patterns. Moreover, the neighborhood clearly satisfied a demand from some households for a suburban home with accessible walking destinations. What the data do reveal is that if you build it, they will come, and they will walk. This supports Levine’s (1999) argument that researchers and policy-makers should focus less on whether form influences behavior and more on providing the variety of urban forms that households want.

The residents of the New Urbanist neighborhood were not significantly more racially diverse than the conventional neighborhood residents surveyed or the county as a whole. The 2000 U.S. Census data confirmed the lack of racial diversity. There may be some greater income diversity. A larger share of the survey respondents in the New Urbanist neighborhood were in the lowest income categories, though there were equal shares in the highest income categories, compared to the conventional neighborhoods surveyed. Finally, while most residents of the New Urbanist neighborhood knew and got along with their neighbors, their levels of neighborliness were not significantly higher than in the conventional subdivisions. The walkability of the New Urbanist neighborhood does help increase neighborliness, perhaps making up for the lack of some common ways of connecting with neighbors, namely children.

While this research supports some of the New Urbanist claims, there are some limitations. The research only examines one New Urbanist neighborhood. While the development was designed based upon New Urbanist principles, it does lack good transit access and is not yet complete. This should be considered when interpreting the findings. With respect to travel behavior, the survey asked for limited information — the trips made *from home* the previous week. Therefore, differences in overall trip making and travel are not known. A full travel or activity diary would capture trade-offs people may make. For example, the New Urbanist neighborhood residents may walk to the post office while residents of other neighborhoods buy stamps at the grocery store or stop at a post office on the way to another destination. If that is the case, total vehicle miles of travel may not differ. The selection of the conventional neighborhoods also influenced the results. Choosing neighborhoods with limited destinations within

a reasonable walking distance was useful in testing one aspect of New Urbanism — mixed land uses. Including neighborhoods with a similar mix of destinations within walking distance, but without the other design features of New Urbanism would also be useful. However, finding such neighborhoods may be difficult. These data do show is that New Urbanist residents do take advantage of their neighborhood's walkability.

There is an increasing focus on the influence of neighborhood design not just on travel, but physical activity and health (Saelens et al. 2003; Sallis et al. 2004). The findings from this research lend support to the notion that residents in walkable neighborhoods may be more physically active. The New Urbanist neighborhood adults definitely walked more often in their neighborhood. The difference in number of walking trips is comparable to that found in similar research summarized in Saelens et al. (2003) and Sallis et al. (2004). The difference in the average number of walking trips from home per week was 4.9 trips. Using a more conservative estimate that the true difference is 4.0 trips per week and assuming that each walking trip is at least fifteen minutes, that would account for one more hour of physical activity per week. What is not known, however, is what other physical activity the residents in all three neighborhoods are undertaking. Residents in the conventional subdivisions may be walking near work, going to a gym, or using a treadmill at home, for example.

The differences in household structure between the neighborhoods are perhaps as important as the differences in walking behavior and present some interesting questions for future research and sustainability. For example, will residents of the New Urbanist neighborhood stay there when they have children, or will they want a home with a larger yard and more families with children as neighbors? If they do remain in the New Urbanist neighborhood with young children, will they still walk more? The findings also highlight the need to conduct research on New Urbanist neighborhoods, rather than in older neighborhoods as proxies. Who chooses to live in a New Urbanist neighborhood is a significant factor in whether the objectives of New Urbanism are met. This research indicates that New Urbanist neighborhoods may be more attractive to white households without children and retired persons. The higher share of older adults is encouraging and indicates a market potential for New Urbanism. The older adults in the New Urbanist neighborhood walked as often as the other adults. This is a positive finding, given the aging population trends in the U.S. New Urbanist neighborhoods may provide an attractive place for elderly who want to remain in a suburban environment, but need to reduce their driving.

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Jennifer Dill is an associate professor in the Nohad A. Toulan School of Urban Studies and Planning at Portland State University. She is also assistant director of the Center for Urban Studies at PSU. Her research interests include transportation policy, travel behavior, transportation–land use interactions, and environmental aspects of transportation. She has a Ph.D. in City and Regional Planning from UC Berkeley and worked as an environmental and transportation planner in California.

The Spatial Distribution of Food Outlet Type and Quality around Schools in Differing Built Environment and Demographic Contexts

Lawrence Frank, Karen Glanz, Meg McCarron, James Sallis, Brian Saelens, and James Chapman

Abstract

Safe and convenient access to healthy foods for all populations is a fundamental transportation and environmental justice concern. Emerging evidence suggests that residents of lower income communities have less access to healthy food choices than those in higher income areas. Most studies to date rely on an assumed level of food quality generalized across different types of food outlets (e.g., grocery versus convenience stores) mapped in space. The current study includes a detailed audit of food quality offered in 302 food establishments in four communities in the Atlanta Region and compares proximity to these outlets in differing urban and demographic settings. The analyses focus on a middle and elementary school in each community and compare the spatial relationships between schools and sit-down and fast food restaurants and between grocery and convenience stores. Road network distances from school sites to each food outlet were calculated in a geographic information system. Results suggest that food quality varies across neighborhoods by income, but not by walkability. Results also suggest the potential for food quality to vary differentially with distance from schools in higher versus lower income communities. Walking or biking to get food is difficult in auto-oriented environments which has important implications on sustainability. Youth, elderly, and other populations which do not drive are more reliant on the food choices offered in their immediate environments, such as in schools or assisted living facilities. Methods employed can be expanded to examine associations between food outlet quality, urban form, travel and activity patterns, dietary behavior, and health outcomes.

Introduction

Emerging research suggests the relative ease of access to healthy versus unhealthy foods may be linked with individuals' dietary behavior (Glanz, Sallis et al. 2005). While not yet proven, it would stand to reason that the nutritional quality of foods that are both proximate in space and financially attainable (Drewnowski and Specter 2004) impact body mass index and

other predictors of population health. While not commonly studied, the ability to access food is a major component of non-work related travel and is a primary function of urban transportation systems. The level of accessibility to healthy foods is an important quality of life indicator. Potential systematic disparities in access across income levels can constitute benefits and burdens for specific groups and is a relevant environmental justice concern. Moreover, increased proximity to healthy food choices from schools or where people live and work can offset vehicle use, increase transportation-related physical activity, and promote a more sustainable transportation system.

The purpose of this paper is to describe and apply a geographic information system (GIS) based methodology to measure the spatial variation in food quality accessibility across levels of neighborhood walkability and income. This methodology is used to measure the proximity of schools to food outlets by type and by nutritional value. An audit tool was developed and applied to assess food quality in four types of food outlets including fast food, restaurant, convenience, and grocery stores (Glanz et al 2006).

This paper is part of the Nutritional Environment Measures Study (NEMS --<http://www.sph.emory.edu/NEMS>) which has the purpose of establishing a definition of community food environments and to establish a system of measuring the quality of those environments. Since environmental factors affect behavior, it is difficult to establish and maintain healthy behaviors when environmental factors create substantial barriers to attempted behavior changes. Travel survey data show that most trips are for non-work purposes and many of these non-work trips involve food. Shorter home based non-work trips are more likely to be viable on foot or bike and provide important opportunities to promote active and sustainable transportation solutions.

A growing body of evidence suggests important relationships may exist between food outlet proximity and health-related outcomes (e.g., body mass index). Evidence further suggests the potential for disparities to exist between the quality of food closest to people of different economic strata. In this initial pilot study, we examined food environments around elementary and middle schools in response to the emerging epidemic of childhood obesity and in order to further the search for promising "public health" or population oriented approaches to address this problem. As students get older, they are increasingly likely to purchase foods that they pay for inside of or nearby to their schools and residences (Neumark-Sztainer et al 2005; Craypo et al 2002). Middle schools often have "open campus" policies where students can leave the school grounds for lunch or to buy food at nearby stores and restaurants. High school catchment areas were thought to yield neighborhoods too large for our assessment purposes.

Past research has shown a distinct link between proximity of health care resources and frequency of use of those resources. Many transportation planning studies employ a “gravity model” which predicts that the likelihood an individual will visit a destination declines exponentially with distance (Zipf 1949). This concept is known as distance decay and has been recently employed within physical activity research to predict park and open space use (Giles-Corti 2005). Thus, there is reason to suspect access to food sources could have similar relations to food purchasing and dietary intake.

Recent studies have shown that access to specific types of food establishments can have a significant impact on diet and health. Laraia et al. found pregnant women closer to supermarkets had a higher diet quality index (Laraia, Siega-Riz et al. 2004). Distance was measured as a Euclidean (straight-line) distance between pregnant women’s homes and food outlets. Austin et al. found that fast food restaurants cluster around schools. Fast food restaurants were geocoded to their street address and a bivariate K function analysis was used to determine the presence of spatial clustering of fast food restaurants near schools (Austin, Melly et al. 2005).

Burdette and Whitaker used a GIS-based approach to quantify the relationship between fast food restaurants, crime rate, presence of playgrounds, and childhood obesity in a low income population (Burdette and Whitaker 2004). Proximity was measured using a child’s home address and calculating the Euclidean distance between their home and fast food restaurants, as well as playgrounds. Findings suggested that proximity to these resources was not a factor in childhood obesity.

GIS-based approaches have been used to assess a variety of “influencers” of behavior and health related outcomes. For example, studies have assessed the impact of alcohol outlet density on violence in Brazil (Laranjeira 2002) and in Austin, TX (Zhu 2004). GIS analysis of grocery store locations has also been conducted in a number of cities, revealing a consistent association between proximity or presence of grocery stores and more healthful diets (Morland, Wing et al. 2002; Rose and Richards 2004; Zenk, Schulz et al. 2005). This finding is arguably a function of the lack of grocery stores in several of the most impoverished urban core areas of the United States.

Methods

Study Sites

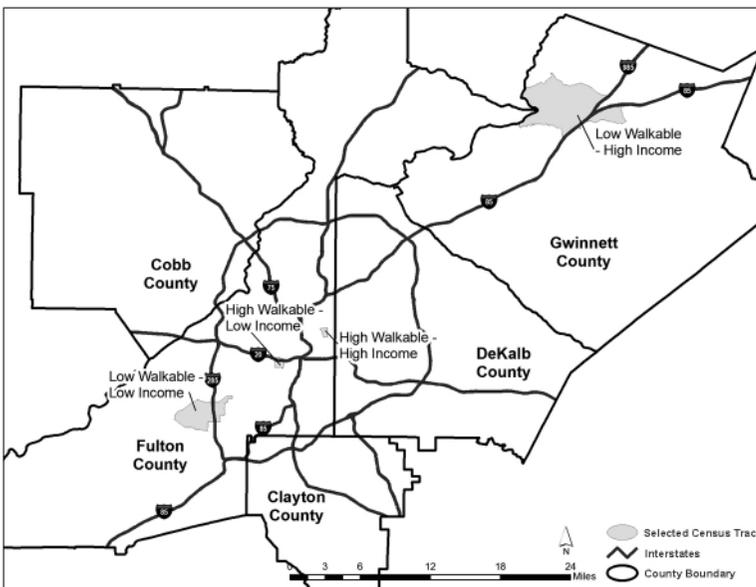
Elementary and middle schools in four neighborhoods in the Atlanta Region were selected for the study, as shown in Figure 1. The neighbor-

hood selection process supports comparisons of food outlet accessibility around schools with high and low levels of walkability and income. The neighborhood selection process included at least one middle school in each neighborhood and one or more elementary school.

Walkability was measured based on the degree to which residential and commercial uses are intermixed, residential density, and presence of an interconnected road network versus a cul-de-sac road layout (Frank et al. 2005; Frank et al 2006). High walkability was defined as having several land uses intermixed and higher levels of residential density and street connectivity. Each neighborhood defined as a census tract was given a “walkability” score based on the measures defined above. An area with a high measure of walkability would imply that there is a road network which lends itself to pedestrian use, and that pedestrians can access different types of land uses (stores, schools, homes, etc.) on foot.

One neighborhood was selected to represent each of four categories: high walkable/high income, high walkable/low income, low walkable/high income, and low walkable/low income. Measures of walkability and income were developed at the census tract scale. Each neighborhood defined census tract was assigned a one-mile buffer delineating the study area. All neighborhoods and the corresponding census tracts contained a middle school and at least one elementary school.

Figure 1. Study Area



Measurement Procedures

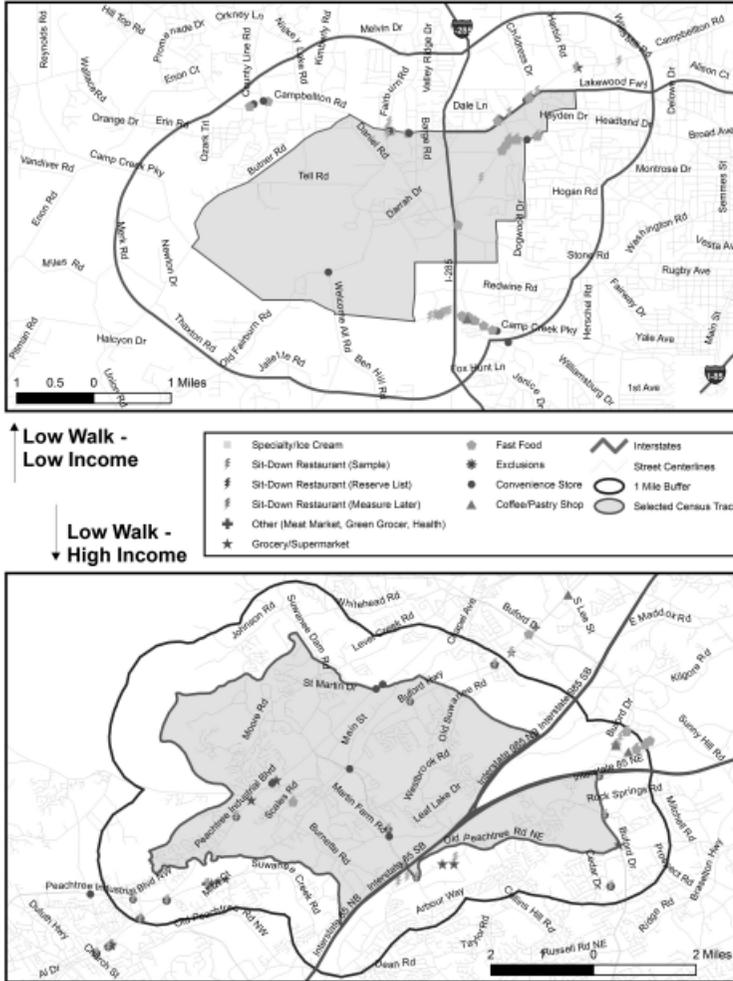
Food outlets were enumerated and categorized in each of the four study areas. The street addresses of food outlets were collected using county Board of Health License Lists, as well as Electronic Yellow Page Directories. These food outlets were categorized according to type – convenience vs. grocery store and sit-down vs. fast food restaurant. A total of 85 stores (Glanz et al. 2006) and 217 restaurants (Saelens et al. 2006) were enumerated in the four study neighborhoods. A rigorous process was employed whereby observational measures for each type of food outlet were developed and their validity and reliability was established. Once trained on the use of a standardized protocol and set of forms, raters evaluated food outlets in each of the four communities shown in Figure 2 (less walkable) and Figure 3 (more walkable), which convey the locations of the food establishments by type and the schools in each of the four neighborhoods.

Through this process, a measure of nutrition environment quality (NEMS score) was developed for retail stores (convenience and grocery) by evaluating the availability of the following: milk, fruit, vegetables, ground beef, hot dogs, frozen dinners, baked goods, beverages (soda/juice), whole grain bread, and baked chips. This evaluation process measures availability of healthful choices, prices, and quality. Raters evaluated these factors among the products identified above through systematic observations during site visits. A scoring system was developed, and a higher NEMS score denotes more healthy food choices, better or equal price for healthy choices, and high quality (Glanz et al. 2006). The NEMS rating system is the focus of a detailed paper (Glanz et al. 2006) on the NEMS food store evaluation protocol.

A similar evaluative system was developed for sit-down and fast food restaurants. The factors related to a restaurant's nutrition environment score include: healthy main dish choices (low-fat, low-calorie, healthy main dish options); availability of fruit, vegetable, whole grain bread, and baked chips; beverages; and children's menus. Included in the restaurant's score were also variables that might act as a facilitator or a barrier to healthy eating, namely pricing, signage, and promotions. Raters conducted evaluation of restaurants through site visits, examination of take-away menus, manager interviews, and internet menu analysis (Saelens et al. 2006).

In order to ensure consistency and reliability of findings in each location, two raters visited each location independently on the same day. Consistency in types of foods available was verified by making two visits to each location, the second visit approximately one month after the first. Test-retest and inter-observer agreement reliabilities were above 0.80 for both stores and restaurants, and the test-retest reliabilities were mostly above 0.70 and are reported elsewhere (Glanz et al. 2006; Saelens et al. 2006). NEMS scores

Figure 2. Low Walk Communities by Income

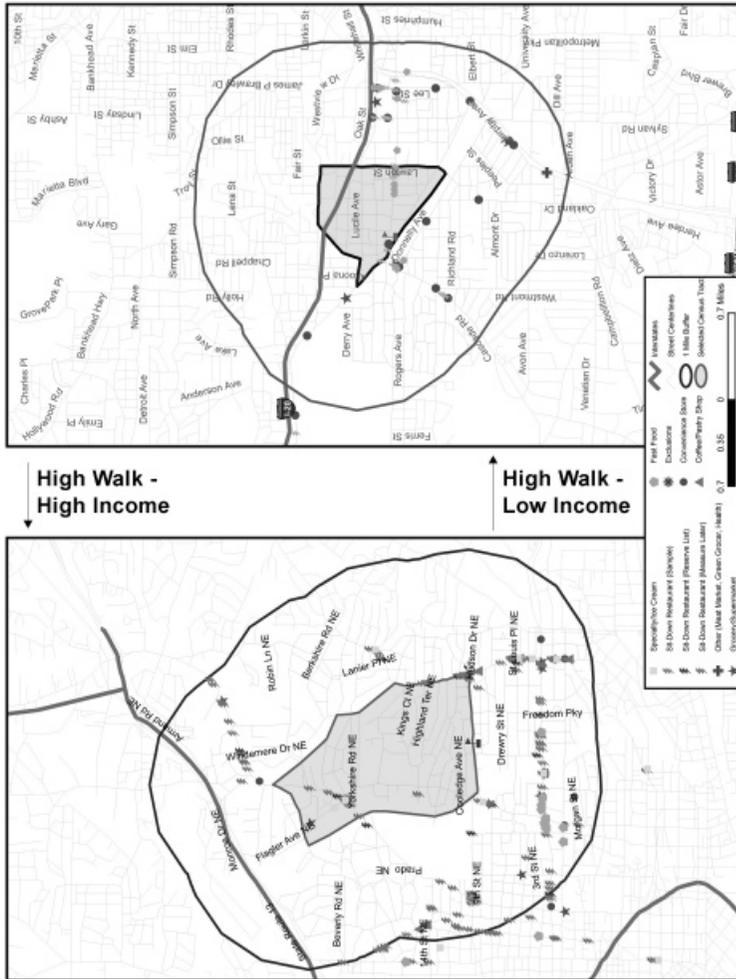


were attached as attributes to the geocoded location with final scores in the current study ranging from 2.5 to 32 for stores (on a scale of 0 to 50), and -10 to 36 for restaurants (on a scale of -27 to 60).

Results

Each food outlet was matched to its street address, using GIS (ArcView 9.0 ESRI). Geocoding is a process by which an address is matched to the corresponding street center line in a digital file. Locations of middle and elementary schools were recorded, using County School Board data. The

Figure 3. High Walk Communities by Income



302 food outlets (grocery and convenience stores, sit-down and fast-food restaurants) that were evaluated, and whose addresses were successfully geocoded, are shown in Table 1.

Distance from each food outlet to schools within each neighborhood was calculated using GIS. A road network distance was measured to approximate real world accessibility of food outlets to schools. A relative mean road network distance between schools and outlets was calculated in order to determine if more or less healthy food choices are located closer to schools by food outlet type within each community. Therefore numbers less than 1.0 represent where distances were shorter to convenience and fast food

Table 1. Frequency of Food Sites by Type and Community

Walkability/Income	Type	N (food sites)	Total
Low/High	Grocery	6	97
	Convenience store	20	
	Sit-down restaurant	43	
	Fast-food restaurant	28	
Low/Low	Grocery	2	63
	Convenience store	14	
	Sit-down restaurant	17	
	Fast-food restaurant	30	
High/High	Grocery	9	80
	Convenience store	9	
	Sit-down restaurant	40	
	Fast-food restaurant	22	
High/Low	Grocery	7	62
	Convenience store	18	
	Sit-down restaurant	15	
	Fast-food restaurant	22	

outlets than to sit-down restaurants and grocery stores. This measure was calculated for distance to elementary schools as well as to middle schools to determine if patterns of location were different for each type of school, as shown in Table 2.

Outlets in the high walkability study areas were split into two groups — those less than 0.75 miles (road network distance) from a school, and those farther than 0.75 miles. This distance was determined to be one that can be walked relatively easily for a child, as well as one in which at least one food outlet was located for each of the two high walkability neighborhoods. Once split into these distance-based groups, mean NEMS quality scores were determined by type of food outlet for each community, by school type, as shown in Table 3. The same process was repeated for the low-walkability communities, although the distance used in this part of the analysis was a less walkable three miles given that the few food outlets were so dispersed, as shown in Table 4.

To determine the best method to detect spatial clustering of food outlets near schools, a second type of analysis was done, using concentric buffers surrounding each school. This pilot analysis was conducted for middle schools only. Six different road network based buffers were created around each school. Study areas with more connectivity in the road network (grid-like, fewer cul-de-sacs) are expected to have buffers with larger areas than

Table 2. Relative Mean Road-Network Distance from Middle and Elementary Schools to Food Outlet by Community (All Food Outlets)

Food Outlet Type	Low Walk High Income	Low Walk Low Income	High Walk High Income	High Walk Low Income
Middle Schools				
Convenience/ grocery store	90.5%	80.0%	100.9%	86.0%
Fast-food/sit-down restaurant	107.0%	92.4%	99.7%	94.8%
Elementary Schools				
Convenience/ grocery store	99.7%	122%	105.2%	92.1%
Fast-food/sit-down restaurant	97.2%	98.1%	131.9%	97.2%

100% means these places are equidistant, <100% means the numerator food outlet type is closer than the denominator food outlet type.

those with fewer interconnected streets. Buffer sizes were determined with pedestrian travel in mind. The smallest buffer size was 0.25 miles, and the largest was 1.25 miles. The intervening buffers increased in 0.25 mile increments. Each larger concentric buffer included all areas in the previous buffers. The number of food outlets within each buffer was tabulated, by type, for middle schools, as shown in Table 5. Mean NEMS scores for each outlet type were also determined within each concentric buffer and for the entire study area around each school.

A third method of analysis was employed, using GIS software to detect spatial clustering of food outlets. Using ArcView, a Moran's I statistic was calculated, in a similar fashion as that used in the Zenk Detroit supermarkets study (Zenk, Schulz et al. 2005). The Moran's I statistic detects spatial clustering using location and attribute values for each feature. The attribute used for the food locations was the road network distance to schools, and the feature location was place on the road network. Moran's I in this case describes the degree of clustering of food outlet locations by considering those features with similar weights to be like features. Clustering for like features is determined by their road network distance from one another. Moran's I statistics was only calculated for a subset of the database — those

Table 3. Mean NEMS Scores, High Walk Communities — Closer Than and Greater Than 0.75 Miles from Middle and Elementary Schools

Community	Type	Distance (road network, miles)	MIDDLE		ELEMENTARY *	
			N	Mean NEMS Score	N*	Mean NEMS Score*
High Walk – High Income	Grocery	< 0.75	2	26.50	0	
		0.75+	7	24.86	9	25.22
	Convenience Store	< 0.75	1	14.00	0	
		0.75+	8	6.63	9	7.44
	Sit-down Restaurant	< 0.75	13	3.31	1	-3
		0.75+	27	5.44	39	4.95
	Fast Food Restaurant	< 0.75	1	6.00	0	
		0.75+	21	6.38	22	6.36
High Walk – Low Income	Grocery	< 0.75	2	24.00	2	24
		0.75+	5	17.20	5	17.2
	Convenience Store	< 0.75	5	4.40	6	4.67
		0.75+	13	5.08	12	5
	Sit-down Restaurant	< 0.75	5	1.20	1	-3
		0.75+	10	5.50	14	4.57
	Fast Food Restaurant	< 0.75	10	7.10	5	-3.8
		0.75+	12	1.00	17	6

Note: * Food outlets were grouped into distance categories based on their relationship to all elementary schools. For example, an outlet is placed in the 0.75+ mile category only if it is not closer than that to any school. If an outlet is within 0.75 miles of one (or more) schools it is placed in the < 0.75 mile category.

locations in the high walkability, high income quadrant, as part of the pilot study to determine its utility for use in future analysis. Statistically significant results were found for the clustering of sit-down restaurants around middle schools, with a Moran's Index of 0.494, and an expected Index of -0.026, and a Z-score of 5.719.

Analysis

The findings describe the relative proximity between schools and different types of food outlets and nutritional quality in our four different community environments. The results are exploratory given there are only four different communities being evaluated, and the emphasis is on describing the application of the measures and analytic methods. However, some interesting patterns emerged in terms of distances from schools to different types of food outlets and their food quality.

Table 4. Mean NEMS Scores, Low Walk Communities—Closer Than and Greater Than 3 miles from Middle and Elementary Schools

Community	Type	Distance (road network, miles)	MIDDLE		ELEMENTARY	
			N	Mean NEMS Score	N	Mean NEMS Score
Low Walk – High Income	Grocery	< 3	0		4	23.5
		3+	6	24.86	2	27.0
	Convenience Store	< 3	4	6.75	12	7.17
		3+	16	6.81	8	6.25
	Sit-down Restaurant	< 3	3	13.67	14	9.53
		3+	40	10.05	29	11.24
Fast Food Restaurant	< 3	0		9	4.0	
	3+	28	9.46	19	8.21	
Low Walk – Low Income	Grocery	< 3	0		2	16.5
		3+	2	16.50	0	
	Convenience Store	< 3	6	6.33	14	4.71
		3+	8	3.50	0	
	Sit-down Restaurant	< 3	3	5.00	17	9.29
		3+	14	10.21	0	
Fast Food Restaurant	< 3	6	-2.00	30	3.3	
	3+	24	4.63	0		

For Middle Schools — Fast food restaurants were closer, on average than sit-down ones in all but the low walk/high income community and convenience stores were closer than grocery stores in all but the high walk/ high income community. The distance to convenience stores was 20 percent less than to grocery stores in the low walk/low income community.

For Elementary Schools — Fast food restaurants were closer, on average than sit-down restaurants in all but the high walk/high income community where distances to sit down restaurants was 32 percent less than to fast food. Convenience stores, on average, were nearly the same distance as grocery stores in the low walk/high income and closer in both the high and low walk/low income communities. While exploratory in nature, these results suggest the possibility that neighborhood type and demographics may be related with food outlet siting.

The spatial clustering of food outlets was further examined based on the actual quality of the food choices estimated from the Nutrition Environment Measurement Study (NEMS) quality score. A distance of 0.75 miles and 3.0 miles was used in the high and low walkable communities respectively to compare differences in overall food outlet quality (mean NEMS scores) between what is closest and furthest from school sites. Overall findings

Table 5. Frequency of Food Outlets (by Type and Community) Grouped by Distance from Middle Schools

Community (Walkability/ Income)	Type	Distance from School (road-network, miles)					
		<0.25	<0.5	<0.75	<1.0	<1.25	Study Area*
		N (# of food outlets)					
Low Walk / High Income	Grocery	0	0	0	0	0	6
	Convenience Store	0	0	0	0	1	20
	Sit Down Restaurant	0	0	0	0	1	43
	Fast Food Restaurant	0	0	0	0	0	28
Low Walk / Low Income	Grocery	0	0	0	0	0	2
	Convenience Store	0	0	0	0	2	14
	Sit Down Restaurant	0	0	0	0	0	17
	Fast Food Restaurant	0	0	0	0	1	30
High Walk / High Income	Grocery	0	1	1	3	6	9
	Convenience Store	0	1	1	1	5	9
	Sit Down Restaurant	0	3	12	19	22	40
	Fast Food Restaurant	0	0	0	11	14	22
High Walk / Low Income	Grocery	1	1	2	2	4	7
	Convenience Store	1	2	5	10	16	18
	Sit Down Restaurant	3	5	5	10	11	15
	Fast Food Restaurant	2	7	10	13	17	22

* Study area is the census tract plus a one-mile buffer around it.

suggest higher NEMS scores in the higher income communities. In both of our high walkability communities grocery stores closer (within 0.75 miles) to middle schools had higher NEMS scores, while closer sit-down restaurants had lower NEMS scores than sit-down restaurants farther away, but still in the same neighborhood. In the high walk/high income community, convenience stores closer to the middle schools had higher NEMS scores. There were no grocery stores or fast food restaurants within 0.75 miles of an elementary school in the high walk/high income community. In the high walk/low income quadrant, grocery stores had higher mean NEMS scores within close proximity to schools, while convenience stores showed little NEMS score difference based on distance. Both fast food and sit-down restaurants were shown to have higher NEMS scores when located farther from a school.

A 3-mile comparison threshold was used in our low walk communities where facilities were more spread out. For the middle school in the low walk/high income area there was little difference in NEMS score for convenience stores based on distance. Sit-down restaurants were shown to have higher NEMS scores in the under-3-mile group. No fast food restaurants or grocery stores were within 3 miles of a middle school in this

low walkability area. In the low walk/low income community both types of restaurants had lower NEMS scores in the under 3-mile group. Doing the same calculations for elementary schools in the low walk/high income area showed that NEMS quality scores increased for all food outlet types, other than convenience stores, as distance from a school increased. No food outlets were located over 3 miles from an elementary school in the low walk/low income community.

The concentric buffer analysis presented in Table 5 conveys the observation that low-walkability communities did not have any food outlets within 1.25 miles of the selected middle school. The high walkability communities had 34 food outlets within a mile from the middle school and the middle school in the high walk/low income community had seven food establishments and all four types within a quarter mile. In this high walk/low income community, grocery stores had declining mean NEMS scores with each larger buffer away from the school. The other food outlet types did not show such a consistent trend with distance from school in this community. The high walk/high income area had three of the four types of food outlets within the 1-mile buffer, but showed no pattern or trend in NEMS scores based on distance from the middle school.

Very few food outlets at all existed within 1.5 miles of the low walk communities. Food choices provided in schools in similar low-walkability communities would logically have the potential for a greater impact on diet than students located in areas with alternative food choices.

Subsequent analyses were conducted to demonstrate the ability to develop food quality (mean NEMS scores) for the quarter mile buffer from each middle school. The mean NEMS scores for the full study area or largest buffer covers a considerable amount of each community's food environment. Results suggest more differences in food quality available in the communities across income level and fewer differences across walkability level (Glanz et al. 2006; Saelens et al. 2006).

