Predicting the Impact of Demand- and Supply-Side Measures on Bus Ridership in Putrajaya, Malaysia

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Abstract

Putrajaya is a unique Malaysian city from a transport policy perspective because of its explicit goal to achieve a 70 percent share of public transport to its core precincts. A study was recently commissioned with the aim of quantifying travelers' responses to policy measures to ensure effective strategy formulation. This article describes and discusses the methods, results, and policy implications of the study. Econometric estimation results show that improvement in public transport alone is incapable of inducing sufficient modal shift to achieve the goal of a 70:30 split between public and private transport. Although service quality positively influences ridership, modal split is generally not very sensitive to variation in the quality of public transport service. Thus, demand management measures appear to be indispensable as a policy tool to reduce dependence on private transport.

Introduction

Malaysia's new federal administrative capital of Putrajaya[1] is a unique Malaysian city from a transport policy perspective due to its explicit policy goal to achieve a

70 percent share of all travels by public transport to its core precincts (Putrajaya 1997). No other city in Malaysia has a target for transportation modal split, let alone a target to make public transport the overwhelmingly dominant form of transportation. The task confronting the city authority, however, appears insurmountable because this goal entails a reversal of the current modal split of 15:85 between public and private transport. Factors contributing to the domination of private transport as the preferred mode of travel in Putrajaya include the provision of a high quality road network with generous road space, the availability of ample parking spaces provided free of charge, and the generally modest cost of owning and operating private vehicles. In addition, poor public transport services further encourage the use of private vehicles.

In its effort to achieve the desired modal split, the city authority has been contemplating the implementation of two broad measures, namely, improving public transport service and imposing penalties on private vehicle travels. To ensure effective strategy formulation, a study was commissioned to model users' travel behaviors with the goal of quantifying their response to a proposal for public transport improvements and demand-restraining measures. Subsidizing public transport services is one of the options the authority is willing to consider to improve service level. Examples of potential demand-restraining measures include the introduction of road pricing schemes for private vehicle travels, a restrictive parking policy that combines limitation on the amount of parking spaces with high charge rates, and private vehicle ownership restriction by ownership tax. Some of these measures have been implemented rather successfully in London, Singapore, and several other European cities.

This article first provides an overview of the public transport system in Putrajaya and then proceeds to discuss the methods that have been adopted in the study, the results of the econometric estimation and simulation of the mode choice models, and the policy implication of the various findings.

Overview of Existing Public Transport Services

Currently, intercity public transport services in Putrajaya are served by several bus companies, which carry passengers from Kuala Lumpur and major towns in the surrounding areas. Three private bus operators serve these external routes, while another private bus company operates intracity bus services, ferrying passengers within Putrajaya. Several contract buses, mostly transporting government ser-

vants working in Putrajaya from towns located at the outskirts of the city, are also in operation. Besides buses, the track-based KLIA Transit provides rail transport services that link KL Sentral in Kuala Lumpur and the Kuala Lumpur International Airport. Figure 1 provides a general overview of the major bus routes and highways in Putrajaya.

