Psychology and the Choice of an Optimal Travel Path

By

Tarun Kabiraj
Indian Statistical Institute, Calcutta

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Abstract

The paper explains why a person might follow a particular route rather than an alternative route although two routes are apparently symmetric. The paper draws attention to psychological factors of the traveler.

Correspondence to:
Tarun Kabiraj,
Economic Research Unit,
Indian Statistical Institute,
203 B. T. Road,
Calcutta – 700 035, India.
E-mail: tarunkabiraj@hotmail.com;
Fax: (91)(33) 5778893

1. Introduction

Generally a person has a number of alternative routes to go from one place to another and he is to choose one from these alternatives. These routes might differ in more than one respect. Some routes are shorter in distance, road conditions of some routes are not equally good, availability of modes of journey and costs of journey may differ along these routes, and finally, the environment and surroundings across the roads can be different. These differences generally determine the choice of routes. But if these routes are otherwise found to be symmetric, or if there is no apparent reason for preferring one route to another, we presume that the person will be indifferent between these alternatives. In that case if we observe the choice of routes of many persons drawn from an ordinary pool of population, we should expect that fifty per cent of the population follows one path and the remaining fifty per cent follows the other path. But for some reasons or other if we consistently observe that a major portion of the sampled population is following a particular route although the other route is apparently symmetric, it calls for a scientific explanation. This paper is an attempt to explain why we might observe a majority of persons following a particular route when an alternative, but apparently symmetric, route is available. We provide an analysis based on exploring the psychology of the ordinary people.

Although not exactly the same, but similar type of question may possibly be raised in the context of a consumer's choice between alternatives. A consumer is assumed rational. By this we mean that a consumer chooses a bundle optimally from the feasible consumption set. So when a consumer is observed buying a particular bundle, we conclude that he buys the bundle either because it is less expensive to other feasible bundles or he prefers it more. Now, if we have the information that the two bundles, A and B, are equally expensive, but the consumer is buying the one, say A, we conclude, by the axiom of revealed preference theory, that he prefers A to B. So if we assume that these products are (horizontally) differentiated but otherwise identical products (for example, red coloured pen and black coloured pen), then looking the behavior of a large number of consumers drawn from the pool of the ordinary consumers, we should expect that on average 50% of them should consume A and the remaining 50% consume B. But if our observations are found to be contradictory, we should guess that either the goods are not perfectly symmetric or we are missing something specifying the utility function.

In the choice theory agents are assumed to act rationally. A person is rational in the sense that he will settle for nothing less than the best (Simon, 1978). However, behavior of the agents may not always appear rational. Economists and psychologists have attempted to explain this behavior. In particular, psychological factors are quite important in this context. An earlier celebrated work on this issue is by Thurstone (1927). Kahneman and Tversky (1984) draw attention to what they called the framing problem. Accordingly, how the decision problem is posed and how the alternatives are presented, these considerations are very important for the outcome of a decision problem. The choice of an agent is also influenced by his personal characteristics, habits and norms (Tversky and Kahneman, 1981).

Motivation of the paper comes from the following observation. From our institute gate to the bus stop there are two rectangular paths (as described in Section 3 of the paper). Majority of the people is observed to follow one path when they go to the bus stop at the end of office hours while they follow the other path when they come to the institute. This paper is an attempt to explain this behavior.

In our paper we assume that there are a number of alternative routes to go from one place (starting point) to a particular place (destination). In particular, we consider only two routes that are otherwise identical in respect of lengths and conditions of roads and modes of journey. Our problem then is to resolve the choice problem of a person regarding its choice of route. We show that a person with certain kind of psychology will strictly prefer a particular route to the other. With this result then his preference will remain for that route even if (marginally) the route is relatively bad or larger in length compared to the other. This means that under certain kind of psychology a consumer might prefer a relatively bad commodity.

Before we go to the next section it may be mentioned at the outset that we should not be too ambitious to apply the theory to all situations. The peculiar psychology we are referring to is possibly applicable only to those situations where the distances to be traveled are short and the traveler are to toil physically to travel the distance, say for instance, by cycling or walking.

The paper is arranged in the following way. The second section provides the structure of analysis. In the third section we resolve the choice problem of a person who possess a particular kind of psychology. The result is extended in the fourth section to analyze a relatively bad consumption. Finally, the fifth section is a conclusion.

2. Analytical structure

Suppose that a person is to go from one position of start (S) to a destination (D). He is drawn from an ordinary pool of population that possesses a certain kind of psychology to be explained very soon. There are a number of alternative routes. Let L_r be the length of the road that he will have to travel following the r-th route. Going from S to D generates some utility to the person, and he will follow the route that generates maximum (net) utility to him. When he goes through the r-th route, let the net utility he derives be $\Omega(R_r)$. We assume that this utility function has following components which are additive.