Discussion

A new and innovative set of methods to define and quantify a "community food environment" in a geographic information system is presented. These methods can be applied in larger, more robust studies of community environments to determine systematic spatial relationships between food access quality and neighborhood characteristics. This pilot assessment focused on the food environments around schools, but similar assessments could be made of other settings and other at-risk populations, including older adults in assisted living facilities and lower income or racial/ethnic

minority populations, who are more likely to be obese. The research design presented provides the opportunity to assess interactions between neighborhood design and income as they relate to the quality of food access, which is an important environmental justice concern.

Analyses are presented based on the spatial distribution of food outlet type and food outlet quality around elementary and middle schools. Comparisons between food access by outlet type and quality within and between communities appeared to vary based on walkability and income. Considerable variation in distance from schools to food outlets emerged across the four different community types. Comparative assessments were made suggesting the possibility of some disparities in food outlet location and food outlet quality across income and walkability.

It is important to incorporate a uniform distance measure between communities of the same type, but finding a measure that will produce comparable results for all communities of a given type was a major challenge. This issue raises questions not only of appropriate distance, but of also why the presence of food outlets within a specified distance might vary from community to community. The variability might be attributed to socio-economic factors such as income level, as was found in Reidpath's study of fast-food density and socio-economic status (Reidpath, Burns et al. 2002). Results presented here suggest that accessibility to any food outlet type on foot in lower walkability areas is difficult from schools, leaving youth to be more dependent on food choices available within schools, at home, or through being driven to other food outlets. Increased proximity to healthy food choices near to schools could promote active transportation while enabling healthier diets and further reduce auto dependence in older youth.

Low-income urban neighborhoods often have a greater number of convenience stores and a lower number of grocery stores than high-income suburban neighborhoods, influencing not only residents' access to healthy food choices, but also the cost of food (Curtis 1995). The variation and richness of food environments reflects largely the interface between zoning designation and income. Zoning influences the ability for commercial uses to be intermixed with residential and school environments, and income establishes the market for such uses to co-locate. The walkability measure presented here captures elements of "regulatory permission" to locate food establishments whereas income impacts business opportunity, profitability, and attractiveness. Lot size and parking requirements also determine the location of activities in space.

There are several limitations with the current study. Foremost, it is a pilot study and does not offer any ability to explain systematic associations between community design, income, and food access quality. Variations

in urban form in the study make it difficult to assess which factors are most influential in explaining access to food environments, including distances and variations in income and walkability, which are all highly interactive.

However, as a pilot study, the NEMS project has been successful in developing criteria and methods for rating quality of food outlets and in examining several methods of evaluating the spatial distribution of food outlets and their quality. The methods reported here can be used to evaluate disparities in access to healthful foods and to document the relation of access to healthful foods to dietary patterns and health outcomes. Understanding the health impact of food environments can inform changes in public policies and business practices that are needed to help people improve their eating habits to reduce the risk of diseases. It is well understood that non-work trips, such as dining out, grocery shopping, and entertainment, comprise the majority of trips taken in the U.S. each day. Proximity to food outlets and the presence and quality of pedestrian connections will influence whether people will walk, bike, drive, or take public transportation for this major travel purpose. A sustainable urban transportation system can only be achieved where it is possible to access basic daily needs, like food, in ways that promote healthy people and healthy places.

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Dr. Lawrence Frank is the Bombardier Chairholder in Sustainable Transportation at the University of British Columbia. He specializes in the interaction between land use, travel behavior, air quality, and health. He has co-authored numerous papers and two books in the past few years on these topics. In 2004 he published the first paper to document significant relationships between built environments, travel patterns, and obesity and was featured in *Time* magazine's special issue in 2004 on obesity.

Dr. Karen Glanz is a Professor and Georgia Cancer Coalition Distinguished Research Scholar in the Rollins School of Public Health at Emory University. She is also the Director of the Emory Prevention Research Center. Her research focuses on theories of health behavior, nutrition education and behavior, obesity and the built environment, cancer prevention and control, and ethnic differences in health behavior and determinants. She is the author or co-author of more than 240 articles and chapters, and is senior author of the text, *Health Behavior and Health Education: Theory, Research and Practice*.

Ms. Margaret McCarron holds a Masters in Public Health from Emory University and is a Research Investigator at the Centers for Disease Control and Prevention. Ms. McCarron has extensive GIS skills and has applied these skills to a variety of health related concerns including food outlet accessibility, the subject of this paper, and the spread of Avian Flu.

Dr. James F. Sallis is Professor of Psychology at San Diego State University and is the Research Director of the Active Living Research Program funded by the Robert Wood Johnson Foundation. Dr. Sallis was recently noted as amongst the most published and widely referenced scholars in his field and is a recognized international thought leader in public health today. In 2004 he was a featured "Obesity Warrior" in *Time* Magazine.

Dr. Brian E. Saelens is an Associate Professor of Pediatrics at the University of Washington and the Seattle Children's Hospital and Regional Medical Center. He does research in pediatric obesity and physical activity, with particular interest in the environmental influences on these health-related factors.

Mr. James Chapman is a Principle Associate with Lawrence Frank and Company, Inc. and was the co-director of the Atlanta based SMARTRAQ research program. Mr. Chapman was the founding executive director of Georgians for Transportation Alternatives and holds a Masters of Science in Civil Engineering from Georgia Tech. Mr. Chapman has extensive experience in research and survey design and database development, management, and analysis.

Sustainable Transport in Canadian Cities: Cycling Trends and Policies

John Pucher and Ralph Buehler

Abstract

This article examines cycling trends over time, as well as differences in cycling levels, policies, and programs among different Canadian provinces and metropolitan areas. Some policies and measures have been quite successful and innovative, providing valuable lessons for other countries about how best to increase cycling while improving its safety. While Canadian cities have been more successful than American cities at promoting cycling as a mode of transport, they fall far short of European cities. As noted in the conclusion of this article, there are two key differences that help explain the much higher levels of cycling in Europe: more compact land-use patterns leading to shorter trip distances and a wide range of policies discouraging car use by making it more expensive or more difficult.

Introduction

In 2002, the Canadian Government ratified the Kyoto Protocol, thus officially committing the country to reduce its greenhouse gas (GHG) emissions. By the year 2012, Canada must achieve at least a 6 percent reduction in total GHG emissions below the 1990 emissions level (Environment Canada 2004). Encouraging Canadians to use their bikes for a higher percentage of trips — and their cars for a lower percentage — would be an ideal way to reduce Canadian GHG emissions from transportation sources (Transportation Association of Canada 1993, 1998, 2004).¹ Bicycling is one of the most sustainable transport modes. Riding a bicycle emits virtually no GHG at all.

¹ In 2002 when Canada ratified the Kyoto Protocol, GHG emissions from petroleum combustion (in millions of metric tons of carbon equivalent) contributed 47 percent of Canada's total emissions. To meet the Kyoto target of 6 percent below 1990 levels (based on 2002 data), the country as a whole must reduce its emissions by 20 percent. Since 2002, the level of emissions has actually increased, making the necessary reductions even greater and more challenging (Energy Information Administration 2006).

Moreover, bikes require far less roadway and parking space, thus helping to relieve the growing congestion problems in most cities. Bicycling is also an equitable mode of transport, since it is affordable for virtually everyone, and with proper training, most people can learn to cycle. Finally, cycling is an extraordinarily valuable form of cardiovascular exercise that improves both physical and mental health (Pucher and Dijkstra 2003).

This article examines cycling trends over time, as well as differences in cycling levels, policies, and programs among different Canadian provinces and metropolitan areas. Some policies and measures have been quite successful and innovative, providing valuable lessons for other countries about how best to increase cycling while improving its safety. While Canadian cities have been more successful than American cities at promoting cycling as a mode of transport, they fall far short of European cities. As noted in the conclusion of this article, there are two key differences that help explain the much higher levels of cycling in Europe: more compact land-use patterns leading to shorter trip distances and a wide range of policies discouraging car use by making it more expensive or more difficult.

The article begins with an overview of aggregate time trends and geographic differences in Canadian cycling levels and injury rates. Most of the policy analysis, however, is focused on eight case study cities in Canada's four most populous provinces: Montreal and Quebec City in Quebec, Toronto and Ottawa in Ontario, Vancouver and Victoria in British Columbia, and Calgary and Edmonton in Alberta. Since urban transport policy in Canada is determined at the provincial and local level, disaggregate case study analysis is the only way to examine the nature, extent, and impacts of cycling policies in Canada.

Overall Trends and Spatial Variation in Canadian Cycling

As shown in Table 1, bicycling accounted for only 1.2 percent of Canadian work trips in 2001. That was a 10 percent increase over the 1996 bike share of 1.1 percent, but it remains a tiny percentage of trips. With over a fourth of all trips in Canadian cities less than two miles long — a distance that can easily be covered by bike — there is obviously much potential for increasing cycling and thus reducing car use that contributes so much to GHG emissions.

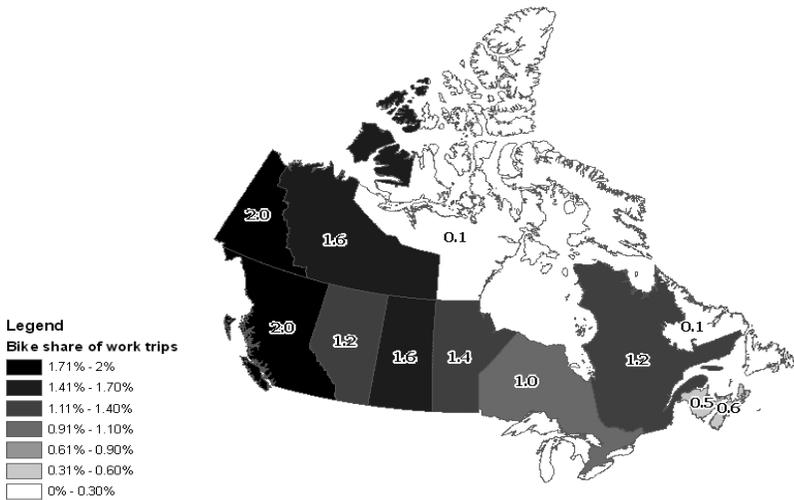
As shown in Figure 1, levels of cycling vary widely among Canada's provinces: from a high of 2.0 percent in both British Columbia and Yukon Territories to a low of 0.1 percent in Newfoundland and Labrador. It is notable that British Columbia has about twice as high a cycling share of work trips as Ontario, Canada's most populous province. Moreover, while the cycling share rose from 1996 to 2001 in British Columbia (from 1.9 to

Table 1. Choice of Transport Mode for the Journey to Work in Canada, 1996 and 2001

	Total Number of Work Trips per Day			Modal Share	
	1996	2001	% increase	1996	2001
All Modes	12,183,410	13,450,855	10.4	100	100
Car, Truck, Van as Driver	8,934,025	9,929,470	11.1	73.3	73.8
Car, Truck, Van as Passenger	899,340	923,975	2.7	7.4	6.9
Public Transport	1,233,870	1,406,585	14.0	10.1	10.5
Walk	850,855	881,085	3.6	7	6.6
Bicycle	137,435	162,910	18.5	1.1	1.2
Other	127,885	146,835	14.8	1	1.1

Source: Statistics Canada (1998 and 2003).

Figure 1. Modal Split of Workers Bicycling to Work in Canadian Provinces and Territories



Source: Statistics Canada (2003).

2.0 percent) and from 1.1 to 1.2 percent in Quebec and Alberta, it remained constant in Ontario (at 1.0 percent).

Table 2 contains the cycling share of work trips for each of Canada’s metropolitan areas with at least 100,000 inhabitants. Of Canada’s two largest cities, Montreal has a considerably higher bike share of work trips than Toronto (1.3 vs. 0.8 percent). In the next largest category, however, Vancouver and Ottawa-Hull are tied at 1.9 percent. In the middle category, the bike share ranges from 1.5 percent in Calgary to 0.9 percent in Hamilton, Ontario. The next category displays much more variation, with a 10 to 1 ratio of bike shares: from 4.8 percent in Victoria, British Columbia, to only

0.5 percent in Oshawa, Ontario. The smallest-size category has the most variation, with a 25 to 1 ratio of bike shares: from 2.5 percent in Saskatoon, Saskatchewan, to only 0.1 percent in St. John's, Newfoundland.

Table 2. Bicycling Share of Work Trips in Canadian Metropolitan Areas, by Population Size Categories, 2001

Number of Inhabitants	Modal Split	Metropolitan Area	Population
3 million or more	1.3	Montreal	3,426,350
	0.8	Toronto	4,682,897
	Group Mean	<u>1.1</u>	
1 million to 2,999,999	1.9	Vancouver	1,986,965
	1.9	Ottawa Hull	1,063,664
	Group Mean	<u>1.9</u>	
500,000 to 999,999	1.5	Calgary	951,395
	1.4	Winnipeg	671,274
	1.3	Quebec	682,757
	1.2	Edmonton	937,845
	0.9	Hamilton	662,401
	Group Mean	<u>1.3</u>	
250,000 to 499,999	4.8	Victoria	311,902
	1.5	London	432,451
	1.1	Windsor	307,877
	1.1	Kitchener	414,284
	0.9	St. Catherines-Ni.	377,009
	0.9	Halifax	359,183
	0.5	Oshawa	296,298
	Group Mean	<u>1.5</u>	
100,000 to 249,999	2.5	Saskatoon	225,927
	2.2	Kingston	146,838
	1.5	Trois Rivieres	137,507
	1.4	Regina	192,800
	1.0	Thunder Bay	121,986
	0.9	Abbotsford	147,370
	0.8	Chicoutimi-Jonquiere	154,438
	0.8	Sherbrooke	153,811
	0.4	Greater Sudbury	155,601
	0.4	Saint John	122,678
	0.1	St John's	172,918
	Group Mean	<u>1.1</u>	

Source: Statistics Canada (2003).

Comparability of Data and Methods

The information presented in this paper comes from several sources. We used consistent data sources as much as possible, relying most heavily on the Canadian Census. The census collects travel data for Canadian cities and provinces and is the only fully comparable source of information on cycling levels in different Canadian provinces and cities. Unfortunately, as with the U.S. Census, the Canadian Census only reports on the journey to work, thus excluding all bike trips for other purposes. Another problem is that the census only reports the primary mode used for the work trip, thus excluding bike trips made to access public transport, for example. That probably understates the total number of bike trips.

As with the U.S. Census, the Canadian Census only collects work trip data during one month of the year: May in Canada vs. April in the U.S. That limitation to one month of the year hides important variations in cycling levels throughout the year in both countries, but especially in Canada. Cycling levels are obviously much lower in the colder and rainier winter months than in May, when the survey is taken. The Canadian Census is taken every five years, but bicycling information has only been collected for the past two censuses, 1996 and 2001.

To supplement the Canadian Census data and to obtain information on non-work trips by bicycle, we also gathered information from a variety of travel surveys that were conducted at the local level, generally for a few large metropolitan areas. Unlike the multipurpose Nationwide Personal Transportation Survey (NPTS) and National Household Travel Survey (NHTS) travel surveys in the United States, Canada has no nationwide travel survey that captures trips for non-work purposes. Only the individual metropolitan area surveys in Canada provide information on total travel, including both work trips and non-work trips, and they are limited to only a few large cities. Those metropolitan surveys, however, suggest considerably higher bike mode shares for total travel, including all trip purposes, than for work trips alone (Pucher and Buehler 2005). Unfortunately, such metropolitan area travel surveys in Canada vary in design, methodology, and timing, and are not fully comparable across Canadian cities.

Unlike the U.S., no study has attempted to collect, standardize, and compare the extent of bicycling facilities for Canada. From our own examination of the metropolitan level information, there appears to be great variability in the classification and measurement of cycling infrastructure in different cities and in the degree of availability of such information at all. Consequently, the corresponding statistics and information we collected for individual metropolitan areas are not necessarily representative.

In general, they were provided by the cycling coordinators either at the provincial level or at the individual metropolitan level.

Trends in Cycling Fatalities and Injuries

Both the aggregate Canadian data cited above — and the case studies discussed later in this article — suggest considerable growth in cycling over the past two decades. In spite of increased exposure through more cycling, both fatalities and injuries have fallen considerably in most provinces over that same period. For Canada as a whole, total cycling fatalities fell by 50 percent from 1984 to 2002 (from 126 to 63), and total cycling injuries fell by 33 percent (from 11,391 to 7,596) (Transport Canada 2004).

Figures 2 and 3 portray cycling safety trends for Canada's four most populous provinces. Fatalities fell by 61 percent in Ontario, by 60 percent in British Columbia, and 46 percent in Quebec. In Alberta, cycling fatalities remained roughly constant. Injuries fell by 41 percent in British Columbia, by 37 percent in Ontario, and by 31 percent in Quebec. In Alberta, cyclist injuries increased by 9 percent. It is notable that all four provinces reported an increase in cycling injuries from 1984 to 1987 and then a decline from 1987 until 2002.² Overall, it seems likely that cycling has, in fact, become safer in all four provinces, especially considering the growth in cycling levels over the same time period, which suggests an even sharper fall in fatalities and injuries per kilometer cycled.

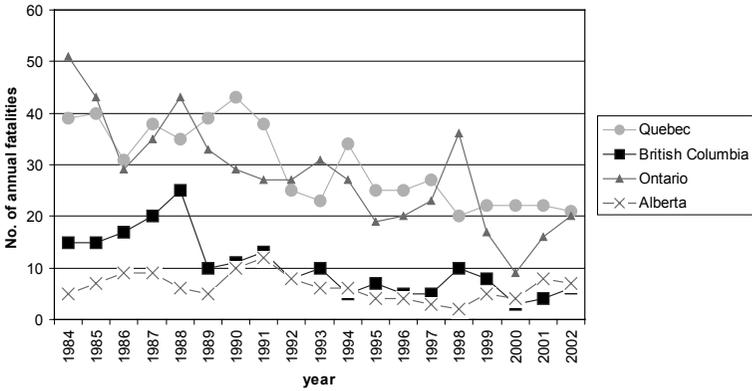
Increases in cycling levels and reductions in cycling fatality rates may be functionally related. For example, Jacobsen (2003) analyzed a wide variety of both time-series and cross-sectional data from different countries and showed that higher levels of cycling are very strongly correlated with lower levels of cycling deaths and injuries. The causation probably goes in both directions. Safer cycling encourages more people to cycle, and as more people cycle, there are more cycling facilities, more cycling training, and more consideration by motorists of cyclists, all of which make cycling safer.

Overall, these trends suggest that Canadian cycling is indeed thriving — increasing in both quantity and quality. Clearly, however, there are important differences between provinces and among cities. Moreover, the

² There is no simple explanation for the increase between 1984 and 1987. There was no change in definition of cycling fatalities and injuries, so that is not the cause. For the province of Quebec, data show that the total number of persons injured or killed using other modes of transport than cycling also increased during this time period. That suggests that the increase was not due to a factor affecting only cycling safety but other modes as well. Experts we interviewed from the Ministry of Transport in Quebec hypothesized that the increase in bike fatalities and injuries might be connected to economic factors that induced an increase in all forms of travel demand, and thus greater exposure to the risk of accidents.

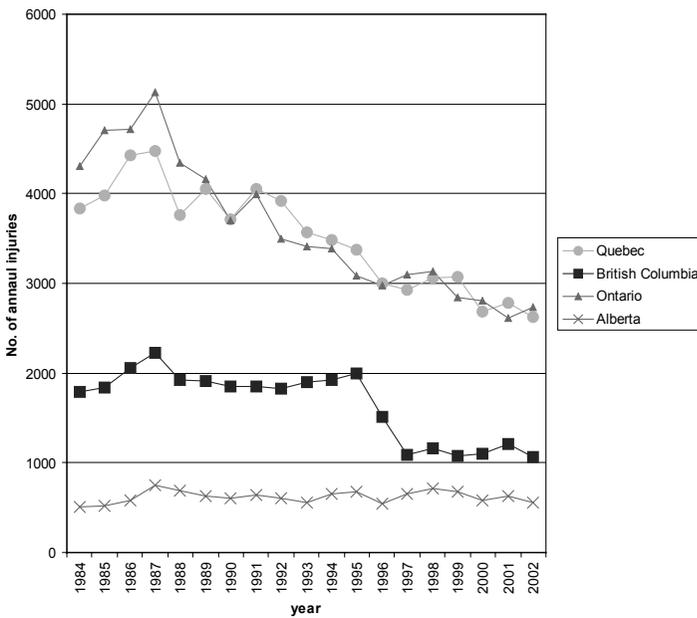
specific measures taken to promote cycling can only be examined at the provincial and local level.

Figure 2. Trends in Bicycling Fatalities in the Provinces of Quebec, Ontario, Alberta and British Columbia, 1984–2002



Source: Transport Canada (2004).

Figure 3. Trends in Bicycling Injuries in the Provinces of Quebec, Ontario, Alberta and British Columbia, 1984–2002



Source: Transport Canada (2004).

Federal Bicycling Policies

Traditionally the federal government in Ottawa had no involvement in cycling policies or funding. Only in 2003 did Transport Canada — the federal ministry of transport — announce the new Urban Transportation Showcase Program. In a nationwide competition, eight Canadian municipalities were awarded a total of \$40 million³ over five years for innovative projects that would help reduce GHGs from transportation sources (Transport Canada 2003). Four of the eight funded proposals included cycling elements in their overall projects. While this new funding is welcome, it is a one-time program and amounts to only about \$2 million a year in federal cycling funds for the entire country.

Bicycling Policies and Funding at the Provincial Level

The extent of provincial involvement in cycling policies and funding varies considerably by province. Generally, the involvement in most provinces relates to safety programming and regulations. Quebec is a notable exception in its strong support of cycling. The provincial ministry of transport, Transports Quebec, and the province-wide bicycle advocacy organization, Velo Quebec, have taken the lead in planning, coordinating, and funding the province-wide network of cycling paths. The province adopted an official bicycle policy in 1995 with the goal of increasing cycling levels while enhancing safety. As part of that official policy, all provincial transport infrastructure projects must incorporate the needs of cyclists in their design. \$89 million dollars in funding from Transports Quebec and about \$180 million from other government agencies and municipalities has helped Quebec's bikeway network grow almost ten-fold from 1992 to 2004 (from 778 to almost 7,000 km), with even more expansion planned (Transports Quebec 2004a and 2004b; Velo Quebec 2003). Contrary to most other Canadian provinces, helmet use is not mandatory in Quebec (Velo Quebec 2001).

The provincial government of Ontario provides virtually no funding, planning or program coordination for cycling. Ontario's involvement is limited to the regulations that most provinces have about whether helmet use is mandatory and on which highways cycling is permitted.

The provincial government of British Columbia provides only very limited funding for improvements in cycling infrastructure. Requiring at least an equal match by local governments, the province provided about \$2 million per year from 1995 to 2001, then suspended the program for three

³ All monetary figures are in Canadian dollars. One Canadian dollar is roughly equal to 0.8 U.S. dollars.

years, and re-instated the program in 2004 at only half the former level of support. Moreover, all municipalities applying for provincial funding are required to establish bicycling facility plans as part of their overall community development plans. That in itself has been a positive development. Helmet use has been mandatory throughout British Columbia since 1995, as well as front and rear lights on bikes used after sunset (Capital Regional District 1999 and 2003a).

Until recently, the direct involvement of Alberta's provincial government in bicycling was mostly limited to traffic regulations and occasional bicycle infrastructure projects, mainly for recreational cycling in parks. Alberta Transportation, the provincial transport ministry, maintains websites on bike safety education and publishes a series of bicycle safety brochures for children and adults, which are distributed free of charge (Alberta Infrastructure and Transportation 2006). Since 2001, a share of Alberta's provincial gasoline sales tax is returned to municipalities for transportation infrastructure improvements, including potential bicycling infrastructure programs. In 2005, the provincial government allowed municipalities to share its annual budget surplus. Local governments have to apply for this money on a project-by-project basis.

Bicycling Policies at the Local Level: General Findings

As difficult as it is to obtain comprehensive, nationwide information on federal and provincial policies and funding, it is even more difficult to obtain comparable data of individual cities. We present in this section, a brief summary of typical measures undertaken by Canadian cities, providing specific examples in a few cities. The cities included may not be fully representative, but they give some indication of what different cities are doing. Most of the information is based on detailed city case studies published elsewhere (Pucher and Buehler 2006 and 2005; Pucher et al. 1999) but with updates and the inclusion of a few additional cities, we investigated especially for this paper. Tables 3 and 4 summarize and compare some selected measures and policies implemented in the eight case study cities. While the information presented in the tables represents the best we could obtain, it is not necessarily exhaustive and not fully comparable, as we noted above. Fully comparable, complete statistics quite simply do not exist.

Bike Network

Table 3 presents our summary of the best available estimates of the length of separate cycling facilities per 100,000 persons in seven Canadian cities. Somewhat similar to the modal split statistics, the bicycling facilities sta-

tistics show large variation among cities within the same population size category. Cycling facilities appear to be considerably more extensive, at least on a per-capita basis, for medium-size cities than for large cities.

Table 3. Extent of Cycling Facilities in Selected Canadian Cities (km per 100,000 Population)

Population Size	Metropolitan Area	Kilometers of Bike Paths and Lanes per 100,000 Persons
3,000,000–5,000,000	Toronto	8.7
	Montreal	29.3
	Average	19.0
1,000,000–2,999,999	Vancouver	29.0
	Ottawa	65.9
	Average	47.5
500,000–999,999	Calgary	68.3
	Edmonton	64.6
	Quebec	54.0
	Average	62.3
	National Average	42.9

Source: Author's calculations, based on information from municipalities.

Statistics on the extent of bike lanes and paths understate the full extent of the cycling network, since they do not include signed bike routes on roadways or traffic-calmed residential streets. For example, Vancouver, Toronto, and Calgary rely heavily on traffic-calmed neighborhood streets as essential components in their overall cycling network. We attempted to collect statistics on the exact extent of traffic calming, but very few cities have this information. Bike lanes and paths can also vary in type. For example, almost all of Montreal's bike lanes are bi-directional and separated from motor vehicles by special barriers. Toronto and a few other cities have mixed-use bike/taxi/bus lanes on downtown streets. Many cities also have so-called "sidepaths," bike paths that closely parallel roads, with some sort of buffer between cyclists and motor vehicle traffic. Cycling on sidewalks is usually illegal, but common in all cities. In Edmonton, however, over 100 km of sidewalks have been officially designated as mixed-use facilities, with signs and pavement markings indicating that cycling is permitted.

Parking and Integration with Transit

Convenient, safe, and ample bike parking is an inducement to cycle, just as convenient, ample free car parking is an inducement to drive. Most of the large Canadian cities we studied in detail require the private provision

of bike parking in their zoning and building codes and make the public provision of bike parking on sidewalks and at transit stops a top priority (Pucher and Buehler 2005). The city of Toronto, for example, has almost 15,000 of its post-and-ring bike racks on sidewalks, and continues to install about 1,000 new racks per year. The city also provides bike parking at most rail transit stations. Indeed, Toronto is reputed to have the most bike parking of any city in either Canada or the U.S. Ottawa has the second-most bike parking in Canada, with over 10,000 bike racks in public spaces and government offices. Many cities in Canada also have specific policies to encourage integration of transit and cycling by putting bike racks on buses, allowing bikes to be taken on trains, and providing bike parking at transit stops.

Intersection Modifications, Safety Programs, and Other Policies

Several Canadian cities provide special intersection modifications that give cyclists an advance stop line as well as priority signaling, triggered either manually by push buttons or automatically by sensors in the pavement. Most Canadian cities have been improving their overall bike route network, with better linkages, better signage, and clearer route designations.

Almost all large and medium-size cities in Canada offer a wide range of cycling courses for all age groups through the national cycling education program CAN-BIKE as well as promotional events such as bike races, bike rodeos, and cycling festivals. Toronto has a Cycling Ambassador outreach program that sends a team of ten professionally trained cyclists into neighborhoods throughout the city to teach cycling safety and skills courses and to promote cycling in general. Several Canadian cities have detailed cycling maps available as well as extensive websites with a wide range of up-to-date information for cyclists. Montreal offers a special cycling café'-restaurant (Maison des Cyclistes) that also serves as a multi-faceted center to coordinate cycling events, provide information, promote cycling tourism, and repair bikes. Finally, many cities have introduced police squads on bikes.

Cycling Trends and Policies in Quebec

Cycling Trends in Montreal and Quebec City

The Province of Quebec overall has the same percentage of bike work-trips as Canada as a whole (1.2 percent). Montreal, however, has a much higher bike share of work trips than Canada's other major metropolis, Toronto

Table 4. Selected Policies Implemented in Canadian Cities to Promote Cycling				
City	Bike Network	Convenience & Parking	Safety Training	Promotion/ Other
Montreal	Some intersections with push-button activated bike traffic lights, 210 km of separate bike paths, 95 km of bike lanes, and 66 km of bike routes	1,600 bike parking spaces at metro stations and 550 spaces at suburban rail stations, bikes allowed on buses and trains during off-peak, lots of bike parking at universities	SAAQ (Societe d'Assurance Automobile du Quebec) promotes bike safety in many schools	Bike tours and races, bike magazine, maps, website, cycling cafe in Montreal
Quebec City	Some intersections with push-button activated bike traffic lights, 220 km of separate bike paths, 121 km of bike lanes, and 66 km of bike routes	Bike parking on sidewalks, at bus stops, and at the university, bike racks on buses		
Toronto	252 km of bikeways, including 154 km of off-road paths, 63 km of bike lanes, and 35 km of shared roadways, traffic calming in many residential neighborhoods	Intersections with special bike traffic signals, zoning code requires all large new developments to provide both bike parking and shower facilities for cyclists, 14,500 bike parking spaces on city sidewalks, bike and ride, bikes on subway and suburban rail at off-peak hours	CAN-BIKE	Cycling Ambassador Program, signage, bike map, bike events
Ottawa	511 km of bike routes on arterial and secondary roads (83km separate bike lanes, 81 km paved shoulders, and 35 km extra-wide shared lanes), 311 km of off-road bike routes	Intersections with special bike traffic signals, zoning and building codes require bike parking for certain kinds of land uses, 6,000 bike parking spaces, plus parking at federal offices	CAN-BIKE	Bike map, bike events
Vancouver	1,347 km of bike routes , mostly on lightly traveled roads	Cyclist-activated traffic signals, buses and ferries with bike racks	CAN-BIKE	Bike Month, bike map
Victoria	377 km of bike routes, some traffic calmed neighborhoods	Cyclist-activated traffic signals, buses and ferries with bike racks	Bike Smarts Program (schools), CAN-BIKE	Bike to Work Week, bike map
Edmonton	603 kilometers of bike trails and paths in parks, 250 kilometers bike routes along road rights-of-way (including 100 kilometers of shared-use sidewalks)	Bikes allowed on light rail and buses, 230 bike racks with over 1,000 bike parking spaces along bike routes	CAN-BIKE	Multi-Use Trail Corridor (MUTC) network project, Ribbon of Steel (ROS)
Calgary	550 kilometers of pathways and 260 kilometers of on-street bicycle routes, traffic calming	Bikes allowed on light rail and buses, 200 U-shaped bike racks in downtown	CAN-BIKE	"Park 'n Bike" sites

Note: The information presented in this table is not exhaustive and not necessarily comparable; details are discussed in the case studies in this paper.