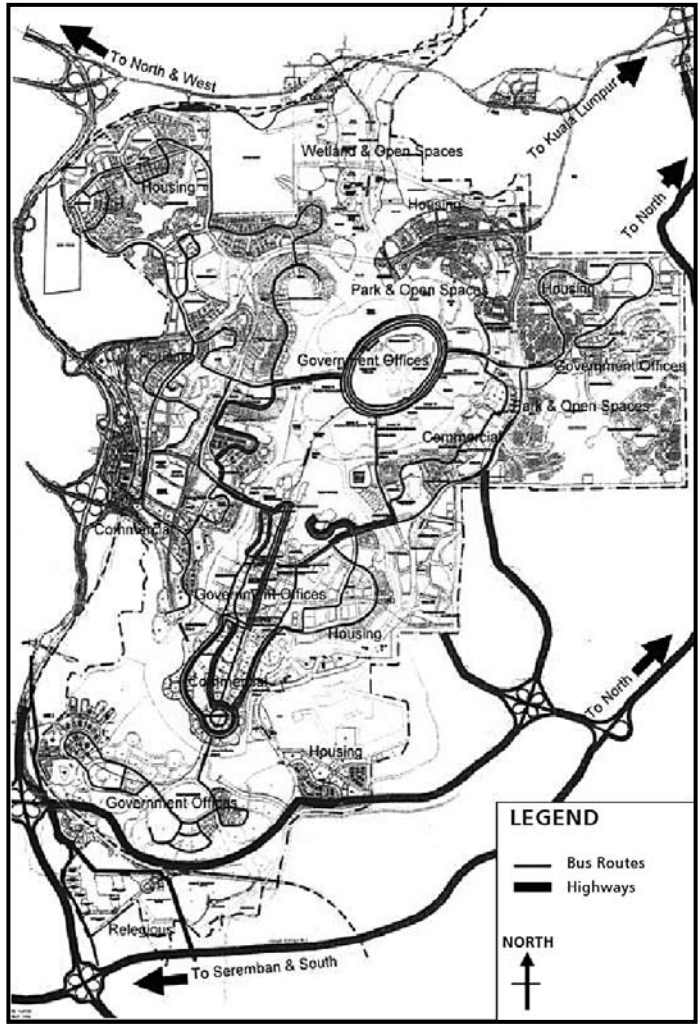

Figure 1. Major Bus Routes and Highways in Putrajaya, Malaysia

The existing public transport system lacks choice, quality, and availability. The intracity bus company operates only 14 buses to transport passengers from residential areas in the periphery to offices and commercial centers in the core area. Generally, these buses have poor service frequency with an average of 2 per hour, even during the morning and afternoon peak periods. The buses are of standard high-floor design with no provision for the disabled and elderly. With limited rolling stock, bus service has also been unreliable. Intercity rail services are provided by the Express Rail System (ERL) and the Keretapi Tanah Melayu Berhad (KTMB) rail commuter system. However, both systems can at best be described as inadequate. For example, the KLIA Transit service provided by the ERL stops at a station quite far from the city center, forcing passengers to take transfer bus rides.

Survey Methodology

The study adopted the stated preference (SP) survey method to solicit the required information to model mode choice behavior. Using elasticities obtained from studies using actual market (revealed preference) data is another option that can be considered. In the course of designing the study methodology, the SP method was deemed preferable for two main reasons.

First, although revealed preference estimates are based on real conditions in which individuals consider the internal costs, benefits, and consequences of their choices, the major weakness of the method is its reliance on historical data. This reliance poses one major difficulty to the current study. Increasing public transport ridership from 15 to 70 percent is expected to require a change in traveling cost and/or service level so substantial that its goes beyond the range of historical experience observed in previous revealed preference studies. The question becomes whether the estimates of the impact on ridership based on relatively small variations in costs and service levels found in these studies is reliable. SP surveys, on the other hand, can be designed to allow for estimation of behavior beyond the range of historical experience.

The second major reason for selecting the SP method is that reliable studies on fare, service, and cross elasticities from the developing or third-world settings are rare. Most elasticity estimates are obtained from studies conducted in the developed countries (see Litman 2005 for an excellent review). Of those studies conducted in developing countries, all were devoted mainly to determining the response of ridership to increase in public transport fare or travel cost. By and

large, it is also fair to argue that these studies (some of which are reviewed by Oum et al. 1992) tend to be outdated.

Despite the above-mentioned advantages, the SP method is known to suffer from several weaknesses. Chief among them is that the approach is not based on the actual market, so respondents may be providing hypothetical answers to hypothetical questions and would not actually behave in the manner stated in the experiment. In many cases, hypothetical choices may not reflect budget and other constraints on behavior. Multi-attribute choice tasks might also place a cognitive burden on interviewees since there is a limit to how much information they can process while making a choice. This, in turn, will cause both learning and fatigue effects, leading to sometimes irrational choices. Hence, the complexity of a choice experiment in terms of the number of choice sets and/or the number of attributes in each choice set may effect the quality of the responses and would require some trade-off between the complexity of the choice experiment and the quality of the responses (e.g., Schkade and Payne 1994).

In a developing country setting, it may be argued that these problems are, in fact, further accentuated because of the respondents' lack of formal education and low socioeconomic status. Fortunately, this is unlikely in Putrajaya because the levels of formal education and socioeconomic status are significantly higher than other parts of the country. Other technical objections to the SP method include design bias in the way information is put across to respondents, strategic bias when respondents may think that they can influence the course of real events by making a particular pattern of choice, and social desirability bias, where respondents attempt to reflect themselves in a favorable light with respect to some social norms.

