Improving Urban Mobility in Singapore: Vehicle Quotas and Electronic Road Pricing

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Urban congestion is a problem faced by many countries. Governments have tried to improve urban mobility in different ways, ranging from road taxes levied on car usage, toll charges for cars entering city business districts and other high-traffic areas during the day, as well as controlling the growth of the vehicle population through ownership taxes. Over the past four decades, Singapore has also grappled and successfully dealt with this problem. Situated at the Southern end of the Malayan Peninsula, Singapore is an island nation, measuring 42 km from East to West and 23 km from North to South, and with a land area of about 700 square km. A former British colony founded by Sir Stamford Raffles in 1819, Singapore attained self-government in 1959, joined Malaysia briefly in 1963 and became an independent nation in 1965. Singapore has enjoyed sustained and rapid economic growth, with an annual average growth rate of about 8 per cent till the mid-1990s.

In 1960, the level of motorization in Singapore was 50 cars per 1000 people, similar to levels in the UK and France then, but was substantially higher than other developing countries and Japan (10 cars per 1000 people). By 1995, with a per-capita GDP of S$33,520 at 1995 prices (or US$19,154, at an 2003 exchange rate of US$1= S$1.79), comparable to the levels in UK, France and Japan, the level of motorization in Singapore, at 105 cars per 1000 people, was about a quarter of the levels experienced in these three countries. At present, Singapore has about 3,200 km of roads for 4.2 million people and about 750,000 registered motor vehicles. Urban congestion not only creates air and noise pollution, but also increases the cost of doing business. This was a particularly serious problem for Singapore in the early 1970s, when traffic during the morning and evening rush hours in the business district slowed to a crawl of about 20 km per hour. Recognizing the repercussions on foreign direct investments into Singapore, the government tackled the problem by formulating a transport policy, which has evolved over the decades. For a country without much natural resources, managing traffic congestion and improving urban mobility was an important part of Singapore's broader strategy to attract multinational corporations to locate their operations in the city-state, and to draw in foreign direct investments.

The private vehicle population in Singapore roughly doubled, from 70,100 to about142,500 over the period 1960-1970, as a result of rising household incomes, a housing programme to develop residential districts in the suburban areas, and slow improvement in public transportation facilities. Over the same period, public buses and taxis increased by about 64 per cent, while the total length of public roads increased by only about 35 per cent. The length of major arterial roads was 240 km in 1970, an increase of over 12 per cent since 1960. With the number of private cars per km of arterial roads rising from 328 in 1961 to 594 in 1970, urban mobility was fast deteriorating in Singapore. The only modes of public transport then were taxis and bus. Although there were ten bus companies, services were infrequent and schedules were uncoordinated. In 1970, the government directed the bus companies to merge into four companies and to substantially expand their fleets. In 1973, these four companies were nationalized and merged to form a new bus company, the Singapore Bus Services. This move resulted in swift and significant improvements in both the quality and quantity of public bus services.

The other significant measures that had been implemented to improve urban mobility included the implementation of an Area Licensing Scheme (ALS), the Vehicle Quota System (VQS) and the Electronic Road Pricing Scheme (ERP) to control urban congestion. The ERP (and its antecedent, the ALS) represents a sophisticated form of marginal cost pricing of road usage, while the VQS remains the only scheme in the world to directly control the growth rate of the vehicle population to manage urban congestion. A key motivation behind the introduction of the VQS, the first of its kind in the world, is the concern that, with rising affluence, existing ownership taxes were not effective in controlling the growth in the vehicle population. Periodic increases in the ARF were politically unpopular. Moreover, announcements of impending increases in ARF had the effect of bringing forward car purchases. Under the VQS, a car buyer must first obtain a license, referred to officially as a Certificate of Entitlement (COE). Each license allows the vehicle to be on the roads for ten years, after which the vehicle must be

deregistered, or the license renewed for a further 5-year or 10-year period, by paying a "prevailing quota license premium", which is the three-month moving average of the license premium.

