Internalising the Externalities of Public Transport in Botswana

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Abstract

In this paper, the externalities generated by public transport and the economics of road pricing are analysed. A case study of Botswana shows the imbalance between the supply and demand for road space as the underlying cause of traffic congestion. Empirically, the determinants of private motor vehicle ownership in Botswana are: credit to the private sector, the exchange rate, and road space. An optimal solution to the problem of traffic congestion in the country requires internalisation of the externalities generated by public transport. Without efforts to internalise the externalities of public transport, private car ownership becomes attractive but worsens traffic congestion and the costs of congestion. Road pricing is one way to internalise the externalities of public transport. This is the approach used by Singapore and other countries. The paper shows how aspects of the scheme can be used in Botswana.

1. Introduction

Public transport generates positive externalities in the form of decongestion benefits to society. As a result, public transport provided by the market system will be sub-optimal, unless civic authorities make efforts to internalise the externalities. This paper is about internalising the externalities of public transport in Botswana. Section 2 of the paper discusses the externalities generated by public transport. Conventional economic theory shows that, public transport provided by the market system is a sub-optimal solution because of externalities. For an optimal solution, there should be internalisation of externalities generated by public transport. Section 3 of the paper focuses on the problem in the context of Botswana. Statistics show that, in the urban areas of Botswana, there is a growing imbalance between the supply and demand for road space. The empirical model in Section 4, examines the determinants of privately owned motor vehicles in Botswana. Section 5 of the paper is on the economics of road pricing and the case of Singapore in the quest to solve the problems of traffic congestion. The policy implications for Botswana are discussed in section 6. This is followed by a summary and conclusions in Section 7.

2. Externalities Generated by Public Transport

Walters (1983) distinguishes the costs of a vehicle's journey into private and social costs. Private costs are operating costs such as the cost of fuel and the wear and tear of the vehicle. These costs are borne by the vehicle operator. Social costs

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consist of such things as the cost of road construction and maintenance. These are borne by public authorities. Social costs also include congestions costs, borne by all road users. When there is heavy traffic, congestion costs rise because motorists "… waste more time in traffic jams and incur higher maintenance costs per mile in the dense traffic" (Walters, 1983: 193). Evidently then, reducing traffic jam is beneficial in that it lowers congestion costs. These benefits are called decongestion benefits and public transport is a source of such benefits. The concept of externality is central to the analysis of how public transport is a source of decongestion benefits.

Economic theory shows that public transport provided by the market system is a sub-optimal solution. The sub-optimal solution occurs because public transport generates externalities (Just, *et al*., 1982; Mueller, 1979; Musgrave and Musgrave, 1989). An externality exists when there are external costs or benefits. Technically, an externality exists "…when at least one of the arguments in a production or utility function falls under the control of an external economic agent" (Davis and Hulett, 1977:7). Public transport generates benefits to the individual user but also external benefits to society. Ordinarily, the market system does not reflect these external benefits. Precisely then: "An *externality* is defined as the case where an action of one economic agent affects the utility or production possibilities of another in a way that is not reflected in the market place," (Just, *et al.,* 1982: 26). This is the reason an unfettered market system cannot optimally provide a good like public transport, which has external benefits. For an optimal solution, the external benefits should be internalised. These observations are illustrated in Figure 1, which depicts a model of the supply and demand for public transport (see, for instance, Just, *et al*., 1982: 279).

