# FARE EVASION AND AUTOMATIC TICKET COLLECTION ON THE LONDON UNDERGROUND

by

**Ronald V. Clarke**

**School of Criminal Justice, Rutgers, The State University of New Jersey**

ABSTRACT: *At the end of 1989 a new ticket issuing and collection system, including automatic gates at 63 busy central stations, was brought into full operation on the London Underground. One of the system's principal objectives, a reduction in fare evasion, appears to have been achieved. The results of before-and-after surveys undertaken by the management of the Underground suggest that fare evasion has been cut by two-thirds and that the additional revenues generated should soon pay for the cost of installing the automatic gates. An analysis of ticket sales also indicates that the more recent installation in December 1991 of automatic gates at two suburban stations has been cost-effective in terms of reduced fare evasion. It is concluded that further research should be directed to identifying other high-risk stations where installation of automatic gates might be cost-effective.*

## INTRODUCTION

The spectrum of crime on mass transit systems falls into two broad categories: crimes committed against passengers, and crimes committed against the system or its employees. Both categories have been the subject of recent research intended to inform preventive efforts. Regarding crimes against passengers, Webb and Laycock (1992), for example, evaluated three pilot projects on the London Underground intended to reduce robberies, thefts and assaults against passengers, and Gaylord and Galliher (1991) described features of Hong Kong's new Mass Transit

Address for correspondence: Professor Ronald V. Clarke, School of Criminal Justice, 15 Washington Street, Newark, NJ 07102.

Railway that make it one of the safest in the world for passengers. As for crimes against the system, Wilson and Healey (1986) have studied graffiti and vandalism on the suburban railways of New South Wales; Sloan-Howitt and Kelling (1990) have described the process by which the New York City subway was rid of graffiti; and van Andel (1989) and DesChamps, Brantingham and Brantingham (1991) have evaluated recent successful efforts to reduce fare evasion on public transit systems, respectively, in Holland and Vancouver.

Fare evasion is also the focus of the present study, which considers the results of introducing automatic ticket collection on the London Underground. The new system, known as the "Underground Ticketing System" or UTS, is similar to that being considered for adoption on the New York City subway and elsewhere in the world (Sims, 1991). The results of the present study may therefore have some more general relevance.

## The Underground Ticketing System (UTS)

The London Underground is one of the largest mass transit systems in the world. From its beginnings in 1863, when it serviced three stations, it has gradually been expanded by the addition of new lines and stations until it now covers 272 stations and 250 miles of track in Central London and the suburbs. Service is provided for 20 hours of the day for an average of about 2.5 million passengers each day.

Until the introduction of the UTS, the issue and collection of tickets on the Underground had remained unchanged for many years. Tickets were purchased by passengers from "booking" offices or free-standing machines, and surrendered at the conclusion of journeys to ticket collectors. A variety of "season" tickets, purchased at a discount and useable for more extended periods, had also been available for many years. This ticketing system, requiring high levels of staffing, was expensive to operate and vulnerable to fare evasion. In 1987, for instance, fare evasion was estimated to have cost London Underground Ltd. (LUL) £25 million.

The UTS, an integrated ticket issuing and collection system developed by Westinghouse-Cubic together with LUL, has the following features:

(1) New automatic ticket machines at all 272 stations consisting of two basic types: self-service machines for passengers issuing a range of daily tickets and giving change, and similar machines for the use of booking office clerks issuing not just daily tickets, but also "season" tickets and ones valid for travel on British Rail.

(2) Tickets that are credit card size, magnetically encoded and electronically readable.

(3) Automatic ticket gates at the 63 stations of the central zone that electronically check tickets, both at entry and exit, and that record details of each successful passenger transaction and the statistics of all tickets presented.

(4) A sophisticated computer system linked to all ticketing machines that provides individual accountability of booking clerks.

(5) Secure booking offices located in the wall of the booking hall (instead of in the center of the hall as was often the case before), which, in most cases, also allow clerks to service the rear of the self-service machines without leaving their offices.

