PARKING BIAS IN TRANSIT CHOICE

By Elbert W. Segelhorst and Larry D. Kirkus*

A business practice which has rapidly grown in popularity is that of providing free parking space to employees and customers. The practice originated at suburban shopping and employment centres, but has increasingly become prevalent within the central city business core. Core retailers were the first to initiate free or validated customer parking to combat the threat from suburban shopping centres, and central non-retail firms have rapidly adopted the practice [1].

In the city of Los Angeles central business core, free or subsidised parking was provided in 1966 for over 30 per cent, and probably 50 per cent or more, of the 208,000 employees [2]. Eighty-five per cent of a national sample of employees in urban areas were found to have free or subsidised parking [3]. Although exact estimates are made difficult by the complexity of validation arrangements, well over 50 per cent of all auto shopping trips to central business districts use free parking [4]. Moreover, as subsequently explained, much if not most of the remaining parking—both in and out of the city core—is effectively subsidised, as the parker does not pay the opportunity cost value of the site. For example, the auto user who parks on city-owned street curb space near his home pays nothing for this privilege. The metered cost of parking in core streets is much less than the alternative business value. Even when the auto is parked on a private lot, the parking rate structure encourages all-day parking; it is not the result of profit maximising competition among parking lot owners. Local zoning laws are continually revised to upgrade the amount of parking space required for new buildings, thus legally reinforcing parking practices that grew out of the subsidy.

The rush-hour private car commuter is often paying in user charges only a small fraction of the marginal costs he imposes on the rest of the community [5], [6].¹ The subsidy is paid by off-peak users of the same facilities, by users of rural arterial highways, and by the community through failure to charge rental (interest and depreciation) for much of the street and highway area used or taxes (property and profit taxes) on the capital invested. Provision of free parking for employees and customers is an additional subsidy that further distorts price below resource cost.

One explanation for the rapid expansion of free parking is the tax exempt status of income-in-kind under federal and state personal income tax codes. The rapid

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¹Excluding congestion cost, Vickrey estimated that urban vehicular traffic is paying in user charges only one-third of the amount paid by users of comparable resources in the private sector of the economy.
PARKING BIAS IN TRANSIT CHOICE  Elbert W. Segelhorst and Larry D. Kirkus

increase in effective marginal income tax rates during and after World War II has deepened and extended to others the advantages of tax-sheltered free parking. Employers and retailers in land-cheap suburbia introduced it as a relatively inexpensive method of making competitive inroads on the central city. Greater auto ownership among suburbanites, with little or no available transit service, made it an effective competitive tool. However, when the city centre responded with identical provision of free parking the result was a rapid decline in transit riding and increased auto congestion, contributing to the decline of business activity in the centre. With strong competition between auto and transit in the central city, free parking subsidies further biased individual modal choice against transit.

Subsidised parking reduces the net cost of auto to the individual user relative to competing public transit, thus inducing substitution. Parking charges and tolls account for 1.8 cents per mile out of a total of 11.9 cents in the 1970 United States average cost of operating an auto [7]. Parking charges are a substantially higher proportion for employees in the central business district. Moreover, recent studies indicate that employees perceive the cost of driving to work at only half of the true cost [8]. Thus parking charges may normally run to 50 per cent of perceived cost. Consequently, introduction of free parking causes 50 per cent reduction in perceived cost (much more than the reduction in actual cost), and thus produces a major change in relative perceived cost of auto versus transit.

The cost of parking thus becomes a substantial control variable over auto and transit usage in the modal split decision when introduced explicitly as part of perceived cost, rather than lumped together with the total of other cost elements. A parking tax has been suggested for central London to restrain traffic congestion. Thomson's analyses [9] show its significant impact, but point to its administrative difficulty because of the large amount of privately-owned free parking facilities. The alternative of daily auto licensing to enter the central district would achieve the same objective with lower administrative cost. It was shown that both policies would be effective because of their importance in perceived cost. Another study [3] estimates that when auto users must pay for parking, choice of this mode is reduced by 20 per cent. In a sample study in Los Angeles auto usage was compared between a group of county employees who received free parking and a control group of federal employees with the same income and job classifications who did not [10]. Simple chi square analysis showed that the subsidised group generated a statistically significant greater amount of auto trips. When firms provide free or subsidised parking, individuals no longer perceive its total money or social cost. The same sample of county employees working in the Los Angeles core was found to value the free parking privilege at $8 per month, while the cost of provision was $24.