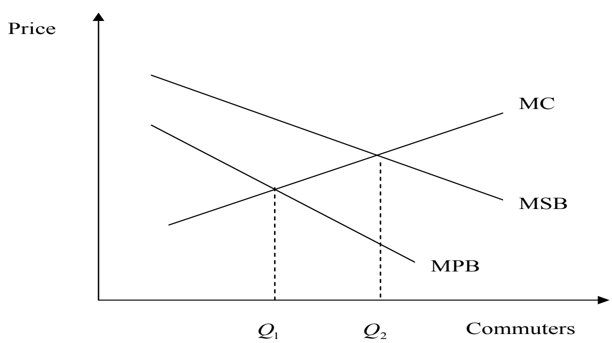
The horizontal axis of Figure 1 shows the quantity demanded for the public transport system and the number of riders on the public transport system. The demand for public transportation is represented by the marginal private benefit curve (MPB). When riders use public transport, they are motivated purely by self-interest and do not take into account the external benefits of using public transport rather than driving their own cars. The external benefits of public transport include street decongestion and reduced fuel consumption because of less traffic on the road. Street decongestion also means that commuter trips will be faster and save time. All these external benefits are not considered when riders use public transport. As a result, the marginal private benefit is lower than the marginal social benefit (MSB) of public transport. The difference between the MPB and the MSB curves are the decongestion benefits, that is, the external benefits generated by public transport. The decongestion benefits rise as more commuters use public transport. This explains why the MPB and MSB curves are not parallel to each other in the model. At each instance, the vertical distance between the MPB and MSB curves measures the decongestion benefits, and these rise as commuters increase.

The vertical axis of Figure 1 shows the marginal costs (MC) for the riders on the public transport. The MC curve represents the supply of public transport. For simplicity, it is assumed that public transport commuters pay the full cost of their ride and as a result, marginal private cost is equal to marginal social cost (MC =

MPC= MSC).

In the diagram, Q_1 is the number of commuters who use public transport. It occurs at the intersection of the supply (MC) and demand (MPB) of public transport. Q_1 is the number of public transport provided by the market system, for example, buses operated by private owners. However, Q_1 is a sub-optimal solution because it occurs at a point where the riders only consider their self-interests and not the external benefits of using public transport. When commuters use public transport, they are motivated purely by self-interest and not such grand schemes like street decongestion or saving fuel costs. What is required is for civic authorities to step in and incorporate these grand schemes when public transport is provided. Economists refer to this process as internalising the externality. When the external benefits of public transport are considered, there will be optimal provision of public transport and this occurs at Q_2, where MSB= MC (= MSC). Clearly, Q_2 is greater than Q_1. This means that society requires a larger provision of public transport than what the market system supplies. This explains why in large cities, civic authorities are involved in the provision of public transport, such as the underground railway system. Public provision of public transport internalises the external benefits of public transport and increases the number of commuters using public transport. This decongests road traffic, saves fuel and commuter time.

Figure 1: Supply and Demand for Public Transport



3. The Case of Botswana

Traffic congestion is rising in the municipal areas of Botswana, especially in Gaborone. In 1990, all registrations of motor vehicles, that is new registrations plus renewals, were 74,399 in Botswana, but by 2004, all the registrations were 130, 048, nearly twice the number in 1990 (Republic of Botswana, 1994:77, 2005:81). Statistics also show that cars and light duty vans are by far the major categories of the new registrations of privately owned motor vehicles in Botswana. In 1990, cars and light duty vans comprised about 70 percent while in 2004 they were 83 percent of all the registrations (Republic of Botswana, 1994:77, 2005:81). The increase in motor vehicle ownership is the result of the availability of credit to purchase private vehicles. It is also the result of the vicious circle documented by Watson and Holland (1983). According to these authors, congestion caused by the increased use of cars has adverse effects on public transport services. When there are frequent traffic jams, public transport, such as buses, become unreliable and therefore people stop using public transport and instead opt to buy and drive their own cars. However, the switch from public to private transport only worsens the congestion because there would now be more vehicles on the road. The worsened congestion further degrades the public transport system, forcing more and more people to opt for private cars, making congestion even more intolerable - a vicious circle of worsening public transport services, increased private vehicles and worsening congestion. Meanwhile, the worsening public transport systems result in financial losses to the operators. The financial losses, in turn, induce the operators to increase fares or cut services or both, and this accelerates the downward spiral of the public transport system.

