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“Dynamic Efficiency and Transportation Infrastructure Investment”
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Summary

The concept of efficiency has long been applied to transportation, and was a prominent justification for the Intermodal Surface Transportation *Efficiency* Act of 1991 (ISTEA) [emphasis added]. However, other ideals have justified transportation policy often to the detriment of efficiency. In this paper I argue that a broader view of efficiency is needed and that it should be the primary criterion in making transportation policy. This conception of efficiency developed here, dynamic efficiency, draws from transaction cost theory to incorporate institutions into the analysis and as such resolves some dilemmas posed by previous economic analysis. It also suggests an analytical method for making decisions about the design of institutional structure in this policy area. Finally it has a dynamic component which charts out a path for optimal economic development in a holistic way that integrates transportation policy with environmental, land use, and social policy. Several illustrations of how existing transportation policy could be changed to improve dynamic efficiency are given.

I. Theoretical model

Efficiency is typically defined by economists to have three components: productive efficiency (cost minimization), allocative efficiency (distribution of goods to those who value them the most), and product-mix efficiency (ensuring that the goods produced are those valued highest by society). In addition, external costs and benefits (positive and negative externalities) need to be taken into consideration. Transaction cost economics has added to these the consideration of the transaction costs of the institutional structure and how that institutional structure evolves over time, hence making this concept dynamic. A more fully efficient arrangement would include in the analysis the transaction costs of the institutional structure used to deliver the goods and services. These five elements of efficiency then unite into what I term *dynamic efficiency*, which incorporates all of these costs and benefits in order to maximize social net benefits over time. I argue that this is the more appropriate concept of efficiency that should be applied.

The central assertion here is that dynamic efficiency should be the main criterion for government action. Drawing from Coase (1960) and Zerbe and McCurdy (1999), the most efficient arrangement is that which best achieves dynamic efficiency. The most appropriate institutional structure is therefore not determined across-the-board by criteria such as rivalry in consumption or excludability, but rather by searching for the institutional arrangement that maximizes dynamic efficiency. This can vary by good or service and from one geographical or social structure to another. For example in a tight social structure where kinship bonds are tight

and sanctions for anti-social behavior are meaningful, it is not unreasonable to expect that the best way to maintain a park might be to expect that each able-bodied person should volunteer a certain amount of time. However in other social situations, different institutional arrangements (such as direct public provision) may be more efficient. Similarly in a sparsely populated area where transportation is difficult, primary education might best be provided in smaller schools than in more densely populated areas with inexpensive transportation. Ultimately, any government intervention and the details of the institutional structure must be justified and explained empirically, on a case-by-case basis, not theoretically.

Policy design should be focused on creating institutional structures to achieve dynamic efficiency. Further, because interventions need to be determined on a case-by-case basis, it is unlikely that uniform policies will appropriately achieve this efficiency. Instead of determining a single institutional structure, policy may best delegate this decision-making to the polities affected by the decision. This may be complicated by spillovers of costs and benefits outside of the geographical areas.

However, this view of policymaking is naive. For many years, economists have hoped that their recommendations could be implemented by a benevolent dictator who could endure the slings and arrows of political interests. A more realistic view recognizes that others may be indifferent or hostile to efficiency and seeks a constitutional design that would be more likely to prevail in the long term. For example, Buchanan suggests that constitutional constraints on government fiscal powers would be the utility maximizing choice of a rational citizen behind a veil of ignorance as they would constrain the state from exploiting one group to benefit another. While this perspective is not without controversy, it does have a crucial insight from the institutional perspective of this paper, that institutional design needs to incorporate not only efficiency considerations, but it needs to take into account political considerations in order to make policy durable over time. Policy durability is a function of both the procedures themselves and the underlying political issues. As Dixit (1996, p. 121) writes, “although procedures do affect outcomes and have their inertia, ultimately these procedures can be changed, and are changed, in response to the underlying political forces and the outcome of their competition. As in architecture, form follows function.”

