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Rationing Rules and Outcomes: The Experience of Singapore's Vehicle Quota System

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Rationing Rules and Outcomes: The Experience of Singapore's Vehicle Quota System

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Abstract

Since 1990, Singapore has sought to control motor vehicle ownership by means of an auction quota system, whereby prospective vehicle buyers need to obtain a quota license before they can make their purchase. This paper assesses the success of the vehicle quota system in meeting its objectives of stability in motor vehicle growth, flexibility in the motor vehicle mix, and equity among motor vehicle buyers. Two important implementation issues—quota subcategorization and license transferability—are highlighted, and policy lessons are drawn for the design of auction quotas in general.

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I. Introduction

Since 1990, Singapore has sought to control the rate of growth of its motor vehicle population by means of a unique auction quota system. Under the vehicle quota system (VQS), the government fixes the number of new motor vehicles allowed on the road each year, then allocates approximately one-twelfth of this annual quota to the public each month by means of a sealed bid uniform price auction. Prospective motor vehicle buyers first have to obtain a quota license (called a certificate of entitlement) before they are allowed to make their purchase.

There is a longstanding literature on optimal government intervention to achieve non-economic objectives. This literature concludes that in the presence of the constraint that domestic consumption of a good not exceed a certain level, the social utility maximizing policy is a consumption tax on the good.[2] Assuming that the objective is to limit motor vehicle ownership and assuming that there is perfect competition in the motor vehicle market, an auction quota would be equivalent to an import tariff, which, in turn—given that Singapore has no domestic automobile manufacturing industry—would be equivalent to a consumption tax. Theoretically, therefore, it could be argued that the VQS is an efficient method of restricting the number of new motor vehicles each year.

In practice, however, the implementation of the VQS involves many rules and restrictions which tend to have highly distortionary effects. This paper highlights two important implementation issues: quota subcategorization and license nontransferability. The first issue refers to the practice of subdividing the overall quota into smaller quotas: under the VQS, motor vehicles are classified into different categories based on type and size, with separate quotas for each category. The second issue refers to the practice of prohibiting resale of quota licenses: when the VQS was first introduced in 1990, quota licenses were transferable across buyers but after about a year, the quota licenses were made nontransferable. These restrictions—subcategorization and nontransferability—were introduced with the aim of achieving a lower and fairer tax burden; however, as the data will show, the outcomes were not always as expected.

Much has already been written about Singapore's VQS. However, this literature has largely considered the issue in the wider context of transportation policy and congestion management.[3] The focus of this paper is not on the effectiveness of the VQS in addressing the problem of traffic congestion.[4] Instead, the focus is on the effectiveness of the implementation of the VQS, taking its objective of restricting vehicle ownership as given.

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[2] See Bhagwati and Srinivasan (1969), for example.

[3] See Phang, Wong, and Chia (1996) and Toh and Phang (1997), for example.

[4] In that regard, one may argue that it would be more effective to target motor vehicle usage rather than ownership. See Chia, Tsui, and Whalley (2001) for a fuller discussion.

Quota rationing schemes are employed throughout the world to restrict commodities as varied as fishery licenses to taxicab medallions. Auction quotas have been used or considered for allocating pollution permits, import licenses, radio frequencies, and foreign work permits, among other things. Traditionally, little attention has been given to the implementation rules of such schemes although more recently, Krishna and Tan (1997, 1998, 1999) have developed some theoretical models of quota implementation. This paper applies theoretical and empirical analysis to the VQS to demonstrate that quota implementation rules matter a great deal in practice as well as in theory. Thus, the experience with the VQS so far may offer potentially useful policy lessons in other applications.

The rest of the paper is organized as follows. Section II describes the workings of the VQS. Section III gives an overview of the outcomes of the auctions. Section IV focuses on the issue of subcategorization. Section V focuses on the issue of transferability. Section VI concludes with some policy lessons for quota implementation in general.

II. The Vehicle Quota System

The VQS became effective in May 1990. Prior to that, the rate of growth of motor vehicle ownership was controlled primarily through price-based measures, including a road tax, an import duty on motor vehicles, a lump-sum registration fee, as well as an ad valorem additional registration fee.[5] Both the road tax and the additional registration fee were increased periodically, the latter from 15 percent of the motor vehicle's open market value in the early 1970s to 175 percent in 1990.[6] From 1975 to 1989, the annual rate of motor vehicle growth averaged 4.4 percent, but with substantial year-to-year fluctuations, with growth ranging from 9.6 percent in 1980 and 1982 to –2.7 percent in 1986.

The inability of the pricing mechanism to restrain and stabilize the motor vehicle growth rate was what prompted the Singapore government to introduce a quota system for new vehicles. The quota system operates on top of the tax measures.[7] Its purpose is to ensure that a targeted number of motor vehicles is maintained annually through fixing the rate of increase of new motor vehicles each year. Thus, the VQS is supposed to limit the volatility in the annual rate of motor vehicle population growth, leaving motor vehicle prices to fluctuate according to the level of demand.

The VQS works in the following way. Each year, the quota for new motor vehicles is determined so as to obtain a targeted rate of growth in the total motor vehicle population.

[5] See Phang, Wong, and Chia (1996) for a description of the motor vehicle tax structure and policies in Singapore prior to the introduction of the VQS.

[6] The open market value is the c.i.f. import price of the motor vehicle. It comprises the manufacturer's price plus freight and insurance costs.

[7] Subsequent to the introduction of the VQS, the additional registration fee was reduced in two steps to 150 percent by February 1991. The motor vehicle tax structure was further rationalized in 1998, following the introduction of electronic road pricing.

(The quota year starts in May.) Since the change in the total motor vehicle population is given by the number of new registrations minus the number of deregistrations, and any unallocated quota in a given year may be carried over to the following year, the quota formula is as follows:

$$\begin{pmatrix}\text{Total}\\ \text{motor vehicle}\\ \text{quota}\end{pmatrix}_{qy} = g.\begin{pmatrix}\text{Motor}\\ \text{vehicle}\\ \text{population}\end{pmatrix}_{y-1} + \begin{pmatrix}\text{Projected}\\ \text{deregistrations}\end{pmatrix}_{y} + \begin{pmatrix}\text{Unallocated}\\ \text{quota}\end{pmatrix}_{qy-1}. \tag{1}$$

Each year, the quota is set to allow for a targeted g percent growth in the total motor vehicle population, plus additional quota licenses to cover the number of motor vehicles that will be deregistered during the (calendar) year, plus any unallocated quota licenses from the previous quota year. The rate of growth, g, was initially fixed at 4.3 percent, then reduced to 3 percent. In the formula above, the subscript y denotes calendar year and the subscript qy denotes quota year (which runs from May to April). Initially, projected deregistrations for (calendar) year y were simply taken to be equal to actual deregistrations in $y-1$ but from quota year 1999–2000 onwards, the authorities have employed a formula to project the number of deregistrations in year y. The formula is not disclosed; only the result is published.

At the beginning of each month, approximately one-twelfth of the quota is auctioned to the public. Prospective motor vehicle buyers have to obtain a quota license in the appropriate category before they are allowed to make their purchase. Any unallocated licenses are added to the quota in the next auction.

The quota licenses are sold through sealed-bid, uniform price auctions. Each individual is allowed to submit only one bid. Each bidder is required to leave a deposit equal to half his bid amount. The minimum bid is \$1, and bids must be in multiples of \$1.[8] Successful bidders pay the lowest winning bid; the difference between the quota premium and the deposit amount is due at the time of registration of the motor vehicle. (If the deposit exceeds the quota premium, the difference is applied toward the buyer's registration fees). Unsuccessful bidders are refunded their deposits.

Initially, the government planned to hold quarterly auctions of quota licenses: the first auction took place in April 1990 and the quota licenses issued during that auction were valid for six months from May 1990 to October 1990, i.e., they had to be used to register a new motor vehicle within that time period. Hence, the quota system is considered to have taken effect from May 1990. After the first auction, the frequency of the auctions was increased to once a month, and the validity period of the quota license shortened to three months. In

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[8] References to \$ are to Singapore dollars. The average exchange rate per US\$1 was:

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.81	1.73	1.63	1.62	1.53	1.42	1.41	1.48	1.67	1.69	1.72

October 1991, the validity period of the quota license for certain categories was lengthened to six months (see Section V below).