Before the VQS was introduced, the expansion of the vehicle population in Singapore was controlled through a range of ownership taxes, including a road tax (based on engine capacity), an import duty, a fixed registration fee, and an additional registration fee (ARF). The ARF has been in place since the late 1950s, when Singapore was still under British colonial rule. Intended originally as a revenue-raising measure, the ARF is an *ad valorem* duty on a vehicle's open market value (OMV), which is essentially the same as cost plus insurance and freight, payable by buyers of new motor vehicles, in addition to an administrative fee, referred to as the Basic Registration Fee (BRF). The ARF was later expanded in scope to control car ownership, and its rate was steadily raised through the 1970s, reaching 125 per cent in 1978 and 150 per cent in 1980. However, as the ARF rate rose, it also discouraged existing vehicle owners from replacing their cars and encouraged new car buyers to buy used cars. Concerned with a stock of aging vehicles, a Preferential Additional Registration Fee (PARF) was introduced to counterbalance the disincentives on vehicle renewal, when the applicable ARF rate was raised to 100 per cent in 1975. The purchaser of a new vehicle paid a substantially lower PARF rate if he de-registered an old vehicle (i.e. by exporting or scrapping it) of the same engine category at the time of his new purchase. PARF rates varied according to the engine capacity; for example between December 1975 and October 1983, they ranged from 35 per cent (expressed as a percentage of the required ARF payment) for the smallest engine category (<1000cc) to 55 per cent for the largest engine category (<3000cc). Since 1997, the PARF has been amended to a system where the applicable discount is a function of the age of the vehicle to be de-registered. In 2003, de-registering a vehicle under 5 years old qualifies for a 25 per cent PARF rate and de-registering a vehicle between 9 and 10 years old qualifies for a 50 per cent PARF rate. Vehicles over 10 years old no longer qualify for PARF treatment.

The Area Licensing Scheme (ALS) was implemented in 1975. Vehicles entering the 7 km^2 restricted zone, which included the central business district (CBD), were required to purchase and display a paper area license on their windscreen. Enforcement was done manually by enforcement officers standing at the boundaries of the RZ. Offending vehicles were not stopped but issued a summons through the post. Drivers could either appeal to the Traffic Police Department or pay the stipulated fine. When the ALS was initially implemented, the restricted hours were from 7.30 to 9.30am daily, except on Sundays and public holidays. No discounts or exemptions were given for residents living inside the RZ. Three weeks later, the restricted hours were extended to 10.15am in order to reduce the excess traffic occurring immediately after 9.30am, as motorists rescheduled their trips to just before and after the restricted hours and businesses delayed their opening hours to avoid paying the area license fee. In June 1989, the scheme was further extended to the evening peak, from 4.30pm to 7pm on weekdays. The evening period was later cut back by half an hour to 6.30pm to accommodate requests from residents who lived inside the charging area but worked outside, although this was subsequently extended back to 7pm, because of increased traffic congestion. In January 1994, the operating hours of the scheme were further extended to cover the inter-peak period, from 10.15am to 4.30pm on weekdays and the post-peak period of 10.15am to 3pm on Saturdays. The Saturday charging hours were later cut back to 2pm. A vehicle displaying the license could enter and leave the RZ an unlimited number of times during the day. In the beginning, taxis, buses, goods vehicles, motorcycles, and passenger cars carrying three or more passengers apart from the driver were all exempted. Later, taxis were required to purchase the permit as well. In 1989, motorcycles and goods vehicles, were also required to purchase the permit, together with car-pools.

The ALS was effective in reducing urban congestion during the morning and evening peak hours. Many studies conclude that the charges were set too high initially and reduced traffic by more than was necessary, leading to under-utilization of the road network and in the process shifting congestion to the expressways and non-restricted times. Upon introduction of the ALS, the volume of cars entering the RZ during the restricted period fell by 73 per cent whilst the volume of cars entering the RZ outside the restricted times rose by 23 per cent. Average speeds went up from 19 to 36 km per hour, exceeding the government's optimal flow target. In January 1994, an alternative 'part-day' license was introduced. Thus, vehicles could purchase a license to enter the RZ throughout the day, or a license that would only allow them to enter the RZ during the inter-peak period. The inter-peak ALS charges were two thirds of the whole day ones. For cars, the fees were S$3 and S$2 respectively. Part-day licenses were valid for use between 10.15AM and 4.30PM on weekdays, and from 10.15am to 3pm on Saturdays.

