PRIVATE INVESTMENT AND ROAD PRICING: THE INVESTMENT PUBLIC-PRIVATE PARTNERSHIP

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ABSTRACT

Private infrastructure investment is often viewed as providing an alternative financing method given a revenue stream from a transportation facility rather than providing additional revenue. However, private investment in the form of upfront concession lease payments for newly priced roads can be used to reduce political resistance to pricing, thus generating additional facility-specific revenue. We suggest preserving a portion of the wealth generated by road pricing in perpetuity through a permanent fund, which is one type of public trust fund. Permanent funds are currently in use in Alaska, Texas, and Norway to preserve wealth originating from natural resources. Following Alaska, we propose that investment income from the fund be used to provide an annual dividend payment to all households within the area that is priced. This has several advantages relative to current proposals to reduce opposition to road pricing. In particular, it ameliorates the agency problem between citizens and elected representatives created by the free cash flows road pricing generates. It also creates direct citizen-stakeholdership in transportation infrastructure which increases public support for road pricing. The Alaskan experience suggests that this approach can also reduce income inequality, create higher personal income, and mitigate recessions.
I. Introduction

The network of roads, bridges, and tunnels that form the backbone of the U.S. transportation system is one of the nation’s most valuable assets. The 4-million-mile road system, with roughly 46,000 miles of interstate highways, is currently valued at about $2.5 trillion (1). Yet the system suffers from ongoing problems. Traffic congestion is a severe demand-side problem, particularly in urban areas. In 2010, congestion wasted 4.8 billion hours of travel time and 1.9 billion gallons of fuel (2). One estimate put the annual overall cost of congestion to the U.S. economy at $168 billion (3). Congestion imposes large social costs in addition to lost time and fuel. Babies developing near congested traffic have worse health outcomes (4) while longer commutes are associated with more obesity and higher divorce rates (5). Less traffic congestion also has negative effects on productivity. Prud'homme and Lee (1999) show that lower levels of congestion lead to a larger effective labor market size, which allows businesses to locate the workers they need. Congestion is also worsening over time. Annual hours of delay per peak-time traveler increased 136 percent between 1982 and 2009 in the nation’s fourteen largest urban areas (6).

The system’s supply-side problems are also legion. Revenues from state and federal fuel taxes that support the system are declining as vehicle fuel efficiency improves and since annual vehicle miles traveled – increasing consistently for decades – leveled off in 2004 (7). A shift into alternative fuels such as natural gas also reduces revenue. Additionally, many segments of the system are mature relative to design standards and suffer from years of deferred maintenance (8). Thirty-two percent of America’s roads are now in poor or mediocre condition, and driving on such roads costs motorists $67 billion in additional operating costs and repairs annually (9). Funds from other sources for maintenance and expansion, such as general funds, are limited due
to the fiscal constraints facing many states and localities, creating a gap between available revenue and required investment. According to one estimate, available funding for U.S. highways alone would fail to cover investment needs by between $139 and $172 billion per year over the next decade (10). Transfers from general revenue into the federal Highway Trust Fund highlight the current system’s fiscal instability (11).

Transportation economists argue that a shift to variable pricing in the form of vehicle miles traveled (VMT) charges addresses many of the above problems (12, 13, 14). VMT charges assign a price for transportation services and facilitate the regulation of traffic flows, particularly during periods of peak demand. In contrast to efforts encouraging the use of a particular mode, variable pricing encourages travelers to choose those alternatives for economizing on road space most appropriate for them, such as bus, transit, carpooling, telecommuting, biking, etc. rather than on the use of one specific mode (15). Improved efficiency in road use resulting from VMT pricing is also important because of rising resistance to new and wider highways due to environmental concerns (16). On the supply side, VMT charges generate facility-specific revenue that increases with the intensity of facility use. Revenue generated is independent of changes in vehicular fuel efficiency, is more stable compared to fuel taxes, and can be used to fund transportation maintenance and improvements.

Revenues from VMT charges can be used to attract financing in addition to traditional tax-exempt municipal bonds. This includes private risk (or equity) capital introduced through public-private partnerships (PPPs). The U.S. Federal Highway Administration states that, “Public-Private Partnerships (PPPs) are contractual agreements formed between a public agency and private sector entity that allow for greater private sector participation in the delivery and financing of transportation projects.” PPPs have been utilized to deliver infrastructure projects in
many countries, including Australia, Canada, the United Kingdom, France, Italy, Portugal, and Spain (17, 18, 19, 20, 21).