The quota license has a life span of ten years. At the end of this period, the motor vehicle owner may either deregister the vehicle—export it or scrap it—or renew the license for a further five or ten years by paying what is called the "prevailing quota premium".[9] If the motor vehicle is sold (within the country) before the expiry of its quota license, the quota license will be transferred to the buyer together with the vehicle; the seller will have to bid for a new quota license if he wishes to purchase a new vehicle. If a motor vehicle is deregistered before the expiry of the quota license, the owner is entitled to a rebate on the quota premium paid, pro-rated to the remaining life span of the license.

Under the VQS, motor vehicles are divided into several different categories, with a separate quota for each category. Prior to May 1999, there were seven quota categories:

- Category 1: Small cars with engine capacity of 1,000 c.c. and below;
- Category 2: Medium-sized cars with engine capacity of 1,001 to 1,600 c.c., and taxis;
- Category 3: Large cars with engine capacity of 1,601 to 2,000 c.c.;
- Category 4: Luxury cars with engine capacity of 2,001 c.c. and above;
- Category 5: Goods vehicles and buses;
- Category 6: Motorcycles and scooters; and
- Category 7: "Open".

Category 7 ("open") quota licenses may be used to purchase any type of motor vehicle.[10] In May 1999, the number of categories was reduced to five: categories 1 and 2 were merged and redesignated category A; categories 3 and 4 were merged and redesignated category B; and categories 5, 6, and 7 were renamed categories C, D, and E respectively. Subcategorization is discussed further in Section IV.

III. AUCTION OUTCOMES: PRELIMINARY EVIDENCE

Has the VQS been successful in controlling the rate of motor vehicle growth? The average annual motor vehicle growth rate during 1975–89 (prior to the introduction of the VQS) was 4.4 percent, with a standard deviation of 4.24 percent. The average annual motor vehicle growth rate during 1990–99 (under the VQS) was 2.9 percent, with a standard

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[9] The prevailing quota premium for a given quota category is computed as a three-month moving average of the quota premium of that category. (Prior to November 1998, a twelve-month moving average was used.)

[10] Bidders of motorcycles in the open category paid one third of the quota premium in that category.

deviation of 2.06 percent. Thus it appears that the VQS has been successful in lowering the average annual rate of motor vehicle growth and its volatility.

There are two points worth noting here. First, the VQS targets the annual growth of the total motor vehicle population, not the growth of new vehicle registrations; the latter has ranged from 22 percent in 1999 to –8.3 percent in 1996, partly because the quota growth rate itself has fluctuated substantially from year to year.[11] Second, the VQS has succeeded only in reducing the volatility in annual motor vehicle growth, not eliminating it.[12] The annual motor vehicle growth rate has ranged from –0.3 percent (in 1992 and 1998) to 5 percent (in 1995). The motor vehicle growth rate is determined by both the number of new motor vehicles registered and the number of motor vehicles deregistered during the year, but the quota only applies to new registrations. Hence each year's quota incorporates a projection of the number of deregistrations during that year. The quota will miss its target if the projection is inaccurate (the actual number of deregistrations each year has fluctuated between 22,000 in 1995–96 and 54,000 in 1998–99) or if the quota is underutilized.

The reduction in quantity uncertainty has been replaced with an increase in price uncertainty. Figure 1 shows the movement of the quota premiums for the seven categories over time: the most striking feature of the graphs is the volatility of the premiums. Although the quota premiums of all categories exhibit a general upward trend, the monthly fluctuations are sizeable. Furthermore, the quota premiums seem to follow more or less the same general pattern: an initial increase, followed by a dip in the last quarter of 1990, a rebound in the first quarter of 1991, and much higher values thereafter. Category 6 (motorcycles) was a special case where the quota premium fell sharply in September 1991 and continued to decline to the minimum bid of $1, at which it remained until March 1994. This was due to the imposition of stricter emission standards effective from October 1991: most of the motorcycles in the market at the time did not meet the standards and redesigned models were not expected for some time.

IV. Subcategorization

As mentioned earlier, separate quotas are specified for different sizes and types of motor vehicle. The subcategorization was introduced to allay fears that the quota system would favor the rich. By holding separate auctions for each category, it was envisioned that

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[11] During 1991/92 to 1998/99, the average annual quota growth rate was 5.2 percent, with a standard deviation of 35.5 percent. The annual quota growth rate was as high as 57.5 percent in 1992/93 and as low as –54.6 percent in 1994/95.

[12] These two points are often missed. For example, Phang, Wong, and Chia (1996, p.148) state that the VQS has "achieved the planners' intention of achieving absolute certainty in the numbers of cars registered in Singapore". Toh and Phang (1997, p.29) state that the VQS has "achieved certainty in the maximum number of new motor vehicle registrations each year"—this is true by definition but says nothing about the effectiveness of the VQS in meeting its objective.

lower-income motor vehicle buyers would not have to bid against wealthier motor vehicle buyers for quota licenses. This is particularly the case for cars, which—up to the May 1999 auction—were subdivided into four categories on the basis of engine capacity: small cars (category 1); medium sized cars (category 2); large cars (category 3); and luxury cars (category 4).

The conventional wisdom holds that subcategorization is an undesirable policy since it can lead to situations where the quota is not binding in certain subcategories and very binding in others, resulting in underutilization of the total quota despite a positive quota premium in the binding subcategories. This phenomenon has certainly been observed under the VQS. As noted previously, there was a collapse in the demand for motorcycles during 1992–93 so that the quota for category 6 licenses (which represented approximately 20 percent of the total quota) was not binding during that time. As a result, the percentage of total quota that went unallocated was 6 percent in 1991–92, 34 percent in 1992–93, and fully 51 percent in 1993–94.[13] During that time, the maximum quota premium in the other categories was as high as $65,000.

Despite this, subcategorization can be (theoretically) desirable under certain conditions, depending on the environment and the objective of the authorities. Krishna and Tan (1997) present a series of stylized targeting models to illustrate these arguments.

The rationale for subcategorization in the VQS may be analyzed using a partial equilibrium framework similar to Krishna and Tan (1997). For simplicity, consider only two categories: category 1 (small cars) and category 2 (large cars). Assume that: (i) the market for cars is perfectly competitive; (ii) there is no substitution across categories; (iii) all cars are imported; and (iv) Singapore is a price-taker on the world market for each category, so that the supply of each category is horizontal at the given world price for that category. Let Q_i represent the quantity of category i cars; $D_i(Q_i)$ the inverse demand function of category i cars; and P_i the given world price for category i cars (inclusive of taxes and other charges), where i=1,2.

Suppose a binding quota of V units is imposed on both categories combined. The quota will introduce a wedge between the demand price, $D_i(Q_i)$ that consumers are willing to pay for the restricted cars and the supply price, P_i. This wedge, $D_i(Q_i) - P_i$ measures the value of the quota license to purchase a category i car. Left to market forces, arbitrage will ensure that the allocation of licenses between the two categories will be such that at the margin, the value of a quota license for a category 1 car is equal to the value of a quota license for a category 2 car. The equilibrium condition under competitive market allocation is thus: $D_1(Q_1) - P_1 = D_2(Q_2) - P_2$, with $Q_1 + Q_2 = V$. These equations implicitly define the

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[13] In general, some 1–3.5 percent of the total quota goes unallocated each year due to the fact that no tie-breaking procedure exists for identical bids at the cutoff level. For example, if the quota is 15 and there are 10 bids of $15,000 and 10 bids of $10,000, then 10 licenses will be allocated at the lowest successful bid of $15,000; the remaining 5 licenses will not be allocated but carried over to the next auction.

equilibrium allocation of category 1 and 2 licenses under competitive market conditions, subject to the total quota, V. Denote these equilibrium quantities as q_1 and q_2 respectively, and the equilibrium quota premium as L. This is illustrated in Figure 2 where the number of category 1 cars is measured rightward from the O_1 axis and the number of category 2 cars is measured leftward from the O_2 axis, where the distance between O_1 and O_2 is V.