If offsetting external benefits accrued to non-auto users, or if external costs were imposed upon others by transit users, a subsidy to auto users only would be warranted on grounds of economic efficiency. However, it is generally agreed that the opposite is true. On balance, the auto generates more external costs than benefits; conversely, transit has more external benefits than costs. Parking subsidies induce a modal choice perverse to relative social efficiencies, thus creating a bias against transit.

Various solutions to correct the price-cost distortion of the parking subsidy are discussed in Section II. Marginal cost pricing enthusiasts have suggested some drastic measures to deal with urban transport problems. A small but significant
step in that direction is proposed in this paper. With the establishment of a transit
district, a choice of an equal subsidy for transit is offered to those who presently
receive free parking. Section III provides an example of expected results for Los
Angeles, California.

I. THE PROBLEM

Transit bias may be analysed by considering a worker who has a choice between
auto and transit for the work trip. Assume that the employee has successfully maxi-
mised his utility function in choice of place of work and residence, subject only to
decision on travel mode. Given the work-residence decision, the employee allocates
his fixed stock of time to maximise utility of leisure and money income. He equates
the money wage rate with the ratio of the marginal utility of leisure to income. Let
us assume that he attains his highest net income curve by choosing transit. When time
spent on leisure or transport is valued at the money wage rate, the principle on which
he might choose a faster, more costly mode is that the value of time saved must
exceed, or at least equal, the added money cost outlay. His modal choice depends
upon his indifference map, his wage rate, and his time and money cost differences
for each mode.

If the employer introduces a subsidy to auto by providing free parking, the worker
attains a higher level of indifference and net income by switching from transit to
auto. Although the employee is better off, his choice of transport mode has been
biased against transit by the subsidy.

When the employer provides the same money subsidy to both auto and transit,
the worker attains an even higher indifference curve by switching back to transit.
Thus, when equal money subsidies are given to auto and transit, the employee gains
satisfaction at no added cost to the employer. The money equivalent of satisfaction
forgone because the employer subsidised only auto is a measure of the transit bias
cause.

The employee would prefer an equal subsidy to both auto and transit over a
money wage increase of equal money cost to the employer. The wage increase is of
less value to the employee than the equal transport subsidy because it distorts his
preference between income and leisure. The equal subsidy to auto and transit is
equivalent to a lump sum money income supplement. It avoids the immediate
distorting effects of an increase in the money wage rate.

Congestion

The work trip is typically made in congested, not (as previously assumed) free-
flowing, traffic. An added work trip results in time and money costs not only to the
individual making the trip, but to all others in the stream of traffic who incur
reduced average speed and higher operating costs. The auto driver finds that the
increased time spent in commuting leaves him no better off than when he commuted
by transit. The potentially greater free-flow speed of the auto is sufficiently reduced
by congestion to leave no net time savings. The employer’s subsidy to auto produces
no utility gains to employees; it is a sheer waste of expenditure. Studies on traffic
flow found that a 45-passenger bus was equivalent to three autos in its retarding
effect on traffic flow [11]. Consequently, a free parking subsidy that induces one bus rider to switch to auto will add to the average congestion that he creates by 12½ times his contribution as a bus rider. If this switch from bus to auto reduces the average speed of both modes by an equal amount, then in the aggregate both auto and bus rider are worse off.

With introduction of an equal value subsidy to both auto and transit, the transit rider remains with transit, and both transit and auto passengers are better off. The equal subsidy to both modes is equivalent to a lump-sum increase in money income, which is allocated between income and leisure under conditions of unchanged traffic congestion. The employer’s subsidy expenditure is converted from sheer waste into an increase in money income.

Estimates of service level elasticities of transit are usually of the order of 7 to 10 times greater than fare elasticities. Because transit is slower than auto on both the line haul and the terminal portion, any further delays result in disastrous diversion of transit ridership. The failure to include congestion cost as part of the price to be paid by the contributing vehicle has a substantially greater cumulative adverse effect upon transit than upon auto. If waiting due to congestion is equally onerous to both classes of commuters, an identical reduction of speed for both classes of vehicles results in 37½ times more cumulative waiting time per bus than per auto vehicle. Thus, because congestion imposes a drastically more serious time cost on transit than on auto, the parking subsidy induces diversion from transit to auto, even though both experience adverse costs.