By including performance-based penalties and rewards, PPPs facilitate enforcement of a regular maintenance schedule that reduces the scope for its deferral (22, 23, 24). Because revenue from VMT charges increases with motorists’ willingness to pay for facility use, PPPs encourage investment dollars to flow to the highest-value projects as in other industries where output is priced (25, 26, 27, 28). Conversely, private investment will not participate in low-revenue projects without subsidies, which reduces the likelihood that scarce investment dollars will be allocated to “white elephant” projects (29, 30). VMT charges coupled with private participation also results in an approach similar to that for other utilities in the United States where customers pay a per-unit price to a private provider. Examples include electricity, natural gas and many water utilities.

Although it is often feasible to price new transportation capacity and to price existing transportation capacity in certain cases by converting high-occupancy vehicle (HOV) lanes to high-occupancy toll (HOT) lanes, substantial barriers to pricing existing transportation capacity remain. Concerns often focus on the equity effects of instituting road pricing since transportation spending absorbs a larger fraction of low-income household budgets.

Small (1983), (1992) and Mohring and Anderson (1994) stress that the use of toll revenues is critical to the political acceptance of road pricing (31, 32, 33). Research has thus focused on how the use of revenue generated by congestion pricing affects its political acceptability, and new approaches have been offered. For example, Small (1992) suggested using a portion of the new revenue for tax reductions and rebates in the relevant region and the remainder for regional transportation improvements (32). King, Manville, and Shoup (2007)
argue for allocating net revenues generated by congestion pricing to the jurisdictions (e.g. cities and towns) through which newly priced freeways extend (34). Gulipalli, Kalmanje, and Kockelman (2008) analyze credit–based congestion pricing, which addresses equity issues by providing monthly allocations to motorists to spend on congestion tolls (35). Arnold, Doan, and DeCorla-Souza (2012) suggest enhancing motorist’s travel choices quickly by converting the right shoulder of a highway into a general purpose lane while converting the left lane into a high-occupancy toll (HOT) lane in order to increase its political acceptability (36). There are other innovative approaches involving toll revenue “recycling” in which toll revenues are rebated back to motorists (15, 37). Similarly, taxes such as fuel or property taxes could be lowered in order to make toll increases more politically appealing.

We here outline a new approach to using revenue from congestion pricing to address those concerns in order to facilitate the use of congestion pricing. The pricing of currently unpriced transportation facilities combined with private sector participation via PPPs releases economic value embedded in infrastructure assets. We suggest that a portion of that value be protected in perpetuity through a permanent fund. We refer to the method as an investment public-private partnership or an IP3. Under the IP3 approach, a permanent fund is capitalized through concession lease payments that allow value to be realized from newly priced roads. Dividend payments from the fund are distributed to all households in the newly priced area. Such universal dividend payments are progressive in that they represent a larger share of income for poor families, so an IP3 reduces income inequality. The IP3 thus challenges the view that private investment is a mechanism to raise financing given an existing revenue stream rather than a way of generating additional revenue. Instead, by reducing political opposition to road pricing, an IP3
allows revenue to be raised on an existing un-priced facility and its underlying value to be
realized.

We proceed as follows. We next briefly describe the IP3 approach and the permanent
fund model. In Section III, we review the benefits of this approach, pointing out its advantages
relative to other approaches to addressing equity concerns in road pricing. We show why an IP3
enhances the political feasibility of pricing currently un-priced transportation capacity, and
discuss other similar transactions in the United States. Section IV reviews reasons why an IP3 is
preferable to the traditional approach of utilizing tax-exempt municipal bond debt backed by toll
revenue. Section V presents a financial model using data from Columbus, Ohio to estimate the
likely revenue, and thus dividend payments, stemming from an IP3.