(1.3 vs. 0.8 percent), in spite of colder weather throughout the year. Quebec City also has a 1.3 percent bike share of work trips, about the average for Canadian cities of that size, but impressive given the cold climate there. Although the bike share of work trips reported in the 2001 Canadian Census is the same in both Montreal and Quebec City (1.3 percent), other surveys suggest slightly higher cycling shares of travel in Montreal. Surely the most impressive accomplishment in Quebec has been increasing cycling levels while sharply reducing cycling injuries (Velo Quebec 2000).

Bicycling Infrastructure and Safety

Clearly, one reason for both the growth in cycling levels and its increasing safety is the enormous expansion of both off-road and on-road cycling facilities throughout the province of Quebec. In Montreal, there are 210 km of separate bike paths, 95 km of bike lanes, and 66 km of bike routes on lightly traveled roads. Although it is much smaller, Quebec City has even more cycling facilities: 220 km of separate bike paths, 121 km of bike lanes, and 66 km of bike routes on lightly traveled roads (Velo Quebec 2004a). For Quebec province as a whole, 41 percent of bike trips are on separate bike paths as opposed to shared roads (Velo Quebec 2001). In general, the Government of Quebec bears the cost of bikeway projects on provincial roadways, while municipalities finance bikeway projects on city streets. There are only a few intersections with push-button activated bike traffic lights, but no automatic sensors for cyclists, as in Toronto, Ottawa, and Victoria.

Cycling safety is promoted in many schools thanks to the Quebec car insurance company Societe d'Assurance Automobile du Quebec (SAAQ). It distributes free bicycling safety instruction materials and offers prizes of free bikes and bike helmets for winners of various cycling safety competitions (SAAQ 2004).

Cycling Convenience and Promotion

While bikes can be taken on some buses, metros, and suburban trains, especially at off-peak times, there are no special provisions for bikes on most transit vehicles (Agence Metropolitaine de Transport (AMT) 2004 and Velo Quebec 2003). Bike parking has also been expanded at metro and suburban rail stations. In 2000, Montreal had 1,600 bike parking spaces at metro stations and 550 spaces at suburban rail stations. Both Montreal and Quebec City have been increasing the number of bike racks on sidewalks, and their universities have thousands of bike parking spaces on their campuses (Velo Quebec 2003).

Quebec has been at the forefront of cycling promotion in Canada thanks to Velo Quebec, a private non-profit organization funded mainly by member fees, events, and sponsors (Velo Quebec 2004b). Velo Quebec sponsors numerous special events such as tours, conferences, races, and cycling courses. The organization also publishes a cycling magazine (Velo Mag), maintains an informative, multifaceted website, and operates a cycling café in Montreal that offers food as well as cycling publications and supplies (Maison des Cyclistes) (Velo Quebec 2004c).

Cycling Trends and Policies in Ontario

Cycling Trends in Ottawa and Toronto

The Ottawa metropolitan area has a considerably higher level of cycling than the Toronto metropolitan area: 1.9 vs. 0.8 percent of work trips (Statistics Canada 2003). Even though cycling's share of travel in metropolitan Ottawa has been falling slightly over the last years, Ottawa still has the highest bike share of travel of any major city in Canada and the United States.

Cycling trends vary greatly in Toronto between the inner and outer portions of the metropolitan area. For the greater metro area, the Canadian Census reports the same 0.8 percent bike share of work trips in both 1996 and 2001 (Statistics Canada 2003). For the much smaller core area called Metro Toronto, however, the Canadian Census bike share of work trips rose from 1.1 percent in 1996 to 1.3 percent in 2001. City counts also suggest considerable cycling growth in the inner portions of the metro area from 1999 to 2003 (Decima Research 2000; City of Toronto 2001).

Both Ottawa and Toronto have succeeded in improving cycling safety. In the past ten years, for example, cycling injuries have fallen by 33 percent in Ottawa, and cycling fatalities have been cut in half (City of Ottawa 1999-2003 and 2003b). Over the same period, cycling injuries in Toronto fell by 9 percent, and fatalities fell by about two-thirds (City of Toronto, 2005a).

Bicycle Infrastructure and Safety Promotion

Ottawa and Toronto have undertaken a broad range of measures to improve cycling safety (City of Ottawa 1994 and 2001; City of Toronto 2001 and 2003). Both cities have greatly expanded their systems of bike paths and lanes to provide more separate rights of way for cyclists. As of 2003, Ottawa had 511 km of bike routes on arterial and secondary roads, of which 83 km had separate bike lanes, 81 km had paved shoulders specifically for

cycling, and 35 km had extra-wide shared lanes. Ottawa also has 311 km of off-road bike routes. Included in Ottawa's total of 822 km of cycling facilities is the extensive system of bike paths known as the National Capital Pathway, mainly along waterways or in parks and greenways.

Although Toronto has been steadily expanding its network of bike routes, it remains much smaller than Ottawa's. In 2003, it offered 252 km of bike-ways (compared to Ottawa's 822 km), including 154 km of off-road paths, 63 km of bike lanes, and 35 km of shared roadways (City of Toronto 2001 and 2004). While Ottawa offers more cycling facilities, Toronto has more extensive traffic calming of its residential neighborhoods, making cycling on shared streets both safer and more pleasant. Toronto and Ottawa have many intersections with special bike traffic signals, including some with innovative roadway sensors that detect waiting bikes and automatically trigger a green light for cyclists.

CAN-BIKE in both Toronto and Ottawa offers a variety of education and training courses for all age groups and skill levels. In addition, Ottawa schools offer instructional programs for cycling skills and traffic safety. The City of Toronto recently took over the CAN-BIKE program and now runs it directly through its parks and recreation department, with instructors hired as city employees.

Toronto offers the most extensive bike parking facilities in all of North America, with a total of 14,500 bike parking spaces on city sidewalks as of 2004. The post-and-ring bike stand was developed in Toronto and has become a symbol of Toronto cycling (City of Toronto 2001). Toronto and Ottawa's zoning codes require new developments to provide both bike parking and shower facilities for cyclists for certain kinds of land uses. The City of Ottawa provides well over 6,000 bike parking spaces, not including the many thousands of bike parking spaces at federal offices and large employers, for which bike parking statistics are not available (City of Ottawa 2004).

Convenience and Bike Promotion

Intermodal coordination of cycling with public transport appears to be much better in Ottawa than in most Canadian cities. In addition to bike parking at all light rail (O-Train) and express bus (Transitway) stops, an increasing number of Ottawa buses come equipped with bike racks. Additionally, bikes are permitted on the O-Train at all times of day, while Toronto's subway and suburban rail trains only allow bikes during off-peak hours. Fortunately, there is bike parking at many subway and commuter rail stations in Toronto, thus facilitating bike and ride.

Both Toronto and Ottawa offer an impressive array of programs to promote cycling (City of Toronto 2001 and 2004; City of Ottawa 2001). Both cities have a detailed map of cycling routes, designating various kinds of bike routes, bike share pickup/drop-off sites, transit connections, and other items of interest to cyclists. Toronto's improved bike route signage system in itself is an attempt to encourage more cycling by making it easier to find the best routes to popular destinations.

Toronto has a unique Cycling Ambassador Program that employs about ten proficient cyclists who reach out to communities throughout the city, disseminating information about cycling; promoting safety; assisting with cycling courses; and gathering feedback from communities to improve the city's cycling policies and programs. In addition to all of these efforts by the Cities of Toronto and Ottawa, citizen groups have been key to promoting cycling.

Cycling Trends and Policies in British Columbia

Cycling Trends in Vancouver and Victoria

The Canadian Census reports that the bike share of work trips in the Vancouver metropolitan area rose from 1.7 percent in 1996 to 1.9 percent in 2001, but that increase may have been caused by a public transport strike during the survey period, which probably forced some riders to cycle instead of taking transit. Since another regional travel survey in 1999 reported the same 1.7 percent bike share of work trips as indicated by the 1996 Census, it is likely that the bike share of trips has been stable in recent years (Translink, 2001). As in Toronto, levels of cycling vary greatly between different portions of Vancouver's metropolitan area. While only 0.6 percent of suburban households made their work trips by bike in 1996, 3.3 percent of city residents commuted by bike, and in the university district, the share was 12.2 percent (Translink 2001).

Greater Victoria has an even higher bike share of work trips than Greater Vancouver — indeed the highest of any Canadian metropolitan area: 4.9 percent in 1996 and 4.8 percent in 2001, according to the Canadian Census.

Bicycling Infrastructure and Safety Promotion

Increased cycling safety in British Columbia is probably due to expanded cycling facilities, traffic calming of neighborhoods, improved education and training of both motorists and cyclists, and increased helmet use. In

addition to the CAN-BIKE program, the Bike Smarts Program in Victoria is aimed at cycling education for school children aged 7 to 13 years old (Capital Region District 2003a). Almost half of all Victoria area elementary schools participate in this program, which entails five hour-long sessions of cycling courses (taught by regular school teachers) on rules of the road, bike handling, and correct helmet use.

Both the Vancouver and Victoria regions have been steadily expanding their network of separate bike paths and lanes, while also extending their systems of bike routes on lightly traveled roads. Vancouver, for example, constructed sixteen bikeways from 1986 to 1999, with a total length of 133 km (City of Vancouver 1999). Nevertheless, most of the 1,347 km of bike routes in the Greater Vancouver area in 2004 were on lightly traveled roads, sometimes with modest accommodations for bikes. Indeed, it is the specific policy of Vancouver to focus on facilitating cycling on local side streets with low traffic volumes, including streets in traffic calmed residential neighborhoods (City of Vancouver 1999).

The Victoria Capital Region has a total of 377 km of bike routes (Capital Regional District 2003b). Moreover, some Victoria neighborhoods have been traffic calmed, thus reducing vehicle speeds and facilitating safe and pleasant cycling. There are ambitious plans for expanding the Capital Region's bike route network to 550 km and improving connections among routes, but funding is a key problem (Capital Regional District 2003a).

Both Victoria and Vancouver have made special efforts to accommodate cyclists at intersections (Capital Regional District 2003a; Translink 2004 and 2005). Cyclist-activated traffic signals are available at many locations. Victoria is expanding the number of intersections with special bike access lanes and bike boxes for cyclists waiting for a green light.

Local Funding, Bike Convenience and Promotion

From 1990 to 1999, Greater Vancouver spent almost \$6 million on bikeway facilities. Translink, the regional transport authority for Greater Vancouver was established in 1999 (Translink 2005). Since then, it has increased funding for cycling infrastructure to several million dollars a year, financed by a portion of the gasoline tax dedicated to transport improvements. Both Victoria and Vancouver have made considerable efforts at intermodal coordination with transit (Capital Regional District 2003a; Translink 2004 and 2005). Thus, most buses in both cities are equipped with bike racks, and bikes can be taken on the ferries at any time (Translink 2004).

Efforts to promote cycling in British Columbia include the Bike-to-Work Week in Greater Victoria and the Bike Month with over 50 events through-

out the Vancouver region (Capital Regional District 2003a; Translink 2004 and 2005). Bike route maps are available for both the Vancouver and Victoria regions.

Cycling Trends and Policies in Alberta

Cycling Trends in Edmonton and Calgary

With a bike share of 1.2 percent, the Edmonton census metropolitan area has the same share as Canada as a whole but trails its provincial neighbor Calgary, which has a bike share of 1.5 percent (Statistics Canada 2003). Cyclist fatalities in Edmonton have averaged a fairly stable one or two a year since 1989, while cyclist injuries have declined by 22 percent, roughly the same as the overall provincial average since 1989 (City of Edmonton 2006b).

Edmonton's mainly flat road and street network is ideal for cycling. In the north, Edmonton is intersected by the North Saskatchewan River Valley and Ravine system, which contains 603 km of bike trails and paths. About 130 km of these are granular or paved multi-use trails, 11 km are shared sidewalks, while 450 km are 0.5 meter or wider unpaved trails where cycling is permitted. Multi-use trails and shared sidewalks are open to all kinds of active transport modes, such as cycling, walking or inline skating. Besides the cycling facilities in parks, Edmonton boasts 250 km of cycling network along road rights-of-way. Of these, 105 km are on-road recommended bike routes, mainly on wide shoulders with special signage. An additional 30 km are multi-use trails along rail or utility rights-of-way, and 100 km are shared-use sidewalks. Shared use sidewalks are a minimum of 2.5 meters wide and are either marked with a "share the sidewalk" sign or a yellow line in the center separating cyclists and pedestrians. Furthermore, there are 6 km of shared bus, taxi and bike lanes and 6 km of contra flow bike lanes on one way streets where cyclists travel with cars in the permitted direction and in the bike lane in the opposite direction.

In 2002, the Edmonton City Council approved the \$22 million, 62 km Multi-Use Trail Corridor (MUTC) network, which will connect all quadrants of Edmonton to the downtown and the River Valley. Together with a planned secondary network of 140 km of connector routes (of which 50 km already exist), the corridor will greatly improve the connectivity of the bike network.

Another noteworthy project is the 600 meter long Ribbon of Steel (ROS). It is situated in a former rail right-of way and includes a 3.0 meter wide, asphalt multi-use trail for pedestrians, cyclists and other active modes, a

historic streetcar, as well as underground access to the light rail running beneath the corridor. The ROS is a good example for the development of bicycle planning in Edmonton since the 1990s. The City adopted its bicycle transportation plan in 1992, where it identified the potential to convert former rail corridors to bike paths. The Transportation Master Plan (1999) outlined the goal to develop non-motorized transportation facilities along abandoned rail lines. The Multi-Use Trail Corridor Study in 2002 resulted in the final approval by City Council.

With a bike share of 1.5 percent, the Calgary metropolitan area has the highest modal split for cycling to work of any Canadian city in its size category. City counts reinforce the impressive bike share of work trips, indicating that about 8 percent of commuters to downtown Calgary either walk or ride their bikes to work (City of Calgary 2006).

Timing of recent bicycle planning in Calgary has been similar to that in Edmonton. The Calgary Cycle Plan was adopted in 1996 and the Pathway and Bikeway Plan, was completed in 2000 (City of Calgary 2006). Within Calgary there are approximately 550 km of pathways and 260 km of on-street bicycle routes, mainly on low-traffic-volume residential roads. Calgary pursues the policy of making every street a bicycle friendly street by ensuring wide curb lanes, road maintenance and repair, bicycle friendly sewer grates and cyclist accommodations in traffic calmed areas.

Convenience and Safety Education

Many buses in Edmonton and Calgary have bike racks. Bikes are also permitted on light rail trains in Edmonton and Calgary, except for weekday morning and evening travel peak times (City of Edmonton 2006b; City of Calgary 2006). Bike parking exists at many light rail stations and major bus stops in both cities. Edmonton also has 230 bike racks with over 1,000 bike parking spaces along bike routes. This number underestimates the amount of bike parking in the city, as it neither includes the previously mentioned bike parking at transit stops nor the bike racks on private property and city facilities, such as recreation centers and libraries (City of Edmonton 2006b). Nearly all major office buildings in downtown Calgary offer secured indoor employee bike parking. The City of Calgary also installed 200 U-shaped bike racks in downtown in 2004 through its bicycle parking sponsorship program (City of Calgary 2006). Finally, the City of Calgary offers seven "Park 'n Bike" sites. They are located about 5 to 8 km from the city center, easily accessible from major highways. They enable direct access to the city core by bike. Commuters can park their cars and avoid downtown traffic congestion by cycling the segment leading to the city center (City of Calgary 2006).

As in most Canadian cities, volunteers run CAN-BIKE courses for children and adults in both Calgary and Edmonton. Both cities also publish and distribute cycling maps. Furthermore, Edmonton and Calgary carry out or support signage and cycle safety campaigns, organize annual bike events and conduct bicycle user surveys.

Conclusions, Policy Recommendations, and Future Research

All eight of the Canadian case study cities examined in this article have made impressive efforts to encourage more and safer cycling. The result is bicycling shares of urban travel roughly three times as high as in U.S. cities of comparable size. For all metropolitan areas in aggregate, the bike share of work trips in Canada was 1.2 percent in 2001, compared to only 0.4 percent in the United States (Statistics Canada 2003; Pucher and Renne 2003). That is particularly impressive given the long, harsh winters in most Canadian cities.

Nevertheless, Canadian cities are now struggling with many obstacles to further increasing cycling levels. Perhaps the most important challenge is the proliferation of low-density, sprawling suburbs spreading out around virtually every Canadian city, usually outside the local governmental jurisdiction of the central city (Nivola 1999). Thus, as noted for several case studies, bicycling is concentrated in the denser urban core, with the bike share of travel steadily declining with increased distance from the center. The strong trend toward suburbanization of both population and jobs in Canada works against efforts to promote cycling. Unless Canadian metropolitan areas can implement more mixed-use, compact, less car-dependent land use policies on a truly regional level that includes the suburbs, an increasing proportion of Canada's population will live in areas where cycling is impractical as a mode of daily transport, and will only be occasionally used for recreation.

There are other reasons as well for the stagnation of cycling levels in many Canadian cities in recent years after considerable growth during the 1970s and 1980s. Until now, only the politically "easy" measures have been adopted. Unlike the wide range of car-restrictive measures found in most European cities, Canadian cities, much like their U.S. neighbors to the south, have been quite hesitant to impose restrictions on car use or to increase its price (Pucher and Lefevre 1996; Pucher 2004; Transportation Research Board 2001). Traffic calming of residential neighborhoods, car-free zones, parking restrictions, and parking supply limitations are not nearly as extensive as in most European cities. Moreover, gasoline prices, motor vehicle registration fees, sales taxes on cars, roadway tolls, and parking prices are generally only a fraction of European levels (Pucher 1998).

The wide range of “carrot and stick” measures in European cities have helped achieve bike modal shares of travel that average about 10 percent for Western European countries, but range widely from lows of 4 to 6 percent in the United Kingdom, Italy, and France to highs of 20 to 30 percent in Denmark and the Netherlands (Pucher and Dijkstra 2003). Unless Canadian cities can implement more of the European-style “stick” measures against excessive car use — while enhancing the safety and feasibility of alternative modes — it may be difficult to convince increasingly suburbanizing Canadians to drive less and bike, walk, and take transit more often.

Even the “carrot” measures used to encourage cycling in Canadian cities have been far more limited than those used in European cities (Pucher 1997). No Canadian city has a truly comprehensive, integrated, regional network of cycling facilities such as those found in so many Dutch, German, and Danish cities. The lack of integrated facilities forces cyclists to share the road with motor vehicles for most of their trips, often diminishing the safety, feasibility, and attractiveness of cycling for many potential cyclists, especially children, the elderly, the inexperienced, and anyone who finds cycling in mixed traffic unpleasant and stressful.

Coordinating public transport with bicycling is crucial to encouraging increased use of both of these modes. Especially in lower-density residential areas, cycling is ideal as a feeder and distribution system to access public transport stops. Such integration can be achieved by provision of convenient and secure bike parking at both rail and bus stops, bike racks on all buses, and accommodation of bikes on all rail transit vehicles.

Virtually all of the many case study respondents contacted for this research indicated that a lack of government funding was a crucial hindrance to that needed infrastructure expansion. With the exception of Quebec, no other Canadian province has provided significant funding, coordination, planning, or policy guidance to assist local communities. The Province of Ontario, in particular, is noteworthy for directing so few resources towards cycling, but British Columbia and Alberta have not been much better.

Similarly, Canada’s federal government has neglected cycling as a serious transport mode. National legislation similar to the U.S. Intermodal Surface Transportation Efficiency Act (ISTEA) and Transportation Equity Act for the 21st century (TEA-21) could greatly increase funding for investments in cycling infrastructure (U.S. Department of Transportation, 2004a, 2004b, and 2004c). The Canadian federal government should also provide more research funding and more guidance in bicycling planning. That would foster the necessary collaboration and exchange of ideas and experiences of local bicycling planners throughout the nation, which is particularly important as provinces and cities in Canada have primary responsibility for meeting the Kyoto Accord targets on curbing GHG emissions.

Cycling is surely the most sustainable of all mechanized transport modes, producing virtually no pollution of any kind and requiring no non-renewable energy resources at all. It is time for the Canadian federal and provincial governments to provide the sort of support for cycling that would enable cities to make the needed investments in cycling infrastructure, as well as fund to complementary educational, training, and law enforcement programs. Without such increased federal and provincial government involvement, it may be that cycling in Canadian cities has now reached a plateau. Even at this current level, Canada far outperforms the United States in cycle use; nonetheless, given concerns for transport sustainability, it would be prudent to provide the funding that would enable Canadian cities to realize the enormous unmet potential for more cycling. That, in turn, would help achieve a range of environmental, safety, energy, congestion reduction, and public health benefits.

Future research on cycling in Canada would benefit from much greater involvement of the federal government in collecting data on bike use and bicycling facilities. As mentioned earlier, Canada does not have a nationwide travel survey collecting comparable data on bicycling for all trip purpose throughout the year. A national travel survey, with a special focus on bike trips, would be an excellent source of information on cycling levels and bicyclist characteristics, including variability across cities and provinces as well as differences by season of the year and trends over a period of years. The federal government might also establish a periodic inventory of bicycling facilities in Canada's cities and provinces. Such data should be collected using standardized definitions of bike facilities and programs. Together, such a nationwide travel survey and inventory of cycling infrastructure would enable researchers and practitioners to evaluate the success of specific measures geared towards promoting bicycling and to identify and implement best practices.

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***John Pucher** is a professor in the Bloustein School of Planning and Public Policy at Rutgers University. For over two decades, he has examined differences in travel behavior, transport systems, and transport policies in Europe, Canada, and the U.S. His current research focuses on walking and bicycling, and in particular, how American cities could learn from European policies to improve the safety, convenience, and feasibility of these non-motorized modes in the United States.*

***Ralph Buehler** is a doctoral candidate in planning and public policy at Rutgers University, New Brunswick, N.J., and a Dwight D. Eisenhower Transportation Fellow. He is interested in international comparative urban transportation. His dissertation compares travel behavior, transport policies, and trends in Germany and the U.S. Other research interests include non-motorized transport, land use, and regional cooperation in Europe and North America.*

Sustainable Campus Transportation through Transit Partnership and Transportation Demand Management: A Case Study from the University of Florida

Alex Bond and Ruth L. Steiner

Abstract

The University of Florida has established a long-term, sustainable partnership with the local transit system in Gainesville, Florida. This partnership provides over \$5.2 million of annual funding to enhance transit services used by students at the university. Ridership on the system has grown by 284 percent between 1995 and 2003. These ridership gains were made possible through a comprehensive campus transportation demand management (TDM) system, which seeks to reduce automobile use in favor of more sustainable modes. The campus TDM system includes policies such as parking restriction, parking pricing, transit service enhancements, and unlimited-access transit.

Introduction

Colleges and universities have unique transportation needs. Educational institutions value a walkable, green campus where buildings are in close proximity to foster academic collaboration. Parking breaks up the campus landscape, occupying valuable space that could be devoted to classrooms or laboratories. Universities can expect a fairly steady flow of commuters throughout the day since classes begin throughout the day, whereas cities expect spikes in transportation demand during rush hours.

Universities are experiencing rising costs for constructing and administering transportation infrastructure, which detracts from the university's primary mission of academics (Balsas 2002). Creating a modal shift away from automobiles is an important goal for many institutions of higher learning today. Universities are in an excellent position to experiment with and implement transportation policy changes. Universities have complete control over the road network, parking facilities, and land uses on their campuses. These policy changes can enhance not only the sustain-

ability of the university's transportation system, but also the surrounding community's (Miller 2001).

To further the goal of creating a more sustainable transportation network, many universities are implementing transportation demand management (TDM) programs that attempt to stimulate non-automobile commuting. One such institution is the University of Florida (UF), a large, public institution that has partnered with the local transit agency to provide viable alternatives to automobile commuting. In the University of Florida case study, it is observed that a combination of four TDM policies resulted in a substantial modal shift. These policies include parking restriction, parking pricing, unlimited-access transit, and transit service improvements.

Literature Review

Transportation demand management (TDM) is a package term for a variety of planning strategies that promote a more efficient use of transportation resources. TDM strategies seek to reduce or mitigate the negative aspects of automobile travel including congestion, air quality, and transportation inequity. They also seek to build upon positive aspects of a balanced transportation system to foster economic development, expanded housing choices, and a reduction in capital expenditure on transportation infrastructure (Ferguson 1990). TDM policy implementation is important for universities that desire to shift people from single occupant automobiles to more efficient modes of commuting to campus.

TDM policies fall into three broad categories: positive, mixed, and negative. Positive TDM policies expand transportation options and access for all users and include: transit service improvements, flextime work hour scheduling, and carpool/vanpool programs. Mixed TDM strategies expand options and access for only one segment of the population, but do not adversely impact those who are not in that target group. Examples of mixed TDM strategies include: high-occupancy vehicle lanes, unlimited-access or fare-free transit programs, and traffic calming. Negative TDM strategies reduce options or increase costs, and include: fuel tax increases, parking pricing, and auto-free zones (Litman 2003).

Individual TDM strategies have a modest impact on the transportation system, but when multiple strategies are applied in a coordinated manner, the impact on mode choice can be substantial. Further, when multiple strategies are applied, the negative impacts on individual users are mitigated (Litman 1999).

The decision to use transit is in large part based on the transportation demand management policies in place — the most important of which are transit service improvements, parking restriction, parking pricing, and unlimited-access transit (Bond 2005). The decision to use transit is also based on the habits, attitudes, and beliefs of the user. Experience with high level of service transit may influence future behavior, since psychologically the experience was a positive one (Verplanken et al. 1994). Therefore, exposing students to alternative modes could have lasting impacts on the nation's transportation system. Tolley (1996) makes the claim that creating a "green," sustainable and multimodal transportation system on a university campus could make lasting impacts on the travel behavior of graduates. Whether providing high-quality transit service to university students translates into lifelong transit ridership is an unanswered question in the existing literature.

Parking Pricing and Restriction

Parking restriction and pricing are two of the most powerful TDM policies, and are frequently employed in dense areas such as central business districts and university campuses (Wilson 1995). Morrall and Bolger (1996) found a strong inverse correlation between the available proportion of parking spaces and transit's share of peak-hour commuters. In areas like central business districts with fewer available parking spaces, transit use was high. In areas with an excess of parking spaces, transit use was low. Universities usually have fewer parking spaces (supply) than the number of commuters who wish to park on campus (demand). Therefore, universities can be expected to behave similarly to central business districts.

For-profit landowners build the cost of free parking into the total expense of the development. The cost of the free parking is then passed along to consumers or tenants. However, universities are non-profit entities and do not produce a product that can be increased to pay for parking facility costs. Universities must charge students and faculty who use parking spaces to recover at least a portion of the costs associated with facility construction and maintenance (Shoup 1999). The process known as "parking pricing" achieves a triple goal: to raise funds, discourage commuters from parking on campus, and to encourage commuters to use alternative modes. In a recent sample, the cost of parking passes on university campuses ranged from \$14 to \$300 per semester, with a mean of \$83.43 (Gutkowski and Daggett 2003). Even at schools with more expensive parking, universities are not pricing parking to recover 100 percent of its costs. The monetary costs of parking to a university include salaries for parking personnel, accounting, construction costs, and loss of available land — which at some point in the future could necessitate the purchase of campus annexes (Tolley 1996).

Transit Service Improvements

Increasing transit ridership is not solely tied to fare cost. To attract riders, service must also be improved. The most important service characteristics for non-users of transit are increased frequency and direct routes from home to work (Mierzejewski 1990). Cervero (1990) found that service frequency was twice as important to riders as fare cost. The wait time for a bus is a substantial component of total travel time. By reducing the total wait time — and thus the total travel time — transit begins to become competitive with the private automobile in terms of convenience (Li 2003). Evans (2004) found that frequency elasticity for transit ridership is 0.5 — for every 10 percent increase in frequency, ridership goes up by 5 percent.

New transit routes are important for capturing new riders. Johnson (2003) found that bus transportation is only effective within a quarter mile radius of bus stops. New routes allow access to parts of the city previously not served by transit. New routes also come in the form of direct and express routes, which are a powerful attractor for commuters (Mierzejewski 1990).

Unlimited-Access Transit

The idea of unlimited-access transit (also known as fare-free transit) has been practiced on university campuses since the late 1970s. In 1998, a survey found that 35 major universities offered some form of unlimited-access transit (Miller 2001). Unlimited-access transit is not free transit. It is a different way of paying for transit service. A third party pre-pays the transit provider to carry members of a constituent group without charging them a fare. The transit provider usually receives an annual lump sum payment from the university (Brown et al. 2001). Through a method similar to group health insurance, fares are substantially discounted because so many fares are being purchased, but only a fraction of payees avail themselves of the benefits (Miller 2001). Transit passes are distributed or third-party identification cards double as passes. Unlimited access is not limited to institutions of higher learning. Third-party prepayment can also be offered by large employers or municipal governments (Nuworsoo 2005).

According to the Simpson-Curtin rule (Curtin 1968), free transit should theoretically increase ridership by a third, since ridership goes up by 3 percent when fares are decreased by 10 percent. In practice, agencies that eliminate fares entirely experience ridership gains closer to 50 percent (Hodge et al. 1994), likely due to the concurrent implementation of other TDM policies. Perrone (2002) suggests that small and medium transit systems benefit the most from an unlimited access or fare-free policy. Small

systems have a limited number of activity centers to serve, lower vehicle costs, and lower incidence of vagrancy and vandalism.

In 2001, passengers occupied only 27 percent of available seats on buses nationwide. The enormous number of empty seats drives up the needed operating subsidy. Transit systems want riders to fill those seats, and universities want to discourage automobile commuters to campus. Through university payments to transit systems, new riders can be brought to the transit system while at the same time relieving the parking demand on campus (Brown et al. 2003).

A Case Study: The University of Florida

The University of Florida is located in Gainesville, an inland city in northern peninsular Florida about 90 miles south of the Georgia border. A medium-sized city, Gainesville had a 2002 population of 108,856. The metropolitan area had 218,000 people. The transit system serves only the City of Gainesville and adjacent areas of the unincorporated Alachua County.

The University of Florida had a total enrollment of 47,373 students in the 2003–2004 academic year. Of that number, 28 percent are graduate or professional students and 72 percent are undergraduates. Most of the student body has moved to Gainesville to attend classes, as relatively few students are native to Alachua County. In addition to the students, there are over 4,000 faculty and 8,000 other staff members. Founded at its present site in 1905, the oldest part of campus is dense and is best navigated on foot or by bicycle. The core part of the campus is largely a pedestrian-only zone during daylight hours and lacks parking resources. The core part of the campus occupies roughly 600 acres, with the other 1,050 acres devoted to less dense uses such as agricultural research and conservation. Accommodating the needs of more than 58,000 regular commuters to the core of campus requires balancing the needs of diverse groups and maintaining a comprehensive transportation demand management plan that promotes transit use over private automobile use.

The methodology of this case study involved a comprehensive analysis of official documents maintained by the university, including the Transportation and Parking Division, Student Government, the Division of Finance and Administration, and the Campus Master Plan. Historical data were obtained from the Regional Transit System, the Transportation and Parking Division, and Student Government. Minutes of meetings, newspaper resources, and personal interviews helped supply subjective insights to the University of Florida case study.