In eliciting mode preferences, the study also tries to incorporate principles and discussion on appropriate instrument and survey methods as in Louviere (1998), Diamond and Hausman (1994), and Hanemann (1994). A review of existing literature reveals that significant travel attributes that affect mode choice are already well known and, hence, repeatedly used in many prior studies. The present study adopted these known attributes, namely, in-vehicle time (travel time), headway, and out-of-pocket financial cost (fuel, fare, toll, and parking charges). In designing the questionnaire, attempts were made to ensure that choices offered to the respondents were as realistic as possible and that the initial attribute levels matched the characteristics of current modes of travel as closely as possible. In the interest of realism and since there are virtually no parking and road-toll charges,

respondents were also reminded that the financial costs of using private vehicles can vary over a relatively wide range of values because of a possible introduction of road-pricing and/or parking charges.

The range of choices and the levels of variation were further refined using focus group techniques. Focus group sessions were conducted to ensure that the selected attributes and their corresponding levels could be combined in a credible manner (Layton and Brown 1998). Participants were also encouraged to provide definite feedback on the complexity and realism of the survey instrument.

Five sets of survey instruments were eventually drafted, one set for each of the five broad travel purposes present in Putrajaya. The travel purposes were work commute from within Putrajaya, work commute from outside Putrajaya, official business with government departments, social/shopping, and tourism/visits. The questionnaire sets were essentially very similar except in the scenario-building section in which the description was customized to suit different trip purposes. Table 1 shows the attributes and attribute levels that were finally incorporated into the questionnaire instrument for the full survey. "Levels" refer to the different level of values that the respective attributes assume in the choice experiments incorporated in the questionnaire set. In this study, financial cost assumes four levels, while in-vehicle time and headway each assumes three levels. Only three levels are offered for in-vehicle time and headway (hence, blanks under Level 3)

Table 1. Attributes and Attribute Levels

	Motorcycle				***Car***				***Public Transport***			
Levels	*0*	*1*	*2*	*3*	*0*	*1*	*2*	*3*	*0*	*1*	*2*	*3*
Financial cost (RM)*	1.50	2.50	3.50	5.50	3.50	5.50	11.50	16.50	0.40	0.80	1.20	2.00
In-vehicle time (minutes)	10	12	15	-	10	20	30	-	15	20	30	-
Headway (minutes)	0	0	0	-	0	0	0	-	5	10	20	-

*Exchange rate: US $1= RM3.65 (April 2006)

to reduce the number of choice experiments presented to the respondents. Due to the popularity of motorcycles in Malaysia, the three modes offered were car, motorcycle, and public transport.[2]

The sampling process attempted to capture sufficient numbers of respondents for each trip category to reflect the population of trip makers. At the beginning of an interview session, respondents were briefed on the purpose of the interview and the expected amount of time required to complete a questionnaire set. Equally important, a thorough description was given to the respondents regarding the types of public transport services being considered in the choice experiment. This was done to avoid the need to incorporate a relatively large number of service attributes and levels. Respondents were told to consider a high quality public transport (bus) service with the following features: clean and comfortable, air-conditioned, ample seating capacity, conveniently located as well as covered bus stops/terminals, provision of park-and-ride facilities, punctual, safe, courteous drivers, and an option for electronic/manual fare collection. The description was provided with some details to encourage respondents to dispel currently held negative perceptions about public transport.

The full survey was conducted in September and October 2003. The total number of respondents for the survey was 2,000; however, only 1,943 were deemed usable for further analysis. The remaining responses were discarded mainly due incomplete responses.

Table 2. Distribution of Respondents by Trip Purpose

Trip Purpose	*Number*	*%*
Work commute (from within Putrajaya)	499	25.7
Work commute (from outside Putrajaya)	660	34.0
Official business with government departments	246	12.7
Social/shopping	293	15.1
Tourism/visits	245	12.6
Total	1943	100.0

Mode Choice Modeling

It is assumed that the mode choice for a trip maker is a reflection of his preference, and the choice can be predicted if all variables pertinent to this choice are known and measurable. Probabilistic choice models can then be estimated to link the probabilities that the different alternatives will be selected to the set of pertinent explanatory variables (Horowitz 1995). Three of the trip purposes (work commute from within, work commute from outside, and official business with government departments) were combined into one business trip category. A multinomial logit model was estimated for each trip purpose and then used as the basis for predicting mode split for different policy choices.