But will small car buyers necessarily be squeezed out of the market in the absence of subcategorization? Clearly, if $D_1(Q_1) - P_1$ is very low relative to $D_2(Q_2) - P_2$, then q_1 will be very small relative to q_2; at the extreme, a corner solution could obtain whereby $q_2 = V$ and $q_1 = 0$. To be sure, one would expect that at any given quantity, the inverse demand function for small cars will be lower than that for large cars, i.e., $D_1(Q_1) < D_2(Q_2)$, since one can think of large cars as being of a higher quality (or providing more "services") than small cars.[14] But one would also expect that the world price of small cars will be lower than the price of large cars, i.e., $P_1 < P_2$. Hence, a priori there would be no reason to expect $D_1(Q_1) - P_1$ to be necessarily lower than $D_2(Q_2) - P_2$, and so no reason to expect q_1 to be necessarily smaller than q_2. However, it will be true that $L/P_1 > L/P_2$ so the overall quota would be relatively unfair to small car buyers as it would result in a higher tax burden for them compared to large car buyers. By contrast, a fairer outcome could be achieved by subdividing the quota such that: $D_1(Q_1)/P_1 = D_2(Q_2)/P_2$, with $Q_1 + Q_2 = V$. The resulting allocation will be v_1 and v_2, as shown in Figure 2, such that $L_1 < L_2$ and $L_1/P_1 = L_2/P_2$.

The above analysis assumed no substitution between the two car categories. If substitution is possible, then the equilibrium market allocation of category 1 licenses will be less than q_1 and the equilibrium allocation of category 2 licenses will be greater than q_2. This is because the overall quota raises the price of small cars relative to large cars, resulting in substitution away from the former toward the latter. In this case, small car buyers are not being squeezed out but are voluntarily upgrading to larger cars. Falvey (1979) analyzes such a case.

A. Categories 1–4: Cars

Has quota subcategorization succeeded in achieving the objective of equity? The data indicate that the answer is no. Figure 3 plots the quota premiums of categories 1, 2, 3, and 4 on the same axis. If subcategorization worked as it should have, the line representing category 1 quota premiums should lie everywhere below the line representing category 2, which should in turn lie everywhere below the line representing category 3, and so on. This is evidently not the case—as can be seen in Figure 3, the lines intersect at several points.

Table 1 shows that of the 106 auctions between May 1990 and April 1999, category 1 premiums ranked the lowest of the four car categories in 86 auctions (81 percent of the time);

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[14] Following Swan (1970), the quality of a product may be thought of as the amount of services obtained from its consumption. These services are a homogeneous good with a uniform price. To the extent that two products embody unequal amounts of services, they will differ in quality and hence, in price.

category 2 premiums ranked second lowest in 62 auctions (58 percent of the time); category 3 premiums ranked second highest in 52 auctions (49 percent of the time); and category 4 premiums ranked highest in 57 auctions (54 percent of the time). But the desired outcome of $L_1 < L_2 < L_3 < L_4$ occurred in only 45 of the 106 auctions—in other words, over half of the auctions involved an instance where the quota premium for a smaller car exceeded that of a larger car. In 14 of these cases, category 1 quota licenses cleared at a higher price than category 4 quota licenses;[15] in two instances (the November 1990 auction and the October 1998 auction), category 1 quota licenses were the most expensive of all the categories auctioned.

Even in those instances where the quota premiums for smaller cars turned out to be lower than those for larger cars, the relative tax burden still fell disproportionately more on small car buyers. For example, in January 1992, the quota premium was \$10,100 for category 1 cars; \$16,602 for category 2 cars; \$18,500 for category 3 cars; and \$19,666 for category 4 cars. During that period, the open market value averaged around \$8,500 for category 1 cars; \$13,500 for category 2 cars; \$24,500 for category 3 cars; and \$70,000 for category 4 cars. Thus, the implicit tax rate was approximately 119 percent for category 1 cars; 123 percent for category 2 cars; 75 percent for category 3 cars; and 28 percent for category 4 cars.

These results highlight the pitfalls of subcategorization. In practice, the shape and position of the demand curves are not known with any degree of precision, so that fixing separate quotas for each category becomes a guessing game. As evidenced by the data, over half of the time one or more of the guesses have been off the mark, with the quotas for small and medium sized cars set too low and the quotas for large and luxury cars have been set too high relative to their demands.

B. Category 7: The Open Category

The rationale for the open category was to introduce flexibility in the motor vehicle mix. Quotas for the different categories are based on their proportion in the total motor vehicle population at the end of the previous (calendar) year. It was thought that by allowing a portion of the total quota to be "open", i.e., usable in any category, there would be some room for deviation from the previous year's motor vehicle mix based on changes in demand.

In practice, the annual quota for each category is determined as follows:

$$\begin{pmatrix}\text{Category } i\\ \text{quota}\end{pmatrix}_{qy} = g.\begin{pmatrix}\text{Category } i\\ \text{population}\end{pmatrix}_{y-1} + \alpha.\begin{pmatrix}\text{Projected}\\ \text{category } i\\ \text{deregistrations}\end{pmatrix}_{y} + \begin{pmatrix}\text{Unallocated}\\ \text{category } i\\ \text{quota}\end{pmatrix}_{qy-1} \quad (2)$$

[15] These 14 cases occurred between May 1990 and November 1998.

for $i = 1,\ldots,6$, where the subscripts y and qy are defined as before. The target growth rate, g, is the same for all categories; as mentioned earlier, it was 4.3 percent initially, later reduced to 3 percent. The parameter, α was initially set at 70 percent but raised to 75 percent in December 1992. So the quota for category i in, say, quota year 1998–99, would have been equal to 3 percent of the number of category i vehicles in December 1997 plus 75 percent of the number of category i vehicles deregistered in 1997 plus any unused category i quota licenses carried over from quota year 1997–98. The annual quota for category 7 is determined as follows:

$$\begin{pmatrix}\text{Category 7}\\ \text{quota}\end{pmatrix}_{qy} = (1-\alpha)\begin{pmatrix}\text{Projected}\\ \text{total}\\ \text{deregistrations}\end{pmatrix}_{y} \tag{3}$$

where α is defined as above.

The following example illustrates how the quotas evolve over time. Let i denote vehicle category ($i = 1,\ldots,6$); category 7 is the open category. For simplicity, assume that: (i) all quotas are fully utilized every year so there is no carryover; (ii) a fraction δ_i of the previous year's population of category i vehicles is deregistered every year; and (iii) the deregistrations are evenly distributed throughout the year so the quota year is effectively equivalent to a calendar year (denoted by t). Denote quota by V_{it}, deregistrations by R_{it}, and vehicle population by Q_{it}.

The initial (year 1) quotas for the seven license categories will then be:

$$\begin{aligned} V_{i1} &= gQ_{i0} + \alpha R_{i1} = (g + \alpha\delta_i)Q_{i0} \\ V_{7,1} &= (1-\alpha)R_1 \end{aligned} \tag{4}$$

where $R_1 = \sum_{i=1}^{6} R_{i1}$, and g and α are defined as above. The total quota is $V_1 = \sum_{i=1}^{6} V_{i1} + V_{7,1}$. Suppose a fraction λ_{it} of the open quota is utilized in category i, where $\sum_{i=1}^{6} \lambda_{it} = 1$. Then during year 1, the population of each vehicle category will increase by the following amount:

$$\Delta Q_{i0} = V_{i1} + \lambda_{i1}V_{7,1} - R_{i1} = \left(g - (1-\alpha)\delta_i\right)Q_{i0} + \lambda_{i1}(1-\alpha)R_1 \tag{5}$$

Hence, the rate of population growth of category i vehicles may be greater or smaller than g, depending on the utilization of open licenses and the rate of deregistrations. Specifically, the rate of population growth for category i is greater than g if $\lambda_{i1}R_1 > R_{i1}$ (i.e., if the number of open category licenses used to register category i vehicles exceeds the number of category i deregistrations) and less than g if $\lambda_{i1}R_1 < R_{i1}$. The rate of total vehicle population growth is equal to g. If there is no open quota ($\alpha = 1$), then the rate of population growth will be equal to g for all vehicle categories, meaning that the composition of vehicles will remain fixed at the year 0 configuration.

In year 2, the quota for category i will be:

$$V_{i2} = (g + \alpha\delta_i)Q_{i1} = (g + \alpha\delta_i)(Q_{i0} + \Delta Q_{i0}) \tag{6}$$

so the rate of quota increase for category i vehicles will be greater than g if $\lambda_{i1}R_1 > R_{i1}$ and less than g if $\lambda_{i1}R_1 > R_{i1}$. Hence, vehicle categories in which open licenses are heavily used will experience an above-average increase in quota for a given rate of deregistrations; vehicle categories in which open licenses are scarcely used will experience a below-average increase in quota.