Regional Transit System

Bus transit in the City of Gainesville is provided by the Regional Transit System (RTS), a division of the Public Works Department of the City of Gainesville. RTS provides the only bus transportation to, from, and around the University. In the 2004-2005 fiscal year, RTS maintained a fleet of 92 diesel busses that operate on 21 standard city routes, 9 campus-only routes, and 4 late night routes. Bus headways range from 60 minutes on some city routes to 6 minutes at peak times on high demand routes operating from student-heavy areas to campus (Perteet Engineering 2002).

Ridership on the Regional Transit System (RTS) has increased each year since 1995. In Table 1 below, ridership increases are documented from 1995-1996 to 2002-2003. Over the study period, ridership increased 284 percent, to 8,106,964 boardings per year. This makes RTS the sixth most patronized transit system in the state of Florida, despite serving the 17th largest county.

Table 1. Total Ridership 1995–2003¹

Year	Boardings	Percent Increase Over Previous Year
95/96	2,110,209	N/A
96/97	2,174,840	3.1%
97/98	2,948,150	35.6%
98/99	4,412,773	49.7%
99/00	5,195,883	17.7%
00/01	6,306,241	21.4%
01/02	7,198,085	14.1%
02/03	8,106,964	12.6%
Increase '95-'03	5,996,755	284.1%

Source: Regional Transit System

The growth in bus ridership on the Regional Transit System has outpaced ridership growth nationwide. Nationwide bus ridership has grown 15 percent to 5.27 trillion over the period 1995 to 2003 (NTST 2003). The disparity between ridership growth in Gainesville and the nationwide total can be attributed to the growth on routes related to the University of Florida. Student subsidy of transit service began in the 1998–1999 academic year and resulted in substantial service improvements, including an unlimited

¹ The RTS fiscal year begins on August 1. This is meant to coincide with the beginning of the academic year. Ridership counts also are recorded by fiscal year.

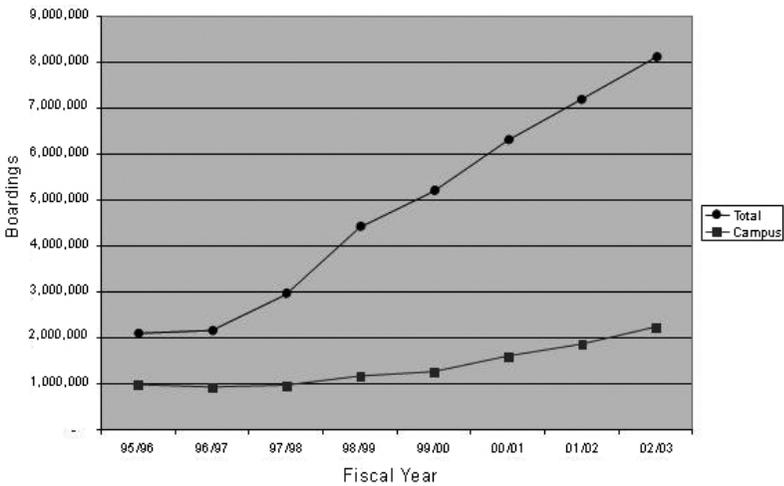
access policy for UF students. RTS experienced the largest increases during the two years when university subsidy of transit services began. Since 1999–2000, ridership has been steadily increasing at more modest rates, although it is far out-distancing transit growth nationwide.

Growth on campus routes has not been as steady as on the total system. Over the period from the 1995–1996 to the 2002–2003 transit fiscal year, ridership on campus circulator routes has increased by 125 percent to 2,253,041 boardings annually. However, the proportion of campus route riders to the total number of riders has been steadily decreasing. Campus-only trips accounted for nearly half, 47.4 percent, of all RTS riders in 1995–1996. That figure had decreased to 27.8 percent in 2002–2003.

Figure 1 demonstrates the separation between the number of riders using campus circulators and the total number of riders. Total ridership growth has outpaced campus-only growth, indicating that off-campus and special routes have been the source of greater ridership growth.

Figure 1. Campus-Only Versus Total RTS Ridership Growth

Figure 1- Ridership 1995 to 2003



Source: Regional Transit System

University of Florida Transportation Demand Management

Multiple TDM policies are maintained by the University of Florida. These policies are chiefly responsible for creating the modal shift toward bus transit. The University does not maintain a stand-alone transportation demand

management plan. Rather, TDM policies are distributed throughout the Campus Master Plan and in the regulations of the Transportation and Parking Services Division. Even without a formal TDM plan, the University is employing several TDM strategies to foster a modal shift among students, faculty, and staff. The university's TDM strategies are summarized as follows according to the broad categories defined by Litman (1999):

- Positive (expands options for all): **Unlimited-access transit, transit service characteristic improvements**, pedestrian/bicycle capital improvements
- Mixed (expands options for certain users): Carpooling program with preferential space assignment, park-and-ride facilities, traffic calming
- Negative (reduces options for all): **Parking pricing, parking restriction**, auto-free zones, transportation fees

The most important of these TDM policies, noted in **boldface**, are parking pricing, parking restriction, unlimited-access transit, and transit service improvements. Each of the four TDM policies is discussed below in detail. However, it is clear that all TDM policies play at least some role in creating a modal shift. For example, without effective pedestrian infrastructure, bus riders would be deposited in an unfriendly and unsafe environment. This has been shown to be detrimental to transit ridership (Cervero 2001).

Unlimited Access

In 1998, the University of Florida entered into a contractual service agreement to provide enhanced transit service to the university in lieu of a massive parking facility construction project. The City of Gainesville made an ongoing commitment to fund the "baseline" levels of service found on routes in 1997. Newly established routes would be city-funded to provide a level of service consistent with routes operating in 1997, which operated with one or two buses on 30- to 60-minute headways. Additional funds to provide higher frequency, unlimited-access transit would come from the university.

The Transportation and Parking Services Division and the Campus Facilities Planning and Construction Office are a second source of funding for the transit system. Each year the Transportation and Parking Services Division provides \$1.5 million to RTS. This revenue source is derived from parking decal sales and parking fine revenue. The administration's payment is the part that actually pays for unlimited access. However, administration funds do not pay for any service improvements.

The bulk of RTS's funds come from a third source, a fee charged to students on a per-credit hour basis, similar to fees charged for capital improvements or activities. These funds pay for service enhancements on selected bus routes. RTS is paid \$42.50 per additional bus operating hour above and beyond the operating level of service paid for by the city.² The cost of constructing bus stop infrastructure is shared by RTS, the UF Transportation and Parking Division, and the Office of Campus Facilities Planning.

The Campus Transit Development Agreement has paid for several bus transit improvements. The most important improvement was the creation of an unlimited access, fare-free system for students, faculty, and staff. Anyone possessing a valid University of Florida Identification Card can board any RTS bus free of charge. The ID Card — referred to as a Gator-1 Card — is presented to the driver upon boarding. There is no need for riders to obtain passes or interact with a third party to gain access to free transit services. This allows students to use bus transit services as frequently or infrequently as they desire. This is an important factor since bus route enhancements are intended to support a variety of different trips, some of which are used infrequently by patrons. The unlimited access program began during the fall semester of 1998 and has been renewed every succeeding year.

Transportation Access Fee

The increase in ridership correlates closely to funding increases to the transit provider. RTS realizes very little of its operating revenues from fare-paying customers. In 2002, farebox revenues accounted for \$714,183 of the agency's \$9,462,631 budget. This represents a farebox recovery rate of only 7.5 percent, less than half the state of Florida average of 15.2 percent. Nationwide, farebox recovery averages 37.7 percent. The remainder of RTS's budget is realized through federal formula programs, state programs, and payments from the University of Florida

The Transportation Access Fee is the discretionary and variable portion of the payments to the Regional Transit System. Student funds are separate and distinct from administration funds. The university administration's share of the service contract pays for unlimited access to RTS buses. Any improvements to service characteristics come from student funds. From 1998 to 2001, student funds were allocated from the Student Government budget. For the period 2001 to 2004, funds came from the Transportation Access Fee.

² The per-operating-hour fee was raised to \$46.75 in 2004–2005. The increase was the first since the inception of the contract. The increase was necessary due to rising costs of fuel and labor.

The responsibility for collecting the Transportation Access Fee rests with the University Financial Affairs Office. Students are required to pay the fee as if it were a component of their tuition, and financial aid awards can be used to pay the fee. The responsibility for setting the Transportation Access Fee and allocating the funds is directed by a seven-member committee of faculty, students, and administrators. Four voting members of the committee are students, all of whom are appointed by the Student Body President.³ The Transportation Access Fee Committee is authorized to charge a required fee to all students under Florida State Statute 240.209 (3)(e)8 to “support the transportation infrastructure of the university for the purpose of increasing student access to transportation services.”⁴

Student funds began to pay for enhanced bus services during academic year 1998–1999. Since a dedicated Transportation Access Fee had not yet been instituted by the Florida Legislature, funds were budgeted through Student Government. In academic year 1998–1999, \$179,055 was paid to RTS, which translates to about \$0.15 per credit hour. This first fee paid for frequency improvements to areas where critical shortages of bus space were occurring on a regular basis, specifically to three routes serving student-heavy areas of southwest Gainesville. The first year of student subsidy of the transit system proved to be a success, and it was renewed for a second year.

During the third year of student bus subsidy (2000–2001), the student contribution increased to \$282,290. Daytime bus service levels remained the same as in previous years, costing \$179,522. The additional \$103,235 was spent to create a new late night bus route known as Later Gator.

The idea of a separate Transportation Access Fee for all State of Florida universities had been discussed as far back as 1996 (Salazar 1996). However, creating a separate Transportation Fee would require approval from the State of Florida legislature and the State University Board of Regents. This approval came during the 2000 legislative session. This allowed the establishment of a dedicated Transportation Access Fee beginning in the Fall 2001 semester.

The Transportation Access Fee grew rapidly to keep pace with the rising demand for transit service. Table 2, below, outlines the fee and the amount raised from academic year 1998–1999 through 2004–2005. The fee amount has risen each year since its inception, starting in Fall 2001 as a \$2 per credit hour fee. In 2004–2005, the fee was \$4.10 per credit hour. One

³ Only 29 percent of university transit agreements guarantee students a voting seat on advisory committees (TCRP #39, 2001).

⁴ Florida State Statute 240.209 (3)(e)8 and Florida Administrative Code Rule 6C-7.003(34), authorizing legislation of the transportation access fee, was passed in 2000.

hundred percent of fee money is spent on motorized mass transportation services. The fee has been increased to provide service enhancements to address congested buses, new residential construction, and rising student demand.

Table 2. Student Subsidy/Transportation Access Fee Growth

Academic Year	Funding Source	Fee Amount per credit hour	Cost Per Student Per Year	Funds Raised
98/99	Student Government	\$0.15 ⁵	\$4.50	\$179,055
99/00	Student Government	\$0.15 ⁵	\$4.50	\$179,055
00/01	Student Government	\$0.24 ⁶	\$7.20	\$282,290
01/02	Transportation Access	\$2.00	\$60.00	\$2,200,000
02/03	Transportation Access	\$3.00	\$90.00	\$3,940,000
03/04	Transportation Access	\$3.59	\$107.70	\$4,510,800
04/05	Transportation Access	\$4.10	\$123.00	\$5,264,500

Source: UF Business Services Division and RTS. Cost to students is based on 30 billed credits per academic year.

The Transportation Access Fee was not intended by the state legislature to be solely a means to subsidize or improve bus transit services. Funds can be used to build bike/pedestrian infrastructure, provide paratransit or jitney bus service, construct parking facilities, or add roadway capacity. Other Florida universities have used Transportation Access Fee funds for all of these purposes, but at the University of Florida it remains solely a means to subsidize bus transit.

Transit Service Improvements

Prior to 1998, RTS operated as a small urban system. Buses covered the city by circuitous routes at infrequent intervals. Nearly all riders on the system were transportation disadvantaged. The system was experiencing declining community support and ridership. Meanwhile the University of Florida had added over 8,000 students to its total enrollment during the previous decade. Off-campus housing patterns had shifted to the southwest of the city into unincorporated Alachua County. The newer student apartment

⁵ Fee amounts in 98/99, 99/00 and were allocated as a portion of the Activity and Service Fee. RTS also benefited from several Department of Transportation grants during this period.

⁶ The fee amount in 00/01 continued service enhancements from the previous two years and funded the first Later Gator late night service route. These fees were also budgeted and appropriated from Student Government's Activity and Service Fee.

complexes were 2 to 5 miles from the core campus. The outward sprawl of student housing coupled with rising enrollment increased the demand for motorized transport to campus. The mid-1990s were a critical juncture for the university. It was during this period that the university adopted most of its transportation demand management policies to place an emphasis on public transit rather than private automobile use.

The Service Contract provides three different services — Standard City Routes, Campus Only Routes, and “Later Gator” Late Night Routes. The service characteristics, funding arrangements, and intended users differ for each type of bus route.

Standard City Routes

Of the city’s 21 Standard Routes, 10 are supplemented by university funds. Standard city routes are identical to fixed bus routes found in cities throughout the U.S., except the subsidized routes provide direct service on a frequent basis for extended hours. They are designed to connect residential areas (trip producers) with trip attractors like the university, hospitals, and the downtown. Increased frequency is intended to entice more off-campus students to use the bus. Subsidized routes have had their operating hours lengthened to accommodate the irregular schedule of college students. There is a disparity between the level of service for UF-supplemented routes and routes operated only on city funds.

The sharing of costs for citywide fixed routes requires close coordination between the university and the Regional Transit System. Transit planners for RTS monitor full bus conditions and the locations of new student-oriented housing developments. They present the information to the responsible parties at UF, including the Transportation Access Fee Committee and the Student Body President, who collectively appropriate funding changes to alter the bus routes, schedules, and hours to accommodate changes in demand for transit service. Final approval of expenditures comes from the University President. In 2004–2005, \$3.02 of the \$4.10 fee went toward supplementing service levels on selected city routes.

Campus Circulator Routes

Campus Circulator Routes run on fixed routes on the UF Campus. Certain routes leave the campus briefly, but only to complete loops when road connections and configurations require completing a loop using city streets. They are intended to facilitate the movement of UF students, faculty, and staff around the campus. The existence of Campus Circulator Routes gives on-campus residents mobility within the campus. These routes also

allow off-campus students to park once or arrive by off-campus bus and move around to multiple destinations. The high-frequency backbone of the campus system runs on 9- to-15 minute headways during peak hours. Three routes primarily transport patrons of remote parking facilities to the center of campus.

The Campus Circulator Routes are funded entirely by the university, but are operated by RTS. The total cost of operating the Campus Circulator Routes is \$2,272,005, or \$48.54 per UF student per year. In 2004–2005, \$1.61 (or 39.5 percent) of the \$4.10 per-credit hour fee was allocated to fund campus circulator routes.

Later Gator

Later Gator buses operate on special routes from 8:30 p.m. to 3:00 a.m. Wednesday through Saturday evenings. These routes are intended to connect student residential areas with evening activity centers, including downtown bars and restaurants. The mission of the Later Gator program is threefold. First, it extends transit options into the late evening hours, a time traditionally ignored by transit providers. This further contributes to the ability of students to go about their daily lives with little or no automobile use. Second, Later Gator seeks to reduce the frequency of driving under the influence of alcohol by connecting student residential areas to popular bar and night club districts. Third, Later Gator seeks to alleviate severe parking shortages along University Avenue and downtown Gainesville, the two primary districts of late evening activity.

The first Later Gator route was instituted during the summer of 2000, by a special appropriation from Student Government. This first trial year cost \$103,276 to operate for the fall and spring semesters from 9:00 pm to 2:00 am on Thursday, Friday and Saturday nights. The first route, known as Later Gator A, continues to operate in a loop through the university campus and downtown Gainesville, where many bars and night clubs are found. The program proved extremely popular, and in 2001 the responsibility of paying for Later Gator was moved to the Transportation Access Fee. Along with the greater funding base, three new routes were created. During the period 2001–2004, routes were added and deleted based on ridership and demand. In 2004–2005, the Later Gator program offered routes that operate Wednesday through Saturday from 8:30 pm to 3:00 am. \$0.34 (or 8.2 percent) of the \$4.10 Transportation Access Fee goes to pay for Later Gator Service.

Campus Parking

The university's Transportation and Parking Services Division (TAPS) implements several TDM policies. Eligibility to park in certain facilities is separated into classes based on student seniority and faculty status. TAPS also issues parking decals and collects fees for their purchase. Stringent parking enforcement is coordinated through the TAPS office. Thus the Transportation and Parking Services Division implements the parking restriction and parking pricing TDM policies.

Four of the most important TDM policies are discussed in the rest of this section. The parking pricing, parking restrictions, bus transit service enhancement, and transportation fees are all investigated in greater depth.

Parking demand far exceeds supply on the University of Florida campus, although some limited parking facilities are available in neighborhoods adjacent to the university. A total of 19,371 spaces are available on campus. The available spaces are prioritized for certain groups' use: 5,094 are reserved for students who live on campus, another 7,719 are reserved for faculty and staff, and only 6,558 spaces remain to accommodate students living off campus.

Approximately 37,750 students live off campus. About half of the spaces reserved for off campus students are located in the core area of campus, and are designated "Commuter." Students with 90 credit hours (senior status) and graduate students can park in these more centrally located commuter spaces, usually in structured parking facilities. Other students must use park-and-ride spaces. Park-and-ride spaces are found on the perimeter of campus, and users require a bus or bicycle ride to reach most instructional facilities. Under the contractual UF-RTS agreement, RTS provides dedicated park-and-ride buses at 10- to 20-minute intervals at a cost of \$995,000 annually.

Analyzing the purchases of parking decals can render useful information about the demand for parking on campus. UF Parking and Transportation Services does not limit the number of decals sold, but lets the supply of parking spaces and the willingness of drivers to search for spaces determine the number of decals sold. Table 3 summarizes the parking situation on campus. Holders of faculty/staff, on-campus, and commuter decals are only allowed to park in spaces reserved for their respective category of decal. Overall, the number of decals sold exceeds the number of spaces by a 1.43-to-1 ratio. The likelihood of finding parking is even more bleak for students; seniors and graduate students can park in close-in facilities, but the number of decals sold in this category exceeds the number spaces by an even larger 2.7-to-1 ratio. Only park-and-ride decals are sold at a rate lower than the number of available spaces.

Table 3. Parking and Decal Sales, 2003

Decal Type	Spaces	Eligible Purchasers	Decals Sold	Decal Cost	Oversell Ratio
Faculty/Staff (Orange, Blue, Official Business)	7,719	N/A ⁷	11,351	Up to \$636	1.47
On-Campus Residents (Red)	5,094	9,623	5,823	\$94	1.14
Commuter	3,393	~21,000	7,655	\$94	2.73
Park and Ride	3,165	~26,300	2,837	\$94	0.89
Total	19,371	~58,000	27,666	-	1.43

Source: UF Office of Parking and Transportation Services

Many of the students commuting daily to campus must use alternative modes of transportation to get to class due to the strategic lack of parking. Some students will live close to campus and walk or bike to class. Some who live farther away will use public transit. Since 1998, the University of Florida has applied substantial monetary resources to the local transit system to make riding the bus a more viable option for students to commute to campus. During the period 1998 to 2004, the number of student riders has been increasing very rapidly. In 2004, the number of students arriving on campus each day by bus was more than double the number of students who arrived by car.

Discussion and Conclusion

Sustainability can be viewed through the lens of TDM. Most of TDM's goals are inherently sustainable, including mitigating transportation inequity, offering better affordability, fostering the development of the overall economy of the community, and reducing environmental impacts. The existing body of TDM literature provides an excellent platform to examine the sustainability of a transportation system (Litman 1999; Ferguson 1990). If a system is designed using TDM principles, it is also likely designed for sustainability.

"Sustainability" should also be defined as transportation systems that literally sustain themselves year after year. Sustainable transportation should be largely immune from political whims. The Regional Transit System/University of Florida partnership continues funding through

⁷ The Faculty/Staff Category is broad and includes Faculty Staff (Orange) Official Business, Medical Resident, Gated Reserved, Shands Hospital (Blue) and certain types of advanced students. Data is not readily available to calculate the total number of eligible Faculty/Staff decal purchasers.

fees set one year in advance. The partnership is designed to be mutually beneficial, which immunizes the program from discontinuation and enhances its sustainability. This stands in stark contrast to federal and state transit programs, which depend on irregular appropriations that supply benefits only in one direction. There is little mutual benefit in federal or state formula programs, which explains their volatility and long-term lack of sustainability.

The University of Florida case study shows that people will use transit under the right circumstances. This experience can serve as an example to other transit agencies — irrespective of whether they serve a college town or not. Partnering with constituent groups like higher education, large employers, or government agencies to provide unlimited-access transit can boost ridership, remove cars from the road, and promote smart growth. There are dozens of potential partners available to every transit agency, but leadership is required on both sides to forge agreements.

The University of Florida's experience with partnering to provide public transit to students demonstrates several principles to equitably balance the transportation system. The provision of unlimited-access transit paid for by student fees is the hallmark of the program. However, an unlimited-access transit component is but one feature of an effective TDM program. Stimulation of a modal shift toward public transit requires other measures demonstrated at the university, including parking restriction, parking pricing, and transit service improvements. These ancillary TDM policies would be necessary for other communities to adopt if similar results are to be expected.

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Alex Bond received his Master of Arts in Urban and Regional Planning from the University of Florida in 2005. He currently lives in Washington, D.C., where he is a transportation policy analyst at the National Association of Regional Councils.

Ruth L. Steiner is an Associate Professor of Urban and Regional Planning at the University of Florida in Gainesville, Fla., and a former editor of the Berkeley Planning Journal. Her research is on the relationship between land use and transportation, with a particular focus on non-automobile travel. She received her MCP and Ph.D. from the Department of City and Regional Planning at the University of California at Berkeley in 1988 and 1996, respectively.

Privatization of Public Transit: A Review of the Research on Contracting of Bus Services in the United States

Lynn Scholl

Abstract

In the face of escalating costs, declining productivity, and constraints on funding for public transit, many governments have turned to transit privatization in an effort to improve cost efficiency. Privatization of bus services occurs in a range of forms and regulatory environments. Privatization proponents argue that publicly owned and subsidized transit operations are inefficient due to higher labor costs, restrictive work rules, and large bureaucracies. Critics of privatization argue that several market failures counteract these theorized benefits, resulting in under-insurance, substandard vehicle maintenance, and higher levels of pollution, congestion, and accident rates, among other inadequacies. This paper reviews the research and debates on privatization in the form of contracting, including its effects on cost-efficiency, quality of transit provision, and labor.

Introduction

Public transit has been increasingly viewed as important to achieving the environmental and social objectives of sustainable transport in the U.S. However, in the face of escalating costs, declining productivity, and constraints on funding for public transit, many national governments have turned to transit privatization in an effort to improve cost efficiency. For example, under Margaret Thatcher's privatization agenda, Great Britain deregulated much of their transit system in 1985, eliminating much of the controls on market entry and exit throughout the country. Similarly, Santiago, Chile, completely liberalized its transit system, allowing free entry in 1979, followed by fare and route deregulation a few years later. In the 1980s, rising costs in the U.S. public transit sector prompted the Reagan administration to substantially cut subsidies and promote contracting of bus services.

Privatization of bus services occurs in a range of forms and regulatory environments. In deregulated bus markets, governments eliminate many of the controls on market entry and exit, allowing private bus operators to compete along fixed routes and semi-fixed routes (Gomez-Ibanez and Meyer 1993). The degree of liberalization schemes vary from complete free-entry to regulations of fares, entry, routing, and vehicle standards. In many countries, governments provide exclusive franchises along routes to private operators based on a competitive bidding process. With contracting of public transit, the public agency coordinates schedules, routes, and fares to overcome the problem of multiple providers, while the private operator owns and maintains vehicles and hires drivers. This arrangement allows public control while reducing operating costs and is more common in developed countries. Finally, privately operated small-scale vehicles, or paratransit, operating along semi-fixed routes are found in a range of regulatory environments, sometimes operating informally or legally as a complement to the formal system such as dial-a-ride services for the disabled or airport shuttle services.

Privatization proponents argue that publicly owned and subsidized transit operations are inefficient due to higher labor costs, restrictive work rules, and large bureaucracies. The profit motive and competition in the private market is theorized to lower costs and improve the quality of services. It is also argued that increased competition in bus transit fosters more innovative services that are more competitive with the private automobile, bringing significant benefits to travelers at a much lower cost. Further, the free-entry of firms is theorized to not only increase mobility and transportation choices, but also to push public sector bus companies to improve their operations, cut costs, and increase productivity.

However, critics of privatization argue that several market failures counteract these theorized benefits. For example, cost-cutting behavior by transit companies often results in under-insurance; substandard vehicle maintenance; higher levels of pollution, congestion, and accident rates; as well as inadequate coordination and integration of routes and fares. In deregulated and informal markets, fierce on-road competition between buses and over-entry of bus firms along profitable routes can lead to significant increases in congestion and accidents. Conversely, private transit operators may leave the less profitable routes underserved. The lower wages and benefits paid by private bus companies has often resulted in higher labor turnover, less qualified drivers, and lower productivity, leading in turn to declines in the safety and quality of service, prompting critics to charge that cost savings are resource transfers rather than true efficiency gains. Finally, some scholars speculate that the competitive forces leading to improved services and cost savings may erode over time, due to collusion among operators, consolidation of small firms into a few big actors, or too few bidders offering tenders for contracted bus services.

This paper reviews the research and debates on privatization in the form of contracting, including its effects on the cost-efficiency and quality of transit provision, and on transit labor.

Background

Contracting is the most common form of privatization in the U.S. It allows the public agency to control planning, route, and scheduling coordination while the private bus companies own, maintain, and operate vehicles, and hire labor (Iseki 2004). Contracting is theorized to reduce costs compared to purely public transit due to labor cost differentials, diseconomies of scale, increased flexibility of service provision and work rules, and increased competition. Private firms, motivated by profit and competition from other bidders, will seek to lower the cost of service and encourage greater production efficiency. Labor costs are theoretically lowered through an increased ability to utilize part-time labor, the reduction of overtime and split-shifts, and lower labor costs paid to often non-unionized labor (Nicosia 2001; Iseki 2004). In addition, the private sector, by virtue of fewer bureaucratic constraints, is assumed to be more able to substitute factor inputs to improve production efficiency, to reduce overtime labor, and to streamline management and maintenance and procurement procedures.

Gomez-Ibanez and Meyer (1993) have observed a cycle of privatization and regulation of bus service within countries. Initially, in the entrepreneurial stage, services are provided entirely by the private sector. Over time, as firms consolidate, governments move to regulate fares and grant franchises along routes. With pressure to keep fares low, in the case of rising incomes and increased auto ownership, the profitability of firms declines as they begin to operate on deteriorating capital and begin cutting back services. Subsequently, the government moves in to subsidize service and take over failing companies, however subsidies often are followed by increased costs, through higher public wages and unionization. Declines in productivity, and subsequently ridership, in turn, lead to calls for re-privatization.

Up until the mid-1960s, bus transit firms in the U.S. were primarily privately owned and operated. Privately owned streetcar lines in the early 1920s were afforded public monopoly status with the rationale that the high initial capital costs associated with rail created a large economy of scale that justified ownership by one public entity (Nicosia 2001). However, rapid growth in automobile usage beginning in the 1920s and continuing more or less through the 1960s and 1970s (with a short decline due to rationing during World War II) eroded transit mode shares, especially for off-peak trips and weekend excursions and shopping trips. In the United States, as private agencies were taken over by public ones in the late 1960s and

early 1970s, the resulting agencies tended to consolidate, leading to larger overhead expenses (Richmond 2001). In response to the growing financial troubles in the transit industry, a series of bills was passed to come to its aid. In 1964, the Urban Mass Transportation Act (UMTA) increased federal involvement in transit, providing grants for public takeovers of failing transit firms as well as capital investments, and, in 1974, the National Mass Transportation Assistance Act marked the beginning of a decade of federal funding of transit operating costs.

Operating subsidies rose rapidly under the UMTA Section 5 program, with payments rising, in constant 1984 dollars, from an initial level of approximately \$540 million in 1975 to \$1 billion by 1978 and to a peak of \$1.3 billion in 1980 (Pickrell 1985). However, as subsidies grew, transit's costs continued to soar faster than inflation, while at the same time its productivity declined.¹ For example, between 1960 and 1992, annual operating costs rose 161 percent, in constant 1992 dollars (from \$6.1 to \$15.9 billion); however, while the total number of passenger trips remained relatively constant, operating costs per passenger increased by 176 percent (from \$0.70 to \$1.93 per trip), in real terms.

Declining transit productivity and cost effectiveness have been attributed to several factors, including subsidies themselves, rising labor and fuel costs, the extension of services to far-reaching, low-density suburbs, overstaffing of transit agencies, high labor costs, stringent work rules, restrictions on the use of part-time labor, and increased utilization of overtime labor (Black 1995; Pucher and Markstedt, 1983; Pickrell 1985; Lave 1991). Pickrell (1985) found that, between 1974 and 1984, 42 percent of increased operating subsidies were absorbed by higher costs for maintaining existing service while the remaining subsidies went to new services and to finance fare reductions. However, during this period ridership only increased by 9 percent with 4.9 billion new annual trips.

Several scholars attribute policies within federal social and environmental legislation to the declines in transit cost efficiencies. Lave (1991) argues that the 1974 legislation redirected efforts away from efficiency objectives and toward social objectives, such as the revitalization of urban areas and increasing access to affordable mobility for the poor and disabled, and led to lower cost efficiencies. He concludes that these policies led to the expansion of transit services into low-density suburban areas and substantial reduction in fares. Additionally, federal environmental goals encouraged the increase of costly commuter and express bus service to lure drivers out of their automobiles resulting in a pattern of transit service in which central city services were curtailed and suburban services expanded. Pick-

¹ Productivity in the transit sector is usually defined as operating cost per vehicle mile or sometimes per vehicle hour.

rell (1985) estimates that as a result of suburban expansions, the average frequency, measured as total vehicle miles over total route miles, declined by 25 percent. Infrequent service over longer more dispersed routes with lower ridership levels led to lower productivity numbers. During this period, fare revenues also declined from about 55 percent of operating expenses in 1975 to 39 percent in 1989. Pucher and Markstedt (1983) find that while productivity declined and costs escalated with public takeovers and increased subsidization of bus transit, riders have also benefited from fare decreases and service expansions supported by subsidies.

Obeng and Sakano (2000) decompose the effects of government subsidies on total factor productivity (TFP) for bus transit for the period 1983 to 1992.² They found that subsidies led to a substitution toward fuel and labor inputs and away from capital inputs over the period.³ Taken together, subsidies, output, and technical-change effects decreased TFP by approximately 4 percent per year. They conclude that capital subsidies for buses increase the use of cost-saving technologies, while bus operating subsidies have the opposite effect. However, the largest factor leading to lower productivity were scale effects, in the form of increased vehicle miles of bus travel, due to the longer distances required to serve growing low-density suburbs.⁴

As transit subsidies increased and productivity fell, the era of federal operating subsidies was followed by calls for privatization by the Reagan administration in the 1980s. Bringing a new emphasis on both cost cutting and increasing the role of the private sector, the administration passed several bills requiring privatization and the reduction of subsidies, leading a number of transit agencies to begin contracting services. As of 2001, over one third of agencies reporting to the National Transit Database (NTD) contracted for some services, spending approximately \$14 billion (Iseki, 2004).