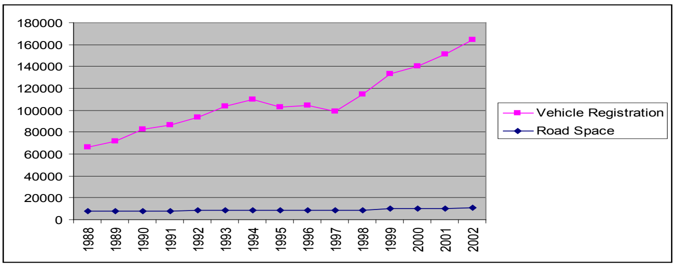
In Gaborone, for instance, some roads seem to be always congested. A case in point is the main road in the Broadhurst Industrial Area, from the Metro Junction to the railway crossing just before Segwana. This road seems to be forever jammed and worse still during the rush hours. Then there is the road that links Mogoditshane to the Mass Media Complex. It is not surprising that authorities decided to expand this road and make it a dual carriageway, but it is still congested during peak hours. Similarly, the Western Bypass is congested during peak hours. Some roads have been built with the basic purpose of reducing traffic congestion. It is apparent, for example, that the Western Bypass was constructed in order for motorists to bypass the traffic congestions in the city centre. However, this purpose is defeated if the Western Bypass is also subjected to congestions.

According to some observers, the reason there are traffic delays and jams in Gaborone is because of roundabouts and traffic lights. Therefore, they suggest that the solution to the traffic problems is to demolish some of the roundabouts. This reasoning is persuasive but untrue for one main reason. There are delays and traffic jams during peak hours because the volume of traffic has risen at a rate faster than road space can be expanded. There are many more vehicles but road construction cannot be undertaken at the same pace as the increase in the number of road users. Traffic congestion is a sign that demand is greater than the supply of road space (Watson and Holland, 1983). Figure 2 shows the registration of motor vehicles and roads maintained by the central government in Botswana. The total road network in Botswana consists of roads maintained by the central government and those maintained by local authorities (see the Appendix, Tables 1 and 2). Although Figure 2 only shows the roads maintained by the central government, it is clear that the increase in road space is gradual while there is an exponential rise in the number of registered vehicles in Botswana. Demand is greater than the supply of road space in the country. Under such circumstances, authorities may try to resolve the imbalance by constructing more roads. However, road construction has an opportunity cost because the resources devoted to road construction projects could have been spent on other activities. Because resources are scarce, society must chose among alternatives. Building more roads means that something else must be sacrificed. This is the essence of the opportunity cost of road construction.

Besides, construction of roads results in what are now known as 'barrier effects.' Roads act as barriers between people and businesses. Stated by Sterner (2003: 219):

"…large roads create barriers to communication and movement of both humans and animals when they cut through a community, effectively making it difficult for people to shop, socialise, or work on the other side of the road…." Road construction may not be a solution to traffic congestion because of the opportunity cost and other costs in the transport sector.

Figure 2: Registration of motor vehicles and road space in Botswana



Source: Republic of Botswana (1994:77, 1999:4 &18, 2003a:7, 2005: 81)

Traffic congestion also causes air and noise pollution because of the increase in the volume of traffic. In turn, air and noise pollution reduce the quality of the environment and human life. The quality of human life is reduced even more because traffic congestion leads to deterioration in the use of public transport services such as buses and trains. Furthermore, traffic jams impose a heavy burden on the driver because of the repeated acceleration and braking that occurs during the jams. Traffic jams increase the likelihood of nose-to-tail collisions. The costs of traffic congestion and jams are many and varied. They range from the simple and basic to the complex and technical ones. The simple and basic costs of traffic congestion are the losses of fuel and time when the motorist crawls through the traffic jams. These losses have an opportunity cost because the fuel and time could have been spent on other activities.

There are signs that the costs of traffic congestion are rising in Botswana. Petrol is the most used petroleum product in Botswana and petrol is primarily used in the transport sector (Republic of Botswana, 2002:3). To raise fares in 2004, mini-bus operators cited the rising cost of petrol in the demands. The Botswana Press Agency (2006:1) presented a more revealing report and it reads:

> *The Department of Energy Affairs has increased fuel prices again, three weeks after another fuel price increase. This is the fifth increase since January this year, and the new prices take effect today…. The department states that the fuel increase was necessitated by increased fuel prices in the international market, which reached US$78, approximately P470, per barrel on August 8. It is attributed to the current instability in the Middle East and other areas around the world.*

