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Letter to the Editor—The Reduction of Queues Through the Use of Price

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Until we have algorithms to solve more general nonlinear models, an iteratively parametric algorithm may solve some practical nonlinear programs.

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THE REDUCTION OF QUEUES THROUGH THE USE OF PRICE

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When an analyst in operations research encounters a queue, he seldom, if ever, looks into the alternative of introducing or changing a price in order to shorten or eliminate the queue. In practice, of course, prices often are used to reduce queues; examples are peak-load charges for electricity, higher daytime prices for parking, and higher Saturday prices for haircuts. But casual observation suggests that there are many unexploited, yet promising, possibilities of queue reduction through the use of price.

Supermarkets might collect a 'check-out fee,' which is higher at certain times of the day or week and lower at others. The fee might be a percentage of the total grocery bill, on grounds that service time is closely related to the size of the bill. Management would adjust the pattern of charges every week or month, relying on a trial-and-error procedure, their objective being to come as close as they could to zero-length queues (obverse queues of customers and reverse queues of clerks). The cost of collecting the service charge would be very low, little more than the time involved in ringing it up on the cash register. The stores would post and advertise their schedules of check-out fees so that customers could regulate the place and time of their shopping accordingly.

At a cab stand there may be a line of customers waiting for a cab or a line of cabs waiting for customers. A special 'boarding fee' might be collected from customers who enter a cab, a fee that is distinct from the usual mileage charge and that varies with time of day and with the location of the cab stand. It would be set by trial and error, the objective being to reduce as much as possible cab stand queues of both customers and cabs. But we might go further. Customers at home out in the suburbs of a city in the morning often are in a queue waiting for a cab and cabs out in the suburbs in the late afternoon frequently are in a queue looking for customers (as they 'deadhead' their way back downtown). A schedule of zonal boarding fees, applicable when cabs are boarded away from cab stands and varying with time of day, might reduce these queues. Perhaps at times such fees might be negative and subtracted from the mileage charge. When one thinks about it, one realizes that taxicab charges that are a function only of distance traveled (and elapsed time) are not very sophisticated. The value of a journey also depends on its time and place of origin (and of course on its destination as well).

An 'entry fee' might be used to reduce queues at toll booths on toll roads, a fee distinct from the usual charge per mile of travel, set by trial and error, varying with time, and different at different entrances. Prices might be used much more than at present to reduce queues on congested highways and urban streets. Take-off and landing charges might be used more effectively to reduce queues of aircraft waiting to take off and waiting to land ('stacking').

There are also possibilities of using prices to reduce queues within a corporation, wherever an affiliate or department is or can be placed on its own profit-and-loss statement. Intracorporate accounting prices might be charged to reduce queues at tool-crib counters, queues waiting for the services of other personnel, or queues waiting for the use of fork-lift trucks, cranes, or other equipment. The prices would be set by trial and error, be charged to the account of the appropriate affiliate or department, and vary with time of day, week, or year.

Queue reduction through price has three advantages. First, the employment of price improves the allocation of existing service facilities. Those who value services at particular points in space and time bid them away from others who value them less, so that scarce spacial-temporal bottlenecks are allocated to those who value them highly rather than on a first-come, first-served basis or on the basis of centrally established priorities. Second, use of a price system decentralizes the making of decisions. Customers decide when and where to seek service in accordance with their own preferences and the prices they encounter; rationing or a system of priorities is not imposed by business men or the authorities. Used within a firm to reduce queues, prices decentralize management decisions. Departments decide when to send men to a tool-crib window (taking into consideration the accounting price they will be charged) rather than top management deciding on a system of priorities.

Finally, the prices set to reduce queues may guide decision makers in the hiring of personnel and in investment in service facilities such as check-out counters, toll booths, runways, etc. Income from check-out fees, entry fees, or takeoff and landing fees may provide a measure of the value of the service provided and can be compared with the costs of adding personnel or the costs of investment in additional physical facilities.

It must be recognized, of course, that the costs of setting and collecting a price (or setting and accounting for an intracorporate price) may be greater than the benefits to be gained through its introduction. But it seems likely that many opportunities of using price to reduce queues remain undiscovered. It is a bit surprising that in a capitalistic economy applied queuing theory limits itself to recommendations of administrative measures for the reduction of queues. One might have expected to find such an approach in a planned economy but not in an economy in which prices and markets play so large a role.

ERRATA

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The following are corrections to "On the Feasibility of Simultaneous Flows in a Network," *Opns. Res.* **12,** 359–360 (1964): On p. 360, after (2) add "the t_{ij} is recalculated for each P, by considering $\bar{P}$ as a single node." Also on p. 360, line 11–13, "$t_{11'}$ is 12, $t_{33'}$ is 2. The total flow capacity is 18 but the total branch capacity in the network is 16."