The first of the new ticket machines was brought into service in April 1987, but the automatic ticket gates did not become fully operational until the end of 1989. The overall cost of the UTS to-date (1989-90 prices) has been about £165 million, £125 million of which was for the ticket machines and booking office modernization and £40 million for the automatic gates. Although only the 63 stations of the central zone have so far been equipped with the automatic gates (with the exception of two suburban stations, see below), most passengers' tickets are in fact electronically checked by the gates. This is because an estimated 80% of journeys begin and/or end in the central zone. Fare evasion is still not difficult, however, for the remaining 20% of journeys that do not either begin or end in the central zone, because at stations outside the central zone tickets are still subject only to visual inspection at entry or exit.

Despite some early resistance from the traveling public and the hostility of the popular press, which dubbed the new gates "Rottweilers" because of their supposed propensity to seize unwary passengers, the automatic gates have now become an accepted part of travel on the Underground.

## STUDY OBJECTIVES

The present study, undertaken with modest resources, was not intended to provide a comprehensive evaluation of the UTS, but only to examine its effect on fare evasion. A more comprehensive evaluation would have had to examine the extent to which the UTS served some of its other principal objectives, including a speedier and more convenient ticket selling and checking service for the public, the reduction of congestion at central London stations, increased protection from robbery for booking office staff, individual accountability for booking clerks, centralized accounting of ticket sales and centralized reporting of management statistics. A comprehensive evaluation might also have needed to consider some other possible benefits, including any savings in staff costs resulting from reductions in numbers of employees or in hours worked. In addition, Clarke and Poyner (1991) have suggested that suicides on the system by derelicts and psychiatric patients might be reduced by the increased difficulty of entering the Underground without a ticket, and Poyner and Warne (1988) hypothesized that the introduction of automated ticket collection should result in fewer assaults on ticket collectors.[1]

## EFFECTS ON FARE EVASION

In examining the effect of the UTS upon fare evasion, two separate analyses were undertaken, both of which made use of data kept by LUL. In the first, the results of annual fare evasion surveys undertaken on the Underground for a period spanning the introduction of the UTS were examined. In the second, information on ticket sales was analyzed for two stations outside the central zone (Stockwell and Brixton), more recently fitted with automatic gates.

### The London Underground Annual Fare Evasion Surveys

Since 1982, regular fare evasion (or "fraud") surveys have been undertaken on the London Underground. Details of the survey method were not recorded for 1982, but from at least 1983 the methodology has been reasonably standard. Each year, for a two-week period in October (but also in March 1989, a year in which two surveys were undertaken), the tickets of approximately 12,500 passengers are checked by small teams of London Underground staff who board train cars within specified geographical limits and time periods. A quota sampling procedure is followed to ensure that each car within the system has the same probability of being boarded. The grades of staff and numbers of individuals—usually five, but sometimes three—in each team have varied somewhat over the years, but this is not thought to have biased the results. Between about 1,000 and 1,150 cars are entered during the course of each survey. As many passengers as possible are checked before the train reaches the next station. Details of the ticket held and of the stated journey are recorded. The number of passengers checked without a valid ticket is compared with the total number of passengers checked on the car. When the train reaches the next station, the team moves to another car to reduce the distortion arising from passengers leaving the train to evade the check.

The survey method has some acknowledged deficiencies, including that: (1) It fails to identify some frauds such as the use of stolen or transferred tickets. (2) Its sampling frame is narrow in terms of the time period (October) and numbers of passengers covered. (3) Passengers can evade checks by leaving the train as the team enters the car. Nevertheless, considerable care has been taken to maintain a standard procedure so that even if the absolute value of fraud may be in doubt, survey results provide **a** good guide to trends over the years.

Percentages of passengers found to be without a valid ticket between 1982 and 1990 are shown in Table 1. It can be seen that fare evasion in 1990 (after the UTS system had been fully operational for about nine months) occurred among 1.9% of passengers checked, or about one-third of the level found in the two surveys undertaken in 1989 (6.2% in March and 6.0% in October), before the automatic gates were brought into full operation. The fact that fare evasion had not been reduced by an even greater amount is not surprising given that it is still relatively easy (as explained above) for passengers to avoid paying fares for the 20% of journeys taken outside the central zone.