Section 13(c) of the 1964 UMTA, which was included to allay fears that transit labor unions would lose rights to collective bargaining in the transition from private to public ownership, has become an obstacle for agencies wanting to contract out services to private firms. The law prohibits a transit

² They estimate the effects of operating and capital subsidies on total factor productivity, defined as total outputs over the costs of total share-weighted inputs, using a panel data set of 45 single-mode bus firms for the period 1983 to 1992.

³ Of this change, they found that capital and operating subsidies decreased TFP on average by 0.47 percent per year, when factor augmentation, changes that lead to technical declines, were considered. Scale effects decreased TFP by 1.28 percent per year, and technological changes, (changes that shift the total cost curve) declined at an average rate of 0.03 percent per year, also causing a decrease in TFP. Their findings indicate that the higher private costs of capital decreased technological change.

⁴ While this study goes beyond using descriptive statistics, one weakness is the apparent lack of attention to possible serial correlation, since they treat the observations in their panel data set as independent, which may have produced biased estimates.

agency from taking any action that will adversely affect its public transit union employees. Consequently, contracting has been more attractive for new or expanded bus services. Most often employed in high-deficit areas, contracting is frequently used in providing services during more expensive peak hours, on long-haul commuter lines, in low-density areas, or for specialized services such as paratransit for the disabled (Morlock, et al. 1971; Teal 1985; Teal and Giuliano 1987; Webster 1988). Larger agencies tend to contract out only some of their services while small ones tend to contract out all service (Iseki 2004).

Studies of service contracting have found cost savings ranging from 10 to 40 percent per unit (e.g., vehicle-mile, vehicle-hour) of contracted service (Teal and Giuliano 1986; Morlok and Viton 1985; Downs 1988; Karlaftis et al. 1997; McCullough et al. 1998; Nicosia, 2001; Iseki 2004). However, Sclar (1997), Teal (1991), and McCullough et al. (1998) found cost increases associated with contracting.

Many studies of contracting have been criticized for methodological shortcomings. McCullough (1998) has cautioned that many studies are too short to provide conclusive information, as they only look at a few years after contracting begins. He criticizes the practice of comparing different-sized operators in many studies. In addition, since in most cases contracting firms are not randomly assigned, the decision to contract is likely to vary systematically across firms and with respect to observed and unobserved factors. For example, more fiscally responsible firms that wish to minimize costs, or conversely, less efficient agencies that have high cost functions may be more likely to contract. Therefore, savings estimates that do not control for the endogeneity of the agency decision to contract may be subject to selection bias.

Privatization has often been implemented in an ideological and politically charged atmosphere (Richmond 2001). As a result, many case studies on contracting are politically motivated, with opposing sides using quantitative methods to justify preconceived ideas (Richmond 2001). Large differences in cost savings estimates can stem from whether the authors used fully or partially allocated costs, measure short-term or long-term effects, or include transaction costs such as the administrative costs associated with contracting. Fully allocated methods compare the cost of in-house overhead plus contracted, while partially allocated accounting methods only compare the cost savings of the contracted portion of service. In the case of a public agency contracting out part of its service, cost allocation methods yield different results. Contracting supporters have often favored fully allocated modeling while opponents have employed a marginal-cost approach.

Contracting out transit service has been criticized on many grounds. Gomez-Ibanez and Meyer (1993) argue that cost savings from contracting are sometimes just a transfer between groups instead of a resource savings for the economy, stating, "Lower wage rates reduce budgetary costs but, without productivity increases, do not reduce the labor resources required" (Gomez-Ibanez and Meyer 1993, 279–80). Transit agency boards usually abstain from wage negotiating processes and instead rely on private contractors to establish market rates. Richmond (2001) and Kim (2005) note that lower wages may result in lower service quality due to high labor turnover and less experienced drivers. Additionally, changes in companies at the end of a contract period often results in drivers losing their jobs or having to start over at the bottom of the wage scale (Richmond 2001).

Sclar (2001) questions many of the assumptions underlying standard economic theory as it applies to contracting. He cautions that contracting markets are likely to become oligopolistic or even monopolistic over time, undermining the competitive forces theorized to lead to cost savings. Transit firms have an incentive to work together to exclude potential competitors and increase market power and profits. In Colorado, for example, where the state legislature mandated a law requiring privatization of 20 percent of Denver's transit services, 18 firms, ranging from large bus operators to small taxi cab companies, initially expressed interest in bidding; however, after the law was implemented, contracts tended to be awarded to the same few large companies with a higher capacity to write qualified proposals and with the ability to finance the required bonding and insurance. These firms also had a greater ability than small firms to submit very low bids, by assuming losses in the initial years. Sclar further argues that since complex services such as transit require longer term contracts, it may inhibit the ability of public agencies to replace firms quickly with competitors if services are not up to par, leading to less real competition. Additionally, the development of relationships between the public agency and the provider may lead to unfair political influences.

Problems of principal-agent, adverse selection, and moral hazards can lead to high contract design, monitoring, and enforcement costs that may counteract cost savings (Sclar 2001). Information asymmetries between the contracting firm (the principal) and the public agency (the agent) substantially increase the costs of contract monitoring and enforcement. Adverse selection, in which the more poorly qualified firms whose inexperience leads to very low and often winning bids, also compromises the quality of service. Adverse selection can increase overall costs due to declines in ridership, increases in accidents, and expenses associated with poor vehicle maintenance. Some public agencies respond to this problem by setting a higher bidding price floor in order to obtain services from the more qualified firms. However, Sclar (2001) notes that this price may equal or exceed

that of the public agency, possibly negating the benefits of contracting. A moral hazard arises where vehicles are owned by the public agency but operated by the private contractor who has a disincentive to maintain them well. Furthermore, he notes that contractors have little incentive to try to increase or maintain the agency's ridership base. However, he does not mention whether public agencies might be able to add provisions for ridership losses in the contract design. The desire for repeat contracts may form incentives to overcome these moral hazards.

Large economies of scale justifying public ownership in transit have often been assumed. However, in bus services this assumption may not hold. Sclar (2001) argues that there may be diseconomies of scale for bus transit. Small, publicly-operated bus agencies have been able to achieve similar operating efficiencies to private operators, and partial contracting tends to be implemented by large agencies with higher cost structures (Richmond, 2001). Several empirical studies have supported these observations. Berechman (1993) and Cowie and Asenova (1999) found that smaller agencies have increasing returns, mid-sized agencies have constant to decreasing returns, and large agencies have decreasing returns to scale. Viton (1991) found that average operating costs decrease for small, are constant for medium, and increase for large bus agencies.

Empirical Studies on Cost-Efficiency of Contracting

Several studies have explored the cost efficiency of contracting. More recent studies have utilized time series and cross-sectional data and increasingly sophisticated methodologies to address issues such as cost allocation, long-term effects, agency size, and issues of endogeneity.

Pucher et al. (1983) estimate (using a pooled cross-sectional time-series for 77 transit systems in 1979 and 135 transit systems in 1980) the effect of subsidies on the performance and productivity of public transit, including dummy variables for private contractors, operating and financial characteristics, and socioeconomics of the transit service area. They estimate that private management reduced per-hour operating cost by \$1.72 (in 1979–1980 dollars) (0.05 significance level); however the authors caution that their results could be biased due to endogeneity issues.

Perry and Babitsky (1986) estimated bus system performance as a function of five organizational structure types using multiple regression⁵ analysis. They found that publicly owned and operated transit systems were no different from publicly owned and privately operated ones. However,

⁵ Data consisted of 246 agencies in 1981 and 249 agencies in 1980 from the NTD.

privately owned and operated systems have higher cost efficiency and higher farebox recovery ratios. One explanation given by the authors for the higher cost-efficiency of the privately owned and operated systems is that these systems tend to be concentrated in the northeastern U.S., serving a solid ridership base of commuters traveling to strong central business districts, in areas with highly congested freeways and high parking costs. The authors also note that their study did not address the redistributive effects of these organizational forms, which are important given the social objectives of mass transit subsidization.

McCullough et al. (1998) used NTD data for the period 1989 to 1993 in a cross-sectional time series design to estimate the effects on fully allocated operating expense per revenue hour of bus service of three types of contracting: no contracting, partially contracted, and fully contracted services. Although they were not able to control for the endogeneity of the agency decision to contract, they found no evidence that fully contracted services are more cost-efficient than services operated by public agencies, but they did identify some savings for partial contracting. They reported that vehicle scheduling and labor utilization were the most important determinants of cost-efficiency. However, private contractors and privately owned bus firms may have more ability to adjust vehicle and labor utilization than public agencies.

Two more recent studies by Iseki (2004) and Nicosia (2001) control for the endogeneity between the decision to contract and cost efficiency. Nicosia (2001) utilized the NTD for 319 transit agencies from 1992 to 2000 to model both the decision to contract and short-run operating costs simultaneously using full-information likelihood methods and fixed effects to control for unobservable firm heterogeneity. She modeled a short-term cost function⁶ and found a 15 to 19 percent operating cost savings for contracted services, with an average savings of \$4 million per year for her sample. Nicosia notes that studies (with the exception of McCullough et al. [1998]) that do not account for endogeneity find more savings, indicating that high-cost firms tend to contract and that cost savings appear to come primarily from labor cost savings.

Iseki (2004) analyzed 400 agencies for the years 1992 to 2000 using a fully allocated operating cost model.⁷ Using a two-stage ordinary least squares and instrumental variables, he controlled for the endogeneity of the decision to contract. He controlled for more political and institutional variables than past studies and estimated the effects of various levels (partial versus

⁶ Including input prices (labor, fuel and parts), outputs (passenger miles and passenger trips), and service area characteristics (service area miles, vehicle miles, route miles, collisions, road-calls).

⁷ Total modal cost for the agency which captures administrative costs.

full contracting) of contracting on cost efficiency. He found cost savings of 7.8 percent for full contracting and 5.2 percent for partial contracting from an average service cost of \$53.06 per vehicle hour.

The Effects of Contract Design on Cost Efficiency

Nicosia (2001) explored how contract design impacts the degree of cost efficiency savings in contracting. Two main types of transit contracts are utilized frequently in the U.S.: cost plus and fixed cost. Under cost-plus contracts the public agency reimburses the contractor for all costs that come up and is more flexible to changing circumstances. With fixed-cost contracts, firms bid based upon their estimates of the cost of providing service. Fares are collected by the public agency and the agency pays the firm for the fixed amount specified initially in the contract. This type of contract is theorized to better minimize costs but to offer less flexibility to the contractor and may result in lower-quality service. A third variation of contract structure is fixed-cost contracting with incentives. These types of contracts are utilized more frequently in the U.K. and New Zealand than in the U.S. and include incentives for improved quality standards and ridership increases (Shaw 1996). Finally, with net-cost contracting the operator keeps fare revenue and is given a subsidy. Also known as minimum-subsidy franchising, the public agency covers any revenue shortfall predicted by the firm at the time of bidding. Firms face more risk from demand fluctuations, which may reduce interest in contracts, or competition in the bidding stage, and induce firms to add a risk premium to their bid price.

Using propensity score methods, Nicosia (2001) found no differences in cost-efficiencies between the cost-plus and fixed-cost contracts, however, she found that agencies self-select into contracts that are more efficient or better suited to their circumstances. She found that cost-plus contracts are more often utilized by agencies with more contracting experience and greater asset specificity,⁸ while fixed-cost contracts are used more frequently by larger agencies or those with more bargaining power relative to the contractor.

Quality of Service and Contracting

The quality of transit services is important to attracting ridership. Studies of Toronto and Boston found elasticity of demand of 0.4 for quality⁹ while

⁸ Specialized technology.

⁹ Service quality was defined as vehicle-miles of service in the Gomez-Ibanez (1996) study.

that for fare was lower, ranging between -0.2 and -0.3 (Gomez-Ibanez 1993). In a Transportation Research Board (2004) survey, 40 percent of transit managers cited declines in service quality as the primary downside of contracting. A Federal Transit Administration (FTA) study found an average demand elasticity of 0.5 in response to service frequency increases, a measure of quality (TCRP 2004).¹⁰

Gomez-Ibanez and Meyer (1993) found several negative impacts of contracting on service quality in London, particularly during transition periods. Coordination and integration of services declined with contracting.

Nicosia (2001) examined the effects of contracting on quality of service in the U.S., measured by vehicle miles and capacity, number of collisions, and road calls. Controlling for the endogeneity¹¹ between service quality and the decision to contract, she estimated the parameters in the decision to contract conditional on bargaining power, transaction cost, and economic and political variables. Using panel data to control for exogenous changes in demand over time, she found a 36 percent increase in recalls, a 76 percent increase in collisions, and a 16 percent decrease in vehicle-miles. As a consequence, ridership also decreased by at least 10 percent. These results are consistent with case studies that found high turnover and low-skilled drivers an issue in some areas (Richmond 2001). However, vehicle-miles are a coarse measure of quality. Better measures might be vehicle-miles per route-mile of service (an indicator of frequency) or passenger-miles per vehicle hour (a measure of speed). Alternative measures of quality could include reliability, on-board safety, information for customers,¹² comfort, and convenience; however, more data on these factors are needed (TCRP 2004).

Labor Impacts

Transit is a labor intensive industry, with labor comprising approximately 70 percent of total operating costs (Kim 2005). While the proponents of contracting argue that labor costs are excessive as a result of public operation, critics of contracting charge that the cost savings of contracting come primarily at the expense of reductions in wages, labor productivity, and service quality. High labor costs have been attributed by some scholars to

¹⁰ The extent of the decrease in demand for a decrease in service frequency varies by service levels prior to the change and also income, with both lower-income riders and higher levels of prior service being less sensitive to quality changes.

¹¹ Service quality and contracting may be endogenous, since contracting may occur along certain types of routes that vary with quality or ridership.

¹² Such as Intelligent Transportation Systems (ITS) reporting real-time bus information and estimated arrival times.

restrictive work rules limiting the hiring of part-time labor or cross-utilization of labor among various job functions, for example drivers performing maintenance tasks or vice versa. In addition, union contracts often require workers to be paid for eight-hour shifts plus split-shift differentials, even though, due to declines in off-peak transit demand, many workers are idle during the off-peak. So while the typical number of hours spent driving is between 4 to 5 hours, workers are usually paid for 12 hours to cover the morning and afternoon peak periods for which part-time drivers cannot be hired.

Recent work by Kim (2005) examined the effects of contracting on transit labor and transit productivity. The study consisted of 12 transit agencies that report to the National Transit Database,¹³ including five private contractors, the in-house portion of service by public agencies that contract out some service to these five contractors, and four public agencies that were matched as comparison groups based on operating characteristics. Because limited access to labor data from private companies (those not receiving federal subsidies and therefore not reporting to the NTD) restricted the sample size available for the study, the ability to generalize the results may also be limited.

Kim's (2005) research findings suggest that drivers working for private transit firms receive substantially lower wages, have fewer paid days off, receive slower seniority increases, and have lower wage ceilings. Private industry drivers in the sample made between 34 and 38 percent lower wages than public drivers, indicating that most of the savings of contracting come from labor cost differentials. They earned approximately \$10 to \$11 per hour (or \$24,000 annual earnings), while public drivers received \$16 to \$18 per hour (or \$36,500 annually). In addition, wages paid by the private contractors in the sample increased more slowly and lagged behind inflation over the study period (1996 to 2001). For example, in Houston, drivers start at \$9.27 an hour and can earn up to \$11.29 with five years' experience.

Kim (2005) hypothesizes that lower wage rates in the private sector result in drivers working longer hours to make ends meet. She states, "A privately hired driver worked on average 100 to 200 hours more per year than a public driver in order to compensate for lower regular wages, but still did not always achieve the same annual earnings as his public counterpart" (Kim 2005, 165). Additionally, private drivers have very few paid days of leave, while public drivers receive three times more paid absences than public drivers. Specifically, public drivers receive approximately 52 paid days off while private drivers receive 15 days off per year. Private opera-

¹³ Only agencies that receive federal assistance are required to report to the NTD.

tors hired fewer part-time drivers than public operators in the sample (2 percent versus 11 percent, on average), a surprising finding given the degree of peaking in transit. Kim (2005) speculates that lower wages paid by the private sector may result in a lower willingness to work part-time, especially given that public agencies offer significantly higher wages and benefits for part-time work in the same metropolitan areas. Finally, payments associated with union work rules, a component of spending considered inefficient, declined over time for public agencies contracting out a portion of their service. According to Kim (2005), this finding may indicate that labor had granted concessions under the threat of contracting.¹⁴

Labor cost savings from contracting came with several tradeoffs. Lower wages and job security were associated with lower service quality, less efficient labor utilization, higher labor turnover, less-experienced drivers, increased absenteeism, and higher accident rates. Higher accident rates, in turn, were associated with increased insurance, training, overtime, and work-rules related costs. Lower labor costs were accompanied by less efficient labor utilization and higher costs due to less qualified and less productive labor. Additionally, although the total operating costs for private operators were lower than those for public operators (\$50 versus \$84 per revenue vehicle hour), the costs of non-labor inputs, such as fuel, maintenance, casualty, liability, and administration were higher for private operators. Surprisingly, private operators also paid significantly more for non-operating labor time, including stand-by time, driver training, union functions, run selection, and accident reporting, which were the most costly components of work rules payments.

Kim (2005) computes the savings that could hypothetically be transferred to labor if private operators were more efficient in three areas (overtime, non-operating time, and insurance), finding that wages could increase on average by \$2.22 per hour, bringing the average private wage to \$12.95 per hour, which remains lower than the average public wage of \$17.30 per hour. Notably, some public agencies were able to achieve similar cost-efficiencies while still paying wages and benefits substantially above those of the private sector. For example, VIA San Antonio, a public operator in Texas, had operating costs of \$52 per revenue vehicle hour (RVH) below that of First (DART), a private operator with similar operating conditions, whose costs were \$64 per RVH. However, VIA drivers received roughly \$3 more per hour than First (DART) drivers and received \$1,500 more in benefits. VIA also had a higher utilization rate of part-time labor and fewer payments due to work rules as well as higher vehicle fuel and maintenance efficiencies. Given these findings, Kim (2005) calls for increased

¹⁴ Work rules related payments are payments to on-call drivers who fill in for unexpected absences and are an indicator of inefficiency in an agency (Kim 2005).

examination of alternative methods to contracting for improving transit operation and organizational efficiency as well as wage standards set by public agencies.

Similarly, Sclar (2001) argues that in cases where transaction costs of contracting exceed savings, those agencies would be better off by restructuring their operations to improve efficiency. He emphasizes that organizational changes require a public agency leadership that is willing to listen to and involve workers in efficiency improving reforms. For example, he cites the costs savings brought by organizational changes in Indianapolis Fleet Services, a public agency that maintained the city's vehicle fleet, under the threat of contracting. Under the pressure to contract, the agency's leadership successfully involved public workers in brainstorming and implementing several cost savings and efficiency improving reforms without wage reductions. Changes implemented were reportedly ones that workers had been requesting for years with no response previously from management. Using this example, Sclar (2001) contends that the costs of better management of public workers may be less than those of managing private contractors. This assertion raises the question of what kinds of institutional changes are needed to create the effective incentives for management and workers to collaborate toward efficiency and improvements in quality.

Summary and Conclusions

Escalating costs, declining productivity, and constraints on funding for transit have spurred many public transit agencies to return to privatization. Early studies on contracting of fixed bus routes in the U.S. have found cost savings from contracting that range from 10 to 40 percent (Iseki 2004). However, many of those studies had methodological issues that brought into question the accuracy of their results. More recent studies by Nicosia (2001) and Iseki (2004) were able to address many of these issues, in particular that of endogeneity between costs and the decision to contract. Nicosia's (2001) results indicate that contracting can save between 15 and 19 percent, while Iseki (2004) finds lower savings, of 8 percent for full contracting and 5 percent for partial contracting. However, these costs savings seem to come at the price of service quality and safety (Nicosia 2001) and reductions in driver compensation levels without increases in labor productivity (Kim 2005). Furthermore, lower wages and higher turnover rates associated with contracting may be in turn related to the observed increase in accidents and lower quality transit service by Nicosia (2001).

More research is needed on how contracting impacts the quality of transit service, such as on-time performance, routing, passenger comfort and

satisfaction, and frequency, as well as longer-term impacts of contracting on labor. This work would require better survey data related to labor and service quality for private contractors not included in the NTD. Contract design and bidding requirements were not found to significantly affect cost-efficiency but may have important, but yet to be identified, implications for the quality of service and fare levels. In this vein, research is needed to address how the details of contract design, such as provisions for labor standards or incentives for maintaining or even increasing ridership, might impact the quality and efficiency of service.

Additionally, research by both Kim (2005) and McCullough et al. (1998) highlights that contracting and wage reductions are not the only means of increasing cost efficiency within transit operations. Other operational changes could include improving labor-utilization, fuel, and maintenance efficiencies through route interlining and optimization, or decreasing non-revenue vehicle operating hours by optimizing locations of maintenance and storage facilities relative to routes (Kim 2005; McCullough et al. 1998; Iseki 2004). These methods might be written in contracts or transit agencies could negotiate with unions to reduce inefficient work rules such as restrictions on part-time workers, split shifts, and limited differentiation of wage rates by seniority levels (Kim 2005).

To this end, more research is needed on what institutional and policy changes, other than the threat of contracting, could foster incentives to improve service cost efficiency and quality. For example, some scholars have proposed that smaller transit zones operated by public agencies achieve similar cost savings through reductions in overhead costs, while maintaining higher wages and a more stable workforce (Richmond 2001).

The research findings reviewed here seem to indicate that responsible and fair labor practices in contracting transit are integral to maintaining high service quality and safety. However, in determining the appropriate labor policies, the social objectives of increasing mobility for all segments of society, especially those who are unable or cannot afford to drive, and reducing environmental externalities of transportation should be kept in focus. That is, to the extent that driver wages and benefits far exceed the market rate for similar skills and educational attainment levels, or that inefficient work rules significantly constrict the supply of transit, bus riders, who are often very low-income, may be paying for these inefficient labor practices with their mobility. Instead, wage rates and benefit packages should be set to attract and retain well-trained and qualified drivers, while negotiating work rules that foster efficient, high-quality transit that meets the needs of both bus riders and transit labor and also furthers environmental objectives. Additionally, income inequality and poverty

are important issues that might be more effectively addressed on a wider scale using policy measures that increase access to job training and higher education opportunities.

Finally, the research reviewed here shows that decline in transit productivity over time has not been due solely to subsidies, high labor costs, and inefficient work rules, but to as a complex combination of factors. The continued growth in auto ownership complemented by low-density, auto-oriented urban growth patterns have continued to erode transit ridership and extend the distances routes must cover, substantially reducing the cost effectiveness of transit. Subsidies and investments in other modes of transportation, such as automobile infrastructure, free parking, and gasoline prices that do not reflect environmental externalities, have exacerbated this trend and put transit at a further disadvantage (Litman 2005). Therefore, addressing other inefficiencies in the passenger transportation sector at a broader level should also be considered as a means of improving transit efficiency. For example, where traffic congestion results in slower bus speeds, investments in Bus Rapid Transit technologies¹⁵ might have higher payoffs in terms of cost efficiency relative to transit contracting, provided concurrent investments in appropriate and supportive land uses are made. In lower-density environments, given the high cost of fixed-route bus service, it may be more cost effective to provide mobility for the poor through subsidized shared taxis, legalized privately owned paratransit services, or even subsidized car ownership (O'Regan and Quigley 1998; Taylor and Ong 1995; Wachs 1997). More research comparing alternatives to contracting to increase operating efficiency is needed.

In conclusion, while contracting appears to have the potential to substantially reduce costs, the tradeoffs involved may be considerable, and the broader social objectives of transit need to be kept in mind. More research is needed on possible ways to reduce these tradeoffs, such as better contract design, quality and safety standards, and contract monitoring. Various alternatives to contracting, such as broader organizational changes or addressing larger transportation system inefficiencies, and their tradeoffs, should be weighed in a broader policy context. Lastly, where contracting is utilized, it should be accompanied by appropriate and enforceable service quality standards and labor practices which support these standards.

¹⁵ Such as providing exclusive right-of-way for buses, signal prioritization, and vehicle-arrival-information technology.

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Lynn Scholl is a doctoral student at the Goldman School of Public Policy at UC Berkeley. She is interested in equity and environmental issues surrounding transportation policy including mobility for the poor, informal transit markets, public transit finance and regulation, and housing and transportation markets. She holds a B.A. in Environmental Sciences and a M.P.P. from UC Berkeley. She has worked as a researcher on issues ranging from international trends in carbon emissions, a policy proposal to reduce criteria emissions from transportation, affordability of transportation for low-income populations, and community economic development. The author is grateful to Professors Martin Wachs and Steven Raphael for their very helpful comments, guidance, and feedback on an earlier and much longer draft of this paper. She also wishes to thank Lewison Lem for his very helpful editing and comments.

Virtual Elevators' Contribution to Sustainable Transport Policies: The Importance of a Smart Regulator and "Not-Too-Smart" Cards

Tristan Chevroulet

Abstract

The most significant contributions of new technologies to the implementation of sustainable urban travel policies appear to be twofold: a better understanding of users' behavior, and the improvement of interfaces between operators.

Smart cards, i.e. chip cards which communicate with the database of a billing company, have the potential to combine the qualities of both of these contributions. But they also raise new problems. In Japan, a financial transactions company is developing a new payment system which coordinates superstore chains and public transport supply. Just as elevators will enable people to move freely within buildings, this system will enable customers to reach the superstores for free from the outside world.

Analysis confirms that this new concept has the potential to stimulate public transport demand. However, three issues need further consideration. First, private businesses may access transportation, financial, and even property data of travelers, which may threaten their privacy. This paper proposes a concept that would prevent such a system failure. Second, small businesses could be discriminated against on the grounds that the turnover they produce does not suffice to bear the cost of running virtual elevators. The study highlights the conditions in which local authorities may require leading businesses to cooperate with smaller ones. Eventually, since virtual elevators may rely upon state transport subsidies while following private commercial profit objectives, the paper also stresses in what matters states and local authorities should require commitments from private partners. The conclusion underscores the importance of public authorities' involvement from the earliest steps of development of the system until and during operation. More specifically, it contrasts two distinct policy requirements: subtlety as the regulator's main quality and "not-too-smart-ness" as a major characteristic of electronic cards.

Introduction

Smart cards have long been sought as a technology that would revolutionize fare payment in metropolitan areas. To date, smart card programs have been implemented in Washington, Chicago, Boston, and other U.S. cities. These implementations, however, have only begun to tap the potential for smart cards to affect the transport system. When applied as a commercial means for implementing sustainable transport policies, smart cards enable new business models that fundamentally question the regulatory system. Ogino (2005) highlights how smart cards can be used for investigating customer behavior, while Bagchi and White (2004) describe smart cards' potential for implementing new payment procedures in public transport. These two features can be merged in developing smart card systems that will enable superstores to offer free transit rides to their customers (Yokoe 2005). Such new services, it is argued, will encourage people to use public transport instead of private motoring. Indeed, superstores already provide free elevators and free escalators within their premises; this paper considers extending this principle to the public transport lines beyond their premises. Hereafter, we will refer to such a service as a "virtual elevator."

The virtual elevator concept is a logical step toward further integration of the transport system (Rothengatter 1991). Such a development is in line with the scenarios for 2020 established by Reynaud and Braun (2001) which stressed that successful innovation in transport would rely more upon improved organization than on pure technological development. By examining a virtual elevators pilot program in Japan, this essay will explore the possibilities of such a scheme and its meaning for actual practice in the U.S. and in Europe.

In Japan, the private sector has recently launched initiatives, such as the new "PiTaPa" program (Postpay IC for "Touch and Pay"), the brand name of the Surutto Kansai scheme, which employs smart cards for billing and financial services. Through these efforts, private companies have shown that they are able to negotiate conditions and tariffs with a wide range of operators to bring them voluntarily into a common scheme, whereas public authorities regularly fail in reaching consensus on similar topics. As a consequence, one may wonder whether the state and municipalities should better give up their regulatory roles and enter such schemes purely as partners, providing public services (a library, for instance) against electronic payments, or if there are still reasons for stronger involvement.

Expected Effects

Long-Term Benefits

Virtual elevators may yield at least five sorts of benefits: corporate profit, business efficiency, retail customer attraction, transit passenger expansion, and improved quality of life. Superstores, public transport companies, and municipalities would share development costs and they could expect returns on investment in the medium-term. Superstores would gain data on customer behavior, expand customer loyalty, attract more clients, advertise more directly, and reduce the number of parking spaces needed. Transport companies will be able to provide services to more users while keeping similar marginal revenue. Finally, municipalities expect to improve access to places, which raises the quality of life of their citizens and makes these places more attractive for tourists.

Financial Model

The virtual elevator model is similar to frequent flier programs, in which program participants receive “air-miles” that can be redeemed for a given range of rewards and benefits, especially free air tickets. In frequent flier programs, a percentage of passenger fees are set aside to pay for the subsequent redemption of rewards. Surutto Kansai expects the PiTaPa scheme to run on a 2 percent fee (Yokoe 2005, slide 58) to be paid by all customers. Virtual elevator schemes differ from frequent flier miles programs, which offer regular customers a special reward worth one hundred Euros or more. Virtual elevator schemes provide all customers with a regular reward that only has a relatively low monetary value.

Using the word “elevator” as a metaphor for free public transport connections to superstores suggests that all people who simply “are within” superstores may travel for free, which is indeed what they do when they use elevators. Yet, this logical option may prove extremely expensive in practice. Therefore, we will make a distinction between two different virtual elevator schemes: the “common virtual elevators,” which are common to all people who visit a department store (row 1 in Table 1) and the “customers’ virtual elevators,” which only customers who buy something can benefit from (row 2 in Table 1).

Keeping in mind that both virtual elevator schemes entail important operation costs, customers are not likely to accept paying extra fees to finance the trips of “free riders” who visit superstores without spending any money. In the following considerations, the name “virtual elevator” will therefore be applied to the “customers’ virtual elevators” category (row 2 in Table 1).

Table 1. Typology of Schemes that Associate Business to Free Public Transport Services: "Miles" and "Virtual Elevators"

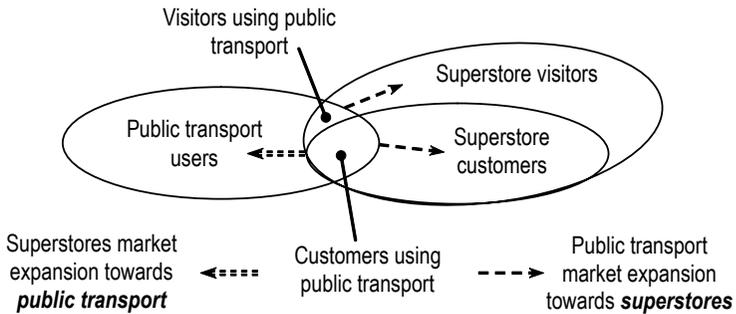
Scheme	Conditions	Who Benefits?	Who Pays?	Cross-financing
"Common Virtual Elevator"	<u>Be within</u> an affiliated shop	<u>Any visitor</u> who travels with public transport	Superstore (all customers who buy something)	All customers pay a fee of about 2% of shopping expenditures that finances the "common virtual elevator." However, the 2% figure seems optimistic, since the scheme shall prove expensive, as all visitors may enjoy free rides, even those who spend no money at all at affiliated shops.
"Customers' Virtual Elevator"	<u>Spend money at</u> affiliated stores	<u>Customers</u> who buy something and travel with public transport	Superstore (all customers who buy something)	All customers pay a fee of about 2% of shopping expenditures, while only part of them actually use the free transport service
"Miles"	<u>Regular travel and spending</u> at affiliated shops	Customers and frequent transport users	Superstore (all customers) and transport co.	Fee of about 1%, which is included within the spending. Frequent in air transport business. Many miles unused (threshold effect).