The report also noted that, previously, the National Petroleum Fund (NPF) cushioned price increases, but now this scheme did not have adequate funds. This also explains why fuel prices were raised five times in 2006. Invariably, because of the increase in fuel prices, the Botswana Taxi Association urged the government to raise the taxi and bus fares. In October 2006, for instance, the fares were raised to P2.50 for buses and P3 for taxis (Gabotlale, 2006: B3). The bus fares were initially P1.25 but were increased to P2, and in October 2006 they were again raised to P2.50. The increases in bus fares adversely affected public transport because some commuters "…chose the easier route- walking whenever they can and staying home whenever it is not absolutely necessary [to travel]" (Gabotlale, 2006: B3). People who previously used buses now walked or simply stayed at home. The increases in bus fares reduced the demand for public transport and as a result, bus operators spent more time waiting for passengers. By April 2008, the price of crude oil on the world market was a record US $117 per barrel (The Botswana Gazette, 2008: 24). In May 2008, the price rose to US $122.03 per barrel (*Mmegi/The Reporter*, 2008: B3). Clearly, the cost of fuel has been rising over time. As a result of the rising price of oil on the world market, the government of Botswana raised the domestic price of fuel three times in one week in May 2008 (Mooketsi, 2008: 9). This was followed by an increase in bus and tax fares: from P2.50 to P3 for buses; and from P3 to P3.60 for taxis (Motlogelwa, 2008:1).

4. Empirical Findings

This study hypothesises that the number of privately owned motor vehicles in Botswana depends on the road space, national income, credit to the private sector and the exchange rate; that is:

$$V = f(S, Y, PSC, EXC) \quad (1)$$

Where, V is the number of privately owned motor vehicles, S is the road space, Y is national income, PSC is private sector credit, and EXC is the exchange rate. The estimated model is:

$$h\ TRV_t = b_0 + b_1 h\ SPACE_t + b_2 h\ GDP_t + h\ b_3 PSC_t + h\ b_4 EXC_t + e_t \quad (2)$$

Where TRV_t is the total of registration of privately owned motor vehicles in Botswana; $SPACE_t$ is the number of roads, in kilometers, maintained by the Central Government in Botswana, this is the proxy for S; GDP_t is per capita gross domestic product, the proxy for Y, in millions of Pula in real terms (2000=100); PSC_t is private sector credit, represented by commercial bank loans and advances to the private sector, including parastals, in millions of Pula in real terms; EXC_t is the exchange rate of the United States (US) Dollar to the Botswana Pula (how much Pula one US Dollar can buy). It is expected that b_1, b_2, and b_3 will be positively related to the number of privately owned vehicles, while b_4 will have a negative impact because appreciation in the US Dollar (that is depreciation in the Pula) will increase the cost of imports and therefore decrease the volume of motor vehicle imports into Botswana.

The data used for the estimation were obtained from various statistical bulletins of the Central Statistics Office and the annual reports of the Bank of Botswana. The period covered was 1988-2002, because the data for SPACE was readily available only for this period (see Table 1 in the Appendix). The estimation was done by the software EViews and the regression results of equation (2) are:

$$\hat{TRV} = 3.984359 + 0.743079 SPACE - 0.309116 GDP + 0.520349 PSC - 0.278680 EXC$$
$$(0.637564) \quad (0.154043) \quad (0.107182) \quad (0.254580)$$
$$t = 1.17 \quad t = -2.01 \quad t = 4.85 \quad t = -1.09$$
$$R^2 = 0.96 \quad \bar{R}^2 = 0.94$$
$$DW = 1.61 \quad n = 15 \qquad (3)$$

In equation (3), the standard errors for the b*s* are in the brackets. It is clear from equation (3) that the significant variables are per capita GDP and credit to the private sector. However, per capita GDP carries a negative sign, contrary to expectations. One plausible explanation for why the GDP coefficient is negative is that there is high correlation between per capita GDP on the one hand, and credit and exchange rate on the other hand. The correlation matrix is shown in the Appendix (Table3). The correlation coefficient between GDP per capita and credit is 0.97 and between GDP per capita and the exchange rate is 0.98. This high degree of correlation implies that the specified econometric model has a problem of multicollinearity, one which is detectable if the R^2 is high and the standard errors are large (Gurjarati, 1988; Kuotsoyiannis, 1977; Studenmund, 1997; Thomas, 1997). The existence of multicollinearity also implies that the $\bar{R}^2$ will not be altered significantly if one or more of the multicollinear variables are dropped from the model. This is the case in equation (4) where per capita GDP is omitted from the regression.