While these data suggest that the UTS has been effective in reducing fare evasion on the Underground, a possible complicating factor has been a concomitant increase in the amount of routine on-train ticket inspection. In 1988, before the full implementation of the UTS, there were 135 traveling ticket inspectors (including supervisory staff) devoted

**Table 1: Percentage of Passengers Found Without Valid Tickets on the London Underground (1982-1990)**

| | Passengers Without Valid Tickets |
|---|---|
| 1982 | 6.3%(3) |
| 1983 | 3.1% |
| 1984 | 3.0% |
| 1986 | 3.8% |
| 1987 | 4.3% |
| 1988 | 5.6% |
| 1989(1) | 6.2% |
| 1989(2) | 6.0% |
| 1990 | 1.9% |

Notes:
(1) March
(2) October
(3) Results for 1982 may not be comparable with later years (see text), but the decline in fraud in 1983 may have derived from a "move to restructured fares, lower fares (which reduced the fraud incentive) and greater publicity—campaigns on TV to make people more aware of the serious nature of such fraud" (Weston, 1992).
Source: London Underground annual fare evasion surveys

to these duties. By 1991, this figure had increased to 267, but even with this increase the chances of any one of the 2.5 million daily passengers having his or her ticket inspected on the train must be very small. Moreover, unless there is clear evidence of the intention to defraud the Underground, the "punishment" for being caught without a valid ticket is merely the requirement to pay the fare due. It seems unlikely, therefore, that these additional staff furnished a materially increased deterrent to fraud, whatever their cost-effectiveness in the collection of additional revenues. In particular, it seems unlikely that the increased on-train ticket inspection explains more than a small part of the reduced fare evasion in 1990.

Using methods developed by Balmer (1976), which, among other things, take account of fares that might be paid by passengers on the completion of their journeys (or "excess" fares), the LUL uses the survey results to estimate how much revenue is lost through fare evasion. In 1989, the two estimates were £30 million for March and £29.1 million for October, whereas the figure for 1990 was £10.4 million. In other words, the cost of fare evasion to the LUL went down by approximately £20 million in the year immediately after the gates had become fully operational. The difficult question of whether this demonstrates the cost-effectiveness of the UTS in view of the £165 million start-up costs is deferred until later in the discussion.

## Automatic Gates at Stockwell and Brixton

As explained above, automatic gates were originally installed only at the 63 stations in the central zone, which meant that there were still considerable opportunities for fare evasion where journeys fell outside the central zone. This was considered a particular problem at certain suburban stations serving the more economically disadvantaged parts of the metropolitan area. Two of these stations were Brixton and Stockwell, where ticket collectors regularly complained that large numbers of passengers pushed past without a ticket and without offering to pay an excess fare. The LUL therefore decided to equip these two stations with automatic gates taken from the stock maintained of replacement gates.

The gates at Brixton and Stockwell were brought into operation on December 9, 1991, and their effect upon fare evasion was examined by comparing the pattern of ticket sales in two randomly-chosen weeks: the first week in October, just before the introduction of the gates, and the second week in January, about a month after. For comparison purposes, ticket sales were also examined in the same two weeks for two adjoining stations (Oval and Clapham North) and for one nearby large interchange station (Elephant and Castle).

Tickets sold fall into one of three categories, the first of which comprises "ordinary" single (i.e., one-way) or return (i.e., round-trip) tickets valid for the day of issue. These tickets will tend to be bought by passengers making casual journeys. The second category consists of a variety of "travelcard" tickets valid for a longer period or for unrestricted travel for one day. These tickets tend to be used by commuters and by visitors spending a short period in London. The third category consists of "excess" fare tickets, which are sold to passengers found to have no tickets or to have paid an inadequate amount for journeys taken.

It was expected that the introduction of the automatic gates would affect the numbers of ordinary and excess tickets sold at Brixton and Stockwell, but not the travelcards. The regular commuters and visitors to London who purchase the latter are more likely to be traveling into the central zone, where they would need a ticket to exit through the automatic gates. Many of those purchasing ordinary tickets, on the other hand, may be making casual journeys outside the central zone and may therefore not need a ticket to exit from the system, while many of those sold excess tickets are people who may have been hoping to slip past the ticket collector without paying[2].