Results

Results of the regression estimation are presented in Table 3. The coefficients for the financial cost variable are of the correct sign and generally statistically significant. Although the coefficients for headway and in-vehicle time mostly carry the correct sign, they are not statistically significant, suggesting that users are not particularly affected by changes in public transport service quality. This observation provides a very important policy implication between the relative efficacy of demand and supply measures, as discussed in the next section. The coefficients for financial cost, headway, and in-vehicle time are mostly negative, implying that the proportion of trips accounted for by public transport increases as the spread in generalized cost, waiting time, and travel time between private and public transport increases. The relative impact certainly differs across factors but is consistent with the fundamental economic principle that demand for public transport should vary inversely with cost (financial or otherwise).

The signs for the gender coefficients are negative and highly significant for business trips (and for both car and motorcycle), supporting the notion that, because of the generally lower occupational/income level of women and alleged bias in local custom against women riding motorcycles, there is greater certainty in the statistical sense that proportionally more women choose public transport compared to men. The results are rather mixed for the other two trip purposes. The coefficients for income are also as expected (all negative for car and generally positive for motorcycle), indicating that relative to the control group of higher income individuals, people in lower income categories are more likely to choose motorcycles and less likely to choose cars compared to public transport.

Table 3. Estimation Results of the Multinomial Logit Model by Trip Purpose

	Business		*Tourism/Visits*		*Social/Shopping*	
Variables	***Coeff.***	***t- stats***	***Coeff.***	***t- stats***	***Coeff.***	***t- stats***
Financial cost	-0.193	-3.447	-0.199	-13.055	-0.031	-4.953
In-vehicle time	-0.006	-1.323	-0.002	-0.213	-0.007	-0.898
Headway	-0.005	-2.362	-0.007	-0.875	0.011	0.323
Motorcycle						
Gender	-1.664	-32.578	-0.603	-4.813	0.206	1.485
Income <1000	1.542	5.203	2.907	3.873	0.833	1.663
Income 1001-2000	1.233	4.161	2.457	3.350	1.082	2.221
Income 2001-3000	0.633	2.071	2.464	3.361	-0.072	-0.142
Income 3001-5000	0.079	0.222	2.294	3.044	-0.009	-2.320
Constant	0.561	1.847	-1.953	-2.604	-2.263	-4.315
Car						
Gender	-0.362	-7.116	0.089	0.663	-0.162	-1.479
Income <1000	-1.883	-11.043	-1.727	-5.232	-1.181	-4.414
Income 1001-2000	-1.381	-8.218	-1.837	-6.872	-0.739	-3.075
Income 2001-3000	-0.775	-4.417	-1.128	-4.400	-0.462	-0.142
Income 3001-5000	-0.405	-2.526	-0.645	-2.212	-0.615	-2.320
Constant	2.387	12.873	1.889	6.153	1.081	3.306

Discussion and Policy Implications

An important policy question for the Putrajaya authority is whether it is sufficient to rely only on improvements in public transport to achieve the desired 70:30 goal. The initial reluctance on the part of the authority to consider demand-restraining measures stems from the notion that since Putrajaya is the federal administrative capital, any penalty imposed on private vehicle use may be construed as the government being insensitive to the wishes of the public. This perception is expected to be further heightened by the fact that Malaysians are generally not used to demand-restraining measures. However, results of the analysis suggest that supply-side policy through improvement in public transport alone is likely to be inadequate. Under the improved scenario, headway and in-vehicle time for bus are assumed to be at 5 minutes and 15 minutes, respectively (lowest values in the

choice set). Other bus service improvements are as described to respondents at the beginning of the interview (i.e., improved bus design and amenities; enhanced bus stops and terminals; park-and-ride facilities; punctual, safe, courteous drivers; and electronic/manual fare collection). Results of further computations (Table 4) reveal that improvements in public transport will increase public transport ridership from the current 10 to 15 percent to about 30 to 40 percent, depending on trip purpose. This figure is nowhere near the target of a 70 percent share of public transport use. However, although headway and in-vehicle time are the only two service characteristics presented in the choice experiment, the increase in ridership cannot be exclusively attributed to improvements in the two characteristics since the respondents were stating their choices within the context in which some other general improvements in bus service had already been assumed.