New Market Potentials

Virtual elevators encourage superstore customers to use public transport, while they simultaneously encourage public transport users to visit superstores and shop within their premises. Hence, virtual elevator schemes represent typical "win-win" agreements between superstores and transport operators. Both seek to gain new clients from the group of the others' customers: they share markets which are complementary, and which do not compete against each other. Such a clear-cut and positive situation seldom occurs in practice.

The apparent autonomy of the virtual elevator concept could give the impression that there is no reason for any sort of state involvement. Still, we will see below that this kind of development is likely to generate problems that market forces do not resolve.

Figure 1. Market View of the “Virtual Elevator” Scheme (Free Rides): Superstores Seek to Attract Public Transport Users, while Transport Companies Expect to Derive New Users from Affiliated Stores



Outcomes and Questions

We shall inquire how the overall system (smart cards, virtual elevator scheme) may change the life of citizens: more precisely, how it may influence users' private lives, modify competition between businesses, and impinge on the use of public resources. Three assumptions have been made:

1. Any customer who spends money at an affiliated superstore or company gets a free day-return on a public transport line that gives access to the business in question (virtual elevators are dedicated to customers only).
2. Superstores and affiliated companies have established close cooperation with (or ownership of) urban transport operators. Municipalities may be involved as well.
3. Virtual elevator schemes are run in densely populated areas with high economic activity, where regular overcrowding occurs at peak hours.

The financial transaction company that launches and runs the complete scheme stands at the crossroads of information, finance and — in short — power. This company comes out as the obvious winner of the scheme. There is no clear winner or loser among the other participants: all have a role to play and the way they play it will determine the impact of the virtual elevator on society, on the economy, and on the environment. The following outcomes and flaws require most attention.

Although elevator schemes have a strong potential for improving participants' access to places in urban areas, advantages remain unclear for society

as a whole: the most important fraction of all citizens are non-customers, who hence miss out on all the advantages, and so do the businesses that stay away from the scheme. Besides, there remain doubts that road congestion problems can be solved just because a number of customers shift from private motoring to public transport to reach a given set of spots in a city. In short, the most significant benefits remain in the hands of participants; these benefits do not trickle down any further.

Weaknesses of elevator schemes show a similar pattern: they mainly affect participants, and they have a more moderate effect on wider circles of society. Two of these weaknesses can be treated properly. First, the potential commercial disadvantage for non-affiliated businesses (more expensive access) is a business issue, even though small businesses may not be able to finance the equipment necessary for entering into the scheme. Second, overcrowding at peak hours is commonly considered as a traffic management issue. Professionals can manage such questions, at least those for which they are trained.

Nevertheless, three other weaknesses appear more critical and should not be left to market forces only. The first is the potential reinforcement of monopolistic cartels. Businesses could build alliances along the transport chain: a superstore could create an alliance with a transport company that stops nearby and with an important estate owner within a given area. The three partners would then provide free trips between the estate and the superstore, which would have the effect of virtually extending the superstore premises up to the estate. Such a strategy could be considered as an unfair competition against non-affiliated stores.

The way wide alliances of businesses may share customer information is the second flaw that can generate potentially severe side effects: how far, for instance, can someone's temporarily insolvency information trickle down the alliance? In the case of a consumer not being able to pay for the goods he intends to purchase in a superstore, would some form of statement reach his landlord's ear? Or could all superstores of an alliance refuse to accept the credit card from someone being involved in a lawsuit with his property owner? And in either of these circumstances, could anyone imagine his electronic public transport pass being purely cancelled until any sort of conflict with alliance businesses is resolved?

The third weak point is that the state and municipalities would lose a substantial part of their sovereignty over public transport strategies if they let private businesses set purely commercial rules for transport fares. There would be an impact on the political agenda in the longer term since such a development philosophy questions the essence of public services for which citizens vote and pay taxes. If access to schools and other non-profit

activities is expensive, while free to large shopping areas, these people may wonder who is ruling the city.

In addition to the above-mentioned weaknesses, virtual elevator schemes provide a wide range of uncertainties for all participants. On the potentially positive side, there are commercial and operational outcomes (for transport companies). Virtual elevators are expected to encourage people to shift from automobiles to public transport, which may increase operators' profitability, while slightly lowering pressure on congested roads. Nevertheless, scientists believe that such "traditional" benefits of information technologies remain unclear (Banister and Stead 2004).

But amongst the uncertainties some may also lead to potentially negative outcomes. Competition is an obvious issue: Non-affiliated businesses located near affiliated ones, especially those which form geographically important clusters of "non-free public transport," will lose clients as they become comparatively less accessible. Then, a risk management question arises: The risks associated with the systems' implementation and ticketing involve important liabilities, for which insurance may be needed. Nevertheless, these risks mainly represent engineering, management and business issues which professionals should be able to keep under control.

The use of public finances raises another question: If the state supports public transport by making land more affordable than pure market conditions would do, by lending money for building infrastructure, or for rehabilitation, or by subsidizing non-profitable services, then it is not clear whether citizens would agree with tax revenues being spent on supporting a transport system which is then used as a virtual elevator on certain lines? Maybe they would if they had a say in where to locate such elevators (near where they live and shop), but such public involvement has not been proposed yet. Here again, the state and municipalities have to play their role and set priorities that match the common interest. Still, the effect of increased demand on subsidized services remains unclear: more travelers enable a more efficient use of the system, which decreases marginal costs. But the benefit may not suffice to compensate for potential additional operating costs, which may, in the end justify higher total subsidies.

Yet the most problematic uncertainty is the one to which the public is exposed: it consists of the misuse or abuse of electronic data. The smart card payment system contains and transfers data concerning purchases, financial accounts, habits, names, locations, phone numbers, and usual travel behavior. Therefore, those who may have access to the whole range of data, legally or not, have the possibility to identify customers extremely precisely, and they would be in a position not only to profit from the situation, for instance by targeted advertising, but even to abuse it. This issue

is crucial because transportation data add a supplementary dimension to citizen privacy: people can be tracked and traced with ultimate precision and in real-time. The following section highlights the sensitivity of this issue.

Privacy vs. Marketing

With real-time tracking and tracing of all cardholders along the network, businesses can further tighten the cybernetic loop that connects them with potential customers. If marketing companies have access to a range of travel behaviors and purchase records which they can match with stimuli to which cardholders have been exposed to, what would prevent them from establishing some form of psychological profile for making marketing far more efficient?

Just imagine this: it is 7:00 p.m., a passenger is coming back from work, exhausted and hungry. One minute before the Ikebukuro station, where he has to change trains, he receives an automatic voice message on his mobile phone:

“Dear Masato-san, you are arriving at Ikebukuro station. Did you know that Tobu stores are launching a new series of “evening-sushi”? I am pleased to invite you for a free tasting tonight. The new sushi bar is on Tobu ground floor, just on your way to Yamanote line. Tasting would just take one minute, you then can catch your Yamanote connection as usual. And, tonight, we can even prepare a small gift dedicated to your wife Yukiko if you just reply “YES” to this message. The free gift will be ready for you at the Tobu sushi bar as you pass by. . .”

Of course the passenger knows that the message has been prompted by a computer, based upon the data he himself provided before receiving the card as well as while traveling and buying things, and he is probably aware that he did nothing more than trigger a program as he passed the platform gates. Nevertheless, such gentle intrusions into private life, carefully tailored according to customers’ habits, time and location, is far more persuasive than hundreds of traditional advertising campaigns. And even if the passenger does not follow the incentive he receives at this precise moment, he is very likely to reveal how he reacts to advertisements while he carries his smart card, which lets the data operating company investigate his behavior and then reach him exactly at the moment he may transform an intention to purchase into an act.

Among all of the stakes considered so far, privacy appears to be the most significant. It seems, however, that it is also the most unclear element of the virtual elevator concept. Privacy needs to be successfully guaranteed before

any attempt at implementation. Therefore, before seeking a conclusion on the global concept, we need to analyze the privacy problem; that is, how the personal data would be created, where it would circulate, and what would happen to it after use. This will lead to a new system architecture that should help avoiding the main flaws.

Data Lifecycle and System Architecture

The overall procedures that enable virtual elevators must allow for three types of function: (1) they must transfer data for commercial transactions and marketing analyses; (2) they must analyze data, validate it, send invoices and (possibly) advertise; and (3) they must ensure that privacy requirements are met. The operational process is described as follows:

1) Data collection and transactions: The gates located in superstores and at transport interfaces transfer users' requests to the company that administers the database.

2) Analysis and billing: The database operator checks whether the user is entitled to the services requested and, in the case of the deal being accepted, the billing company gets involved. Usually the companies which provide private data — superstores and transport operators — do not directly exploit it, but rather they gather aggregated (hence impersonal) data for improving their services.

3) Marketing purposes vs. confidentiality requirements: As the case of Japan suggests, the database operator is in a position to make very fine analyses that may serve marketing purposes; nevertheless, such potential is limited by the fact that, according to law in many industrialized countries, the operator must guarantee extremely strict confidentiality. For instance, in the Cyberrail project, under Japanese law, Ogino (2005 B, pp.7–8) proposes to protect privacy by cleverly separating the cardholder's position information from his or her identity data. In this context, the state acts as a regulator, making sure the laws are adequate and obeyed by all those involved. Still, concerns about private or even public Orwellian surveillance remain (Orwell 1949).

Now we can extrapolate general practice in electronic commerce to the virtual elevator case. On the contract, the "business side" participants (billing companies and database operators, superstores, and transport companies) clearly explain the kind of services they supply to customers and the behavior they expect from them. But customers' questions and concerns are likely to be brought up only later, in the case of a problem. Unfortunately, abuse of personal data, for instance, may put a customer

in a very bad situation extremely quickly, and by the time justice is carried out the damage may be irreparable.

It is extremely difficult for the users to evaluate for themselves, whether there are risks to participation since the full system architecture is not transparent to the user. In terms of data processing, we may expect to find information technology experts miles away from lay people, which would seriously compromise the outcome of any direct dialogue between them. At this point, we see two ways of bringing the parties closer to each other: (a) by providing a sequential analysis, where each information process is carefully described and linked to all those that may potentially follow, or (b) by exploring potential outcomes, actions, and expectations at the most significant steps, after the continuous process has been broken down to a set of “meaningful” snapshots. Even though the first approach (a) would reduce the interpretation gap between experts and lay people, we reject it here since it would still require that potential card users possess a high level of data processing familiarity. On the contrary, the synthetic approach (b) would focus on essential operations which all can understand, such as those listed at the start of this section, i.e. data collection and transactions, data analysis, use of results, plus the final stage of data removal. Experts, then, may consider the issues at stake during each operation and provide answers or design a system architecture that responds to the needs of concerned customers and stakeholders. These issues are displayed in Table 2.

Next to technologies, the steps listed above obviously involve regulatory issues. The problem is that there is no established advocate for the future customers in designing the system. This is due to a deliberate business focus, which, due to market forces, is assumed to encourage customer participation without design input. Table 3, displaying public concern about electronic transactions via smart cards (SDPC, 2004), clearly shows that most questions relate to privacy, not to business. Efficient information technology is, of course, an essential prerequisite for the virtual elevator scheme but, on its own, it does not suffice.

Data operators, state agencies as well as private companies, need to build trust between affiliated partners and customers. They should not only provide detailed information on their objectives and on the data they will handle, but also demonstrate compliance with the regulating agency accountable to the public.

Table 2. Individuals' and Private Participants' Roles and Expectations during the Data Lifecycle

Participants	Data Lifecycle			
	1) Collection / Transactions	2) Analysis	3) Use of results	4) Data removal
Individuals	Provide private as well as optional data. ¹ Expect confidentiality	-	Convenient payment	Expect to receive notification after data has been removed.
Billing and database operators	Gather private data and protect against unauthorised access	Expenses & travel behaviour	Check creditworthiness. Produce financial transactions and bills	Store and protect data during a given period of time (contract). Delete data (definitely)
Other stakeholders (superstores, transport co. and other businesses)	Transmit a limited flow of data at tills and portals	Optional part and anonymous aggregates	Marketing, stock or supply management	Remove data (definitely)

¹ Optional data adds information to the mere identification number, but it does not threaten privacy; it may contain age group, gender, customer program affiliations and preferences. On the contrary, name and address belong to private data. They are not considered "optional."

Implementation Strategies

Implementation and Project Lifecycle

Having highlighted the main stakes of the virtual elevator system, we have deepened our analysis of information processing, splitting the process into four snapshots (Table 2), in which we then examined the most sensitive issues (Table 3). As the essential objective of this paper is to consider the contribution of virtual elevators to sustainable transport policies, we now have to connect our findings to the virtual elevators' implementation process.

As it is in a position to control information as well as finance, the database operation and financial transaction company is the "natural" instigator and promoter of virtual elevators. The promoter seeks commercial partners and support from governments, with whom he shapes the project structure and its implementation strategy. Marketing services shall of course have interviewed a selection of potential customers in advance, but we can see that customers are thoroughly involved (Table 4, raw "operation") only

Table 3. Most critical issues from a citizen's point of view. See the importance of privacy and data protection.

Data Lifecycle Steps	Questions
1) Collection/ Transactions	What is the exact reason for collecting every single piece of data? What kind of analysis will be carried out and by whom? Who will have access to what data? How is my data protected against any sort of abuse? Where is the database located (country & place)? How long will my personal data be stored? What sort of information do I get?
2) Analysis	How is my privacy protected if data is transmitted to other companies for marketing purposes? (for instance by randomizing, or aggregating personal data) Will analysts intend to carry out cross information traces? (look for interactions between smart card data and data stemming from other payment systems, such as credit cards) What may happen to me in case of abuse of the system?
3) Use of results	Who gets the analysis results? (Just the billing company, or transport companies and affiliated stores as well?) What shall I do in case bills / records do not match with my behavior? (If, for instance, the billing company has failed to deliver free trips, or if fees do not match with actual journeys) May any of the partners use partial or aggregated results for targeted advertising? (such as customer localization and direct announcements by mobile phone)
4) Data removal	Who is in charge of removing data? What is the procedure for doing so? Is any body/institution responsible for checking that no data somehow remains after the process has been completed?

Adapted from: Swiss Data Protection Commissioner, SDPC 2004, p.10.

after the full system has been implemented. At that stage, no important changes can be made for incorporating citizens' concerns and, among others, better safeguarding their privacy.

The state is the only participant which can potentially represent citizens during the earliest phases of the project. It may influence the scheme's conception, implementation, and operation. It may also set the rules that regulate its termination. But state regulation on business activities does not suffice: one still has to suppose that some cases may exist in which law-breakers attempt to read more data than they are allowed to. The main

Table 4. Participants' Roles and Expectations in the Main Phases of a "Virtual Elevator" Scheme

Participants	Scheme proposed	Actions, roles and expectations during project lifecycle			Dismantling
		Negotiation and Consultation	Implementation	Operation	
Citizens	-	-	-	Some of them may benefit from free rides	-
Database and Billing Co	Proposer	Expects Return on investment (ROI)	Coordinator	Database handling and billing; data removal Transmitting of profiles* to partners	Coordinator Database Destruction
Affiliated Superstores	Partner	Expects ROI More clients	Partner, in charge of hardware at superstore	Levy fee Send data for billing Use profiles* to optimize marketing	Dismantle hardware at superstore
Customers at affiliated stores	-	-	-	Pay a fee on all items purchased Qualify for free rides	-
Visitors	-	-	-	No free rides	-
Public transport co.	Partner	Expects ROI More users	Partner, in charge of hardware at stations	Send data for billing Use profiles* to improve service	Dismantle hardware at stations
Public transport users	-	-	Change in habits	More convenient use & charging	-
State/ Municipalities	Provide service requirements	Specify conditions** Right of veto	May provide funding Control	Regulator: May subsidize or levy tax Control	Set minimal requirements Control

* In order to guarantee privacy, the billing company aggregates data into anonymous "profiles" (or groups of non-identifiable individuals) before transmitting them to partners.

** Such as legal requirements (privacy, accountability), ethical issues (use of personal data, fair competition) and development strategies (especially adequacy with mid- and long-term planning policies).

problem is that cardholders have no control of the information retrieved from the cards when they pass electronic gates. Therefore, in addition to designing a system architecture that enables responsibility and efficient information flow, we must also clarify what sort of information participants will store on their cards.

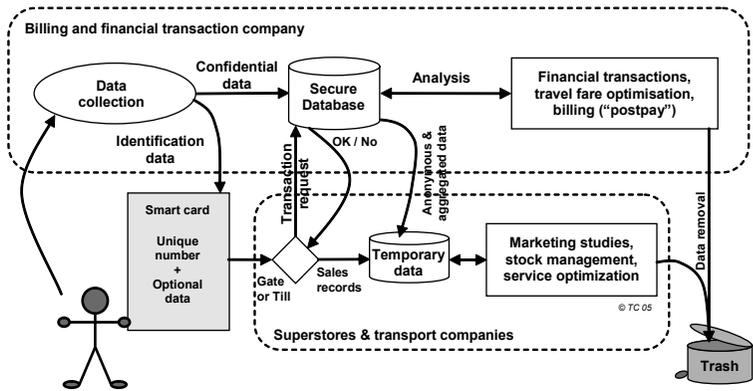
Process and Privacy: How Smart Should Smart Cards Be?

Safeguarding citizens' privacy vis-à-vis commercial interests requires not only that personal data should not be used for individualized marketing but that the database operator and billing company are completely independent from the other partners (superstores, transport operators, estate owners, and so on). It is not enough to presuppose that problems are unlikely to arise. Such independence between information and power must be guaranteed by the law, and public authorities should take the necessary steps.

Decoupling information and power means that each time a given task has to be performed, only the amount of information that is sufficient and necessary is made available, which calls for "not-too-smart" cards. This principle may seem abstract, but its application has crucial consequences. To give an example, imagine a very basic structure for data processing in a virtual elevator in which smart cards do not contain any private data (Figure 2): Confidential data is stored at a single place only, i.e. within the transaction company database. Smart cards allow for holder identification (unique number) and they may contain optional data (related to groups, but not affecting privacy). Confidential data is only transmitted in an anonymous, aggregated form to partner companies.

With this structure in mind, let us take a typical case. Customers who intend to participate in a virtual elevator scheme become members after they have indicated their identity, place of residence, and salary to the database operator. These data are strictly confidential. Once the data operator and the billing company have this information, the new member needs neither to carry it along anywhere nor to transmit it to anyone. Then, when a purchase is made, it is sufficient that the salesman knows whether the cardholder is able to pay for the goods being purchased. This means that the smart card may, in this case, only transmit a single identifier, such as a number, which the database operator compares with the client's account and the cost of the goods to be purchased. There is no need to transmit private data, as it is already at the place where the data are being processed.

Figure 2. Data Lifecycle for a Virtual Elevator Scheme in Which Smart Cards Do Not Contain Any Private Data



The case for public transport is quite similar: the cardholder is identified when he or she passes the electronic gates and the identifier is sent, together with the gate location and the time to the data operator for processing. Journey and fare are then determined and the information is transmitted to the billing company. This means that the best way to safeguard privacy, on the cardholder's side, is to strictly minimize the information content of the smart card. Theoretically, that minimum might be a single number. Then it is possible to add another number for cross-checking and, on top of this, the card may contain a few optional pieces of data (gender, age group, and the like) that superstores may directly use for marketing purposes. Still, it is essential that this data not contain any sensitive (that is, mainly personal) information.

Summary and Conclusion

This paper has explored the implications for citizens, the state and other stakeholders, as well as for sustainable transport, of using a single smart card system to charge customers for goods and reward them with journeys on public transport. A special feature of smart cards is that they are able to communicate with financial and billing companies at nearly any distance. The Japanese finance company Surutto Kansai proposes to use a new smart card system as a single means of payment for public transport, superstores, and other purposes. In this concept, smart card holders would receive free journeys with public transport when they shop at affiliated superstores. This fare exemption would be compensated by a fee of approximately 2 percent that would be levied on all purchases. This scheme can be interpreted as the commerce drawing a parallel between public transport and

superstore elevators, with full integration of transport expenditure within the superstore's operating costs.

Such a smart card system not only allows superstores to extend their zone of influence into the external world, but should also stimulate a shift from private motoring towards public transport (Figure 1), hence reducing car-related problems and saving parking spaces. Public transport companies would be able to take new users onboard and they could pass fare calculations for all smart card holders to the billing company. That company could even facilitate the transfer of travelers between various operators of transport because it has the data on all the completed journeys. By gathering the great diversity of metropolitan transport systems into a single and homogeneous unit, the virtual elevator provides a good example of how new technologies enable the invention of a new range of services.

Implementing virtual elevators delivers important assets in favor of a more sustainable urban mobility. Nevertheless, the advantages should not conceal the difficulties and risks. Questions remain about some fundamental issues. First, and perhaps most serious, is the difficulty of ensuring that citizens' privacy is not threatened in that cardholders transmit confidential data to the billing and financial company. Cardholders must receive a full guarantee that data will only be used within the defined framework, and only for the purpose stated and that it will not be transmitted any further. The holder must also be sure that the database will be protected against any unauthorized external access. Finally, all data must be definitively erased after a given period of time, or once the contract has ended. We suggest a system architecture (Figure 2) that clarifies technical privacy issues.

A second question relates to the use of public funds that have been assigned to public transport. Generally the taxpayers support public transport by means of state subsidies (for provision of infrastructure, maintenance, non-profitable services, and so on). But virtual elevators have a fundamentally commercial objective. Should they, nevertheless, benefit from public money as well, or should their fares merely reflect true costs? In this perspective, the virtual elevator can be considered as a value-capturing system, by which the stores along the transport line return to the public transport companies a part of the benefit generated by improved access.

Then there is the question of discrimination among stores. Superstores gain obvious commercial advantages when they extend their zones of free mobility into the external world. But this questions the limits of fair competition between businesses: the stores that are not equipped (particularly the small ones) with the electronic devices for running smart card schemes become less accessible. These stores will be discriminated against. Moreover, if the fee consists of a fixed percentage of the sales amount, whereby a customer may get one ticket or none, all shops which

generate smaller sales by customers than the superstores are penalized: in the end, they collect a lower fee, while still having to finance a given number of free tickets.

The obvious leitmotif associated with virtual elevator concepts, whatever they are called, is the promotion of public transport. Indeed, public authorities as well as citizens are keen to consider such initiatives as “sustainable” or, for projects in developing countries, as examples of Clean Development Mechanisms (Kato et al. 2003) and, therefore, worthy of support. We have assumed this so far. Still, one may wonder whether the public transport aspect is being used as a socially strong argument to persuade politicians and might later be extended for also financing “free parking” or “free gasoline” or both. If virtual elevators merely follow business rules, they may extend to any kind of transport. As long as promoters do not commit themselves to stick to sustainable mobility, there is no reason to believe that they will do so. They may extend the scheme to private motorists as well. This issue needs to be clarified. Public authorities can play a role here, discussing the system with the promoters and setting rules that guide the implementation of travel policies, and hence their effects, in the long term.

A customer may view virtual elevators as “free transport,” which is only part of the global picture, since they entail important costs. Nevertheless, virtual elevators may be justified, even if the public transport is subsidized. The main issue is to make sure that superstores bear the costs appropriately, without passing them to the public transport system. Assuming that the state’s involvement in virtual elevator schemes would not generate obstacles to healthy innovation, there is still an important need for regulation. The outcomes analysis and the study of the data lifecycle (Table 2) demonstrated the importance of the state’s role in terms of privacy: it is hard to conceive that any other authority would ensure that people could preserve their rights. As institutions, the state and municipalities may suggest which questions people ask before entering into any such schemes (see, for instance, Table 3). They may also provide legal support to citizens. Holistic investigation of the virtual elevator lifecycle (Table 4) defines the context in which the state and municipalities have to set rules on privacy and legal limits, and the extent to which these need to be clear. This is what we would call “smart regulation”: letting business forces act where they are doing well, especially in innovation, while simultaneously making sure that competition and the quest for profit remain ethical. The uncertainties that surround the implementation process support the argument in favor of the state’s and municipalities’ strong involvement as a guarantee that the policies follow their “genuine objectives,” that is, that they cannot be biased toward mere commercial advantage and possibly environmental damage after their most profitable part has been implemented. Finally, in terms of infrastructure and operational subsidies, the state needs to have a

very clear picture of public money use: when it comes to financing private profit, public resources should be assigned only after services have been exhaustively specified, with clear explanation of regulatory regimes over a long term.

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Tristan Chevroulet is a researcher at the Swiss Federal Institute of Technology, Lausanne. His research focuses on the interface between transportation, environment, and energy. He has worked as team leader for Daimler-Benz's Smart Car and as associate to the president of a national research programme on the interactions between transportation and the environment (CD-ROM: http://lem.epfl.ch/francais/cd_pnr.htm). He reviewed proposals on transportation and sustainable cities for the European Commission, and he regularly conducts analysis for the Observatory for Transportation in Europe. He wrote this paper during his stay as a visiting scholar at the University of California Transportation Center (UCTC), Berkeley.

THOUGHT PIECE**Sustainable Transport****by Melvin M. Webber**

I assume we'll want to sustain any mode of transport only if we judge it to be effective and desirable, and of course, only if we think we can afford to sustain it. Over time, we've abandoned any number of modes that failed those tests — horsecars, trollycars, and pullmancars, among others; and we've kept those that passed the tests — most notably motorcars, airplanes, and ships. In retrospect, it seems we've been pretty draconian in rejecting transport modes that have failed in the market place of public favor.

Now the test for sustainability is being pressed most vociferously against the automobile, because cars pollute a lot, use a lot of land, injure and kill a lot of people, and consume a lot of petroleum. More than that, and perhaps most important of all, automobiles have accumulated a growing circle of critics who regard cars as instruments of evil, deserving to be rejected into the dustbin where the world's sinful and dangerous instruments are consigned.

I find this sentiment peculiar, especially when voiced by liberals who are quick to defend the have-nots of the world. I say peculiar because the poor typically have-not cars as well as the other accoutrements of modern society. Of course, it's not only the poor who want cars, but the vast majorities of populations everywhere. Witness the current explosion in the market for cars in China, where but few consumers have been able to afford the ones that have made it into the marketplace. But we don't need to look to far-off China to gauge consumer demand. A glance out of any office window anywhere in the U.S. should suffice, for Americans remain the world's most avid consumers of cars. If the low-income groups could afford what others own, numbers of cars on our roads would be greater than they already are.

There can be but few questions about why that should be so, because the personal car has become equivalent to the magic carpet. It allows one to go whenever and wherever fancy or perceived need may direct, and at a tolerable price. Cars create access to jobs, medical services, recreational facilities, friends and kin, and indeed to the wide spectrum of opportunities that are the hallmarks of modern urban society. In places where cars are the dominant transport medium, as they are in suburban America, their presence and availability make them integral attributes of modern society, providing essential access to the services

of that society. I find it hard to imagine a mode of egalitarian modernity lacking the accessibility that automobiles supply to the economy and to so vast a proportion of today's people.

Yes, I of course, realize that real and serious costs are associated with cars; many analysts and commentators have been exposing those costs. But I'm also alert to the great benefits that are associated with widespread auto use and yet are typically ignored by those same analysts and commentators. I'm betting that a qualitative and unbiased benefit-cost analysis of cars in contemporary America would show that benefits far exceed costs. I'm also betting the analysis would expose a large deficit accounted by the many carless people who remain handicapped for lack of personal vehicles. If we care about the benefit-cost ratio, we should be advocating a sustainability policy that calls for reducing costs while providing cars for the carless and for those others who still lack adequate access to the benefits of modern times. Concurrently, we also need to invent a form of public transit whose service attributes resemble those of the private car — including door-to-door, no-wait, flexible-route, and no-transfer service.

I expect such a successor to the automobile will eventually prove possible; but, until then, I vote for sustaining and selectively expanding America's currently dominant transport system. Yes, that of course, means additional and large-scale investments in infrastructure — in roads, fuels, safety equipment, practices to lessen environmental damage, and financing systems to assure fiscal reliability for all transport modes. But it also means greater responsiveness to consumer wants and an increase in social equity.

Melvin M. Webber, recently deceased, was a Professor Emeritus in the Department of City and Regional Planning at the University of California, Berkeley. He co-founded, and served as Director of, the university's Institute of Urban and Regional Development. He also served for many years as Director of the University of California Transportation Center.

THOUGHT PIECE**Achieving Sustainable Transportation****by Jonathan Mason**

Sustainability is a serious concern for future transportation planning, but it should not be regarded as a straightforward problem with a simple but difficult solution. Achieving sustainability is a contextual and multi-dimensional process. Just as transportation pollutes the environment in a variety of ways and over a long period of time, addressing these pollutants requires a long-term, incremental, and multi-dimensional strategy to achieve sustainability. Genuine sustainability will likely take generations to achieve, but such a goal is most likely to be achieved through steady, incremental understanding and improvements in environmental impact. Given that sustainability is a long-term agenda, history is a useful and essential guide.

Sustainability by nature suggests a longitudinal process, measured by historical change and trends. After all, environmental disruption is not a new problem. Indeed, the climate changes we are now experiencing are likely caused by decades-old pollution. The historical legacy of environmental regulation and planning — of what has worked, what has not, and what were unexpected side-effects — is essential in guiding the best way forward. The proper questions have to be addressed in order to build a framework of change and to properly define measures of improvement. Understanding the historical context will enable better planning for the future.

Transportation should be at the top of the agenda for sustainability, yet transportation planning has to satisfy many competing agendas, such as managing economic growth, safety, equity, and social networks. Globalization is the central challenge to sustainability, and transportation is the backbone sustaining the global economy. Without travel and trade, the global economy simply would not exist, yet all this movement has a significant environmental impact. Furthermore, despite the increasing pollution burden from transportation, more travel is expected, not less. Stemming from the strong complementary nature between transportation and global communications, we can expect the global demand for travel to rise significantly. Dealing with more travel in a sustainable manner is the great challenge ahead.

A sustainable transportation agenda requires a flexible, holistic approach, as its agenda has to be integrated with other competing

objectives, such as equity, economy, and safety. The historical trend of globalization is profound, and increased travel should be accommodated as opposed to restricted. In addition to the deleterious economic effects, restricting mobility raises serious equity concerns, as it is likely that only elites will retain their right to mobility. Sustainable transport is thus just that: a sustained system, not a constrained, limited system. Energy consumption is a popular concern due to the atmospheric pollutants produced, but many other types of pollutants should also be of concern: the global impacts of transportation also involve land degradation, water pollution, and the transfer of invasive species. A great deal of waste exists in the transport sector, particularly when moving people, and sustainability should involve an agenda of eliminating such waste and improving efficiency.

