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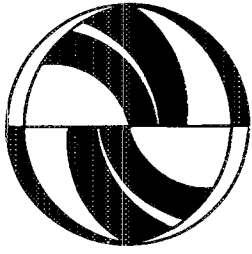**Permalink**
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**Ameliorating Congestion
by Income Redistribution**

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Ameliorating Congestion by Income Redistribution

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Ameliorating congestion by income redistribution

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Consider a community with individuals who consume a private good and use a congestible facility. Without a congestion fee, use of the congestible facility will exceed the socially optimal level. We show that under some conditions this externality problem can be solved by income redistribution. Indeed, the poor can gain from a redistribution to the rich.

JEL classification: D62; D72; D31

1. Introduction

It is well known that tolls can solve congestion problems [see Walters (1961), Weitzman (1974)]. But that is not the only tool. The purpose of a toll is to induce some persons to make less use of the congestible facility. We shall see that a pure transfer of income can achieve this purpose. Under some conditions such a redistribution, even from the poor to the rich, can increase the welfare of all. This result is all the more surprising in the context of congestion rather than of simpler externalities. For a policy that reduces congestion makes the congestible facility more attractive, thus reducing the effectiveness of that policy. Moreover, when the demand elasticity for the congested good is very low, the qualitative effect of a Pigovian tax may be difficult to predict. Regulation through income effects may then be better. Finally, a policy of imposing a congestion toll without redistributing the revenue to users will make at least some consumers worse off [see Weitzman (1974), Glazer (1981), and Niskanen (1987)]. In the most recent statement of the result [which corrects an error by deMeza and Gould (1987)], Evans

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(1992) correctly notes that a congestion toll cannot increase the welfare of all consumers. For the welfare of some consumers can increase only if fewer persons use the road. But that will happen only if the costs (toll costs plus time costs) increase for at least some users. These persons are necessarily worse off.

In some cases an expansion of the facility may be the best policy. But not if such expansion is expensive. Indeed, some congestible public goods are in almost fixed supply – beaches and unique national parks are two examples. The supply of other congestible facilities can be increased at a cost. Roads are an example. But this cost can be high, particularly because congestion is most severe in urban areas, where road expansion is expensive.

This paper focuses on the effects of income inequality on congestion. In particular, we show how a redistribution that increases inequality can reduce congestion. Moreover, even a redistribution from the poor to the rich can make everyone better off. Heretofore the literature studied Pareto-optimal redistribution in the context of relative status, envy, and altruism [see Hochman and Rodgers (1969), Fuerstenberg and Mueller (1971), Brennan (1973) and Boskin and Sheshinski (1978)]. Pareto-optimal redistribution has also been considered from an insurance perspective. Varian (1980), for instance, argues that redistributive taxation may be desirable from an ex-ante point of view if individuals are risk averse. Broadly speaking, these theories favor equalizing incomes.

Our analysis of the effect of inequality can be applied to many situations. We can examine the circumstances that would make individuals in a rich community favor low-income housing. The analysis thus offers a partial explanation for why communities are not as homogeneous as Tiebout's (1956) model would predict. [For other arguments on homogeneity of communities see Atkinson and Stiglitz (1980), and Stiglitz (1983, p. 35)]. We can also apply the model to understand the benefits of allowing immigration of the poor, or the reasons university students not eligible for scholarships would nevertheless favor them for others. Moreover, studying the effect of income on congestion is useful even if congestion tolls are feasible. For any tax policy that returns revenue to potential users of the congested facility involves an income effect. As we show, this effect alone can control congestion, with no need for additional price effects.

2. Income redistribution reduces congestion

We use a model with discrete choices to show that a redistribution of income can be a Pareto improvement. If all individuals with income less than y^0 use the good, and if average income is less than y^0, then in an egalitarian community all use this good. (We shall also consider the opposite case.) In a non-egalitarian community some do not use the good. This reduces conges-

tion and can increase welfare. Our approach is thus first to consider a community consisting of individuals with identical incomes and utility functions. We then show that a redistribution of income can be a Pareto improvement. This effect implies that a redistribution that starts from a state of some inequality can also increase welfare.

2.1. Only the poor use the congestible facility

We shall consider two possibilities: the poor or the rich have the greater desire to use a congestible facility. A redistribution of income to the rich can reduce congestion and improve the welfare of all if the following conditions are met: (a) the rich choose not to use the congestible facility, even at the lower congestion in the new equilibrium; (b) the poor, who continue to use the congestible facility, value the reduced congestion by more than the redistributive taxes they pay.

We give an example to illustrate the mechanism at work and to demonstrate that these conditions can be met. Consider an economy with two private goods, x and z. Good z is a final good; x is an intermediate good (as explained below). The second consumption good is a service which is produced from x and from a congestible public good in fixed supply, g. We write this service as $f(x, g, n)$, where n is the number of persons who use the congestible facility. Assume that an increase in the number of users reduces the quality of service at an increasing rate: $\partial f/\partial n \equiv f_n < 0$, $\partial^2 f/\partial n^2 \equiv f_{nn} < 0$. Let the transformation rate between x and z be linear, and choose appropriate units for x and z to make their prices equal to 1. Goods z and f are mutually exclusive in consumption. An example is the use of private and public swimming pools. A private pool is good z. A public pool is good f, which requires private expenditures (say for transportation) in the amount x. Similarly, we may think of sending a message by facsimile (good z), or using a private car (good x) on a congestible public road (good g). Utility for individual i is