$$\hat{TRV} = -4.661355 + 1.535349 SPACE + 0.391846 PSC - 0.640098 EXC$$
$$(0.565302) \quad (0.097056) \quad (0.203174)$$
$$t = 2.72 \quad t = 4.04 \quad t = -3.15$$
$$R^2 = 0.94 \quad \bar{R}^2 = 0.93$$
$$DW = 1.53 \quad n = 15 \qquad (4)$$

In equation (4) the values of the standard errors decline while the $\bar{R}^2$ falls slight to 0.93; all the variables are significant and have the expected signs. Private sector credit is significant at the one percent level, while exchange and road space are significant at the five and ten percent levels, respectively. These results suggest that the most significant factor that determines private motor vehicle ownership in Botswana is credit to the private sector. Not surprisingly, the second most significant factor is the exchange, because the vehicles are imported. The results show that appreciation in US Dollar raises the cost of imports and adversely affects motor vehicle imports into Botswana. These results are interesting considering that, since the 1980s, the Pula has been pegged to a basket of currencies consisting of the Special Drawing Rights (SDR) and the South African Rand, with relatively more weight given to the Rand because of the significance of trade between Botswana and South Africa. The SDR, in turn, comprises the US Dollar, the Pound Sterling, the Euro and the Japanese Yen (Republic of Botswana, 2003b). Despite these complexities, the results of the present study suggest that the exchange rate of the US Dollar to the Pula can be used as proxy for the nominal value of the Pula.

The results of the study also show that there is a positively and significant relationship between private motor vehicle ownership and road space in Botswana. The institution in this case is simple; vehicles have to be driven on roads. Traffic congestion is a sign that the supply of vehicles exceeds the demand for road space, and not a sign that roads are bad for motor vehicles. The empirical results do not contradict the earlier observations about traffic congestion.

5. The Economics of Road Pricing

Solutions to the problem of traffic congestion should be seen in terms of supply and demand. For instance, according to Watson and Holland (1983), reducing the number of private cars can raise the efficiency of public transport and thereby induce people to use public transport. This is what is known, in the transport planning profession, as a demand side approach. Other demand side approaches include road pricing, as well as reserving streets for pedestrians and buses. Road pricing is an approach that taxes motorists so that they can pay for congestion and other costs associated with the transportation sector. This is generally considered to be the solution to traffic congestion.

The damage function of the transportation sector is complex because the components of the damage involve local, regional, and global externalities. Ideally, however, a specification of the damage function may be necessary in designing a Piguvian tax for road transportation. Thus, Sterner (2003) specifies the damage function as:

$$D = D(e, g, t, w) \tag{5}$$

where D is environmental damage caused by motor vehicles, e is vehicle emissions, g is location, t is time of day, and w is weather. This equation simply says that the environmental damage caused by motor vehicles depends on the vehicle emissions, location and time of the emissions, and also on weather conditions. It is important to note that vehicle emissions, in turn, depend on the distance traveled (m) and the rate of emissions (x). Furthermore, the rate of emissions is specified as:

$$\mathrm{x} = \mathrm{x}(v, f, t_0, o, z) \tag{6}$$

where v is vehicle characteristics, f is fuel, t_0 is outside temperature, o is road condition, and z is a vector of driving-related variables such as speed, vehicle maintenance and engine temperature. Then a road-pricing tax can be set as:

$$T = f(g, t, v) \tag{7}$$

where T is tax, g is geographical location, t is time, and v is vehicle characteristics. Geographical location is about where the vehicle is driven, in the city or in the countryside. Time as a variable distinguishes between the rush hour and the off-peak period. Vehicle characteristics categorize motor vehicles according to the amount of pollution they emit, from the least to the high polluters.