But what determines the utilization of the open category licenses, i.e., the λ_{it}s? Intuitively, one can think of the open quota as being imposed on the aggregate residual demand for quota licenses. Hence, as long as the open quota is not too large, one would expect that its quota premium would be close to the maximum quota premium in the other categories and that it would be used in the categories with the highest quota premiums (i.e., the categories with the most binding quotas). The pricing of open category licenses is considered further in Section V.

Data on the usage of category 7 quota licenses are not published, but data on new registrations indicate that the open licenses have been used mainly to purchase large cars. This is consistent with the information in Table 1 that category 3 or 4 quota premiums were the highest in 87 percent of the auctions.[16] On average during 1990–99, the ratio of new registrations to quota level was 95 percent for category 1, 113 percent for category 2, 195 percent for category 3, and 260 percent for category 4. In other words, the number of new category 3 cars that were actually purchased during that period was almost double the amount set by the category 3 quota and the number of new category 4 cars purchased was over two and a half times the amount set by the category 4 quota. This would have been possible only through the use of the open quota.

The composition of the car population has indeed shifted over the last ten years toward larger cars and away from smaller cars. In 1990, the makeup of the car population was: 15 percent category 1 cars; 67 percent category 2 cars; 14 percent category 3 cars; and

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[16] During 1990–99, the correlation coefficients between the quota premiums in category 7 and those in the other categories were as follows:

Category 1	Category 2	Category 3	Category 4	Category 5	Category 6
0.7366	0.9097	0.9627	0.9808	0.9062	0.6456

(The correlation coefficient between category 7 and category 6 takes into account the rule that individuals using a category 7 license to register a category 6 vehicle pay only one-third of the category 7 quota premium.)

4 percent category 4 cars. By 1999 the proportions had changed to: 12 percent category 1 cars; 60 percent category 2 cars; 20 percent category 3 cars; and 8 percent category 4 cars. In fact, according to Phang, Wong, and Chia (1996, pp.148), "by 1995, the Mercedes Benz had overtaken the Toyota as the most popular make of car registered in Singapore." This increasing population of large cars has led to larger quotas for these cars: between 1990–91 and 1998–99, category 1 and 2 quotas declined on average by 6 percent and 1 percent per year respectively, while category 3 and 4 quotas grew on average by 4 percent and 8 percent per year respectively.

Therefore, it would appear that the open quota has met its objective of allowing flexibility in the composition of the motor vehicle population. However, this flexibility may be more illusory than real. The mechanism by which the open quota allows flexibility is through price arbitrage across categories—as mentioned above, the open quota will be used in the category with the highest license price, or the greatest residual demand. But the objective of subcategorization was precisely to prevent price arbitrage so as to achieve a more equitable tax burden among the different groups of car buyers. Hence the two rules are inconsistent. As a result, the observed shift in preferences may not reflect an exogenous change in the public's tastes so much as a response to the quota system itself. Put differently, the shift toward large cars may not have been because the public grew to prefer large cars over small cars and the open quota allowed the system to accommodate this change in preferences; rather, the shift toward large cars may have been caused by the open category, subcategorization, and the quota formula.

C. An Alternative to Subcategorization: Ad Valorem Bids

The experience with quota subcategorization provides a good illustration of the distortions that come with such a practice. Although social equity is a desirable objective, quota subcategorization is not the best means by which to achieve it. Interestingly, the authorities have so far not considered the possibility of eliminating subcategorization and introducing ad valorem bids.[17] Under such a scheme, there would be only one overall quota and potential motor vehicle buyers would bid in terms of a percentage over the open market value of the motor vehicle rather than in nominal (Singapore dollar) terms. In other words, auction participants would be required to specify the extra ad valorem duty that they would be willing to pay for their desired vehicle (in addition to existing taxes and fees).[18] The equity objective would be better served by this scheme since buyers of expensive motor vehicles would pay the same percentage premium (relative to the price of the motor vehicle)

[17] This was first suggested by Koh and Lee (1994). The VQS review committee did consider a suggestion for a single car category with a scaling factor based on the open market value of the motor vehicle to be purchased, but rejected it on the basis that it would make the system "unnecessarily complex" (www.gov.sg/mincom/mincompr/full_text5.htm, pp.3).

[18] The same effect could be achieved by having a value quota rather than a volume quota. However, a value quota would be much harder to implement in the context of the VQS, where the objective is to control the number of motor vehicles rather than their total value.

as buyers of less expensive vehicles.[19] Under the current system of quota subcategorization, buyers of expensive motor vehicles usually pay a lower percentage premium (and sometimes even a lower value premium) than buyers of less expensive vehicles.

The idea of ad valorem bids is not unrealistic; Australia's auction quotas for import licenses in the 1980s utilized such a method.[20] It may be argued that ad valorem bids could encourage under-invoicing; however, there is no reason to assume that this would be more likely for more expensive motor vehicles than less expensive ones. Furthermore, such a system would be considerably simpler than the current system of quota subcategorization, both for the general public (by eliminating the need for strategic decisions on which category to place a bid) as well as for the authorities (by eliminating the need for separate auctions and complicated formulas for distributing the quota).

V. NONTRANSFERABILITY

When the VQS was first introduced in 1990, the quota licenses were transferable: quota licenses could be resold once for a transfer fee of $10, prior to being used for purchasing a motor vehicle. Once a quota license was used to purchase a vehicle, it became "attached" to the vehicle in the sense that the vehicle could not be resold without the license. During the transferable period, there were no penalties on the resale of (license inclusive) vehicles.

In mid-1991, the local media began reporting that quota premiums were at "all-time highs". The public placed the blame on excessive speculative activity in the quota license market and called for additional restrictions. The government initially maintained that transferability was a desirable option as it enabled the market to determine the allocation of rights to purchase motor vehicles according to willingness to pay, but eventually acceded to public opinion.

In October 1991, resale of quota licenses in all categories except 5 (goods vehicles and buses) and 7 (open) was prohibited for a trial period of twelve months. The rule change meant that a prospective motor vehicle buyer now had to bid for a quota license in his own name instead of obtaining it from a motor vehicle distributor or from the secondary market;

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[19] Falvey (1979) and Rodriguez (1979) show that unlike quotas or specific tariffs, ad valorem tariffs do not result in a shift in the composition of imports in favor of more expensive items.

[20] During the 1980s, Australia auctioned import licenses for textiles, clothing, footwear, and motor vehicles. Bidders in these auctions had to specify the category of the items, the quantity (or value) that they were bidding for, and the ad valorem duty rate they would pay above the duty rate otherwise applicable to the item. Unlike the VQS, the purpose of the Australian quota auction was primarily to obtain information on the degree of protection to the import-competing industries and not to restrict consumption; hence a comparison of the two quota systems would not be very meaningful. The point to note here is simply that a quota system with ad valorem bids is feasible. For further information on the Australian quota auctions, see Takacs (1994).

once a license was allocated, it could only be used to purchase a vehicle by the individual named in the license. At the same time, the validity period of the nontransferable quota licenses was lengthened to six months, i.e., the vehicle purchase had to be made within half a year of buying a license. (The validity period of category 5 and 7 licenses remained at 3 months.) Transfers of ownership of motor vehicles inclusive of the quota license were still permitted, subject to a transfer fee of 2 percent of the value of the vehicle. However, in April 1995, additional restrictions were introduced to discourage such transfers: transfers of ownership of motor vehicles registered using (nontransferable) quota licenses from categories 1 through 4 (i.e., cars) within three months of registration were disallowed, and transfers of ownership within four to six months from registration were subject to an additional levy.

In the discussion that follows, license nontransferability refers to the inability to resell the quota license before it is used to purchase a motor vehicle. Once a quota license is used to purchase a vehicle, it can technically be transferred (together with the vehicle), subject to the restrictions described above. However, the nature of the transaction will be very different—the sale of a used car versus the sale of a quota license that can be used to purchase a new car—and as such, it will not be the focus of the following discussion.

As can be seen in Figure 1, the initial effect of the switch from transferability to nontransferability was a drop in quota premiums across the six categories affected. (The vertical lines in the graphs mark the introduction of nontransferability in October 1991.) However, this result was short-lived, as quota premiums in all the car categories continued to rise after October 1991, reaching new heights well beyond those attained when quota licenses were transferable.[21] Despite this, it was decided that the nontransferable categories would remain nontransferable after the trial period was over.