$$u_i = u(z_i, f(x_i, g, n)) \equiv \max(z_i, f(x_i, g, n)).$$

An individual's budget constraint is

$$y_i = x_i + z_i.$$

All individuals are initially identical. Individual utility maximization requires that

$$x_i = y_i, z_i = 0 \quad \text{for} \quad f(y_i, g, n) > y_i,$$

$$z_i = y_i, x_i = 0 \quad \text{for} \quad f(y_i, g, n) < y_i.$$

With natural restrictions on f,[1] and a given distribution of income, all persons with an income below some critical level (say y^0) use the congestible facility; all persons with a higher income instead consume good z.[2] The number of users is simply the number of persons with income less than y^0. In the egalitarian community each person has income $y^0 - \varepsilon$. In this case everybody uses the congestible facility.

Consider a tax of $2\varepsilon/(N-1)$ imposed on $N-1$ individuals, with the revenue given to one person. This individual chooses not to use the congestible facility any more, but is better off. The taxed individuals consume less of the private good. Their consumption of the congestible service increases by $-(\partial u/\partial f)(\partial f/\partial n)$. When ε is small and congestibility is high, the decreased congestion, $-f_n$, can overcompensate their income loss. Everyone has higher utility.

2.2. Only the rich use the congestible facility

Inequality can increase welfare both when the poor use the congestible facility (as just demonstrated), and when only the rich do. We show this second effect with a somewhat different model. Let utility be a function of consumption of a private good x, and of a service $f(g, n)$ that depends on a congestible public good g and the number of users, n:

$$u_i = u(x_i, f(g, n)).$$

Obtaining the service f requires a fixed private cost of c. Consumer i has exogenous income y_i. He must choose between (a) paying the cost c and using the congestible service, and (b) using only the private good. He will use g if and only if

$$u(y_i - c, f(g, n)) > u(y_i, 0).$$

For simplicity assume that u is additive in x and f:

$$u(x_i, f) = x_i + f.$$

Assume that $f(g, N) > c$. Then all persons with income c or more use the congestible facility. Persons with lower income do not. The number of users is the number of persons with income greater than or equal to c. Suppose again that the congestible facility is in fixed supply.

Consider an egalitarian community with N individuals. Each has income y

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[1]A sufficient condition is $f(0, g, n) = 0$, $f_x(0, g, n) > 1$, $\lim_{x_i \to \infty} f_x(x_i, g, n) = 0$, $f_{xx} < 0$, and $f_{xn} \leq 0$.

[2]If the distribution of income is not atomless and if $f_{xn} < 0$, then $f(y^0, g, n) = y^0$ holds when only a fraction of individuals with income y^0 use the facility.

greater than c, so that utility is $u = y + f(g, N) - c$. When the congestion externalities are large, $-(N-1)f_n(g, N)$ may be larger than $f(g, N) - c$. The utility of the Nth user of the congestible good is less than the externality he imposes. When this inequality holds, maximizing social welfare requires excluding some individuals from using the congestible facility. The optimal number of users, n, is determined by the condition

$$nf_n(g, n) = f(g, n) - c.$$

This can be achieved by redistributing wealth to make $N - n$ individuals slightly poorer than c. Assume the redistribution is made by first determining N gains and losses, and then randomly allocating these transfers to the N persons. If consumers are risk neutral, this redistribution gives each an expected utility of

$$Eu = y + (f(g, n) - c)(n/N).$$

This can be greater than $u = y + f(g, N) - c$, the utility before a redistribution which creates inequality.

3. Conclusions

We do not intend to defend inequality. Nevertheless, see have seen that under some plausible assumptions individuals will prefer an ex-post unequal distribution of income.

Though we spoke of congestion, the central idea applies more generally. Income inequality that induces persons to desire different goods can increase welfare. We briefly give another example, which focuses on the benefits of diversity in consumption. [For a full discussion of a different solution, see Romano (1991).] Consider a community that initially consists of 1,000 identical persons. Each can consume a good, say leisure, that has constant marginal utility of 1 and a cost of $1 per unit. Each can also go to restaurants. A restaurant has a fixed cost of $50,000. If all go to the same restaurant, the average fixed cost is $50 for the meals eaten there, at a price of, say $10 per meal. There exists an alternative French restaurant, but each poor person would want to eat at most one meal there. The cost would be $50 per person; if the value of a meal is less than that, no one will partake. Suppose for the balance that each poor person values a French meal at $48. Now let 100 of these 1,000 original persons be rich. Say that each would eat all his meals at the French restaurant, eating 10 meals per person. The total number of meals eaten is $(100)(10) + 900 = 1,900$, so the cost per meal is $50,000/1,900 = 26.32. Each poor person has consumer surplus of $48-$26.32 = $21.68 from the meals. We must also consider the increase in the cost at the restaurant the poor frequent. The $50,000 is now spread among

900 consumers instead of among 1,000. The per capita cost therefore increases from $50 to $55.56. So the net gain to each poor consumer is $21.68−$5.56=$16.12 from the existence of the new rich consumers who love French food. Clearly, under some conditions the original members of the community would even be willing to transfer income to others to obtain these benefits. A redistribution of income which increases inequality can be a Pareto improvement.

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