Equity

The preceding example dealt with the transit rider who switched to auto on the introduction of a parking subsidy. For many transit riders the auto subsidy is of no value, since the required subsidy would just induce them to switch to auto is more than the offered subsidy. For example, two employees, paid the same money wage, may have different tastes and preferences for housing, auto ownership, and leisure. Short of purchasing an auto, the employee who lacks an auto is unable to avail himself of the subsidy. Equals are treated unequally, creating ill-will and inequity among comparable employees. Women employees, less inclined to drive an auto, are discriminated against relative to their male equals. Los Angeles County presently provides free parking to all employees, but nothing for transit riders—an example of this type of horizontal inequity.

Non-taxable free parking may be substituted, at least in part, for a taxable increase in money wages. If as a fringe benefit the free parking privilege is given selectively in lieu of a wage increase, horizontal and vertical equity are approximated.

The steady increase in free parking privileges to all worker categories has made discrimination between unequals more overt. Auto ownership, a requirement for receipt of the parking subsidy, is positively correlated with income and money wages. Consequently, the higher one’s income, the more likely the realisation of benefit from the auto subsidy.

The inequity created by subsidising only auto becomes more obvious when congestion is included. Two equally productive employees who receive the same wage rate and ride transit are both offered free parking. One employee switches to auto, and is compensated with the subsidy for the congestion he generates; he main-
tains a constant level of utility. The non-switching transit rider incurs the same added congestion time cost caused by the switcher, but is not compensated. Equalinds are treated unequally.

Likewise the distance is widened between the net income curves of employees with unequal wage rates. The high income-wage employee who continues with auto is compensated for the increased congestion he experiences, but the low income-wage employee who continues with transit incurs the added congestion cost without compensating subsidy. Net incomes become more unequally distributed.

II. THE SOLUTION

The most direct and economically efficient solution to the problems caused by introduction of parking subsidies is to remove them throughout the urban area. Unless one argues that marginal social benefits of added auto usage exceed marginal private benefits, achievement of overall economic efficiency requires that all sectors, including transport, set price equal to marginal cost. Moreover, since the journey-to-work is normally under congestion such that marginal social cost exceeds private cost, marginal cost pricing implies a differentially higher price to peak hour users of transport throughout the entire urban area—taxes rather than subsidies.

Marginal cost considerations would require a restructuring of the entire pricing of both auto and transit in urban areas. Cross-subsidy between peak and off-peak users, imputed resource cost in the form of various tax exemptions and congestion time costs, and ownership-parking biases work to misallocate prices to the preponderant advantage of auto usage. Fitch estimates that the marginal social cost of peak-hour use of a high-capacity urban freeway to and from the central business district ordinarily exceeds 11 cents per vehicle-mile, ten (or more) times greater than the 1 cent per vehicle-mile now paid in gasoline taxes [12].

For various reasons, such rationalisation of the price-fare structure of urban transport systems will be difficult to attain. A precondition for moving in the direction of this best solution is that federal and state governments assess parking and transit privileges provided by firms as taxable income of the individual. More critically, it would require that the entire urban transport pricing structure be reformulated. The individual must always confront a price that equals the marginal social cost of the mode, the price varying according to time, distance, direction, and parking-congestion cost characteristics of his modal choice.

Given the existing tax shelter of the parking perquisite, employees will tend to favour parking subsidies over an equivalent increase in money income.

Where the parking privilege has been extended to groups with low marginal income tax rates, a compensatory increase in money income may be preferred and attainable. In such situations, the possibility of maximum efficiency gains exists even under present tax arrangements. The question of how these efficiency gains are to be distributed may prove a stumbling block. If only present recipients of the parking privileges are to receive a compensating increase in income, the discriminatory nature of the present system becomes abjectly apparent, and the employer is discouraged from making the offer. If the gains are shared with transit riding employees presently eligible for the parking subsidy, the efficiency gain per employee

62
PARKING BIAS IN TRANSIT CHOICE

Elbert W. Segelhorst and Larry D. Kirkus

presently driving auto declines. And if the gains are further shared with all employees, those presently eligible and ineligible for the parking privilege, the average gain per employee further declines, and many present auto drivers with parking privileges end up net losers. Moreover, employers who cancel their employee parking privileges would mainly reduce congestion for employees of other firms who maintain free parking. Spillover of net benefits would thus further complicate any voluntary approach to this best solution.