How to instrumentally deal with a sustainable globalism requires a subtle, flexible approach on case-by-case bases, but general outlines can be determined. Problems should be understood scientifically, and innovation should be based on iterative learning of what works and what does not: a process of trial and error. Technology certainly has a central role in achieving sustainable transportation, but political reform is just as important. In understanding how to encourage effective and responsible technological development, political structures are crucial to such development. Too often transport is considered a field only for technical enquiry, an exclusively engineering subdiscipline, yet politics are central to the development of transportation infrastructure.

Within the political spectrum, methods of implementing solutions are diverse and should not be driven by such political ideologies as statism or privatization. A growing consensus is settling on the need for well-regulated markets to achieve policy goals. Market mechanisms have proved to be useful in improving efficiencies, but they are weaker in addressing strategic social goals, such as pursuing equitable outcomes. Proper regulation is necessary to guide the market mechanism. For instance, congestion pricing and parking pricing have great promise in better managing existing automobile use and its infrastructure, yet equity concerns could also be addressed in a regulation that transferred the pricing revenue for achieving equity in the system. Much progress is to be achieved with creative congestion pricing and parking charges utilizing a properly regulated market structure to achieve social and environmental ends. The techniques for implementation are essentially well established, but the political obstacles are the main hurdle. Approaches to solutions should not be assumed or ideologically driven, as trial-and-error is an effective instrument of improvement and progress.

What will a better model of sustainable transportation look like? Again, the future will develop upon existing historical trends. Strategically, a single solution such as fuel cells or a bicycle revolution may have promise, but it lacks the diversity of innovation required. Promoting bicycling and walking is a promising trend, but such narrow, individual measures clearly have their limits, especially in dealing with longer travel distances. Radical shifts are hard to achieve and thus less likely to be implemented.

Incremental shifts hold far more promise. Multiple fronts for innovation and change offer hope for comprehensive reform, while a proper understanding of why certain modes are dominant at the moment is instructive of achievable change. If only due to the vast capital infrastructure already developed for it, the automobile will be with us for some time, but planners would be wise to appreciate the popular appeal of automobiles in providing their users with control and convenience.

Transportation choices are not solely defined by the mobility they provide, but by a myriad of social and economic factors. For instance, the consumerism attached to the automobile is also crucial in understanding the popularity of the automobile. Transit has a great deal to learn from the flexibility, adaptability, and consumer popularity of cars. Great improvement in fuel efficiency and emissions can be achieved simply through off-the-shelf technology and better regulations, yet other social factors resist such change. Simply making vehicle weights lighter reduces fuel consumption and emissions considerably, yet consumers often consider heavier cars safer. Meaningful reform requires an appreciation of the complex nature of transportation choices.

A distinction between short-term versus long-term strategies provides a realistic framework for achieving sustainability. Over the long term, entirely new power plants may be developed for automobiles, but over the short term, improvements in the internal combustion engine hold the most promise. Land use changes can produce measurable results towards sustainable transportation, but it must be recognized that widespread land use changes take decades to be implemented and, thus, to have a measurable impact. The challenges of sustainable transportation are great, but they are not insurmountable with wise and concerted effort.

Jonathan Mason is completing his PhD in the Department of City and Regional Planning at the University of California, Berkeley. His interests cover the interactions between transportation policy, land use planning, and urban design and how they relate to the globalizing economy.

THOUGHT PIECE**Sustainability and Transport****by Richard Gilbert**

Almost 20 years after the term “sustainable development” was popularized in the Brundtland Report (World Commission on Environment and Development 1987), the U.S. government turned its attention towards application of the concept of sustainability to transport planning. In response to a 2003 request by the Secretary of Transportation, the Transportation Research Board (TRB) of the National Research Council established a committee to consider how sustainability could be integrated into transport planning, chiefly through holding a conference on the topic. The committee’s report concluded that “a goal of transportation planning should be to address transportation’s unsustainable impacts including depletion of nonrenewable fuels, climate change, air pollution, fatalities and injuries, congestion, noise pollution, low mobility, biological damage, and lack of equity” (TRB 2005, 5).

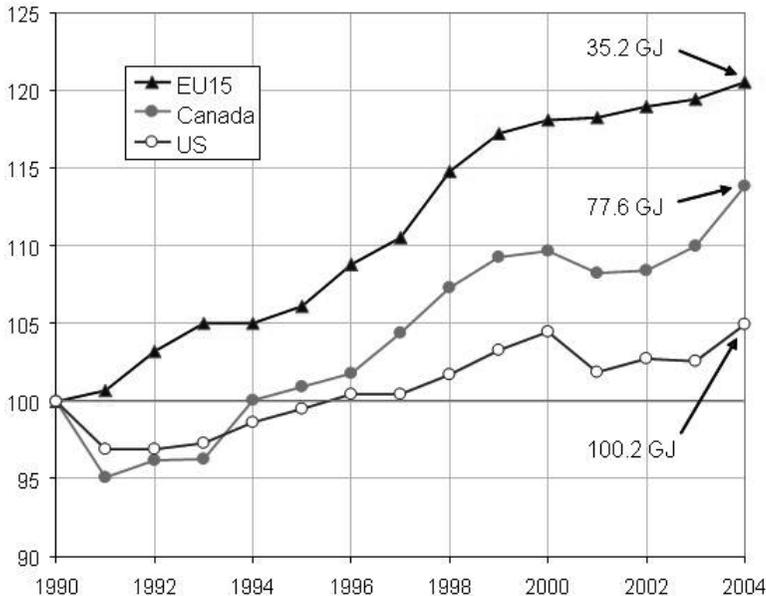
Until that report, the main transport sustainability focus of the U.S. government had been on technology. Notions of transport sustainability had a broader reach in the discourse of state and local governments. For example, the State of Idaho posts this definition: “Sustainable transportation is defined as a means to satisfy current transport and mobility needs without compromising the ability of future generations to meet their needs.” (Idaho 2005). It echoes that of the Brundtland Report: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development 1987, 43).

In Canada, transport sustainability has been a stronger part of federal discourse. It began with the hosting of an Organization for Economic Cooperation and Development conference in 1996 entitled “Towards Sustainable Transportation” (OECD 1997), continued through Canada’s submission Sustainable Transportation to the April 1997 meeting of the United Nations Commission on Sustainable Development (Canada 1997), and is maintained today by the Sustainable Development Division of Transport Canada, a department of the federal government.

The stronger discourse in Canada has not translated into evidently greater progress towards transport sustainability. Perhaps the best indicator of transport sustainability is per-capita use of energy for transport. Most of what is unsustainable about transport is the result of its combustion of fossil fuel, which comprises almost all transport energy use. Figure 1

shows that, since 1990, this indicator has risen more steeply in Canada than in the U.S. — i.e., there has been more movement in Canada away from sustainability. U.S. per-capita consumption of transport energy remains higher (100.2 vs. 77.6 gigajoules in 2004) and its lower rate of growth may indicate a “plateau” effect.

Figure 1. Relative Changes in Per Capita Transport Energy Use, 1990–2004, in the US, Canada, and European Union Countries (EU15)



This last possibility is supported by the plot in Figure 1 for the 15 countries that comprised the European Union (EU15) between 1990 and 2004. There, discourse about sustainability has been even stronger, but the outcome has been even more relative movement away from sustainability. Per-capita transport energy use is much lower in EU15 (35.2 gigajoules in 2004), perhaps allowing more scope for an increase in use and less likelihood that a plateau in use is near.

The TRB committee did not formally define sustainable transport. It used a working characterization that is similar to Idaho’s definition: “a sustainable transportation system is one that meets the transportation and other needs of the present without compromising the ability of future generations to meet their needs” (TRB 2005, 3). At the committee’s conference, participants bemoaned the lack of a uniform definition of sustainability. This, they said, with the “complexity and uncertainty of the issues,” made it difficult to discuss “how to set priorities, fund programs, and establish

rules to implement policy that furthers the goal of sustainable transportation" (TRB 2005, 22).

In Europe, there is a common definition of sustainable transport, also known there as sustainable mobility. This definition was developed in 1997 by Canada's Centre for Sustainable Transportation and, in a slightly modified form, was adopted unanimously as a working definition by the transport ministers of the European Union member countries (EU 2001). The EU version defines a sustainable transport system as one that:

- allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;
- is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development;
- limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimising the impact on the use of land and the generation of noise.

According to the European arm of the Rand Corporation and several partners, this definition of sustainable transport should be favoured because it is concrete, comprehensive, and "has been reviewed by political mechanisms and received general political acceptance" (Rand Europe et al. 2003, 15). As well as its use by the EU, the Centre's definition has achieved considerable acceptance elsewhere. A U.S. report noted, "Discussions with leading transportation research institutions have highlighted a growing international acceptance of the definition of sustainable transportation developed by the Canadian Centre for Sustainable Transportation" (Hall 2002, 15).

Only one criticism of this definition has been noted. Timmermans (2004, 4) characterized it as "a typical political definition: it lacks rigor, is vague and potentially inconsistent. Regardless, it seems to be based on the notion that if we build such sustainable (transit-oriented) systems and urban environments, people will use it. Where did we hear this before? Is there any empirical evidence to support this view?"

Another criticism of proposals to secure transport sustainability is that for the most part they focus on reducing transport's adverse impacts rather than on ensuring that transport is effective. At first, this might sound like a typical "business" argument against action: "we can't reduce those emis-

sions because it would cost an arm and a leg, people would be put out of work, and profits would plummet.” It is actually a different argument: very high transport fuel prices are likely and if we don’t prepare for them by dramatically reducing consumption our transport will become unaffordable and thus unsustainable.

The specific threat is very high energy prices — notably for transport fuels, but also for natural gas and, not far ahead, coal — consequent on production peaks in these fossil fuel resources. The most plausible analyses suggest that North American production of oil (all petroleum liquids) peaked in 1985 (BP 2006) and world production will peak in 2011 (ASPO 2007). North American production of natural gas peaked in 2001 (BP 2006); world production will peak in about 2045 (Hughes 2006). North American and world production of coal will peak in about 2025 (Zittel & Schindler 2007).

After the peak in world production of a resource there could be a growing shortfall of supply in relation to potential demand causing massive price increases or severely depressed economic activity, or both. For oil, this could happen soon after 2011.

The TRB report listed “depletion of nonrenewable fuels” as the first “unsustainable impact” to be addressed when integrating sustainability into transport planning. This recommendation was made with no sense of urgency or its profound importance. North Americans are utterly dependent on motorized transport, not only for their movement but for their very sustenance. Fourfold or more increases in transport fuel prices during the next decade could cause unsurvivable chaos, followed by the grim kind of sustainability that would come with a winding down of what we know as civilization.

Avoidance of such a bleak outcome within a decade requires an early, progressive and substantial transition to transport systems based on electric traction powered from renewable resources.

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Richard Gilbert is a Toronto-based transport and energy consultant with clients in Asia, Europe and North America. He is co-author of the forthcoming book Transport Revolutions: Making the Movement of People and Freight Work for the 21st Century (www.transportrevolutions.info).

TRIBUTE TO MARTIN WACHS UPON HIS RETIREMENT

Marty Wachs: The Teacher

by Elizabeth Deakin

Martin Wachs was a consummate teacher. At UCLA, he won a distinguished teaching award and got rave reviews from his students. When he arrived at Berkeley in 1996, he immediately drew overflow enrollments in his classes on transportation policy, planning, and finance.

Marty's teaching style was the perfect mix of careful preparation and impromptu elaborations. He came to class with lecture notes, transparencies, handouts, chalk, newspaper clippings, and the occasional PowerPoint presentation — a one-man multimedia show. He liked to lecture but didn't mind questions in the middle of the talk. He'd weave his response right back into his discourse.

No one could doubt Marty's love for the subject matter. His voice would rise with excitement as he made a particularly telling observation. He would rise up on his toes when he made his points. His excitement was infectious — his students loved his classes and were hooked for life on transportation policy.

Marty wanted his students to be prudent consumers of the transportation literature and he taught them how to evaluate what they read. He'd often start out by asking them to think about their own values and experiences in a critical way.

"How many of you think that transit will be a central transportation mode in the future?" (Many hands go up.)

"How many of you use transit yourselves?" (Many hands again, this being Berkeley.)

"And how many of you have parents who commute to work by transit?" (Few hands this time.)

"For those of you whose parents don't use transit, how many of you think they could be persuaded to do so in the future?" (Mostly sheepish glances around the classroom.)

Marty then would lead the students through an analysis of why transit might work for them in Berkeley, but not work at all for their parents, mostly in the suburbs. The vivid discussion, full of concrete examples,

pumped life into the lesson on travel behavior research findings — how value of time depends on income and trip purpose, how consumers make time and cost trade-offs, the barriers operators face when asked to offer transit service in sprawling suburbs, and so on.

Marty's interest in equity came through loud and clear in his teaching. Like much of his research, the lectures he gave and the discussions he led often focused on the transportation needs of the elderly, the disabled, and the poor. When he taught about finance issues, the analysis was permeated with a concern for how funding mechanisms and expenditure decisions affect the well-being of the least well off. He expected his students to consider the ethics and the fairness of the policies they analyzed and the proposals they put forth, and by his own example, he showed them how to do it.

His grading, like his teaching, was thoughtful and instructive. A splendid writer himself, he often edited a page or two for a student whose prose was soggy. Papers graded by Marty were handed back with the margins filled with questions and compliments and a closing paragraph suggesting ways to improve the analysis or extend it farther.

I had the experience of teaching the Transportation Policy class with Marty one Fall shortly before his retirement. About half of the students were engineering majors, many of them new to the U.S. Few had much experience in writing papers. They were used to calculations whose results could be checked, not arguments whose contours were indeterminate. They were quiet in class and, when asked what they thought about a particular article we'd read, unsure about voicing an opinion. So Marty decided that we should stage some debates, each of us showcasing the positions taken by key stakeholders on policy issues like road pricing and auto restraints and showing how policy arguments are put forward and defended. At first, some of the students were uneasy. One said to me, "How can the students know the right answer if even the professors disagree?"

By the end of the semester, though, the students were all jumping into the discussions with energy and conviction. The same student who had questioned our debates had figured out their purpose, telling me, "You want us to be critical and to question what we read. You trust us to be reviewers of papers, not just consumers."

Marty's teaching was not confined to the classroom. Indeed, the door to his office was nearly always open to students, who would drop in to ask him to elaborate on a point he had made or to bounce their own research ideas around with him. Students were a priority for Marty. He

was famous for telling a senator's office that he would call back because he was meeting with a student just then.

His "retirement" to RAND has not ended his Berkeley teaching — he continues to supervise dissertations and to advise graduate students who consider him their mentor. And surely the RAND staff members are also enjoying the benefits of Martin Wachs's extraordinary gift for teaching.

Elizabeth Deakin is a Professor in the Department of City and Regional Planning at the University of California, Berkeley, and is also Director of the University of California Transportation Center.

TRIBUTE TO MARTIN WACHS UPON HIS RETIREMENT

Marty Wachs: The Scholar

by Robert Cervero

While I could easily praise Marty for his outstanding contributions in many realms, I'm going to focus my remarks on a few seminal articles, ones from earlier years of his academic career — and ones that had a particularly profound effect on my own views about transportation planning. I first came across the writings of Marty Wachs while a freshly minted MCP graduate heading the transportation planning department in Billings, Montana. After months of butting heads with state highway officials whose chief concern was to lay asphalt as quickly as possible, I realized I needed to adopt a more holistic, “big-picture” perspective of the field. Doctoral studies seemed a natural trajectory. In the pre-Internet era, deciding where to pursue a Ph.D. in planning, especially in a remote burg like Billings, wasn't easy. While thumbing through back issues of *Traffic Quarterly*, the only transportation journal available in my office, one piece caught my eye: “Abstract Values and Concrete Highways,” penned by Marty and his friend from college years, Joseph Schofer. This pithy essay offered a new and refreshing perspective about the role of transportation in society, addressing issues like social equity, environmental quality, and community values that were rarely mentioned in the transportation literature. This one piece led me to read more of Marty's work, prompting me to apply to UCLA's doctoral program and spend three wonderful years under Marty's tutelage.

While studying at UCLA, another eye-opening article by Marty that I came across was “Physical Accessibility as a Social Indicator,” co-authored with a UCLA master's student, Thomas Kumagai, in a 1973 issue of *Socio-Economic Planning Science*. This pioneering piece advanced both the theory and method of that all-important transportation principle, “accessibility.” Using clever mathematics and compelling logic, Wachs and Kumagai provided a normative framework for thinking about and measuring accessibility, planting the seeds for numerous policy studies on spatial mismatch, jobs-housing balance, and welfare-to-work that followed. One might live in an area interspersed by roads and close to well-paying jobs; however, if one does not own a car or qualify for the jobs, he or she is hardly accessible. By casting accessibility in such qualitative terms, Wachs and Kumagai revealed the important policy levers necessary for enhancing access to jobs, commercial centers, medical services, and other key urban destinations.

Marty's systemic understanding of the transportation field is no better displayed than in "Transportation Policy in the Eighties," published in a 1977 issue of the journal *Transportation*. This eloquent piece foretold the future of ever-worsening traffic congestion in American cities due in large part to the "tragedy of the commons." Borrowing from Garret Hardin's writings on how agrarian-based towns of medieval Europe disappeared from overgrazing of "commons" areas, Marty analogized that American cities were poised for serious air quality and traffic problems because underpricing of car use results in overconsumption of highways. Marty argued that congestion charges and road-tolling, ideas very much in vogue today, were the best ways of getting motorists to internalize the external costs they impose. I continued to use this cogent and lively piece in my course reader well into the 1990s despite its focus on "future" transportation issues in the 1980s.

One other earlier piece that seeded Marty's research on transportation finance over the past two decades and steered me to my own dissertation work was "The Cost-Revenue Squeeze in American Public Transit," co-written with his doctoral student, James Ortner, and published in a 1979 issue of the *Journal of the American Planning Association*. Ortner and Wachs trace the cumulative effects of suburbanization, wage concessions to labor interests, low and flat fares, over-capitalization, and public monopoly status on the transit industry's steadily deteriorating fiscal health. They forewarn that unless major policy reforms are introduced — both within and outside America's public transit industry — transit's downward spiral would only hasten. This and other writings of the time helped make the case for such initiatives of the 1980s as competitive tendering of bus operations, peak-period surcharges, and transit-friendly suburban designs. In my own case, it opened the door for my dissertation on transit fare policy, which I was delighted to have turned into a co-authored article with my mentor and advisor: "An Answer to the Transit Crisis: The Case for Distance-Based Fares" (*Journal of Contemporary Studies*, 1982).

Others no doubt would come up with a different list of writings by Marty that strongly influenced their thinking. And I could cite many other seminal contributions of Marty's in the areas of mobility planning for the elderly, the political economy in urban transportation, ethics in forecasting, and highway finance. For me, however, these four delightful pieces indelibly shaped my views of the field and research interests.

I have had the privilege of being around Marty as a student and colleague over the past 30 years. It is an unspoken truth by those in the transportation planning academy that Marty is the gold standard on how to be a Professor — sharp, decisive and demanding, yet warm, caring and approachable. His profound and lasting influence on the field and today's generation of transportation professionals and scholars is unparalleled.

Robert Cervero is a Professor and Chair of the Department of City and Regional Planning at the University of California, Berkeley.

TRIBUTE TO MARTIN WACHS UPON HIS RETIREMENT

The Impact of Martin Wachs' Work on Transportation Policy

by Lewison Lem

The work of Professor Martin Wachs' career has made broad and deep impacts upon the transportation planning field. While his contributions to research and teaching are widely recognized, his contributions to transportation policy are likewise worthy of highlight and review.

In the university setting, service is the third leg of the stool of a professor's contribution. In Marty's case, his public and community service has sustained itself over the three decades of his tenure at the University of California, and his impacts on transportation planning and policy will reverberate for many more decades through his students, his writings, and his legacy in other forms.

Professor Wachs' policy-related work in the 1970s and 1980s at UCLA established him as a national leader in the transportation planning and policy professional field. As one example of this leadership, Professor Wachs collaborated with Professor Genevieve Giuliano of the University of Southern California and conducted groundbreaking evaluations of "Regulation XV." The South Coast Air Quality Management District instituted Regulation XV, which called for mandatory employer-based transportation demand management (TDM) programs.

As with all of his policy-oriented work, Professor Wachs was not governed by ideology or preconceived notions about what the conclusions of research should be. The groundbreaking TDM work on the Regulation XV measures found that employer-based demand management was both effective and costly. As is usual with good policy analysis work, the political advocates and opponents both found something in Marty's work that they liked. The advocates cited his work because it showed that TDM programs could be effective, while the opponents questioned the cost-effectiveness of the programs, based upon the conclusions of Wachs and Giuliano.

While always gracious in person and diplomatic in meetings, Professor Wachs was not averse to going against the political wisdom of the moment. When millions of dollars in funding were being directed to develop plans for a county-wide system of rail transit in Los Angeles, Marty was one of the few consistent voices raising questions about the wisdom of this spending and the opportunity cost of not using these resources for bus

transit, which he and others had shown to be both more effective and more cost-effective in the Southern California environment.

During the early 1990s, Professor Wachs' critiques of the expensive Los Angeles rail transit plans seemed like the metaphorical "voice in the wilderness" while so many public officials trumpeted the expected benefits of the ambitious system. Marty's conclusions about the cost-ineffectiveness of rail systems amidst Los Angeles' dispersed settlement patterns soon became an important force in the David-and-Goliath struggle between the advocates of transit equity and the board of directors of the richest transportation planning agency in the country. When any decent betting line in Las Vegas would have given million-to-one odds against the lawsuit by public-interest legal advocates, he worked carefully to ensure that the best research-based information was available to inform the debate. The consent decree that arose from the lawsuit moved transportation planning in Los Angeles County largely in the direction that the transit equity advocates were calling for.

The judicial system recognized the important contribution that Professor Wachs could continue to make when the special master overseeing the implementation of the consent decree asked Marty to advise him on the merits of the evidence and arguments that were being presented by the bus riders' union in the ongoing legal battles. At the end of the day, the political system also recognized the value of Professor Wachs' work when a new mayor appointed a new board of directors to the Los Angeles Metropolitan Transportation Agency. The new board and the new executive director implemented a landmark program to purchase additional buses and provide additional bus service to reduce overcrowding and improve travel times.

Professor Wachs' professional work has extended over many years through committees and collegiality in association with the Transportation Research Board (TRB), a division of the National Academy of Sciences. In the last decade, Marty has both chaired the Executive Committee of the TRB and also chaired several committees to produce important policy-oriented TRB Special Reports. One important example of these special reports was produced by the committee that conducted an evaluation of the efficacy of the U.S. Department of Transportation's Congestion Management and Air Quality (CMAQ) program.

The CMAQ program is a landmark federal program that, for the first time, dedicated transportation funding to programs and projects that had the goal of improving air quality in those areas of the country where public health was threatened by air pollution from automobiles and other mobile sources. For over a decade, members of Congress had debated whether the CMAQ program should be ended, extended, or expanded.

Struggling with a deadlock at the legislative level, Congress eventually mandated that an independent expert committee convened by the TRB assess the program.

The TRB report from the committee chaired by Professor Wachs looked carefully at the CMAQ program and examined the effectiveness of individual projects and programs that ranged from traffic signal improvements to bicycle lanes and engine retrofits. The TRB report found that, while many individual projects were effective in improving the transportation system while improving air quality, the overall CMAQ program was so broad and diverse that no clear conclusions could be scientifically drawn about the overall efficacy of the program. As a result, Marty's stewardship on the TRB committee successfully steered the work between the shoals of too much political interference and the rocks of policy irrelevance. The CMAQ program was reauthorized by Congress with some improvements.

In more recent years, Marty has been one of the most consistent public voices for strengthening the role of user fees in the financing and improvement of the transportation system. Informing the debates on federal transportation legislation and discussions of alternatives for financing transportation improvements at the state level, Professor Wachs' "Ten Reasons to Raise the Gasoline Tax" is perhaps the most clear and concise set of arguments made to policy makers about the need to rebuild the deteriorating system of pay-as-you-go fuel taxes. Marty's reasoning is consistently based upon good principles, such as linking the financing of the transportation system to the direct beneficiaries of the system.

As many students of Professor Martin Wachs will recall from their classroom experience with him, his advocacy of transportation user fees and other transportation planning ideas were examples of how he consistently worked to balance effectiveness with fairness. Perhaps this idea of balancing effectiveness with fairness is one of Martin Wachs' most important legacies in the field of transportation planning and policy.

Lewison Lem (PhD, UCLA, 1996) has been a visiting scholar at the University of California Transportation Center from 2006-2007. His consulting work currently focuses on transportation, energy, and climate change issues, primarily through the Center for Climate Strategies. He has held several transportation policy positions at the AAA of Northern California, Nevada, and Utah, the United States Environmental Protection Agency (USEPA) Office of Policy, and the United States Government Accountability Office. (USGAO).

BOOK REVIEW**Sprawl: A Compact History****by Robert Bruegmann****University of Chicago Press, 2005, 301 pages**

Reviewed by Jason Alexander Hayter

Search a well-stocked library or bookstore for works on urban form and you might reach the same conclusion drawn by Robert Bruegmann: “Most of what has been written about sprawl to date has been written about complaints” (p. 3). But what separates Bruegmann, a professor of art history, architecture, and urban planning at the University of Illinois at Chicago, from most people is what he does next. “[S]o many ‘right-minded’ people were so vociferous on the subject that I began to suspect that there must be something suspicious about the argument itself” (p. 8). The result of this questioning is a work lauded by Alexander Garvin on the book’s jacket as no less than “the most important book on the American landscape since Jane Jacobs’ *The Death and Life of Great American Cities*”. This surprisingly ebullient endorsement from one of the most public personalities in city planning should make us all take notice.

In *Sprawl: A Compact History*, Bruegmann presents a history, not of suburbia, but of, as the title indicates, *sprawl*, which he defines as “low-density, scattered, urban development without systematic large-scale or regional public land-use planning” (p. 18). Divided into three major sections, the book delineates the history of sprawl, the history of campaigns against sprawl, and the history of proposed solutions to sprawl. Bruegmann does all of this while presenting *sprawl* as a non-pejorative term, part of a “process that affects every part of the metropolitan area” (p. 9). In choosing this ideological tack, and in presenting the history of sprawl together with the cultural and policy responses it has evoked, Bruegmann has created a unique, if somewhat flawed, work of considerable educational utility.

Bruegmann’s central contention is that sprawl is not an aberration in history, but the norm. Sprawl is not unique to a particular era, on a particular historical trajectory, nor the manifestation of a specific cultural value system. To those who claim that sprawl is a post-World War II phenomenon that has been growing ever worse since William Levitt began developing on Long Island, Bruegmann notes that Levittown was not particularly different from the late-nineteenth-century work of large Chicago developers such as Samuel Gross (p. 43). What’s more, despite the claims of critics, suburban lot sizes peaked in the 1950s (p. 5). To those who lament

that sprawl is inherently American, he asserts it is “only possible to call Americans anti-urban if one accepts a specific set of assumptions about urbanity” (p. 96). After all, that which we consider “urban” and that which is “suburban” is forever changing; yesterday’s “sprawl” is today’s Faubourg Saint Germain.

More importantly, Bruegmann asserts that from ancient Babylon to imperial Rome to Ming Dynasty China, high density was almost always “the great urban evil” which “the wealthiest and most powerful citizens found ways to escape” (p. 23). Today, “from Boston to Bangkok and from Buenos Aires to Berlin” dispersed development is occurring everywhere “where incomes have risen and there has been an active real estate market (p. 12). These factors — rising affluence combined with social and market freedom — are what allow for sprawl. Urban dwellers, regardless of geography, culture, or time, cause sprawl by merely seeking the options historically only afforded to the affluent (p. 109).

This leads to Bruegmann’s second key argument: “[W]herever and whenever a new class of people has been able to gain some of the privileges once exclusively enjoyed by an entrenched group, the chorus of complaints has suddenly swelled” (p. 116). If sprawl is caused by urban have-nots becoming haves, then anti-sprawl movements are caused by the haves growing outraged. Bruegmann asserts that while there is “no strong correlation between political affiliation and anti-sprawl,” there is such an affiliation of class (p. 163). When the “rush to the urban periphery” became a “mass movement” (p. 33), it was then one began to hear individuals such as Clough Williams-Ellis make criticisms “drenched in class resentment” (p. 118).

While Bruegmann makes these points well, throughout the book he also attempts to respond to virtually every factual and rhetorical arrow hurled at sprawl. In this task he falters at times. With certain issues, such as how rates of urbanization are calculated, he makes compelling arguments. But with other issues he slouches into the dismissive tone of those he condemns, giving, for example, the same short shrift to important arguments about redlining that he does to aesthetic rants about societal taste. More disappointingly, at other moments he counters overstatement with overstatement, making comments that fly in the face of on-the-ground evidence, such as asserting that exurban development is not a problem in the Southwest (p. 88).

While this work seeks to use the term “sprawl” in a non-ideological way, Bruegmann makes no claims of impartiality. Since the vast majority of literature on the topic of sprawl is against it, he states that “I am stressing instead the other side of the coin” (p. 11). Presenting argument and counterargument together is useful in theory, but in practice he unfortunately

creates multiple opportunities to pigeon-hole this work as a simple pro-sprawl tome. This book is too important to be dismissed in such a way.

Suburbs are not the counterpoint to the city anymore; statistically speaking, they are the city. According to some estimates, suburbs are home to 62 percent of metropolitan area populations.¹ Yet today the public debate on urban form often seems as if it was scripted fifty years ago, and the academy appears only capable of shaking its collective head in condescending disgust. *Sprawl* is not a deep historical work along the lines of Kenneth Jackson's *Crabgrass Frontier* or Robert Fishman's *Bourgeois Utopias*, nor does it claim to be. But Bruegmann brings fresh thinking to a topic that desperately needs it, and gives readers something that is woefully lacking on all sides of the debate: perspective. If eighteenth-century London is now considered an urban "golden age," he asks, is "it so inconceivable that in fifty years Los Angeles and Atlanta in the 1990s might not be seen in a similar way?" (p. 165). If Bruegmann's predictions for the future turn out to be true, this book may live up to the claims of Alexander Garvin.

¹ U.S. Census, "Population Trends in Metropolitan Areas and Central Cities: 1990 to 1998," taken from U.S. Census website: www.census.gov.

Jason Alexander Hayter is a doctoral candidate in the Department of City and Regional Planning at the University of California, Berkeley. His research areas include urban design, environmental planning, and cultural landscape studies. He is currently investigating North American high-rise districts.

BOOK REVIEW**Street Science: Community Knowledge and Environmental Health Justice****by Jason Corburn****MIT Press, 2005, 304 pages**

Reviewed by Duane De Witt

One hundred years after Jane Addams published her classic 1895 book *Hull House Maps and Papers*, another book that could become a classic for urban planning and public health disciplines has been published by Dr. Jason Corburn of Columbia University. His recent book *Street Science* has received positive reviews as Corburn has sought to “reconnect” or “recouple” the fields of public health and city planning. These fields of study grew into separate professions during the twentieth century. Now, in the twenty-first century, Corburn addresses the realization that “local knowledge” can be a helpful component of good contemporary city planning, just as it was one hundred years ago.