Table 4. Mode Shares by Trip Purpose (Improvement in Public Transport Only)

Trip Purpose	*Public Transport*	*Car*	*Motorcycle*
Business	30%	52%	18%
Social/shopping	29%	60%	11%
Tourism/visits	42%	34%	24%

Having found that improvement in public transport alone is inadequate, further simulation is performed to determine the required financial disincentive to switch sufficiently large numbers of users to public transport. Table 5 provides the magnitude of the required financial disincentive by trip purpose and vehicle type to achieve the 70:30 split. To provide some perspective, the required financial disincentives (say new toll and parking charges) are equivalent to between a 100 to 300 percent increase in the current out-of-pocket traveling costs. As a policy tool, such a steep increase appears to be unrealistic for immediate implementation because it is very likely to be politically unpopular. However, increases in penalties for private vehicle travel may be introduced in stages over a longer period of time along with improvements in the public transport system.

Table 5. Summary of Required Incentive/Penalty (RM) to Induce 70:30 Split between Public and Private Transport

Business		*Social/ Shopping*		*Tourism/ Visits*	
Motorcycle	Car	Motorcycle	Car	Motorcycle	Car
3.00-3.50	12.00-13.00	6.00-7.00	27.00-28.00	3.00-3.50	10.00-11.00

Separate simulation results also show that worktrips from outside Putrajaya require higher absolute incentives or penalty compared to worktrips originating from within Putrajaya to realize the same degree of mode switch from private to public transport. One reason for this observation is that for the same amount of absolute financial disincentive, the impact on trip costs (both in terms of money and time) is proportionally lower for those traveling from outside Putrajaya compared to those from within the city since trip cost is a function of traveling distance. Such a divergence can complicate the implementation of demand-restraining measures because the scheme must be capable of differentiating and charging the two groups of commuters. One possible solution is to set up an external cordon for charging commuters from outside Putrajaya and enforce parking charges for both internal and external users. The difference in the amount required to deter external users will be picked up by the external cordon charges.

Car users on social and shopping trips are willing to pay the most to use private transport relative to other users. This is probably due to the occasional nature of their trips and convenience of carrying purchased items and traveling in a group with other family members for shopping and social trips by private vehicles.

Any pricing measure on cars (or motorcycles) must take into account not only the impact of relative cost and attractiveness of the mode compared to public transport, but also to motorcycles (or cars). For example, increasing the cost of using a car relative to public transport will not only switch users to public transport but also to motorcycles. Hence, pricing measures should not be targeted on car users in isolation (however attractive it may be from the social perspective). Mode switching from cars to motorcycles instead of to public transport may render the impact of increasing the cost of car use less effective. This is especially important in light of the obvious temptation to leave motorcyclists alone for equity reason when it comes to pricing measures to avoid "harming the low-income group."

Since imposing penalties on motorcyclists is unavoidable, affordable public transport must be made accessible to switching motorcycle users, particularly those from the lower income group for equity reasons. This can be done through a fare subsidy wholly or partly financed by toll or parking collection on individuals who continue to use private transport.

Finally, calling for financial penalties on private vehicle use may be a delicate option to pursue as it entails potential political ramifications. A strong political will on the part of policymakers is required to realize the transport objective. This policy will, however, become more palatable to the traveling public if a high quality yet affordable public transport system is put in place. When the two measures are coupled together, the increased cost of transport will be less of an issue since those users having to switch to public transport will then have access to an affordable public transport system. Gradual introduction of financial disincentives to private vehicle travel is also likely to be more politically palatable.

Summary

This article describes methods and results of a study conducted in Putrajaya, Malaysia, to induce large numbers of users to public transport. Results from the stated preference survey and the subsequent mode-split modeling and simulations suggest one major policy conclusion. Improvement in public transport alone appears to be incapable of inducing sufficient mode shift in favor of public transport to achieve the overriding objective of 70:30 split. It must be recognized, however, that simulation results clearly indicate that improvement in service quality does increase public transport use by generating a 20 to 25 percent increase in ridership. Since the current public transport fare is already low, lowering the transit fare (along with improvements in public transport service) is also unlikely to induce the desired shift because the cost difference between public and private transport will still be small. Thus, demand-restraining measures, such as cordon pricing and parking charges, appear to be indispensable as a policy tool to achieve the desired goal.

Endnotes

[1] Putrajaya, which is situated 25 km south of the capital city of Malaysia (Kuala Lumpur), occupies a total area of 4,932 hectares and is divided into 20 precincts

(Putrajaya 1997). When fully developed in 2012, Putrajaya is expected to have a night-time population of 330,000 and provide 254,000 job opportunities.

[2] The current modal split is 70 percent for cars; 15 percent, motorcycles; 15 percent public transport.

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