First component is the gross utility that he derives from reaching to the destination (i.e., by consuming the good). This will be denoted by u(D). This is independent of the route he follows.

Second component is the loss of utility that arises from the condition and quality of the route vis-à-vis the best route among the alternatives. We assume that available modes of journey are equally available along all the routes. To the extent the route he is following is worse compared to the best one, he will discount his utility. This loss function is denoted by $\delta_r u(D), 0 \le \delta_r \le 1$; $\delta_r = 0$ implies that the r-th route is just equally comparable or as good as the best one. So δ_r represents depreciation of his utility. Then $\delta_r = 1$ means that even leaving aside any other factors under consideration there is no point of going through this route.

Third, there is a cost of journey $C(R_r)$ that includes both monetary and physical cost. When this is measured in utility units, it is equivalent to a loss of utility of the amount $\lambda C(R_r), \lambda > 0$.

Final component, $G(R_r)$, represents disutility for his psychological cost. We assume that the person under our consideration has the following type of psychology. Once the person reaches the destination, he is relieved and becomes free from all tensions, uncertainties and hazards. The far he is from the destination the larger is the psychological cost. We assume that at any position of his journey his psychological cost is the function of the diagonal distance between his position and the destination. Then given any choice of route, if he has already traveled a distance x from the start (S), the diagonal distance, d_x, is the length of the straight line joining his location at x and D. So from every possible position of his journey he is to calculate, either unconciously or subconciously, a cost in his mind. Quite naturally, the psychological cost is minimum if there were a route directly diagonally to the destination. Along the r-th route, given the length of the route L_r, the total loss of utility due to psychological cost is measured to be:

$$G(R_r) = \int_0^{L_r} \phi(d_x)dx .$$

Note that $\phi(d_x)$ is non-increasing function of x.

Taking into account all these factors, his net utility following the r-th route is:

$$\Omega(R_r) = (1-\delta_r)u(D) - \lambda C(R_r) - G(R_r) . \qquad (1)$$

Then a person will choose the z-th route if and only if

$$\Omega(R_z) \ge \Omega(R_r) \forall r . \qquad (2)$$

3. Rectangular Route

As a case to the structure explained in the last section, consider the following scenario. There are two routes, east (E) and west (W), where $E = \overset{\mapsto}{SXD}$ and $W = \overset{\mapsto}{SYD}$, and there are no other routes available. Assume that SXDY forms a rectangle with SY = XD = a and SX = YD = b (see Figure 1). Hence to reach to the destination he is to travel a distance L = a + b by either route. We further assume in this section that qualitatively these routes are identical implying $\delta_r = 0$. Then if he follows the route E, his net utility, as follows from Eqn. (1), is

$$\Omega(E) = u(D) - \lambda C(E) - G(E) ; \qquad (3)$$

the corresponding net utility from the route W is

$$\Omega(W) = u(D) - \lambda C(W) - G(W) . \quad (4)$$

Then in our construction, route W will be preferred if and only if

$$G(W) \le G(E) , \quad (5)$$

that is, the person will choose a route when his loss of utility due to psychological factor is minimum. It must be noted that such a psychological factor is working subconciously in his mind. We have following results.

Proposition 1: *Given the assumption regarding psychological cost of a person, his optimal choice of route is (i) W if a>b and (ii) E if a<b; he is indifferent when a = b.*

Proof: Assume that a > b. Now starting from S if he travels a distance x, the diagonal distance between his position at x and D along routes W and E are, respectively, d_x^w will and d_x^e. Then from Figure 1 it is easy to see that

(i) at x = L, $d_x^w = d_x^e = 0$;

(ii) for $x \ge a$, $d_x^w = d_x^e = a + b - x$;

(iii) for $b \le x < a$, $d_x^w = \sqrt{(a-x)^2 + b^2} < d_x^e = a + b - x$

(iv) for $0 < x \le b$, $d_x^w = \sqrt{(a-x)^2 + b^2} < d_x^e = \sqrt{(b-x)^2 + a^2}$

(v) at x = 0, $d_x^w = d_x^e = \sqrt{a^2 + b^2}$

Then, given the definition of G(.), it is clear that G(W) < G(E). Thus if a > b, the optimal choice of route by the person under consideration is W. This proves the first part of the proposition. Similarly, the other parts can be proved. □

Consider now the following scenario. We have the same rectangular path from S to D, but the final destination is either D_1 or D_2 (but both via D). There are two persons, person 1 to go to D_1 and person 2 to go to D_2 from the same point, S. In Figure 1 it is clear that both D_1 and D_2 can be reached either via $\overset{\mapsto}{SXD}$ or via $\overset{\mapsto}{SYD}$. Further assume that the distances $\overset{\mapsto}{DD_1}$ and $\overset{\mapsto}{DD_2}$ are equal. Then extending the idea of the paper we may predict that person 1 will follow the route $\overset{\mapsto}{SXDD_1}$ and person 2 will take the route $\overset{\mapsto}{SYDD_2}$, although both would follow the east route if D were the destination (as we have a < b in Figure 1). In Figure 2 we have given an example where the routes are not rectangular; out of the two routes $\overset{\mapsto}{SXD}$ and $\overset{\mapsto}{SX_1Y_1X_2Y_2X_3D}$, a traveler, with the psychology as described in the paper, should follow the second path. Thus, psychologically speaking, people prefer to walk as far as practicable along a straight line to the destination.