Corburn was a community organizer in Seattle who went on to obtain a Ph.D. in urban environmental planning from M.I.T. in 2002. *Street Science* grew out of his research in Brooklyn from 1996 to 2002 starting when he was a senior environmental planner with the New York City Department of Environmental Protection from 1996 to 1998. He was also a mediator for the Consensus Building Institute and dealt with environmental and public health disputes.

He uses the term “street science” to describe the combination of professional and local community knowledge as a means to seek solutions to environmental health issues. He accurately describes how there is a tension between technocratic professionals such as city planners, public health practitioners plus other public policy makers such as politicians, and the community residents who seek to be involved in the resolution of environmental health problems. He seeks “democratically robust problem solving” and makes recommendations for how community members and professional practitioners can cooperate successfully. The book details four distinctly different “street science episodes” as case studies to illustrate instances of environmental difficulties helped by community input of local knowledge.

In the introduction he briefly “situates” where these examples of street science took place, and are continuing to take place: the Greenpoint/Wil-

Williamsburg section of Brooklyn. Here he also defines street science as “a practice of knowledge production that embraces the co-production framework...and is also a process that builds on a number of existing participatory models of knowing and doing” (p. 8). He points out previous researchers have coined the term co-production in the field of science. He uses the term “to suggest that scientific knowledge and political order are interdependent and evolve jointly.”

Corburn describes community-based participatory research (CBPR) and participatory action research (PAR) before telling of the “science on the streets of Brooklyn.” He also mentions though there are a “plethora of hazards in the neighborhood, few public health studies have focused on Greenpoint/Williamsburg.” The environmental health controversies in Brooklyn he highlights are air pollution, asthma, childhood lead poisoning, and the risk of subsistence fishing from the contaminated East River. Each case is given a full chapter in the book and all of them are quite intriguing. They are also provocative in that they demonstrate how the current “technocratic” model of urban planning that weighs the “costs and benefits and informs policymaking” can sometimes be “captured” by private interest groups. He feels this is usually to the detriment of the greater community at large.

Corburn asserts that this situation can lead to potential conflicts with the public so there are times “the analysts or planners often decide that the tacit operating rule is that the best public is a quiescent one.” The first chapter of the book gives an historical account of how citizen-based groups from the past have risen up to question technocrats and experts over pollution and its effects on their communities. He explores the link between environmental justice and street science while pointing out “a fundamental aspect of environmental-health justice is the creation of a more democratic partnership between professionals and the public.” Corburn believes street science is a practice “of science, political inquiry, and action.” Due to the fact that street science evolves in a community, its social character is an important aspect of the concept.

With a democratic aspect to planning for environmental health, Corburn unabashedly seeks to reconnect urban planning and public health “around a social justice agenda.” His book is written in a prose that is accessible to lay people at the same time as it focuses on the highly technocratic world of city, state, and federal agencies dealing with the environmental health of a neighborhood. Though the neighborhood he has chosen is in a big city, the same scenarios play out across the nation in communities large and small.

The book serves as a clarion call to professionals in city planning, public health, and public policy making to reserve spaces at the public policy

bargaining table for members of the community and their local knowledge. As Corburn states, "Street Science offers a way for environmental-health decisions to draw from the best science has to offer while also upholding the democratic ideals of participation and justice."

Duane De Witt is a Master's candidate in the Department of City and Regional Planning and the Department of Landscape Architecture and Environmental Planning at the University of California, Berkeley. His current focus is on environmental planning, particularly brownfields revitalization. Topics of interest for future research include international environmental planning, urban forestry, transit-oriented development, and housing. Mr. De Witt is based in Santa Rosa, California.

BOOK REVIEW

New Urbanism and American Planning: The Conflict of Cultures

by Emily Talen

Routledge, 2005, 318 pages

Reviewed by Jason Alexander Hayter

New Urbanism is official. Not merely a transitory fashion or a conceptual aesthetic, the publishing of Emily Talen's work *New Urbanism & American Planning: The Conflict of Cultures* ensures that from now on even those critical of the hybridized, resurgent neo-traditionalism of the Congress for the New Urbanism will have to acknowledge them, just as the New Urbanists today have to acknowledge the *Congrès Internationaux d'Architecture Modern*. Talen, an Assistant Professor in the Department of Urban and Regional Planning at the University of Illinois, Urbana-Champaign, has created the type of book that can be found in the canon of every trend-turned-movement: a reframing of history which places the ideology of the converted at the end of the tale. Yet, while New Urbanist writers may have a well earned reputation for placing polemics over research and romance over history, in this book Talen makes a considerable contribution to the field of planning — regardless of what one thinks of Seaside, Florida. The reason for this has to do with the scope of her subject, which is not New Urbanism but rather *American* urbanism, and in framing the topic this way the author grants herself ample intellectual room to explore.

Talen begins pragmatically by framing American urbanism as "the vision and the quest to achieve the best possible human settlement . . . within the context of certain established principles" (p. 2). But she quickly asserts that there is "an American teleology when it comes to urbanism" that elevates these "urbanist proposals from mere utopian dreaming into something more substantial" (p. 5). In examining this national teleology she categorizes American urbanism into four "planning cultures": "Incrementalism," which originates with the settlement house movement, but includes Camillo Sitte, William Whyte, Jane Jacobs, and Christopher Alexander (p. 18); "Urban plan-making," which contains the more comprehensive visions embodied by the City Beautiful and City Efficient movements and their associated metropolitanism (p. 19); "Planned communities," which includes "utopian and quasi-utopian ideas," from Ebenezer Howard to Frank Lloyd Wright, about how cities and societies function (p. 19); and, lastly, "Region-

alism," which addresses settlements in their "natural regional context" and draws on works from Patrick Geddes to Ian McHarg (p. 19).

American urbanism, Talen feels, "can be interpreted as a project that needs to reconcile these cultures" (p. 35). This viewpoint leads to an investigation that is integrative and synthesizing, that deconstructs prominent ideologies and important settlement forms that are usually dealt with as conceptual monoliths and reconstructs new ideas from their component parts. She finds some good in the patterns of planned communities, fault in some of the writings of Jane Jacobs, and breaks down careers of individuals such as Charles Mulford Robinson into different eras that cross categories. The result is an often compelling rethinking of otherwise standard planning history.

This is still, however, the work of a committed New Urbanist, with a foreword from no less than Andrés Duany. Of course being a philosophical partisan does not automatically negate one's ability to write authoritatively. Lewis Mumford, after all, was a fierce ideologue with a singular vision and membership in an equally vociferous organization — the Regional Planning Association of America — who still uplifted the whole of American letters with *The City in History*. Talen's adherence to New Urbanist principles is at times a benefit, but in other instances it leads her to stumble, and in one key instance, to fall.

Talen's general definition of urbanism — "human settlement that is guided by principles of diversity, connectivity, mix, equity, and the importance of public space" — shows her partisan credentials (p. 37). But in her application of this ideal to planned communities, regionalist principles, and garden cities — often while directly questioning the writings of luminaries such as Mumford and Jacobs — Talen surprisingly expands classic urbanism into realms still ignored by even the harshest critics of New Urbanism. In her discussion of those things which work against urbanism, though, Talen occasionally lets doctrine affect her line of argument. Her commentary on zoning is practically devoid of acknowledgement of the important concerns of public health and property protection, as if all zoning ever did was separate retail from housing. But, this slight at a key tool of professional planning is minor. Talen's discussion of Modernism, however, is another story.

If Talen works to expand the application of the ideals of urbanism, she also works to drastically narrow concepts of "anti-urbanism." She explicitly defines it as the "tendency toward separation, segregation, planning by monolithic elements ... and the neglect of equity, place, the public realm, historical structure and human scale of urban form" (p. 37). Central in her mind is modernist urbanism, which she unwaveringly excoriates as "the near embodiment of anti-urbanism" (p. 38). To Talen this movement did

nothing more than leave a “deleterious mark on American places” and is now the “exemplar of anti-urbanism” (p. 38). In fact, at times the author is so vehement, and so vitriolic, in her condemnation of the usual modernist suspects that she allows her ideology to drown out any appearance of concern for factual exploration.

All told, *New Urbanism & American Planning* is a work that can be at turns enlightening and infuriating. But Talen’s integrative, thoughtful approach to the broad, disparate field of planning history more than makes up for her anti-modernist fervor. What’s more, this work addresses the importance of the physical realm at a point in time when the planning profession seems to have moved as far away from urban design as possible. Most importantly, though, her work expresses a refreshing hopefulness, and argues for the importance of optimism in creating a better future. She rightfully notes how the “inability to pull something together out of the rich history of American urbanism has been damaging to a profession like city planning” (p. 277). Yet, the “innate appeal of an emerging American urbanism,” Talen asserts, “will ultimately find the power to turn things around” (p.117). No matter what the future may hold for New Urbanism, anyone who believes in the role of planning in the world can only hope that she is right.

Jason Alexander Hayter is a doctoral candidate in the Department of City and Regional Planning at the University of California, Berkeley. His research areas include urban design, environmental planning, and cultural landscape studies. He is currently investigating North American high-rise districts.

RECENT DOCTORAL DISSERTATIONS**Local Government Roles in Water Conservation****by Caitlin Dyckman****Fall 2005****Abstract**

This dissertation focuses on the roles of local government in successfully mandating and implementing water conservation mechanisms. While water supply planning has been the traditional purview of water districts in many states and countries, a number of factors are converging to thrust water supply responsibility on local government. This research explores the following questions: (1) what role(s) have local governments effectively assumed in encouraging and/or causing water conservation within their jurisdictions? (2) How have local governments applied conservation to existing homeowners and how have homeowner associations impeded or assisted these efforts? (3) What effects do a household's landscape aesthetic, conservation knowledge, positions on market versus regulation, and environmental beliefs have on household water consumption levels? (4) What are the implications of current planning practices with respect to water conservation and where should there be improvements?

To answer these questions, the dissertation employs an economic and legal literature review; key informant interviews with planners, homeowner association boards, water districts, and developers in the case study areas of Santa Rosa, CA, the Irvine Ranch Water District service area and the Long Island Pine Barrens in New York; and an individual household-level survey administered in Santa Rosa, CA combined with associated household water consumption data. The research reveals that planners are playing an increasingly important role in water conservation because planning has the tools to both incentivize and to require water conservation as part of ongoing land use regulation.

Water conservation is being encouraged through an integrated program of semi-permanent water conserving hardware and fixtures, lot size constraints, and landscape designs that minimize outdoor water use. The individual choice to conserve is influenced by landscape aesthetic ("lawn lust"), income, demographics, the homeowner's ethics, and whether the home is part of a homeowners association. Well-crafted plans and ordinances can integrate measures and strategies in locally-appropriate amalgamations that allow planners to guide their communities toward a healthy future despite water constraint. It is recommended that future planning efforts

integrate public education, incentives and regulations with a particular focus on outdoor water use and conservation options.

The Effects of Teleshopping on Travel Behavior and Urban Form

by Christopher Ferrell

Fall 2005

Abstract

This dissertation employs structural equation modeling (SEM) techniques to explore the tradeoffs people make when engaging in teleshopping activities from home. Using the Bay Area Travel Survey (BATS) 2000 this dissertation performs an activities analysis to investigate these relationships. Time use variables are included that predict the amount of time each individual spends during the day on work, maintenance, discretionary, and shopping activities, both in and outside of the home. These activities are used to predict the amount of shopping travel each person undertook. Results suggest that people substitute home teleshopping time for shopping travel time, and teleshoppers take fewer shopping trips and travel shorter total distances for shopping purposes. However, these effects are mainly “indirect” and appear to be mediated through two time-use variables – In-Home Maintenance and In-Home Discretionary activities. Home teleshoppers tended to spend more time on In-Home Maintenance and less on In-Home Discretionary activities than non-home teleshoppers.

Variables constructed to represent the degree to which people are “time-starved” from the demands of their work and maintenance activities revealed that female heads of households tend to home teleshop more, make more shopping trips and shopping trip chains, shop out-of-home more, and shop travel for longer periods than the rest of the survey population. A variable constructed to measure each survey participant household’s accessibility to shopping opportunities suggests that people who live in high retail accessibility areas tend to home teleshop slightly (but statistically significantly) more, take more shop trips, make more shop trip chains, and travel shorter total distances for shopping purposes than those who live in lower accessibility neighborhoods.

These results suggest that home teleshopping is primarily used as a tool to restructure a person’s daily activities participation, which in turn, restructures a person’s shop travel behavior. The degree to which someone is time-starved – particularly, female head of households – appears to play a role in determining the propensity to home teleshop as does a person’s

relative accessibility to retail opportunities. While confirmatory analysis is necessary, these results suggest that activity-based travel demand models would benefit from the inclusion of home teleshopping, time-starved, and retail accessibility variables.

The Making and Un-Making of the San Francisco–Oakland Bay Bridge: A Case in Megaproject Planning and Decisionmaking

by Karen Frick
Fall 2005

Abstract

After over a decade of debate, construction of the San Francisco–Oakland Bay Bridge’s eastern span finally began in 2002 at a current approximate cost estimate of \$6 billion. The intense and controversial debate ranged from whether the bridge should be seismically retrofitted or replaced, how it should be designed, where it should be located, and how it should be funded. Decisions on these issues provided fertile ground for a highly contested process as public agencies at every level of government and mobilized groups and citizens participated and significantly altered the decisionmaking process. The design process also signified a fundamental change in how state and regional agencies plan and manage projects of this magnitude. This dissertation provides a detailed history and analysis of the new span’s state and regional decisionmaking processes.

To guide this case study of a major transportation infrastructure project (also known as a “megaproject”), the research questions addressed are: What are the key characteristics and issues of debate for a major infrastructure project, such as the new Bay Bridge, and how do these impact policy decisions and project outcomes? These questions were designed to set the Bay Bridge case within a larger theoretical context while at the same time allowing the analysis to be of practical interest. This research contributes to the literature by knitting together the themes of megaproject planning, problem definition, agenda setting and policy implementation, as well as the “technological sublime,” which details how large scale projects capture the public’s attention and imagination. For the analysis, a megaproject typology and a conceptual framework focusing on megaproject characteristics and results are developed and applied to the Bay Bridge case. Lastly, several recurring themes throughout the bridge’s development process are examined, including substantial conflicts over the project’s purpose and definition; varying perceptions of crisis; and, disputes over accountability for cost overruns and delay that impeded the project’s implementation.

Low-Income Communities in the Information Age: Technology, Development and Community Practice

by Blanca Gordo

Fall 2005

Abstract

The digital divide reflects the difference between institutional-level Websites and the individual-level exclusions from opportunities to participate, compete and prosper in today's knowledge-based economies. As the ability to manipulate this information technology becomes more crucial, the negative result for those excluded is digital destitution. More solid theoretical frameworks and socio-economic metrics are needed to assess the effects of the digital divide and civic interventions for public policy. Special attention is given to the collective organization of community technology agents, which seek to support public access to modern social and technical infrastructures as a safety net to ensure competence and fairness. This is an empirical in-depth case study about the strategy, work process and governance structure of the "Plugged In" experiment in the poorest part of the Silicon Valley—a model for development with public and private funding support. The public services that it provides are aimed at low-income communities at the grassroots level in East Palo Alto, an urban pocket of poverty in the region. This project works towards preparing populations to meet social and market demand within a high technology metropolis. Innovative programs afford these users the opportunity to experiment and develop expertise to overcome conditions of poverty and inequality. A culture of innovation is one factor that contributes to the community-based organization's success in attaining funds despite high levels of competition and uncertainty. Reciprocal network relations are critical when resources are few.

This dissertation discusses and interrelated problem with three topic areas: 1) A new form and process of inequality begins in digital destitution caused by technology disparity, and seen in unequal ownership rates in society, which arise with the integration of network technology into the productive functions of society in the knowledge economy; 2) The type of community-level strategies underway and their specific roles in addressing the "digital divide"; 3) One community-level governance structure which has the potential to sustain efforts that address and may reverse the negative externality of this social problem.

The thesis posits that the community technology development agency is able to create a complex set of technology based social services, designed to support the development goals of the community it serves, through an

innovative and organized collective of agents for positive social change. The Plugged In experiment maintains its competitive edge and advances under economic recession that runs alongside institutional crisis because it employs a cycle of innovation that continuously refines community technology development programs that meet economic and social demand of end users. This strategic network partnership, whose work process and productive relations are sustained by technology related efficiency, across space, is maintained by a shared culture of innovation, collaboration, reciprocity and flexibility.

The contribution of this study is the drawing of a theoretical framework with concepts for socio-economic metrics that can lead to the collection of information data by institutions to help assess the effects of public policy programs and in so doing, refine social systems of public intervention.

A Case Study of Pedestrian Space Networks in Two Traditional Urban Neighborhoods, Copenhagen, Denmark

**by Neil Hrushowy
Spring 2006**

Abstract

Most pedestrian environment and behavior research has applied concepts of connectivity and access uniformly at the neighborhood scale. Actual pedestrian networks rely on a limited number of routes to provide intra- and inter-neighborhood pedestrian connections, suggesting the need to focus research. Also, much of the literature has proposed improvements to the built environment that have little relation to the planning system's ability to implement them.

This research aims to assess the applicability of a network approach to pedestrian planning. It includes two case studies of comparable neighborhoods in Copenhagen, Denmark. One neighborhood has a robust pedestrian space network rich with choice, while the other has a fragmented network that limits pedestrian route choice.

A randomized survey of 600 households collected data on walking behavior and perceptions of the pedestrian environment. Also, 17 in-person interviews were conducted with residents to understand how attitudes and pedestrian opportunities influenced walking behavior.

This research also explored the role of Copenhagen's political culture of planning in building and maintaining robust pedestrian space networks. The theme of state-market balance of power and its relevance to pedestrian

policy implementation was explored through over 20 interviews with planners, politicians and private developers, as well as a detailed study of planning documents.

Survey results found that residents living in a robust pedestrian space network walked to a greater number of local destinations and a broader range of destination types. The relationship held for optional trips to social destinations. Residents living in a more robust pedestrian environment had a larger social network, suggesting neighborhood design can influence social interaction.

The in-person interviews illustrated how residents chose routes through their neighborhood, what constituted a barrier to pedestrian movement, and how social barriers affected the desirability of destinations that seemingly meet standard urban design criteria.

The political culture research demonstrated that economic constraints place stress on any planning system. A planning system that enjoys consistent political and financial support from elected officials, however, was found to have a superior ability to respond to collective challenges and develop innovative solutions. Further, the enhanced ability to implement policy appears associated with a more reflective approach to planning that encourages planners to enhance their skills and knowledge over time.

Great Neighborhoods: The Livability and Morphology of High Density Neighborhoods in Urban North America

by Michael Larice

Fall 2005

Abstract

Alongside sustainability, the concept of livability is one of the driving visions of early 21st Century city planning. The term is widely used in practice but lacks convergence on a single definition due to its relativistic nature and its use as an ensemble concept that aggregates a variety of ideas about place-based quality of life. This dissertation explores the concept of livability through a grounded theory approach to use of the term in practice. Further than theory creation, grounded theory was useful in identifying definitional attributes, which could then be operationalized as a method of assessing the livability and morphology of neighborhoods in the United States and Canada. After thematic coding of historic, academic, theoretical and practical literature on the topic of urban livability, a set of definitional attributes was determined that could then be used to

focus attention on local challenges in improving livability in dense urban neighborhoods. These livability attributes included: sufficient density to support services, walkability, balanced transportation modes, mixed land uses, housing choice and affordability, well-programmed leisure space amenities, a sense of place, and a locally relevant means for addressing neighborhood challenges and threats. The research adopted a place-based approach in assessing unique neighborhood contexts, and found that issues of everyday life and the functioning of place for diverse needs are at the heart of livability practice.

Comparative multi-case study work was undertaken to test the operationalization of these livability attributes. Analyzing urban gross densities longitudinally from 1940-2000 in the 50 most populous cities in the US, and GIS mapping the distribution of housing densities from the 1990 census helped in the identification of case study neighborhoods. After scoping possible cases, twelve dense neighborhoods were selected and grouped historically into two groups of six: traditional neighborhoods that were initially developed prior to the introduction of land use planning, and planning-era neighborhoods of the 20th Century. Each neighborhood was selected for its ability to offer various livability lessons, but also as an example of regional, temporal and morphological difference. A number of general research findings came forth, suggesting the value of history in shaping neighborhoods and the numerous ways that livability can be achieved. Most of the neighborhoods were able to meet a great number of livability attributes. Neighborhoods perceived to be less livable offered more limited choice in housing, retail, transportation and leisure space amenities – or conversely were not able to meet physical, social and economic challenges that threatened, or made vulnerable, everyday life practices. The research suggests that livability in contexts of high-density housing could be reached through a variety of urban form models, and that the eight defined livability attributes were a useful method of focusing attention on local neighborhood livability and everyday life needs.

Cluster Adaptability Across Sector and Border: The Case of Taiwan's Information Technology Industry

by Chuan-Kai Lee
Spring 2006

Abstract

The dissertation explores the adaptability of Taiwan's IT industry in the transformation from the personal computer sector to the handset sector and the transplantation from Taiwan to the Yangtze River Delta region (YRD),

China. It proposes a systematic approach from the bottom-up perspective, which on the one hand transcends the limited scope of existing approaches offered to explain Taiwan's late development, and on the other hand, rejects the rigid framework of the global production network (GPN) approach that is flagship-centric, exogenously-driven, market-oriented and power-static, with the intention of embracing the multi-faceted dimensions of the processes involved in the transformation and transplantation of Taiwan's decentralized industrial system.

Based on two fieldwork trips in both Taiwan and the YRD region in which more than sixty interviews were conducted, this dissertation has three main findings.

First, at the systematic level, the adaptability of Taiwan's IT industry came from the multiplicity of coordination mechanisms embedded in the industrial system, which provided interconnected and interdependent actors in this system with a variety of ways to respond flexibly and collaboratively to technological, organizational and geographical change. The restructuring of the handset global production networks (GPN) set up a backdrop for the flexible adaptation of Taiwan's IT industry to take place. By way of decentralized collaboration, Taiwan's IT industry not only built up capabilities rapidly around handset manufacturing by grasping opportunities in the value chain, but also was able to upgrade rapidly by taking advantage of tensions in the structure.

Second, at the sectoral level, the decentralized collaboration was at work simultaneously at three different scales. At the global scale, it was a structural coupling between the handset GPN and Taiwan's PC industrial system that triggered the transformation. Although due to different sectoral characteristics, there were substantial differences between these two systems, and the interactive process has had mixed results. At the cluster level, three coordination mechanisms were in play to facilitate the adaptation. First, the intra-and inter-firm networks allowed firms to redirect and reorganize resources and capabilities within and outside the firm boundary. Second, the state offered a helping hand in supporting the transition through state-funded R&D projects, talent training and the improvement of the economic infrastructure. Third, the technical community acted as a vehicle for brain circulation across sector and border. At the firm level, the emphasis was mainly put on the learning process, in which five channels were used alternately: technology transfer, merge and acquisition, reverse engineering, training programs, and scaling up. Although these are strategies common to firms all over the world, however, due to rapid brain circulation, the knowledge and expertise had been diffused among all major players within only a few years.

Third, at the spatial level, the decentralized collaboration was at work in the process of mutual institutional building. The ecological fit between Taiwan and Suzhou should be regarded as a collaborative initiative jointly promoted by both parties rather than an imperative driven by exogenous force or by local state activism only. In this process, the relationship between the Taiwanese managerial communities and Chinese local cadres was most worthy of investigation because these two groups of actors were indeed the “visible hands” behind the transplantation. The close collaboration between Taiwanese firms and Chinese local states explained why Taiwan was so successful in tapping into Chinese local resources where Taiwanese investment was prominent, not only in scale but also in scope.

Children’s Travel: Patterns and Influences

by Noreen McDonald
Spring 2005

Abstract

Childhood obesity has doubled in the last thirty years. At the same time, youth travel patterns have changed greatly. In 1969 42% of students walked or biked to school; now 13% do. These two trends have caught the attention of policymakers who have identified walking to school as a way to reintroduce physical activity into children’s lives. However, these policies have been made without much knowledge of children’s travel – an area which has been understudied by transportation researchers. This dissertation seeks to fill this knowledge gap and provide information to design better policies by asking three questions: 1) What are the current patterns of children’s travel? 2) What factors have the greatest influence on children’s mode choice for school trips, particularly for walk trips? and 3) How can land use planning affect walking to school?

All analyses identify the spatial distribution of students and schools as the primary reason for the low rates of walking to school. For example, in 1969 45% of elementary school students lived less than a mile from their school; today fewer than 24% live within this distance. The simple fact is that most children do not live within a walkable distance of their schools. When children do live close to school, substantial numbers walk. However, current policies aimed at increasing walking to school focus on improving trip safety rather than changing distance to school.

To encourage large numbers of children to walk to school, planners will need to coordinate land use and school planning. Including children’s distance from school as a planning criterion could be an effective way to change community design and encourage walking. This coordination is

most necessary in moderate and high density areas where neighborhood schools are a possibility. However, even in low-density areas, planners can optimize school and housing placement so that a large portion of students live within a walkable distance of their school.

Doing Well by Doing Good: The Case of Interface and its Journey Towards Sustainability

by Peter Melhus
Fall 2005

Abstract

Organizational decision-making literature tells us that profit maximization is such a predominant factor influencing decisions within for-profit organizations that it would be difficult, even if theoretically possible, to integrate into the organization a long-term environmental sustainability ethic.

In this dissertation I study Interface, Inc., a \$900 million, publicly traded manufacturer of broadloom and carpet tile for commercial buildings. I present a case that demonstrates that Interface has internalized an environmental sustainability ethic and I illustrate how it was done. The means by which Interface instituted this organizational cultural change may serve as an exemplar for other organizations.

My methodology was a combination of exploratory and explanatory. I interviewed key people involved in the decision-making process within Interface and supplemented this with my own observations of the decision making processes. I reviewed official company records, such as training manuals, performance review programs and compensation packages. Along with publicly available financial materials I used this information to analyze and explicate the extent to which the economic and non-economic factors identified in the academic literature explain the decisions made.

I studied the scholarly-described economic and non-economic influences on Interface's decision makers. Economic influences include direct cost-benefit of projects and individualized financial incentives, such as salary and incentive pay. Non-economic influences include the mission, culture and history of the organization, clarity of goals and their internal translations, the way things 'really work,' the rigor and frequency of performance reviews, and so on. I ascertained that decision-makers were sufficiently compelled by non-economic influences to make decisions that might result in lower personal economic returns.

I conclude that the combination of leadership, vision and internal incentive systems, supplemented by the development and maintenance of a corporate culture that supports the simultaneous consideration in decision-making of environmental sustainability and profitability, has enabled Interface to achieve an organization in which environmental and financial influences on decision-making are at parity. Like employees in other for-profit organizations, Interface's associates are expected to make money for the company. But they are expected to do more. They are also expected to deliver environmental returns on investment in conjunction with financial returns.

Multinational Research and Development Labs in China: Local and Global Innovation

by Xiaohong Quan
Fall 2005

Abstract

Multinational corporations (MNCs) began to locate research and development (R&D) in developing countries like China and India in the 1990s. This thesis, which focuses on the location of MNC R&D labs in Beijing, documents an emerging spatial division of labor in R&D based on the increasing specialization of R&D activities.

A 2004 survey of MNC R&D labs in information technology industries in Beijing found that these MNC R&D labs are not just providing technical support, product localization, or product development for the local market; rather, they are increasingly innovating for the global market. Considering MNCs' concerns about weak intellectual property right (IPR) protection in China, this study suggests that a 'hierarchical modular R&D structure' can be an effective way for MNC R&D labs to protect their IP in weak IPR regime countries. This 'hierarchy' includes 'core R&D' and 'peripheral R&D', based on two dimensions—technology value-added, desire and ease of IP protection. While 'core R&D' is mostly done in developed countries, 'peripheral R&D' is conducted in developing countries. My study suggests that this hierarchical modular R&D structure facilitates the global configuration of MNC R&D labs.

At the regional level, this thesis provides in-depth analysis of the interaction between MNC R&D labs and local innovation actors in Beijing. It appears from my interviews and surveys that direct forms of technology transfer and spillover are limited; however, institutional learning by local firms and universities contributes to local innovation capability in the long

term. Furthermore, technologies on core components and system architecture are crucial for any region's technology advancement; however, my analysis shows most local Chinese firms do not possess such knowledge. Based on my research, it is also clear that MNCs establish R&D labs in China specifically for local resources, especially low cost R&D labor, not for the 'thickness' of local institutions. In-depth case studies are presented, and strategic suggestions for MNC management and host countries are recommended.

Location Choices of California Businesses and Households during the 1990s

by Michael Kaston Reilly
Fall 2005

Abstract

During the 1990s, the pattern of urban development in California was the result of varied household and firm location choices. This research highlights the factors that drove spatial choices for particular subsets of the state's diverse population and economy. The dissertation consists of three parts: the growth of employment centers, the residential location choices of households, and the overall pattern of residential density change resulting from new development.

The first section examines the spatial dynamics of business establishments in the state's largest metropolitan areas with an emphasis on estimating net agglomerative and congestion effects for particular industries. The dependent variable is either a static count of business establishments at an employment location or the change in the count of establishments at a location. Poisson regression is used to model these counts for subsets of establishments expected to demonstrate similar spatial strategies as a function of regional and local agglomerative/congestion effects and subcenter characteristics. As expected, the agglomerative variables were generally strongest for businesses emphasizing face-to-face contact and weakest for population-serving businesses.

The second portion of the dissertation investigates the residential behavior of the state's varied sub-populations. California's major metropolitan areas are divided into four Urban Morphological Types (UMTs) based on their regional location, employment density, and housing age: central city, inner suburb, outer suburb, and exurb. Multinomial logit models of choice of UMT and nested multinomial logit models of choice of a Public-Use Micro-

Sample Area and UMT are fit for each major ethnic group. Some trends held for all ethnic groups while others varied in direction or intensity.

The final section of the dissertation combines insights from the earlier work to build a tractable cell-based urban modeling system for the entire state. Upward changes in housing unit density class are modeled using the multinomial logit model as a function of physical, accessibility, socio-demographic, and land supply factors. While the first two sections provide deeper insight into the spatial dynamics of California's metropolitan areas, the final section provides a useful tool for modeling very large regions with limited information while retaining the fundamental dynamics of urbanization.

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Volume 21, Summer 2008

Contrast and Inequality in the Californias Contrastes y Desigualdades entre las Californias

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During the sixteenth century, a popular Spanish romance novel told the story of California as an island of Amazon women ruled by a queen named Califia. More recently, the image of California as an island has returned. Fears that the state will break off from the mainland of the United States are often linked to sensationalist depictions of a nightmarish urban future of California, as in John Carpenter's 1996 movie, *Escape from L.A.* In many ways, the two ideas of California as an island are appropriate metaphors for the myths and the problems of the Californias, where contrasts abound and reality can be stranger than fiction.

The 21st volume of the Berkeley Planning Journal will explore the contrasts of the Californias through papers that examine inequality, growth, innovation, transnationalism, migration, multiculturalism and the US/Mexico border. We define the Californias as the three states that bear the name, including Baja California Norte and Baja California Sur. We invite abstract submissions for a special bilingual edition of the Berkeley Planning Journal, in which all articles will appear in both Spanish and English. A timeline for abstract and paper submission deadlines will be made available on the website of the Berkeley Planning Journal shortly.

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