II. The Investment Public-Private Partnership

The concept at the center of the IP3 approach is a permanent fund. Similar to a trust fund,
a permanent fund preserves wealth in perpetuity since the fund’s principal is never spent. A
permanent fund is one type of U.S. sovereign wealth fund. Such funds have been used to
preserve natural resource wealth in Alaska, Texas, and several Canadian provinces (38). The
largest U.S. examples are the $38 billion Alaska Permanent Fund and the $25 billion Texas
Permanent School Fund. The Alaska Permanent Fund is a semi-independent corporation created
in the Alaskan constitution of 1976. It was established after the discovery of North Slope oil
reserves to help preserve natural resource wealth after initial oil wealth was quickly spent. The
Alaskan constitution required that at least 25 percent of the revenue from oil and gas sales or
royalties be placed into the Permanent Fund. Investment income from the fund is used to pay an
annual dividend to all Alaskan citizens. Similarly, the Texas Permanent School Fund was created
in the Texas Constitution of 1876 and funded by sales, trades, leases and improvements to lands
set aside for that purpose. Income generated by the fund is used for schools. Texas also has a Permanent University Fund created in the Constitution of 1876 to support the state’s universities.

We next discuss several key steps in the implementation of an IP3 using the permanent fund model. A jurisdiction should utilize an IP3 only after extensive public education, comment, and input. Once it has decided that the IP3 approach is appropriate, the public project sponsor must choose the appropriate area, facility, or system to be congestion priced and subsequently leased. The benefits of implementing congestion pricing are likely to be greatest in congested areas because the welfare gain from managing traffic flows and raising revenue for maintenance and expansion are higher. However, the U.S. experience with brownfield PPPs, or PPPs on existing roads, suggests that concession payments can also be obtained from facilities with uncongested portions. Project sponsors may also wish, at least initially, to avoid networks that cross jurisdictional lines to reduce coordination problems across those jurisdictions.

The project sponsor must also determine what fraction of lease proceeds will be deposited into the permanent fund and what fraction will be utilized to invest in transportation in the region. This is a critical tradeoff, since larger deposits into the permanent fund will increase the dividend while reducing the resources available for improving transportation within the region. The sponsor should also consider how quickly alternative transportation modes can be implemented or improved, and how that schedule conforms with the implementation of pricing.

The public sponsor must carefully consider the terms of the concession contract since it will govern the relationship between the public project sponsor and the private partner for its duration. A key consideration is the usage price or VMT charge, which includes variables in addition to congestion levels that may affect price, as well as its rate of increase over time (typically capped at some well-specified rate, such as the consumer price index). Other key
contractual elements are desired levels of service, required maintenance and expansion, and how those aspects of performance are incentivized through the contract. Linking toll increases to inflation, for example, constrains the exercise of potential market power while creating an inflation-protected revenue stream to attract larger upfront concession payments.

Lease length is also critical. The public may view relatively short leases favorably if they provide the public sponsor with added flexibility and increased competition, thus increasing the political feasibility of the IP3, while longer leases have the benefit of allowing the private sponsor to expense depreciation, thus raising concession value and upfront payments, which allows larger dividend payments. Another critical aspect of the concession contract is appropriate oversight and enforcement throughout its life, which may necessitate the creation of an office to oversee contract compliance. This office has added benefits in that it creates an explicit infrastructure trustee that would have responsibility for ensuring that the infrastructure was properly maintained and operated.

Once details of the concession contract are determined, the public sponsor announces a request for qualification (RFQ) to attract and screen qualified bidders. Bidders are likely to be a consortium of a road operator and a financier coordinated through a legal entity created for that purpose. Project financing, in which non-recourse debt is backed by revenues from the leased facility, is often used. The RFQ also allows the project sponsor to gauge interest in the lease and to assess the expected number of bidders.

Subject to the terms of the lease, the winning bidder is selected based on concession payment size. Such bidding maximizes the size of the upfront payment and thus annual dividend payments. Once the winner is selected and the lease completed, the majority of the concession payment can be used to create the fund. As per the decision above, the remaining portion can be
used to improve other modes of transportation in the same area or corridor as the newly priced
network or facility, providing motorists using priced facilities with additional transportation
options.

The facility is then priced and operation begins under the concessionaire. There are now
an array of suggested approaches to assist implementation of congestion pricing, such as gradual
phase-ins and “premium service” versus standard lanes that may serve to enhance its political
acceptability (39). The concession payment is received, with proceeds placed into a permanent
fund utilizing a diversified portfolio of investments.