The Second Best Solution

An analysis has been made of the effectiveness of parking taxes in reducing auto usage and congestion. As a response to free suburban parking they would place firms in the central business district at a competitive disadvantage. If the parking tax were levied directly on the auto driver, his net income would deteriorate relative to his suburban counterpart. Economic incentives are unleashed which would divert employment toward suburbia.

On the other hand, if the tax were levied on the employer on the basis of the number of private parking spaces provided for employees, the firm might absorb the tax, passing this cost on to its customers. This type of response would be especially likely in an imperfectly competitive market, where a union zealously protects its fringe parking benefit. Employees would not be motivated to substitute transit for auto.

To allow local government parking taxes to have their full effect upon marginal transit-auto choice by employees, the federal government must disallow parking provided for employees as a business expense of firms, and require employees to include this parking benefit as income in kind.

An alternative policy might be for local government to compulsorily purchase or lease some of the largest private car parks, and charge for their lease or purchase, and for a tax to be charged per parking space on the remaining public car parks. Unless the federal government removes the sheltered tax status of employee parking in both corporate and personal income tax codes, local government will be powerless to affect marginal auto-transit choice, for the reasons discussed in the preceding paragraphs. Moreover, there is the added question whether government bureaucracy would end up substantially increasing the supply of parking, further diverting traffic to auto.

The policy that firms should adopt, which does not require as a precondition any change in taxation, is to subsidise both transit and parking. This solution is "second best" because neither mode has a price equated to its marginal cost. The subsidy would not discourage general over-utilisation of resources for urban transport. But a subsidy to transit would remove the present bias against transit, helping to correct the present over-extended auto usage, and would thus permit gains in efficiency and equity.

Because of the divergence between private and social costs, in order to realise the social gains of reduced aggregate congestion time all firms must simultaneously introduce the transit subsidy, and all must bear the subsidy cost in proportion to their shares in social benefit gains. If any one firm were to introduce a transit subsidy on its own, nearly all the time savings from reduced congestion would go to customers and employees of other firms. Because of this "free rider" effect, it is unlikely that all
firms would voluntarily agree to introduce transit subsidies simultaneously. Thus a compulsory solution is usually necessary.

Where none exists, a public transit district must be formed, with definition of the geographical boundaries of its service territory. The area may be limited initially to the central business district. Firms outside the district could join voluntarily by subscribing to the district's membership rules. All firms located within the transit district would be required to join the district as a condition of receiving a business licence. The transit district could sell to each firm the number of monthly transit passes or tickets it requested for eligible customers and employees requesting the transit privilege.

The administrative procedure of channelling the subsidy to the transit company could be handled at the firm level. A firm that presently does not subsidise parking would not be required to offer a subsidy to its transit riding employees or customers. Where a firm had a policy for subsidised parking, it would pay the same dollar value toward the transit fare. If the transit fare were less than the amount paid for parking, the total dollar value would be credited to the employee's monthly pay check, and separately coded on his statement of earnings and deductions. Conversely, if the transit fare or parking fee exceeded the designated dollar amount, the employee's salary would be debited by the over-payment. Employees would be required to submit validated transit or parking tickets to the firm's payroll office before the date of payment. This would minimise the administrative cost and even allow employees to alternate between modes within a pay period.

Because every firm would benefit from reduced loss in congestion time, whether or not it subsidised any of its customers' or employees' transit fares, each would receive an annual tax assessment against its property value to underwrite a portion of the cost of other participating firms. The aggregate of these property value tax assessments should constitute approximately the same proportion of total transit district cost as time savings from reduction of congestion are of total benefits. Ideally, land value, rather than total property value, should be the basis for this portion of the cost assessment, because centrally located firms are better served by transit and have the best potential for benefitting. Under-utilisation of this potential, e.g., parking lots, should not be favoured by low property tax assessment, nor should full utilisation, e.g., high-rise offices, be penalised. Because administrative and technical problems associated with shifting from a general property to a land value base would make the entire transit subsidy scheme more controversial, this ideal solution should be deferred until the programme has been in operation for a time.