A. Theoretical Considerations

As explained in Krishna and Tan (1998, 1999), transferability is an important consideration when there is some uncertainty surrounding the value of the quota licenses. Purchasing a car in Singapore involves a considerable financial outlay and since a quota license has to be obtained at least one month before the purchase is made, it is conceivable that an individual may be uncertain of his future valuation of the quota license at the time of the auction. It is often taken for granted that transferability commands a positive premium in the presence of uncertainty; the public's (and government's) expectation that the quota premiums would fall when resales were prohibited reflect this assumption. Intuitively, one would think that a transferable quota license has an option value in this case, as it gives its holder the option of using it to purchase a motor vehicle, or selling it on the secondary market. In an uncertain world, this option has value which should be reflected in a higher price for a transferable quota license relative to a nontransferable quota license.

The following model shows that this assumption is incorrect and more generally illustrates the effect of (non)transferability on quota premiums. It is based on Krishna and

[21] The exception was category 6 (motorcycles) mentioned earlier.

Tan (1998, 1999) with an extension to include open licenses. Assume for simplicity that: (i) there are two types of cars—small (type 1) and large (type 2)—which are nonsubstitutable; (ii) car prices are fixed at world prices: P_1 for small cars and P_2 for large cars; (iii) there are three categories of licenses: category 1 for buying small cars, category 2 for buying large cars, and category 0 (open) for buying either type of car, with quotas V_1, V_2, and V_0 respectively; (iv) individuals desire either small cars or large cars: there is a continuum of potential small car buyers with mass N_1 and a continuum of potential large car buyers with mass N_2; and (v) each individual demands at most one license.

Let w_1 denote the value of a license to a small car buyer, where $w_1 = D_1 - P_1$; D_1 is his (random) willingness to pay for a small car; and P_1 is the fixed world price for a small car. Since D_1 is a random variable, w_1 is also a random variable. Similarly let w_2 denote the (random) value of a license to a large car buyer, where $w_2 = D_2 - P_2$, D_2 being his (random) willingness to pay for a large car. All small car buyers are identical ex ante and share a common i.i.d. distribution of realizations ex post; the same is true for large car buyers. Let $f(w_1)$ be the density function and $F(w_1)$ the cumulative density function associated with the valuations of a small car buyer, and let $\overline{w}_1$ and $\underline{w}_1$ be the upper and lower bounds of the density function. Let $g(w_2)$ be the density function and $G(w_2)$ the cumulative density function associated with the valuations of a large car buyer, and let $\overline{w}_2$ and $\underline{w}_2$ be the upper and lower bounds of the density function. Assume that $\underline{w}_1$ and $\underline{w}_2$ are positive so that licenses will always be used ex post, even if they are nontransferable.

Assume there are two time periods. In period 1, the valuations are not yet realized so each individual is uncertain about his valuation; in period 2, the valuations are realized. Licenses are sold in period 1. Under transferability, since resale is allowed, the markets for all three categories of licenses clear after the uncertainty is resolved.[22] Under nontransferability, the markets for licenses of categories 1 and 2 clear in period 1, before the uncertainty is resolved; the market for category 0 licenses (which remain transferable) clears in period 2, after the uncertainty is resolved.

First consider what happens if the licenses are transferable. In this case, by arbitrage, the open licenses will be distributed so as to equalize the quota premiums of all categories. The equilibrium (interior) solution will be the quota premium at which the residual demand for licenses is equal to the open quota:

$$\{N_1[1 - F(L^T)] - V_1\} + \{N_2[1 - G(L^T)] - V_2\} = V_0. \tag{7}$$

The above expression implicitly defines L^T, the equilibrium quota premium for all three categories of licenses.

[22] Krishna and Tan (1997) explain why the ex ante license price will be equivalent to the ex post license price in this case.

However, it is possible that if the open quota, V_0, is relatively small, it may be insufficient to complete the arbitrage process. Suppose there is a corner solution and all the open licenses are applied toward large cars. Then the quota premiums will not be equalized and:

$$L_1^T = F^{-1}\left(1 - \frac{V_1}{N_1}\right)$$
$$L_0^T = L_2^T = G^{-1}\left(1 - \frac{V_2 + V_0}{N_2}\right) \tag{8}$$

where $L_2^T > L_1^T$. Hence the quota premiums of categories 1 and 2 (denoted L_1^T and L_2^T respectively) will be negatively related to the restrictiveness of their effective quota (defined as the number of licenses available for buying that car type relative to the number of potential buyers for that car type), and the open quota premium (denoted L_0^T) will be equal to the highest (category 2) quota premium. In practice, this is the outcome that is usually observed.

Now consider what happens when category 1 and 2 licenses are nontransferable but the open category is transferable. This means that individuals who purchased category 1 or 2 licenses in period 1 may not resell them in period 2, but individuals who purchased open licenses may do so. As usual, the problem is solved backward, beginning with period 2. In period 2, V_1 category 1 licenses and V_2 category 2 licenses have already been sold so holders of those licenses are effectively out of the market. The equilibrium interior solution for the open quota premium will be such that:

$$(N_1 - V_1)[1 - F(L_0^{NT})] + (N_2 - V_2)[1 - G(L_0^{NT})] = V_0 \tag{9}$$

The above expression implicitly defines L_0^{NT}, the equilibrium open quota premium under nontransferability. Note that all else constant, L_0^{NT} is higher the smaller is the open quota, V_0.

In period 1, individuals purchase category 1 and 2 licenses before knowing their true valuations. In the absence of open quota, since all small car buyers are identical ex ante, they will all be willing to pay the same amount for a category 1 license, namely $E(w_1)$. But if there are open licenses available then a potential small car buyer has the option of either buying a category 1 license in period 1 or buying an open license in either period 1 or period 2. If he purchases a category 1 license, he cannot resell it in period 2 if his realization turns out to be low; his expected surplus from this option is thus $E(w_1) - L_1^{NT}$, where L_1^{NT} denotes the nontransferable category 1 license price. But if he purchases an open license, he will use the license only if his realization turns out to be high (i.e., above L_0^{NT}) and he will resell the license if his realization turns out to be low (i.e., below L_0^{NT}); his expected surplus from this option is thus $\int_{L_0^{NT}}^{\bar{w}_1}(w_1 - L_0^{NT})f(w_1)dw_1$. Equating the expected surplus from the two options yields the equilibrium nontransferable category 1 license price:

$$L_1^{NT} = E(w_1) - \int_{L_0^{NT}}^{\bar{w}_1}(w_1 - L_0^{NT})f(w_1)dw_1 \tag{10}$$

Note that $L_1^{NT} \le E(w_1)$, so the nontransferable category 1 license price will be lower in presence of the open quota than without the open quota. Furthermore, note that $L_1^{NT} \le L_0^{NT}$, so the transferable open category license will be more expensive than the nontransferable category 1 license.[23] Intuitively, this may be understood by noting that if the individual purchases a nontransferable category 1 license, his actual surplus may be positive (if his realization turns out to be above L_1^{NT}) or negative (if his realization turns out to be below L_1^{NT}), but if he purchases an open license, his actual surplus cannot be negative since he can always resell the license if his realization turns out to be below L_0^{NT}. Thus in order for him to be indifferent between the two options, the transferable open license will have to cost more than the nontransferable category 1 license.

The same reasoning holds for potential large car buyers, so:

$$L_2^{NT} = E(w_2) - \int_{L_0^{NT}}^{\bar{w}_2}(w_2 - L_0^{NT})f(w_2)dw_2 \tag{11}$$

where $L_2^{NT} \le E(w_2)$ and $L_2^{NT} \le L_0^{NT}$

What if there is a corner solution? Again, suppose that all the open licenses are applied toward large cars. Then the open quota premium under nontransferability will be:

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[23] To see this, subtract L_0^{NT} from both sides of the expression for L_1^{NT}:

$$\begin{aligned} L_1^{NT} - L_0^{NT} &= \int_{\underline{w}_1}^{\bar{w}_1} w_1 f(w_1)dw_1 - \int_{L_0^{NT}}^{\bar{w}_1}(w_1 - L_0^{NT})f(w_1)dw_1 - \int_{\underline{w}_1}^{\bar{w}_1} L_0^{NT} f(w_1)dw_1 \\ &= \int_{\underline{w}_1}^{L_0^{NT}}(w_1 - L_0^{NT})f(w_1)dw_1 \le 0. \end{aligned}$$

$$L_0^{NT} = G^{-1}\left(1 - \frac{V_0}{N_2 - V_2}\right) \tag{12}$$

In this case, potential small car buyers know that there will not be any open licenses available for them, so they will bid $E(w_1)$ for category 1 licenses. Potential large car buyers will bid L_2^{NT} as given above. Hence, $L_1^{NT} < L_2^{NT} \leq L_0^{NT}$.