Rather than assuming that governments will be ruled by benevolent despots and that they will only choose efficient policies, instead one should construct a framework that constrains governments from inefficient or unfair practices, and allows for welfare-enhancing initiatives. The classic example given by Horn is of the “pay as you go” feature of the Social Security program that tied current generations to future generations, making the policy more politically durable over time. Patashnik (2000) has made the same point in his analysis of federal trust funds.

The importance of viewpoint is demonstrated in a dynamic framework. The existing design of institutions helps shape the range of incentives influencing actors. Assuming bounded rationality, they respond to these incentives in their decisions about infrastructure investments. The increasing returns to scale on technological and capital investments then create a path

dependence that makes it difficult and expensive to alter that path. As a result, the productivity of social institutions may or may not be efficient in the long run; nevertheless, the institutional structure that created it tends to reinforce itself. The three variables – institutions, incentives, and investments -- feed back to each other to create an endogenous web that charts an economic development path. If the incentives stimulate institutional actors to make socially inefficient investments, then over time economic development will be low or perhaps negative considering the negative effects of the taxes used to fund the expenditures. (The example of the many statues of Saddam Hussain built in Iraq comes to mind).

Therefore an efficient policy is one that achieves the greatest social net benefits by considering transaction costs and externalities as well as the traditional components of economic efficiency. Institutions and the incentives they create should stimulate investments that achieve dynamic efficiency in a way that is responsive to local differences relevant to exchanges, and finally is politically durable over time. Inefficient incentives create a path that leads toward a misallocation of investments, and a physical infrastructure that will create an inefficient path for the long-term.

II. Application to Transportation Infrastructure Policy

The United States has developed a world class transportation system that demonstrates many healthy characteristics. Reform should build from these strengths and recognize the many positive incentives and institutional structures that currently exist. However there are some inefficient practices and features that need to be changed. Two of those that need no elaboration are: the generally insufficient internalization of external costs of noise and air pollution, and the inefficiency of congestion on some urban roadways.

Certain other inefficient institutional arrangements require some explanation. One policy that sends the wrong incentives to users and producers is the waste caused by a highway tax policy that does not reflect the costs of damage to pavement (Small, Winston and Evans, 1989). Highway maintenance costs are largely a function of pavement thickness and the number and weight of loadings passing over the road. Crucially, as the weight per axle (measured by equivalent standard axle loads, [ESAL]) increases, pavement damage increases to the third power (Small, Winston and Evans, 1989). Thus it is essential that the prices paid by users be related to axle loadings. None of the current taxes do so. However, the solution is not just to tax in proportion to ESAL. Thicker pavement greatly reduces the pavement stress of loadings. Thus, the appropriate policy is a combination of investment in thicker pavement and a reformed tax structure. Small, Winston, and Evans find that such a policy dramatically lowers maintenance costs for government, improves the welfare of other transportation modes, and even makes trucking firms better off as they respond to the tax by changing the number of axles on their trucks, and shifting load sizes.

A second important arrangement in need of reform is the current structure of transportation taxation. In many different modes of transportation, and at both federal and state levels, fuel taxes are the main source of revenue contributing to trust funds, which in turn fund

investments that partially facilitates more travel. However the externality of air pollution caused by vehicle emissions suggests that these revenues should not be used to promote further pollution. Because the motor fuel tax used for roads and many other of the taxes that contribute to federal and state transportation funds are not true user taxes, there are distortions negatively affecting land use, modal choice, and environmental capacity.

A third important institutional feature is the structure of federal aid. While there were some changes in the ISTEA legislation, and other reforms, federal aid still tends to use predetermined matching rates in distributing funds. As Gramlich (1994) has pointed out, these matching rates tend to be too high with overly-restrictive rules regarding use of funds. A better policy is suggested by some of the reforms of the Airport Improvement Program and the FHWA Innovative Financing program, which allow for more flexible matching shares in return for greater flexibility in the use of funds and the sources of these matches. Further, the FAA also requires a benefit-cost analysis for projects more than \$5 million. A relatively easy change that would be highly beneficial would be to simply use the ratio of the external to total benefits for each project as the matching rate.