Tax assessment financing might cover 50 per cent of the total cost of transit subsidy. Since local school districts and other government departments share in the benefits of higher property values by added tax revenue or reduced traffic-related service expenditure, these government departments should also help to underwrite the cost of the transit district, perhaps up to 25 per cent. The remaining 25–50 per cent of cost would be apportioned to firms in proportion to the number of tickets requested by each. Since the cost of added transit tickets to each member firm is only 25–50 per cent of the normal transit fare, all firms would be motivated to use the plan actively and promote it among their customers and employees.

Because peak period auto travel is subsidised by society in other ways than through parking provided by employers, a dual standard might be approved whereby new
PARKING BIAS IN TRANSIT CHOICE
Elbert W. Segelhorst and Larry D. Kirkus

employees, or those formerly ineligible for parking, could become eligible for the
transit but not the parking subsidy. The converse would not be recognised.

The transit company must be encouraged to introduce a differential marginal cost
fare policy, distinguishing between peak and off-peak, and between directions and
distances travelled. Employers and retailers would thus be encouraged to change
their work and shopping hours if the savings from reduced travel cost were significant.

If employers did not wish to incur added current expenditure on transit subsidies,
they could set up a fully vested deferred transit subsidy account in favour of eligible
employees who switch to transit. Compound interest would be paid on this account,
but the employee could withdraw it only upon retirement or on leaving the firm’s
employment. In effect, the firm would gain an interest-deferred tax-reducible loan
from its employees, and the employee would gain an assured retirement benefit with
added advantages of tax shelter.

III. APPLICATION TO LOS ANGELES
The following equations estimate the total gains per work day to present employees
in the central business district of Los Angeles from a subsidy for transit equal in value
to the parking subsidy. The analysis covers the short term, excluding favourable
long-run benefits that would accrue to employees, employers and consumers.
Long-run benefits would result from locational changes in business, employment,
residence, shopping and related activities, generated by improved efficiency of the
transport system. The estimates of increased income and value of added leisure from
employer participation are assigned entirely to employees. In the long run, part of
these efficiency gains may be transferred to owners, customers, and other suppliers
of participating business and government employers. In a separate study, Segelhorst
[1] estimates short-run income gains of shoppers from reduction of transit bias and
for added profits within the central business district of Long Beach from diverted
suburban sales. We assume that local governments do not share in the benefits of
added tax revenue or service reductions. Consequently, no portion of the cost of the
transit district is underwritten by local government.

All employees are assumed to commute during peak rush hours. Cost and time
reductions to commercial vehicles and through traffic which are part of the rush-
hour traffic flow are not included in the benefit estimates. We assume that the transit
company can rapidly make a substantial increase in rush-hour service by adding
vehicles and operators, and that the amortised cost of such added capacity is ade-
quately covered by the peak-hour transit fare. Core employers retain existing
employees; thus we ignore productivity gains that may accrue from the improved
accessibility of the labour market. The total number of peak period core trips
remains constant—total trip demand is assumed perfectly price inelastic. Employees
make only one round trip to work per work day.

The total cost of the employee transit subsidy programme ($C_s$) is expressed in
equation (1):

$$ C_s = B_0(x_1 + y_1 + z_1) $$ (1)
where

\[ B = \text{Average round trip transit fare.} \]
\[ s = \text{Average per cent decrease in round trip transit fare to employees from} \]
\[ \text{introduction of transit subsidy by employers.} \]
\[ X_1 = \text{Total number of employees riding transit who have the subsidised parking} \]
\[ \text{option.} \]
\[ y = \text{Percentage of} \ X_1 \text{that switch to transit with introduction of transit} \]
\[ \text{subsidy.} \]
\[ Y_1 = \text{Total number of core employment trips by price inelastic automobile} \]
\[ \text{commuters who receive subsidised parking.} \]
\[ z = \text{Percentage of} \ Z_1 \text{that switch to transit with introduction of transit} \]
\[ \text{subsidy.} \]
\[ Z_1 = \text{Total number of core employment trips by price elastic automobile} \]
\[ \text{commuters who receive subsidised parking.} \]

Those who presently work in the central business district and are eligible to receive the existing parking subsidy are divided into three categories according to mode and degree of preference. The first group \( (X_1) \) are a few transit riding employees who have not switched to auto even though they are eligible for the parking subsidy. They comprise a relatively small proportion of total transit riding employees, and represent those few remaining transit riders who own an auto and have a choice, but prefer riding transit. Equity and the possibility of long-run diversion indicate the desirability of extending the transit subsidy to these employees.