Comparing L_1^{NT} with L_1^{T} and L_2^{NT} with L_2^{T} shows that the transferability premium depends on the effective quota for that category (i.e., the quota for that category plus any open licenses that are used in that category). If the effective quota is very restrictive relative to demand, then the transferability premium is positive but if the effective quota is not very restrictive relative to demand, then the transferability premium may be negative.[24] For the open category, the open quota premium will be equal to the maximum of the category 1 and category 2 quota premiums under transferability (assuming incomplete arbitrage), but should exceed the maximum under nontransferability.

B. Empirical Analysis

Did the switch to nontransferability lower license prices in the affected categories? Casual observation of Figure 1 suggests that nontransferability raised rather than lowered the quota premiums in categories 1 through 4. According to the model above, this would imply that the effective quotas for those categories were not restrictive. However, there are other factors that may have affected the quota premiums such as the supply of quota licenses and demand shifts that were unrelated to nontransferability (possible factors may include income growth and road infrastructure development, among others). In fact, Figure 1 shows that the quota premiums for category 5 (which remained transferable throughout) were also higher after the third quarter of 1991.

In an earlier study, Koh and Lee (1993) estimate the impact of nontransferability on the quota premium by regressing the quota premium on a dummy variable for transferability and other variables such as the ratio of bids received to successful bids and the bid range, for categories 1, 2, 3, and 4 separately. They find that nontransferability was associated with a lower quota premium in category 1; had no significant effect in category 2; and was associated with a higher quota premium in categories 3 and 4.

This paper takes a different approach by looking at license prices in categories 1, 2, 3, and 4 relative to category 5. The rationale for doing this is to control for any exogenous

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[24] Krishna and Tan (1998) show that relaxing the assumptions to allow for bidders' valuations to depend on the restrictiveness of the quota or to allow for heterogeneous bidders does not change the flavor of the basic result.

demand-shift factors that were common to all motor vehicles.[25] Category 5 was chosen as a base because it was not affected by the regime switch.[26]

The regressions were based on the following very simple model. Denote the relative demand for category i licenses by: $D_{it} = D(L_{it}/L_{5t}, B_{it}/B_{5t}, Dummy)$ where L_{it} denotes the license price (in Singapore dollars) of category i at time t; B_{it} denotes a demand shift parameter, such as the number of bids for category i licenses at time t; and the dummy variable is equal to 0 for the transferability period (1990:9 to 1991:9) and 1 for the nontransferability period (1991:10 to 1999:04).[27] The relative demand for category i licenses should be negatively related to the relative price of category i licenses and positively related to the relative number of bids for category i licenses, but could be positively or negatively related to the dummy variable.[28] On the supply side, denote the relative quota of category i licenses by V_{it}/V_{5t}. Setting demand equal to supply in equilibrium yields a reduced form such as the following:

$$\ln(L_{it} / L_{5t}) = \beta_0 + \beta_1 Dummy_t + \beta_2 \ln(V_{it} / V_{5t}) + \beta_3 \ln(B_{it} / B_{5t}) + \varepsilon_{it}. \qquad (13)$$

The log transformation was used as a means of removing growth over time of the variance of the data. Separate regressions were run for categories 1, 2, 3, and 4, using monthly auction data from September 1990 to April 1999.

If the switch to nontransferability had the desired effect, the estimated coefficient on the dummy variable, β_1, should be negative and significant. The coefficient β_2 is expected to

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[25] The assumption here is that the fundamentals driving the premium for category 5 are the same as those driving the premiums for categories 1 to 4. Robustness checks indicate that this is not unreasonable: the license price paths of categories 1 to 5 are quite closely related to movements in domestic asset prices in general (i.e., the stock market index).

[26] Also, one can reasonably assume no substitution effects between category 5 (goods vehicles and buses) and category 1–4 (cars). Category 7—the open category—was also unaffected by the regime switch, but as argued above, the quota premium for category 7 is determined jointly with the quota premiums of the other categories, so the inverse demand relative to category 7 would be harder to interpret.

[27] It is possible that transferability/nontransferability affects not only the intercept of the demand function but also the slopes. However, the data are insufficient to allow for this (there are only 14 observations during the transferable period).

[28] One may argue that the open market value of category i cars relative to category 5 vehicles should also be included as an independent variable in the inverse demand function for category i licenses. Unfortunately, while some information is available on these values, no consistent data series exists. This omission is not too serious if the world prices of the different categories of vehicles move in tandem so that their relative prices do not change much over time.

be negative since all else constant, a larger supply of category i licenses relative to category 5 should be associated with a lower license price for that category relative to category 5. The coefficient β_3 is expected to be positive since all else constant, a larger number of bids received for category i licenses relative to category 5 licenses suggests a greater relative demand for category i licenses and hence should be associated with a higher license price for that category relative to category 5.

Pre-regression tests indicate that the unit root hypothesis can be rejected for all four relative license price variables—$\ln(L_1/L_5)$, $\ln(L_2/L_5)$, $\ln(L_3/L_5)$, and $\ln(L_4/L_5)$—using both the augmented Dickey-Fuller (ADF) and Phillips Perron tests. The unit root hypothesis can also be rejected for the relative demand variables, $\ln(B_i/B_5)$. The unit root tests for the relative quota variables, $\ln(V_i/V_5)$, are less conclusive, although weak evidence of stationarity can be found for all except $\ln(V_1/V_5)$. However, it can be argued in principle that the ratio of quotas should be stationary in the long run and thus the series may be treated as stationary for purposes of finite sample inference.

With this caveat in mind, the regression results are reported in Table 2. Given that nontransferability did not affect category 5, the results indicate that nontransferability lowered the quota premium by 85 percent for categories 1 and 2, 80 percent for category 3, and 70 percent for category 4.[29] The coefficients on the other regressors have the expected signs and are statistically significant. Thus it appears that after controlling for license supply and demand shifts (both category-specific as well as those affecting all motor vehicles), the switch to nontransferability in categories 1–4 lowered their quota premiums by some 70-85 percent. Although this effect seems substantial, it should be considered in the context of the actual increase in license prices. Between the transferable period (1990:05–1991:09) and the nontransferable period (1991:10–1999:04), the average license price rose by 471 percent in category 1; 572 percent in category 2; 556 percent in category 3; and 795 percent in category 4. The regression results imply that had the switch from transferability to nontransferability not taken place, the license price increase between the two periods would have been 556 percent in category 1; 656 percent in category 2; 635 percent in category 3; and 865 percent in category 4. Furthermore, it must be borne in mind that nontransferability does carry costs that are difficult to quantify. As demonstrated in Krishna and Tan (1998, 1999), welfare—defined as the sum of surplus and quota rent—is generally lower under nontransferability compared with transferability.

Finally, an estimate of the transferability premium associated with the open category license may be obtained by comparing the category 7 quota premium against the maximum quota premium (excluding category 7) in the same auction. Recall that open quota licenses remained transferable throughout the sample period. The analysis in the previous section shows that under transferability, the open quota premium will be equal to the maximum quota premium (assuming the open quota is not large enough for complete arbitrage) whereas under nontransferability, the open quota premium should exceed the maximum quota

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[29] Following Halvorsen and Palmquist (1980), the percentage effect of the dummy variable on (L_{it}/L_{5t}) is calculated as $100(\exp(\beta_2)–1)$.

premium. A log-linear regression of the open quota premium relative to the maximum quota premium, $L_7/L_{\max}$, on a constant and the transferability dummy (0 for the transferable period; 1 for the nontransferable period) yields the following result:

$$\ln(L_7 / L_{\max}) = \underset{(0.053)}{-0.069} + \underset{(0.054)}{0.045}\ \text{Dummy} \tag{14}$$

106 observations; $R^2 = 0.019$; Adjusted $R^2 = 0.009$;
S.E. of regression = 0.114; DW statistic = 1.892;
Standard errors (heteroskedasticity-consistent) in parentheses;
$Q(4) = 1.669$ (p-value 0.796); $Q(8) = 4.391$ (p-value 0.820);
$Q(12) = 7.382$ (p–value 0.831)
DF test statistic for $\ln(L_7/L_{\max}) = -10.537$; reject unit root at 1 percent level.