Another feature in need of change in highway policy include the use of highway cost allocation as a method for attributing costs to road users. From an economic perspective, cost allocation approaches are flawed for four reasons. First, they only include pecuniary costs and not the social costs of pollution or congestion. Second, they ignore the importance of signals that prices send to users. If users respond to prices by adjusting their consumption as one would expect, then the user fees would need to be adjusted. Third, cost allocation is a form of average cost pricing, not marginal cost pricing. Fourth, within groups, some users may differ from the average, and so should be treated differently. In aviation, most local airports use either a compensatory cost method or a residual cost method which suffers from similar problems.

In the aviation, many of the taxes used also do not correlate well with use. The ticket tax and the international departure and arrival taxes are not related to the costs incurred by the Federal Aviation Administration (FAA) for the air traffic control (ATC) system. The FAA's costs are related to the number of air route traffic control centers an airplane moves through, the number of take-offs and landings, and the use of weather and mapping information. Taxes related to the number of passengers and the fares they pay do not reflect costs well (U.S. Congressional Budget Office, 1992). The fuel tax has some relationship to ATC costs, as fuel use is correlated with distance traveled, which in turn is loosely related to the use of ATC services, but this relationship is weak and does not send appropriate price signals. Similarly, the cargo excise tax is not closely related to ATC costs.

Politically, surface transportation is a notoriously strong policy network where there is a strong alliance among the producer groups (road contractors and trucking firms), state and local officials, the FHWA, and the Congressional committees. Other modes are not as strong as the highway lobby, but still can pack a punch. This has led to "rent-seeking" where the provider/interest groups have lobbied heavily and used campaign contributions to influence the level of public funds devoted to transportation projects, as well as the specific location and

characteristics of certain projects. This leads to wasteful investment decisions, as well as wasteful expenditure of resources as providers compete to influence the decisions.

III. Institutional Efficiency

As the first section of this paper informs us, this detached efficiency analysis of these problems gets us nowhere. Ultimately, meaningful reform requires an alteration of the institutional structure. What are the characteristics of a better institutional structure? In this context I would argue that the answer is given by the concept of dynamic efficiency outlined earlier. The institutional arrangement should attempt to allocate goods to those consumers who have the highest value for them; to minimize all relevant input, social, and transaction costs; and attain product-mix efficiency. Equity is less relevant here because transportation is for the most part an intermediate good whose distribution is less relevant than some final goods such as housing or health care.

The application of dynamic efficiency here needs to be done on a project basis rather than on a system-wide basis. A single across-the-board aid rate, even if correct in the aggregate, gives some projects too much and others too little. If instead aid formulas were recalculated on a project basis to be equal to the aggregate ratio of external benefits to total benefits, projects would be aided in an efficient way and investment and use would be more efficient. As Boarnet (1999) has pointed out, many highway projects produce local benefits inducing local sponsorship, but they also cause economic losses elsewhere, for example because of the diversion of commercial activity. Federal grants that make these projects affordable to local sponsors do so at the expense of other areas losing economic activity, and overall we have misallocated resources. As he writes (p. 298) a “more decentralized system of highway finance should be designed to match the geographic area of benefit with the geographic area that funds the project. The goal should be to face localities with incentives to efficiently build and finance highway infrastructure.”