The variables in this model show the complexity of implementing a full-fledged environmental road pricing. According to Sterner (2003: 228): "Whereas no country has yet been able to implement advanced environmentally differentiated road pricing, some sophisticated examples of road pricing, area licensing, and mileage taxes include advanced traffic-management schemes in Singapore, toll roads in Norway, and a road pricing scheme in Switzerland that uses the Global Positioning System (GPS)." The Singapore road-pricing scheme is often cited as a model worth considering in transport management (see for instance, Watson and Holland, 1983; Sterner, 2003). The scheme was first introduced in the 1970s but has been modernised by the use of automation to enable motorists to pay road prices electronically and avoid delays. The main features of the scheme.

Singapore introduced a road-pricing scheme in June 1975 and was the only city at the time to have done so. This solution to the problem of traffic congestion is also known as the area license scheme. When the scheme was introduced in Singapore, the transport planners had short-term and long-term objectives in implementing the scheme. The short-term objectives were to contain the rise in traffic congestion and the costs associated with the congestion. Based on the number of traffic during the off-peak period, the planners aimed to reduce peak-hour traffic volumes entering the restricted zone by a target of 25 to 30 percent. This was equivalent to reducing by 50 percent, the number of cars entering the restricted zone during the peak-hour.

The long-term objective of the road-pricing scheme was to change the attitudes of the people about the ownership and use of cars. Singapore's transport planners hoped that, in the long run, people would be less inclined to own and use cars but instead rely on public transport services. However, for this to happen, the short-term objectives needed to succeed. Precisely, the main aspects of the road-pricing scheme were as follows:

- A certain part of the city was designated as a restricted zone and a special license had to be bought and displayed on any car that was driven into this zone during the morning rush hours.
- To complement the special license scheme, parking rates were raised in the city centre (downtown).
- Also to complement the special license scheme, the authorities made earnest efforts to improve bus services.
- The major expenditure incurred by the authorities in implementing the special license scheme was S$6 million (US $2.5 million) spent on the construction of what are known as 'fringe car parks', with capacity for 10,000 cars.

Fringe car parks were essentially car parks built on the outskirts of the central business district (city centre). They were the heart of a system called 'park-and-ride'. The system works as follows. Private motor vehicle owners drive up to the fringe or outskirts of the central business district, park their vehicles and then take bus shuttles to the central business district. The drivers park their private cars and ride to the city centre hence, the term 'park-and-ride'.

The Singapore road-pricing scheme charges motorists according to the vehicle, time of the day and the target level of congestion. Table 2 shows how the tolls in Singapore depend on the type of vehicle and time of the day. For cars, the fee in 2002 was US$ 0.50 between 7.30 and 8 a. m., but was US$2.50 during the rush hours of 8 to 9 a. m. In 1998, the scheme was modernised by the introduction of 'smart cards' that enable motorists to pay the road price electronically and avoid toll delays.

The Singapore transport management system has been successful partly because the bus shuttles in the park-and- ride scheme reduce congestion. This has to do with economies of scale. A bus carrying 50 passengers occupies less road space than 50 cars that would be driven by each of the 50 passengers in the absence of the bus ride. This is the kind of message that needs to be transmitted to car owners in order to induce them to change their attitudes. In the case of Singapore, it is said that there was a year long campaign to inform the public about the road pricing scheme before the scheme was introduced in June 1975.

Table 2: Fees in the Singapore Road Pricing Scheme

	Time			
	7:30 – 8 am	**8 – 8:30 am**	**8:30 – 9am**	**9– 9:30 am**
Restricted zone, Nicoll Highway				
Cars……….	0.50	2.50	2.50	2.00
Motorcycles	0.25	1.25	1.25	1.00
Buses etc….	0.75	3.75	3.75	3.00
Restricted zone, remaining areas				
Cars……….	0	2.00	2.50	2.00
Motorcycles	0	1.00	1.25	1.00
Buses etc….	0	3.00	3.75	3.00
Portsdown to Alexandra				
	0	0.50	1.50	0
Cars……….	0	0.25	0.75	0
Motorcycles Buses .	0	0.75	2.25	0

Notes: The fees are in U. S. dollars.
Source: Thomas Sterner (2003 : 232).