Numbers of tickets sold before and after the introduction of the automatic gates are shown for Brixton and Stockwell in Table 2, and for the comparison stations in Table 3. It will be seen that there were substantial increases at both Brixton and Stockwell in the numbers of ordinary and excess tickets sold after the introduction of the gates. At Brixton, the increase was 12.9% in ordinary tickets and 85.3% in excess tickets. At Stockwell, the respective increases were slightly smaller at 9.0% and 57.3%. In the three comparison stations, the numbers of these tickets sold declined in the later period (with the exception of an unexplained 25.8% increase of excess tickets sold at the Oval). This decline, similar to that in the numbers of travelcards sold at all five stations (i.e, in Brixton and Stockwell as well as the three comparison stations), may be due to seasonal patterns in travel or to a general drop in travel due to the recession and the decline in tourism. Despite a possible decline in travel, sales of ordinary and excess tickets at Brixton and Stockwell increased. This indicates that the gates have been effective in reducing fare evasion, and that the true savings may have been larger than indicated by the recorded increases in sales[3].

The gains in revenue resulting from increased ticket sales can be estimated by expressing these as a proportion of ticket sales. For Brixton, in the seven days beginning January 5, 1992, £31,039 was collected

**Table 2: Tickets Issued Before and After the Introduction of Automatic Gates at Brixton and Stockwell**

| | BRIXTON | | | STOCKWELL | | |
|---|---|---|---|---|---|---|
| Tickets | Before* | After** | Change | Before* | After** | Change |
| Ordinary | 18,739 | 21,153 | + 12.9% | 11,009 | 12,004 | + 9.0% |
| Excess | 860 | 1,594 | + 85.3% | 613 | 964 | + 57.3% |
| Travel cards, etc. | 9,200 | 8,782 | - 4.5% | 5,440 | 5,135 | - 5.6% |
| Total | 28,799 | 31,529 | + 9.5% | 17,062 | 18,103 | + 6.1% |

* Monday-Friday, October 7-11, 1991
** Monday-Friday, January 6-10, 1992

from the sale of ordinary tickets and £1557 from the sale of excess tickets. For Stockwell, the comparable sales figures were £16,244 and £884, respectively. On the basis of the percentage increases in tickets sold in each category, it can be estimated that in this one week alone the gates produced an increase in revenue of £4,387 at Brixton and £1,904 at Stockwell. Assuming that the weekly gains continue to be of this order, these figures translate into annual gains of about £228,000 at Brixton and £99,000 at Stockwell, or a total of £327,000. According to the LUL, the cost of installing the gates at these two stations was £623,000 (£463,000 for the gates and £160,000 for installation). This means that the cost of the gates at Brixton and Stockwell should be recovered within two years.

The fact that more daily tickets were sold at Brixton and Stockwell following installation of the gates might mean that fewer excess fares were paid by passengers leaving the system elsewhere. Moreover, the costs of equipping these two stations with the gates would have been substantially more if the gates had not already been in stock and had to be specially purchased. This and other considerations that might limit the conclusions to be drawn from the experience at Brixton and Stockwell will be discussed below.

**Table 3: Tickets Issued at Nearby Stations Before and After the Introduction of Automatic Gates at Brixton and Stockwell**

| | CLAPHAM NORTH | | | OVAL | | | ELEPHANT & CASTLE | | |
|---|---|---|---|---|---|---|---|---|---|
| Tickets | Before* | After** | Change | Before* | After** | Change | Before* | After** | Change |
| Ordinary | 6,734 | 6,773 | + 0.6% | 7,446 | 7,032 | -5.6% | 19,236 | 18,107 | -5.9% |
| Excess | 259 | 226 | -12.7% | 93 | 117 | + 25.8% | 620 | 602 | -2.9% |
| Travel cards, etc. | 2,889 | 2,721 | -5.8% | 3,316 | 3,009 | -9.3% | 6,396 | 5,312 | -16.9% |
| Total | 9,882 | 9,720 | -1.6% | 10,855 | 10,158 | -6.4% | 26,252 | 24,021 | -8.5% |