The constant is negative but not significantly different from 0, implying that $L_7/L_{\max}$ is not significantly different from 1 under transferability. This is in line with the results of the model presented earlier. Nontransferability (of categories 1–4) is associated with an increase in $L_7/L_{\max}$, but the increase is not statistically significant. This suggests that the transferability premium on the open quota was negligible. However, this finding may be partly due to the fact that the transferable open category licenses had to be used within a shorter time period than the nontransferable category 1–4 licenses. (As mentioned in Section V, the switch to nontransferability for categories 1–4 was accompanied by a lengthening of the validity period of those licenses from three months to six months, while the validity period of the transferable open category licenses remained at three months.)

VI. Conclusions and Policy Lessons

Singapore's experience with the VQS demonstrates that quota implementation can turn out to be quite complicated. The original aim of the VQS was to control the growth rate of the motor vehicle population as efficiently and fairly as possible. Theoretically, one could argue that a quota would be an optimal policy to achieve this aim. However, as this paper serves to highlight, the actual implementation of the quota makes a difference as seemingly rational rules may have unexpected and undesirable consequences. Singapore's experience with the VQS offers some potential lessons for quota implementation in general.

The first lesson highlighted in the paper is that whereas a reasonable theoretical case may be made for quota subcategorization, in practice the relevant information for setting the individual quotas is often lacking, so that the end result may not be the desired one. In the case of the VQS, the rationale for subcategorization was to ensure social equity in the sense that buyers of small inexpensive cars should not have to pay the same quota premium as buyers of expensive luxury cars. But in practice, subcategorization led to a highly regressive outcome, with buyers of inexpensive cars paying more in relative—and, in some cases, absolute—terms than buyers of expensive cars.

A related point is the importance of consistency among the rules. It is logically inconsistent to have subcategorization for social equity together with an open category for flexibility as the aim of subcategorization is to have different quota premiums for different categories, whereas the open category works in the opposite direction, through price arbitrage across categories. Hence, the present design of the VQS cannot achieve both social equity and flexibility at the same time.

Switching to a single quota with ad valorem bids would take care of these considerations automatically and greatly simplify the system as well. Although it is somewhat unusual to require that bidders specify an ad valorem tax rate rather than a nominal (Singapore dollar) bid amount, this has been implemented in other countries, notably in Australia's quota tariffication exercise during the 1980s. Ad valorem bids would encourage the public to think of the quota license more correctly as a tax on the motor vehicle rather than as an asset in its own right. Such a system would at least be neutral rather than regressive, and doing away with the subcategorization should substantially reduce quota administrative costs.

Another lesson is that making the quota licenses transferable (or nontransferable) has non-obvious implications for the quota premium. Although it is often assumed that the transferability premium is positive, theoretically it can be shown that this need not be the case, depending on the restrictiveness of the quota. In the case of the VQS, it appears that after controlling for license supply and demand factors, the switch to nontransferability did have the desired dampening effect on the quota premiums of the car categories, although this effect was overwhelmed by other developments that caused an outward shift of the demand for motor vehicles licenses. Further, this effect should be weighed against the disadvantages of nontransferability, namely the loss of flexibility in an uncertain environment and the consequent deterioration in welfare.

As an ongoing experiment in auction quota implementation, the VQS offers many other potential lessons that are worth exploring. The government has recently replaced the sealed bid auction system with "open" bidding whereby potential bidders are able to observe others' bids before submitting their own. The argument is that the sealed bid system encourages excessively high bids so increased transparency should result in lower quota premiums. The issue is worth studying in greater detail when sufficient data become available.

Table 1. Ranking of Quota Premiums

Ranking (lowest to highest)	Number of Auctions
1, 2, 3, 4	45
1, 2, 4, 3	17
1, 3, 2, 4	7
1, 3, 4, 2	2
1, 4, 2, 3	13
1, 4, 3, 2	2
2, 1, 3, 4	3
2, 1, 4, 3	0
2, 3, 1, 4	0
2, 3, 4, 1	0
2, 4, 1, 3	0
2, 4, 3, 1	0
3, 1, 2, 4	2
3, 1, 4, 2	1
3, 2, 1, 4	0
3, 2, 4, 1	0
3, 4, 1, 2	5
3, 4, 2, 1	1
4, 1, 2, 3	5
4, 1, 3, 2	2
4, 2, 1, 3	0
4, 2, 3, 1	0
4, 3, 1, 2	0
4, 3, 2, 1	1
	Total = 106

Source: Singapore, Land Transport Authority.

Table 2. Regression Results

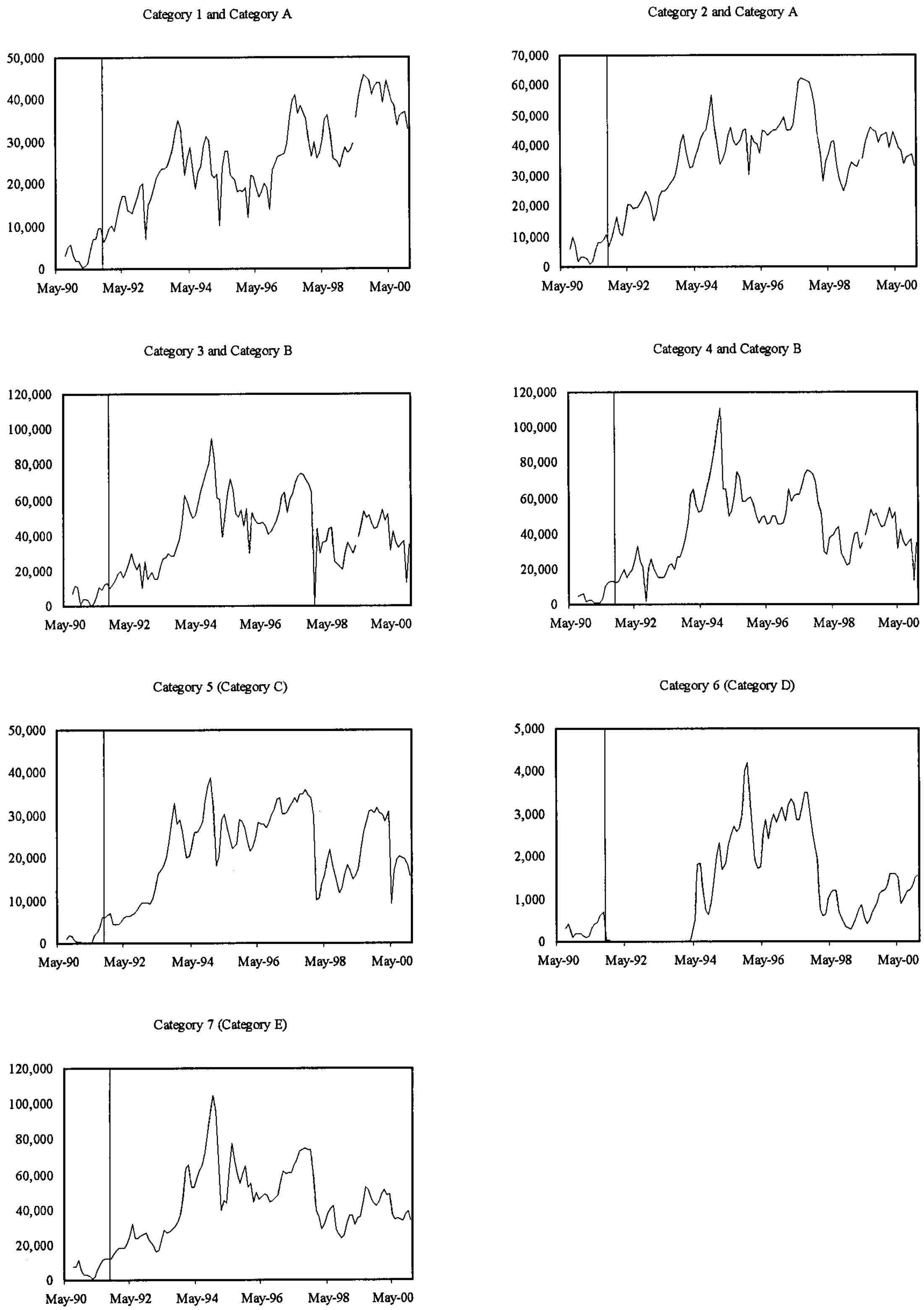
Dependent Variable: $\ln(L_i/L_5)$	$i = 1$	$i = 2$	$i = 3$	$i = 4$
Constant	1.009*	2.594*	1.432**	0.980
	(0.414)	(0.401)	(0.887)	(0.967)
Dummy (0=transferable; 1=nontransferable)	−1.934*	−1.880*	−1.578*	−1.220*
	(0.260)	(0.328)	(0.452)	(0.330)
$\ln(V_i/V_5)$	−1.703*	−1.732*	−1.901*	−0.967*
	(0.352)	(0.418)	(0.771)	(0.433)
$\ln(B_i/B_5)$	0.911*	1.340*	1.347*	0.576*
	(0.166)	(0.212)	(1.271)	(0.169)
AR parameters:				
AR(1)	0.554*	0.583*	0.389*	0.491*
	(0.099)	(0.095)	(0.110)	(0.090)
AR(2)	−0.169**			
	(0.098)			
Number of observations	103	104	104	104
R^2	0.711	0.716	0.403	0.529
Adjusted R^2	0.696	0.705	0.378	0.510
S.E. of regression	0.523	0.485	0.880	0.557
$Q(4)$	2.578 [0.275]	0.251 [0.969]	2.849 [0.415]	0.578 [0.901]
$Q(8)$	4.350 [0.629]	5.198 [0.636]	5.307 [0.623]	4.076 [0.771]
$Q(12)$	7.809 [0.647]	10.798 [0.460]	6.690 [0.824]	5.729 [0.891]