The Singapore's road pricing scheme achieved the short-term objectives of containing the rise in traffic congestion and the costs associated with the congestion. The scheme reduced peak-hour traffic volumes entering the restricted zone by more than 40 percent, which was above the planned target of 25 to 30 percent reduction

(Watson and Holland, 1983:81). This was equivalent to reducing by more than 70 per cent, the number of cars entering the restricted zone during the peak-hour, well above the planned target of 50 per cent reduction. The scheme succeeded in reducing congestion in the central business district mainly by diverting traffic away from the central business district during the peak-hours. The scheme induced motorists to shift to earlier times and routes that avoided the restricted zone. It spread traffic volumes in the city, induced commuters to use public transport and car pools, instead of private cars driven by one or two individuals only. The scheme also succeeded in reducing air and noise pollution. Furthermore, Singapore's road pricing scheme was profitable, with revenues that were nine times more than the cost of the scheme.

Clearly, the planners succeeded in the short-term objectives of the scheme. Because there was a shift toward the use of public transport in the short run, a basis was set for the achievement of the long-term goal of changing the attitudes of the people about the ownership and use of cars. The expectation was that the people would rely on an efficient public transport system and therefore, in the long run, the commuters would be less inclined to own and use cars.

However, the planners of the road license scheme in Singapore faced some unexpected challenges and a seemingly insurmountable problem. One of these challenges was on how to set the fee for the special road license. By 1975, there was no identical scheme elsewhere in the world that could guide the planners in Singapore on the level at which to peg the fee for the road license. Another difficult challenge was the under-utilisation of the park-and-ride bus shuttles and the fringe car parks. The officials, however, successfully overcame these challenges. Rather, the problem that seemed insoluble was that of traffic congestion in the evening. The officials solved the problem of morning peak-hour congestion but failed to solve that of evening peak-hour traffic jams. According to Watson and Holland (1983), no good solution was found to this problem.

There is an additional lesson to be learned from the experience of Singapore. The planners decided to tackle the problem of traffic congestion before the problem became severe. The road-pricing scheme was introduced at a time when traffic congestion in the central business district was not severe. The road-pricing scheme was a measure designed to prevalent a bad situation from becoming worse.

6. Policy Implications for Botswana

In Botswana, there are foundations on which to tackle the problems of traffic congestion and road accidents. The country enjoys political and economic stability. The rise in the private ownership of motor vehicles in Botswana is determined by private sector credit, the exchange rate and road space. What is more, taxis and mini-buses are run by the private sector and in Gaborone, public transport operators have an organisation called the Gaborone Taxi and Bus Service Association. This association can be enlisted in the strategy to solve the traffic problem. Intuitively, traffic congestion costs are higher in Gaborone because it is both the administrative and commercial capital of the country. Solving the problem of traffic congestion in Gaborone can set a precedent on how to deal with the problem elsewhere in the country.

Based on the road-pricing scheme in Singapore and other countries, authorities would define the central business district of Gaborone and then aim to restrict the number of vehicles entering this area during morning rush hours. This could be done by giving special licenses to cars driven in the area, with a supplementary 'park-and-ride' system, as in the case of Singapore. For Gaborone, the 'park-and-ride' system could be as follows. Private commuters from Mochudi, Odi and Phakalane would drive their cars up to a car park just before the road junction to Sir Seretse Khama International Airport. They would park their private cars there and then take a bus shuttle to the city centre. Fringe car parks would also be built for commuters from Molepolole, Mogoditshane, Kanye, Gabane, Lobatse and Tlokweng. Franchises would be granted to bus operators to run shuttles from all these fringe car parks. This system would help to internalise the externalities of public transport.

Invariably, for the foregoing measures to succeed, concerted efforts should be made to improve bus services in Goborone. This would induce a change in perceptions and values about private car ownership. As implied earlier in this paper, an efficient public transport system can modify the attitude of people toward the ownership of vehicles. In the long run, people should be less inclined to own and use cars but instead rely on public transport. Another lesson of experience is that planners in Singapore decided to reduce traffic congestion before the problem worsened. The issue really is not about the scientific precision of road pricing or the merits and demerits of the scheme. The issue is about deciding to act before a problem becomes severe.