In 1998, with the advancement in technology, electronic road pricing (ERP) replaced the ALS. Gantries were installed at all the approach roads to the ERP zone and on the expressways. The ERP

scheme charges vehicles each time they cross a gantry. The system uses a dedicated short-range radio communication system. Since 1996, all vehicles in Singapore are fitted with an In-vehicle Unit (IU), which consists of a radio transponder in which a stored-value smart card is inserted. The fees are deducted from the smart card when a vehicle passes under a gantry at the restricted times, and the IU displays the remaining balance on the smart card. ERP charges vary between different gantries and different times of the day, depending on the level of congestion. The ERP scheme originally applied during the morning peak times only on expressways and from 7.30am to 7pm in all areas that had been covered by the ALS. The charges are reviewed quarterly and for the June and December school holidays to achieve an optimal flow of traffic.

In principle, usage taxes can fully internalize congestion externalities, as these taxes directly affect the cost of urban travel. The main justification for a quota system is that they allow for tighter control over the size of the vehicle population, which in turn affects the magnitude of potential urban congestion. Clearly, in a world of certainty, ownership taxes and a quota system are clearly equivalent means to control the vehicle population. However, when the demand for vehicles varies over time and cannot be forecast accurately, controlling the growth rate of motor vehicle population requires periodic adjustments of the various taxes to check the increase in the vehicle population. On the other hand, a vehicle quota system provides almost complete control over the growth of the vehicle population, but leads to fluctuations in license prices and uncertainty in the cost of vehicle ownership.

The VQS came into effect in May 1990. Every quota year beginning in May (following the first auction in May 1990), the available quota for new motor vehicles is determined in accordance with a targeted rate of growth in the vehicle population, and taking into account the forecast de-registration of vehicles in the coming year. The Land Transport Authority of Singapore (LTA) releases on its website (http://www.lta.gov.sg) the exact calculations for the target vehicle population and the number of vehicle licenses available for auction each month. To allow changes in tastes to influence the composition of the vehicle population over time, 25% of the licenses created from the deregistered vehicles in each category are allotted to the "Open" category, where the quota licenses can be used to register motor vehicles belonging to any of the quota categories. The other 75% of the new quota licenses are allocated back to the original category. From May 1990 to June 2001, the vehicle licenses were allocated on monthly basis via a sealed-bid auction, where successful bidders pay the lowest successful bid. Following a government review in 1999-2000, the bidding format for the vehicle quota license auctions switched to an online open-bid format in several phases, beginning in July 2001. Currently, two auctions are held each month. Bidders can see, in real time, the market clearing bids at each point in time before the auction closes. Bidders can update their valuations, decide to enter or drop out of the auction, or revise their bids on-line.

Under the VQS, motor vehicles are classified into several categories, with a separate license quota for each category. When first introduced in 1990, there were seven quota license categories, namely: Category 1 for cars of 1000 cc and below; Category 2 for cars of 1001-1600 cc and below, and taxis; Category 3 for cars of 1601-2000 cc and below; Category 4 for cars of above 2000 cc; Category 5 for goods vehicles and buses; Category 6 for motorcycles; Category 7, an "Open" category for registration of all types of vehicles. Following a review of the VQS, Categories 1 and 2 were merged in May 1999 into one category to form Category A for cars of 1600cc and below, and taxis. Similarly, Categories 3 and 4 were merged to form Category B for cars of 1601 cc and above. Under the revamped classification, Categories 5, 6 and 7 were renamed as Categories C, D and E, respectively. In May 1991, a "weekend" car quota license category was also introduced, but later abolished in 1994. The weekend car was originally conceived as a measure to broaden the ownership of vehicles among Singaporeans who wanted the convenience of private transport but only outside of office hours and weekends. Besides Saturday (after 1 pm) and Sunday, the weekend car can be used during public holidays, and at specific times during weekdays (before 7 am and after 9 pm). Outside of these permitted times, weekend car owners may use the cars during weekdays by purchasing a S$10 daily license for half-day usage, or a S$20 daily license to full-day usage. The option to purchase daily-usage licenses led to situations where the estimated total license cost of a weekend car for normal usage (every day, over 10 years) was substantially lower than the price of a vehicle license of a non-weekend car.