Figures in parentheses are standard errors. L denotes quota premium (in dollars); V denotes quota level (in number of vehicles); B denotes number of bids; subscripts denote license category. Equation (1) was estimated as an AR(2) model; Equations (2)–(4) were estimated as AR(1). $Q(k)$ denotes the Ljung-Box Q-statistic with k lags; figures in square brackets are the corresponding p-values.

* Significant at the 5 percent level.

** Significant at the 10 percent level.

Figure 1. Singapore: Quota Premiums, 1990-2000 1/
(in Singapore dollars)



Source: Singapore, Land Transport Authority.

1/ In May 1999: categories 1 and 2 were merged and redesignated category A; categories 3 and 4 were merged and redesignated category B; category 5 was renamed category C; category 6 was renamed category D; and category 7 was renamed category E.

Figure 2. Quota subcategorization *v*. market allocation

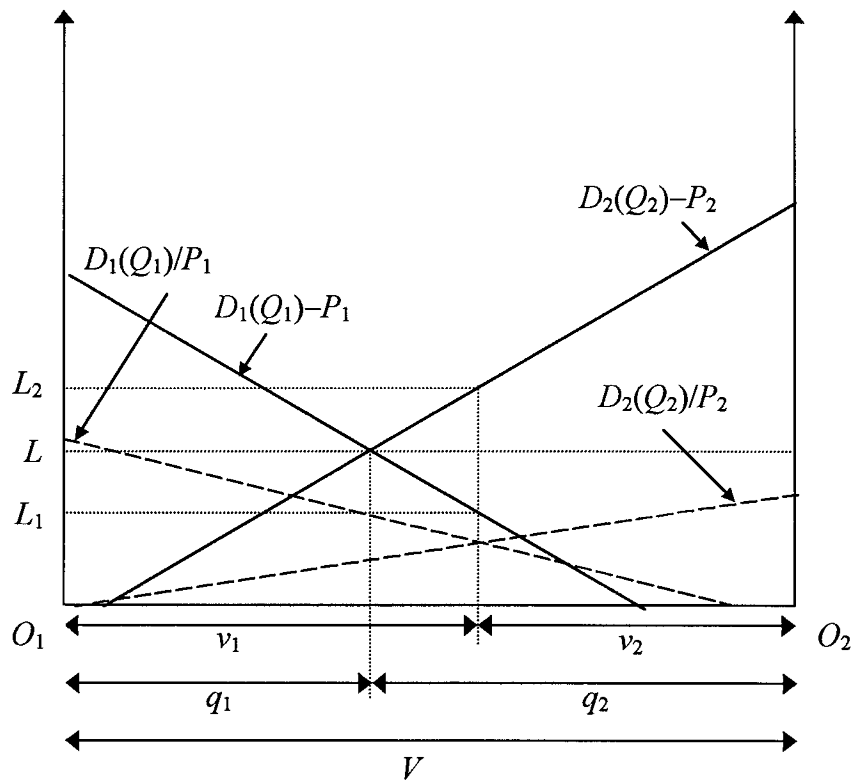
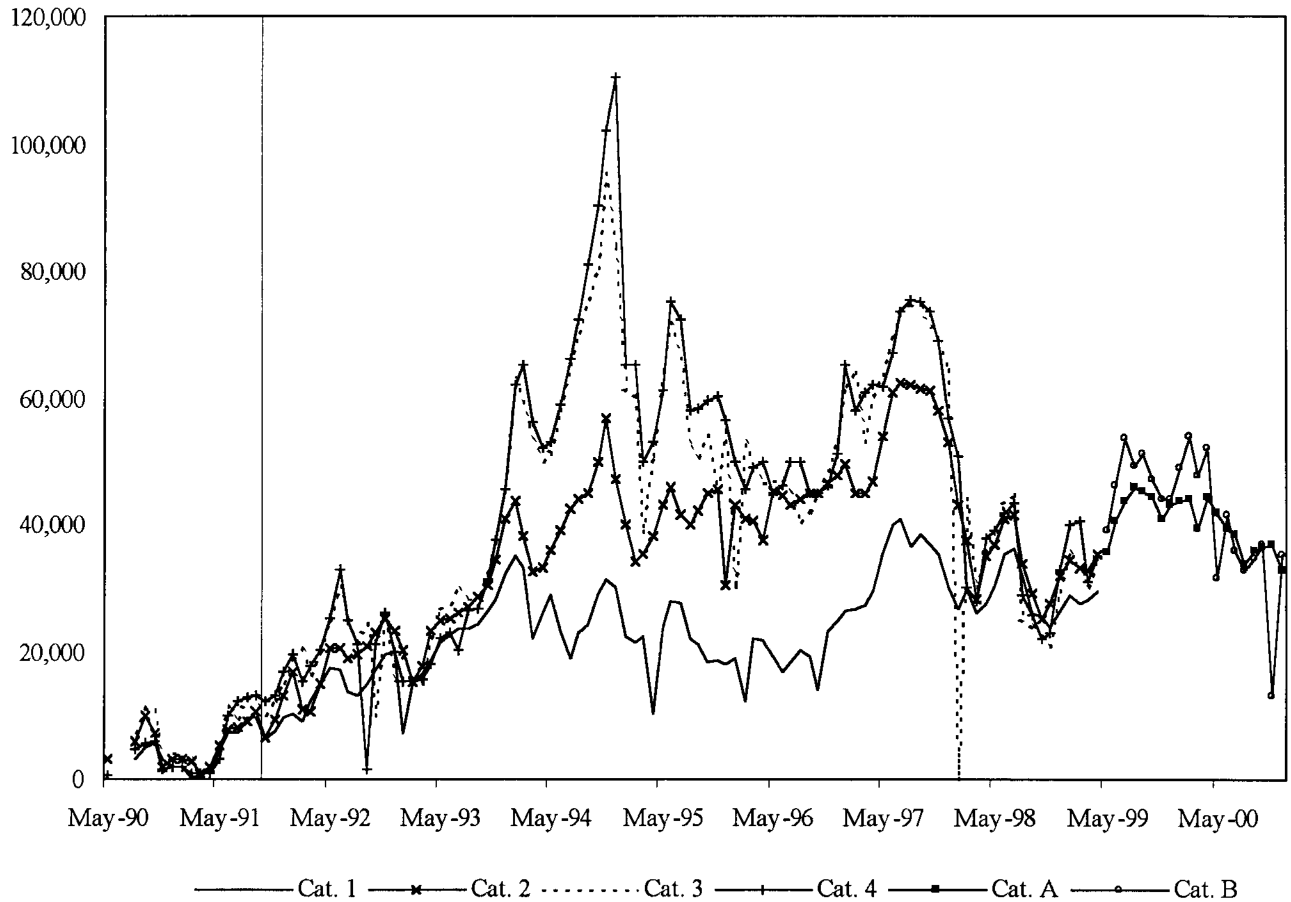


Figure 3. Singapore: Quota premiums for car categories, 1990–2000
(in Singapore dollars)



Source: Singapore, Land Transport Authority.

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