* Monday-Friday, October 7-11, 1991

** Monday-Friday, January 6-10, 1992

## COST EFFECTIVENESS OF THE UNDERGROUND TICKETING SYSTEM

As explained, the present study was not intended to provide a comprehensive evaluation of the UTS. This would have required the collection of evaluative data relating not merely to fare evasion, but to the full range of benefits expected from the system. The lack of such data precludes conclusions about the cost-effectiveness of the UTS, though these conclusions would also have required much fuller information about the system costs. As explained, the UTS is an integrated system of booking offices, ticket machines, automatic gates and computing system. At present, only crude estimates are available of installation costs (£40 million for the gates, £125 million for the new booking offices and ticketing machines), and no, information is available about operating costs, including any savings in staff costs brought about by greater automation of ticket issuing and checking. Nevertheless, it appears that an estimated £20 million was saved in fare evasion during the first year in which the UTS was fully operational, which is a respectable return on the initial investment of £165 million. Indeed, it seems safe to assert that the cost of the automatic gates, arguably the most important component in reducing fare evasion, will have been recouped within the first two or three years of the system's full operation.

The result also supports the logic of having installed the automatic gates at the 63 stations of the central zone only. To have installed them on the more than 200 other stations at a cost of another £100 million or so is much less likely to have been cost-effective. Assuming that the annual cost of fare evasion is now about £10 million, as suggested by the 1990 survey, it would take at least ten years to recoup the cost of the additional gates—a far less favorable result than for the 63 stations of the central zone.

Nevertheless, it may still prove cost-effective to install gates at particular high-risk stations outside the central zone. This is indicated by the recent experience of installing automatic gates at Brixton and Stockwell in December 1991, which suggests that the costs of installation ought to be recouped within two years through the reductions in fare evasion. (The cost-effectiveness issues in this case were much easier since there were no additional expenditures for ticket machines or booking offices to consider.)

Admittedly, Brixton and Stockwell were thought to have had a particularly serious problem of fare evasion, and the gates were supplied at low cost from stock. Even so, there are almost certainly other stations where the anticipated reductions in fare evasion would justify the installation of automatic gates, and possibly some others where the cost would never be justified.[4] An attempt to predict the likely gains at individual stations, on the basis of ticket sales and demographic and crime data relating to the areas served by stations, would be very worthwhile. This would establish an ordering of priorities for new investment in automatic gates that might translate into substantial amounts of cash saved.

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## NOTES

1. This suggestion was not supported by data examined in the course of the present study, though the before-and-after comparison of assaults that was undertaken was made difficult by two important changes in the record system implemented at the beginning of 1991: records were computerized, and paperwork was considerably reduced for those reporting assaults by the requirement to complete just one rather than two forms as previously. These changes may largely account for the very large increase in assaults recorded in 1991. These numbered 612, compared with an annual average of 295.7 for the three previous years (315 in 1988, 263 in 1989 and 309 in 1990). Consequently, it was decided to examine the proportion of assaults related to ticket collection in the before (1987) and after (1991) periods. Poyner and Warne (1988:30) had shown that in 1987, 24% of assaults had taken place at the exit barrier or at the collector's box. In 1991, assaults at the exit barriers and gates or at the collector's box numbered 123, or 20% of the total of 612, which is not significantly less than the proportion observed in 1988—before the introduction of the automatic gates. A possible explanation for the apparent absence of any effect of the gates is that many assaults are committed by people returning home from a night's drinking to stations outside the central zone that do not have the gates.

2. Since excess tickets sold at stations with automatic gates have to be surrendered to the gates before the passenger can exit, this also reduces the scope for fraud by ticket collectors who are no longer able to pocket money given at exit without issuing a ticket.

3. It is theoretically possible that installation of the gates at Brixton and Stockwell may have displaced fare evasion to other stations, i.e., fare dodgers may have begun to use nearby stations instead, where it was still not difficult to avoid paying fares. This is unlikely to have occurred on any wide scale in view of the inconvenience of starting or ending a journey at a station other than the nearest one.

4. Apart from reduced fare evasion at the stations with gates, there may be some "diffusion of benefits" (Clarke, 1992) for the system as a whole, resulting from installing gates at more suburban stations. This is because some passengers may not know whether gates will be encountered at their destinations and may, therefore, be more inclined to purchase tickets when beginning their journeys.

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