Group \( Y_1 \) is somewhat larger, but still a minority group of employees eligible for the parking subsidy. These executive, administrative and professional two-or-more-car-family employees, and those who require the auto in their work, normally commute long distances from suburbia; because of poor accessibility to transit, they have very low cross elasticities of substitution between auto and transit. This group chose auto before the introduction of parking subsidies.

The third group \( (Z_1) \) are less biased against transit. In many instances they come from lower middle income one-car families with many licensed drivers, or ride to work in car pools. A large proportion of this group chose transit before the introduction of parking subsidies. For this group, a transit subsidy will induce substantial diversion from auto to transit, saving income and releasing the auto for use by other members of the family, and the commuter from the binding auto pool.

The cost of extending a transit subsidy to groups \( Y_1 \) and \( Z_1 \) is offset by savings in parking subsidy costs, as auto commuters are diverted to transit. The shift will result in cost savings \( (S_e) \) expressed in equation (2):

\[ S_e = Bs(yY_1 + zZ_1) \]  

(2)

Since employers adopt the policy of an equal dollar value subsidy payment per employee to both auto and transit, by definition their cost of providing parking would be reduced by the identical amount of their increased transit subsidy expenditure to employees in categories \( Y_1 \) and \( Z_1 \).

Introduction of an equal subsidy to transit removes the bias against transit. The employees who switch from auto to transit realise an increase in net income \( (Y_e) \) equal to the value of time equivalent savings expressed in equation (3):
where

\[ E_a = \text{Average money expenditure of an employee's round trip by auto.} \]
\[ W = \text{Average wage rate of all employees.} \]
\[ T_r = \text{Average overall round trip time by transit.} \]
\[ T_a = \text{Average overall round trip time by auto.} \]

The increase in net income has a positive component \((E_a - B)\), the savings in money expenditure from taking the cheaper transit mode, and a negative component \([\frac{1}{3}W(T_r - T_a)]\), the loss of time from taking the slower transit mode, valued at one-third of the money wage rate. The positive sum of these two components is the time savings, valued at one-third \(W\), which the employee is free to allocate between leisure and income. The sum of these components must be positive because the employee voluntarily makes the change to transit.

A further increase in net income results from the total value of reduced travel time of all work trips \((T_n)\), expressed in equation (4):

\[ T_n = \frac{1}{3}W \left[ (X + Y + Z) \left( \frac{L}{S} - \frac{L}{S + \Delta S} \right) \right] \]  

where

\[ X = \text{Total number of employees who use transit, composed of those with } (X_1) \text{ and those without } (X_2) \text{ the subsidised parking option.} \]
\[ Y = \text{Total number of core employment trips by price inelastic automobile commuters, composed of those with } (Y_1) \text{ and those without } (Y_2) \text{ the subsidised parking option.} \]
\[ Z = \text{Total number of core employment trips by price elastic automobile commuters, composed of those with } (Z_1) \text{ and those without } (Z_2) \text{ the subsidised parking option.} \]
\[ L = \text{Average length of journey to work under congestion.} \]
\[ S = \text{Average speed of journey to work under congestion.} \]
\[ \Delta S = \text{Average change in speed of journey to work in congested length of trip.} \]

All employees, whether or not eligible for the parking subsidy, benefit in time savings resulting from the faster average speed realised with substitution of transit for auto. The increase in average speed, and the average length of the congested portion of each work trip, are assumed equal for all three commuter categories.

The aggregate net income gain \((Y_n)\) per average work day is expressed in equation (5) and estimated values in Table I:

\[ Y_n = Y_s + Y_e + S_e - C_e \]  

The estimated values of \(z\) and \(\Delta S\) represent the most questionable magnitudes. Elasticities have already been discussed, and \(S\) is dependent on traffic engineering studies, of which few exist. The exact values of speed and volume relationships for Los Angeles are unknown. The ranges of increases in speed (\(\Delta S\)) from the switch from auto to transit are those used by Roth [13] and others for London, and appear
Table I