In their book examining rural water projects in the third world, Ostrom, Schroeder and Wynne (1993) present an analytical framework which applies well in this context. A variety of criteria are articulated to judge the comparative performance of different institutional arrangements in the provision and production of infrastructure. Those criteria are: transformation (production) costs, transaction costs which include coordination, information and strategic costs. Strategic costs in turn include free riding, rent-seeking, corruption, shirking, adverse selection and moral hazard. They discuss six different broad types of institutional arrangements: a pure market exchange, a differentiated market, a user group, administrative centralization, administrative decentralization, and polycentric governance. These criteria can be used to evaluate different institutional forms to determine the advantages and disadvantages of different arrangements. No single approach is likely to dominate; ultimately the specifics of each situation need to be compared to others.

Ostrom, Schroeder and Wynne argue that “with respect to the provision of facilities like roads, provision units should be organized in ways that facilitate the communication of

preferences between users and providers.” (1993, p. 228) The U.S. transportation system generally facilitates this, as there are providers at the federal, state, county, and city/township level receiving input from their users. This increases the likelihood that the correspondence principle (the geographical match between costs and benefits) articulated by Oates (1972) will be fulfilled. But as Boarnet suggests, the current grant system with its high matching rates undermines the favorable division responsibilities among governments. Further, more direct input from users would be facilitated by taxes more directly related to facility use.

The key difference between this criterion and that typically employed by economists in their analyses of transportation policy is transaction cost. Although this concept is rooted in economics, it has only been applied to transportation policy sparingly. Because of this, economists have long advocated certain policies that are inefficient when the transaction costs are considered. Congestion tolls are the best example of this. While congestion tolls are used in a few cases, there are numerous administrative costs and vexing practical considerations that render it not just impractical but inefficient compared to less perfect but “good enough” alternatives. Briefly, congestion tolling would require resolution of some of these concerns: Is the fee fixed or variable according to traffic volumes? Does it vary by vehicle occupancy? How finely are the gradations in the fee moving from low to high congestion? How would the necessary be data collected, and how would the decision be made about when and how much to change the fee? Are people residing in the congested area subject to the fee? (See Rufolo, Bertini and Kimpel, 2001). While these issues are solvable, they do suggest that the high degree of abstraction from reality that is common in much economic analysis has lead to neglecting the practical administrative issues that are represented by the concept of transaction costs. Thus this perspective helps answer the dilemma as to why the common economic answer to this question has not been implemented: ironically because it is not administratively efficient.

IV. Future Shock

There are a variety of environmental changes that will profoundly change technology and incentive patterns. They include:

- Changes in automotive technology such as bringing to market hybrid vehicles and the increase in the numbers of vehicles running on natural gas are causing rapid increases in fuel economy and thus reduced fuel tax revenues.
- President Bush’s call to move to hydrogen-fueled vehicles, would ultimately eliminate fuel tax revenues.
- Declining ticket tax revenues and threats to the financial stability of major U.S. airlines draws into question the stability of the Airport and Airway Trust Fund.
- The potential of intelligent transportation systems and on-board computers allows for greater responsiveness to the needs of different types of motor vehicles and aircraft, and also allows for improved user charges.
- NASA’s Small Aircraft Transportation System (SATS) has developed small planes with improved avionics at a lower cost to allow for some degree of personal ownership or fractional ownership that could by-pass the hub-and-spoke commercial air system.

While the impacts of these changes are too vast and uncertain to predict, they do underscore the opportunity for reform. As major technological changes feed into the system, they will scramble existing political alliances and realign interests. As North (1990) suggests, changes in technology leads to changes in factor input prices, which in turn leads actors to perceive potentially advantageous changes in political and economic contracts. This upsets the existing equilibrium which is the beginning of organizational and institutional reform. The key is for the path of change to create the appropriate incentives. The goal should be for the political and economic incentives in the system to be redesigned to align individual payments with the value of society's resources used up in producing the good, considering all costs (private, social, and transaction-related). This implies major changes in federal aid programs, tax structure, and perhaps institutions such as the federal trust funds. Making the institutional changes durable so they support a healthy path for long-term economic development would be the best possible infrastructure investment possible.

NOTES

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