4. Asymmetric Routes

Let us assume that relative to E, W route is qualitatively bad so that there is some disutility due to bad quality or conditions. This means, $\delta_e = 0$, but $\delta_w > 0$. But suppose that the route lengths are the same. Then W will be preferred if and if $\Omega(W) \geq \Omega(E)$, that is,

$$(1-\delta_w)u(D) - G(W) \geq u(D) - G(E)$$

or, $G(E) - G(W) \geq \delta_w u(D)$.

Assuming a > b, G(E) > G(W), i.e., LHS>0. Therefore, the west route will continue to be the preferred choice if

$$\delta_w \leq \frac{G(E) - G(W)}{u(D)} = \delta^*. \tag{5}$$

(Of course, by construction of the model, $\delta^* < 1$.)

It may be easily understood that the rectangular path assumption is just for convenience. Hence by the similar argument it is possible to prove that when road conditions of two roads are identical, one route may be preferred even if it is little bit longer in length.

5. Conclusion

The paper analyses which way to follow to travel from one place to a particular destination, assuming that there are alternative routes. We provide a psychological analysis to this choice. In particular, we argue that a person with certain kind of psychology may prefer a particular route to the other although apparently the routes are identical. Hence, it is also possible that the person concerned chooses the one which is apparently bad in quality or longer in distance. Equivalently, this is the scenario when the consumption basket is given, but acquiring the basket involves various costs, both monetary and psychological. Different consumers will be willing to pay different amount not only just because they differ in terms of their tastes and income, but, importantly, they might differ psychologically and hence have different perception regarding valuation of the good. Thus we model explicitly the psychological factor to the choice of the consumer. Presumably, we also apply the theory to the choice of investment projects that require investment in capital assets but the capital assets have different rates of depreciation.

References

Kahneman, D. and A. Tversky (1984), "Choices, Values and Frames", *American Psychologist* 39, 341-350.

Simon, H.A. (1978), "Rationality as Process and as Product of Thought", *American Economic Review* 68, 1-16.

Thurstone, L.L. (1927), "A Law of Comparative Judgement", *Psychological Review* 34, 273-286.

Tversky, A. and D. Kahneman (1981), "The Framing of Decisions and the Psychology of Choice", *Science* 211, 453-458.

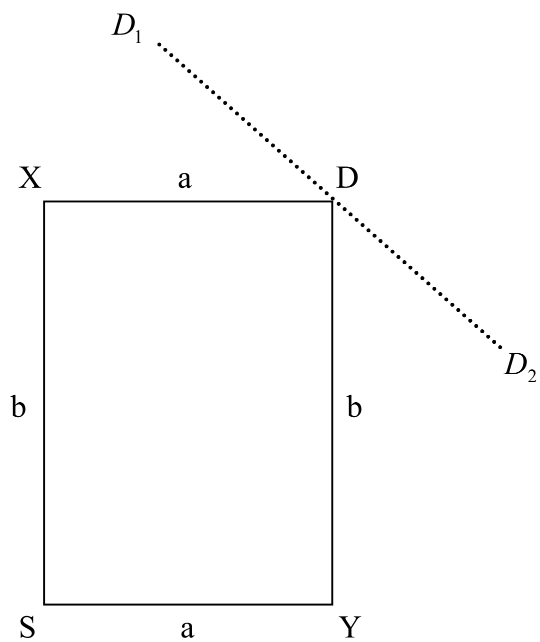

Figure 1: Rectangular Route (with a < b)

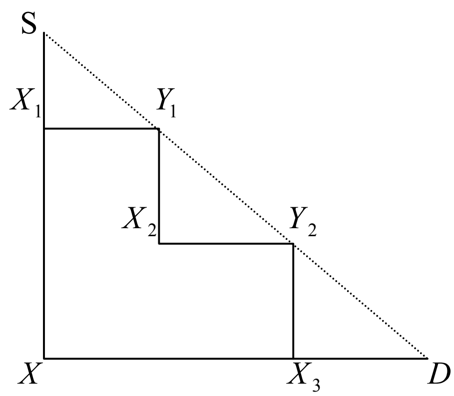

Figure 2: Non-Rectangular Route