<table>
<thead>
<tr>
<th>Elasticity</th>
<th>( \Delta S )</th>
<th>Speed (miles per hour)</th>
<th>2</th>
<th>4</th>
<th>6</th>
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<tbody>
<tr>
<td>0.3</td>
<td>( Y_e )</td>
<td>14,334</td>
<td>14,334</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>( Y_c )</td>
<td>19,219</td>
<td>32,947</td>
<td>46,675</td>
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<tr>
<td></td>
<td>( Y_n )</td>
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<tr>
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<td>34,154</td>
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<tr>
<td></td>
<td>( Y_c )</td>
<td>19,219</td>
<td>32,947</td>
<td>46,675</td>
<td></td>
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<td>( Y_n )</td>
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<td></td>
<td>( Y_n )</td>
<td>68,474</td>
<td>82,202</td>
<td>95,930</td>
<td></td>
</tr>
</tbody>
</table>

\( S_e - C_e = \text{Constant of } -4,942 \)
\( Y_1 + Z_1 = 50\% \text{ of } 10^{4}8,108; \ Y_1 = 0.32; \ Z_1 = 0.68; \ X = 68,640; \ Y = 33,541; \ Z = 71,276; \ y = 0.01; \ L = 14; \ S = 20; \ E_d = 3.08; \ B = 1.20; \ W = 4.00; \ T_l = 1.4; \ T_a = 1.0; \ S = 1.0. \)

Sources: Wilber Smith and Associates: Los Angeles Central Business District Parking Study (1967) for \( X, Y, Z, X_1, Y, Z; \) U.S. Dept. of Transportation for \( E_d; \) Dept. of Commerce, Bureau of Census, for \( W; \) Los Angeles Rapid Transit District, Engineering Dept., for \( T_l \) and \( B; \) Rolland Marino, Inventory of Freeway Geometric Bottleneck Congestion First Interim Report, Freeway Operations Department, District of California Division of Highways, 1970, for \( T_a, L \) and \( S. \)

to be conservative for Los Angeles. With conservative values for these two variables, net income gain is still substantial (as shown in Table I).

The only added cost to the employer (\( S_e - C_e \)) is the transit subsidy given to employees who rode transit before introduction of the transit subsidy and who qualified for the parking subsidy. The gain in net income from \( Y_e \) per employee who switches to transit is approximately $1.36 a day, or $354.00 a year. If the employee credited this added amount to a special fully vested retirement fund at 6 per cent compound interest, after 40 years the employee would realise a lump sum additional cash settlement upon retirement of $5,327.
The degree of success from introduction of transit subsidies is largely dependent on the response in ridership. An argument often cited against free or subsidised transit as a means of reducing auto congestion is that, because of low price elasticities of substitution between auto and transit, transit subsidies would be too costly as compared with alternative ways of reducing congestion, e.g., improved service levels of transit or added highway capacity.

The question of elasticities is still in debate. Moses and Williamson [14] estimated that 13 to 18 per cent of auto commuters would be diverted to transit if its price were zero. Kraft [15] concluded that fare reduction would divert rush-hour transit work trips from auto, but that direct transit elasticity and auto cross-elasticity, although approximately the same, are quite low, about 0·14. His adjustment for free transit gives a reduction in peak traffic of 9 per cent for morning and 6 per cent for evening peaks. On the other hand, much higher elasticities were found by Warner [16], Quarmby [8], McGillivray [17] and Thomson [9]. Warner states that, for those with a choice of modes, elasticity is unitary.

We accept the overall low price elasticities of auto users for transit. However, the transit subsidy only applies to a select sub-group of auto users: those who receive free parking. Because perceived cost of parking is more important in the modal choice decision of this sub-group, their direct elasticity of auto use with respect to cost is higher. Since direct and cross elasticities were found to be about the same (and they are identical in our analysis), the response to transit subsidy is higher for this sub-group with subsidised parking, although low for the entire group of auto users.2 One may think of the sub-group of auto users with subsidised parking as containing a larger proportion of former transit riders than the non-subsidised auto users. They switched to auto because of the importance of the reduction in auto cost from the parking subsidy. The income (cost) effect of the transit subsidy again induces a greater response from this "cost conscious" group.

With the introduction of a transit subsidy of equal value to present free or subsidised parking, the apparent conflict in objectives of the low elasticity transit critics and the marginal cost pricing advocates can be reconciled. The limited diversion from auto to transit projected by the first group is achieved without the huge public money subsidies they estimate, and a limited reduction is attained in distorted prices of auto and transit, making price more nearly equal to marginal cost.

REFERENCES


2We have assigned 0·7 to the more elastic subsidised group. This is consistent with the low 0·33 overall average elasticity used by the transit industry as a "rule of thumb".