The key advantage of a VQS in improving urban mobility is direct control over the vehicle population which is the key factor in urban congestion. Congestion-free roads and its urban infrastructure form part of its competitive advantages to attract investments and businesses to Singapore. However, the adverse impact of fluctuations in license premiums and the consequent uncertainty over the cost of car ownership that the population is subject to has prompted calls for the vehicle quota system to

be modified to improve social welfare. Motorists complained about the presence of speculation and the consequent volatile movements in license prices. When the VQS was first introduced in 1990, speculation drove the price of vehicle licenses, then transferable, to levels as high as US$70,000 in 1994 – about the price of a luxury car in Singapore. This led to calls to abolish the license transferability. The licenses were soon made non-transferable, but although this eliminated the speculative trade, the effect is to make the quota system less efficient, as the presence of a secondary market trading in a way facilitated the optimal (re)allocation of the quota licenses as market conditions change.

Besides calls for the removal of license transferability, there were also suggestions to do away with sub-categorization, and have only one category of car licenses. The original rationale behind sub-categorization is to ensure that buyers of smaller cars do not compete with and pay the same license premiums as the buyers of large cars; however, the actual experience proved otherwise. The prices for licenses of smaller cars were often as high, if not higher, than those for larger cars. Since the vehicle license premium is fundamentally another ownership tax, it has been argued that it would be more socially equitable to have a system whereby car buyers bid a percentage of the car value that they are willing to pay as additional road tax. In this way, although the buyers of large cars pay the same percentage of ownership tax as buyers of smaller cars, they would pay more in absolute amounts.

The VQS has succeeded in controlling the growth of Singapore's vehicle population. The average annual vehicle growth rate stayed at 3% from 1990 to 2005. By comparison, the average annual growth in the vehicle population during the 1975-1989 period (before the VQS was introduced) was 4.4%. The VQS has also generated auction revenues exceeding US$12 billion. Although the auction revenues are not channeled into a specific account to finance the development of transport infrastructure – such as the expansion of the mass rapid transit (MRT) rail system – or to increase the capacity of the road networks, these revenues had made it possible to fund the construction of the underground rail system. The development and continual expansion of the MRT system has cut travel time, improved the quality of urban travel, as well as reduced urban congestion, as more commuters switched from traveling by bus to the MRT system and fewer cars are driven into the central business district.

Besides controlling the growth of the vehicle population, investment to expand the road infrastructure was another important part of the strategy improving urban mobility. Beginning in the mid-1970s, there was a substantial expansion in the strategic road network of arterials and motorways, with a six-fold increase in investments in road construction and upgrades between 1975 and 1980. Road density doubled between 1975 and 1985, and tripled by 1997. Between 1996 and 2001, the road network increased by 415-lane-km. In the 1980s, the construction of a mass rapid rail system across the whole island began in the 1980s, and is still ongoing. By 2010, a new Circle Line System will be added to the expanding MRT system. With further investment in the road infrastructure, the vehicle population has been allowed to grow, without compromising the objective to control urban congestion. Going forward, with the expansion (and refinement) of the electronic pricing scheme to more parts of the city-state, the cost of car ownership will be gradually shifted to towards a usage-based charge, in line with the economic principle of marginal-cost pricing for road usage. To conclude, Singapore's bold strategy in controlling urban congestion provides an interesting case study for other countries grappling with the problem of improving urban mobility.