7. Summary and Conclusions

Traffic congestion imposes a heavy burden on society. The costs to society include the loss of fuel and time when motorists crawl through traffic jams. Traffic jams are stressful to drivers and also increase the opportunity cost of driving. Economic theory shows that public transport generates positive externalities known as decongestion benefits. However, public transport provided by the market system is a sub-optimal solution because the external benefits of public transport are not internalised. This paper discussed the rise in traffic congestion in Botswana. The problem essentially is that the volume of traffic in the country has risen at a faster rate than the road space can be expanded. Traffic congestion is a sign that demand is greater than the supply of road space. The empirical results of this study show that the most significant determinants of private vehicle ownership in Botswana are credit to the private sector, the exchange rate and road space.

This paper described efforts made to reduce traffic congestion and encourage the use of public transport in Singapore. Some aspects of the Singapore area license scheme can be adopted in Botswana. The paper explained how the 'park-and-ride' scheme can be operated in Gaborone. Solving the problem of traffic congestion in Gaborone can be a model of how to address the problem elsewhere in the country. The policy implications for Botswana include the need to solve the problem of traffic congestion before the problem worsens.

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Appendix

The total road network in Botswana consists of roads maintained by the central government and those maintained by local authorities. Table 1 in the Appendix shows the number of roads maintained by the central government during the period 1988-2002. These are the data shown plotted in Figure 2, against the registration of motor vehicles in Botswana. Although Figure 2 only shows the roads maintained by the central government, it is clear that the increase in road space is gradual while the rise in the number of registered vehicles is exponential. Table 2 shows the number of roads maintained by the local authorities in 2001 and 2002. There was a 12.5 percent increase in the length of roads maintained by local authorities, from 13, 503 kilometres in 2001 to 15, 186 kilometres in 2002.

Table 1: Roads maintained by the Central Government in Botswana (K'metres)

Year	Bitumen	Gravel	Sand	Total
1988	2,320	932	4,734	7,986
1989	2,483	932	4,631	8,046
1990	2,565	932	4,589	8,086
1991	2,831	932	4,371	8,134
1992	3,663	2,950	2,148	8,761
1993	3,874	2,739	2,148	8,761
1994	4,177	2,632	1,957	8,766
1995	4,761	2,087	1,957	8,805
1996	4,729	2,191	1,841	8,761
1997	4,789	2,131	1,841	8,761
1998	4,969	2,131	1,841	8,941
1999	5,570	2,688	1,959	10,217
2000	6,082	2,950	1,447	10,479
2001	6,421	2,611	1,447	10,479
2002	7,111	1,732	1,685	10,528

Source: Republic of Botswana (2003a :7).

Table 2: Roads maintained by Local Authorities in Botswana K'metres) District/Town

Council	Bitumen	Gravel	Earth/Sand	Total 2002	Total 2001
Selibe-Phikwe	96	11	27	134	133
Francistown	350	106	70	526	460
Lobatse	117	117	1	235	225
Jwaneng	82	14	34	130	130
Southern	686	506	1,540	2,732	1,874
Northeast	18	115	239	372	372
Kgatleng	31	89	380	500	400
Bobirwa	-	139	446	585	562
Mahalapye	152	164	340	565	565
South East	47	288	23	358	265
Kgalagadi	-	141	1,095	1,236	1,162
North West	82	400	1,494	1,976	1,942
Tutume	40	229	980	1,249	1,247
Boteti	5	133	340	478	341

Gaborone	550	235	30	815	815
Kweneng	145	298	792	1,235	1,048
Ghanzi	45	393	947	1,385	1,287
Serowe/Palapye	107	181	296	584	584
Total	**2,553**	**3,559**	**9,074**	**15,186**	**13,503**

Source: Republic of Botswana (2003a: 7).

Table 3: Correlation Matrix for the variables in the empirical model, equation (2)

	TVR	SPACE	GDP	PSC	EXC
TVR	1.000000	0.942119	0.861308	0.926287	0.866838
SPACE	0.942119	1.000000	0.886381	0.938295	0.916878
GDP	0.861308	0.886381	1.000000	0.971045	0.977742
PSC	0.926287	0.938295	0.971045	1.000000	0.957535
EXC	0.866838	0.916878	0.977742	0.957535	1.000000

Source: generated by EViews.