The final step is to ascertain the size of annual dividend payments and determine which
households are qualified to receive it. Dividends can then be paid out of interest from the fund’s
investment income. Dividends will increase as more facilities are leased over time. They will
also grow as facilities are re-leased because the fund exists in perpetuity. The IP3 thus utilizes
private infrastructure investment to provide households with an annual payment in order to offset
the effects of adopting new tolls.

III. Benefits of the Investment Public-Private Partnership

We next discuss benefits that the IP3 approach offers relative to other proposals to
overcome political resistance to congestion pricing that do not rely on private participation and
the permanent fund model. We are unaware of extant proposals for road pricing that incorporate
private participation through a PPP to increase acceptance of pricing. There are benefits of
private participation that we do not discuss here, such as clear performance standards and the
transparency of risk. Discussions of such benefits are available elsewhere (10, 23). Those are in
addition to benefits flowing from the variable pricing that the IP3 facilitates per se. We here
discuss only benefits arising from core innovations in the IP3, which are the permanent fund model and the universal dividend payment.

*The IP3 lowers agency costs between citizens and elected representatives.*

A key aspect of implementing road pricing when utilizing revenue from a newly priced facility is institutional arrangements to reduce agency problems surrounding the new revenue streams that such pricing generates. Such institutional arrangements provide the governance structures surrounding the use of revenue streams. Governance should be considered within the context of the principal-agent problem between taxpayers and their elected representatives (40, 41). It requires assessment of monitoring and control mechanisms available to principals to ensure that new revenue streams are used in citizens’ interest. This is likely to be a concern for use of both new revenue streams and for lump sum payments generated by concession leases. The agency problems created by large uncommitted cash streams, or free cash flows, have long been recognized as a concern in the governance literature on publicly traded corporations (42).

The Alaskan experience with revenue from oil leases is again instructive regarding agency problems associated with upfront payments. Prior to the establishment of the Alaska Permanent Fund, oil lease revenue received by the government was spent quickly. Evidence of poorly directed transportation investment is consistent with taxpayer-politician agency concerns (43). A key benefit of the permanent fund structure over existing proposals is improved governance by placing the value inherent in priced transportation facilities into an independent, transparent fund insulated from short-term spending.

There are several ways in which the placement of concession lease proceeds into a permanent fund reduces agency costs. First, as the Alaska example illustrates, placing lease proceeds directly into a permanent fund reduces opportunities for using value realized through
pricing to fund projects that may be politically appealing but not cost beneficial. Additionally, the transparency of the fund’s balance and performance (and the straightforward comparison with standard benchmarks), are likely to reduce agency costs associated with preservation of principal.

A second channel through which agency costs are reduced is via the creation of well-defined citizen-stakeholders. Under an IP3, households observe the value they hold in a permanent fund and receive dividends based on that value. This encourages households to take a greater interest in maintenance and operation of transportation infrastructure, since the size of future concession payments depends on those factors. It also underscores the role of a jurisdiction’s citizens as the ultimate owners of its transportation infrastructure. The permanent fund approach allows the value created by road pricing to remain under public control while insulating it from political pressure.

A third channel for reducing agency costs is by improving the allocation of transportation infrastructure investment. By facilitating variable road pricing, the IP3 creates a price signal indicating where investment dollars should flow. That is, it provides an objective measure of where investment is most valuable to motorists. Which maintenance and expansion projects are self-funding and which are not thus becomes more transparent, reducing the scope for non-economic projects.

The IP3 and equity in road pricing

There are several ways in which an IP3 enhances equity. The IP3 generates a lump-sum payment for all households. A lump-sum dividend represents a larger fraction of annual income for low-income families. By releasing value embedded in infrastructure, the IP3 reduces income
inequality without taxation. In addition to low-income families, it is also beneficial to those on fixed incomes, such as retirees.

The IP3 approach also enhances intergenerational equity by ensuring that transportation network value is preserved for future generations and is a well-maintained asset that can generate dividends in perpetuity. The approach also allows fund value to increase through compounding. Because it increases national savings, it effectively counteracts the intergenerational effects of accumulated government debt, and can improve a state’s bond rating, and thus its debt costs, as a result.

An IP3 generates the initial wealth necessary to create a permanent fund. Deposits into the fund are of course not limited to road concessions. Once the fund is created, the institutional structure exists to accept additions to the fund’s principal from any source, increasing the size of the dividend. Additions to the permanent fund need not come exclusively from infrastructure, however. If, for example, a state creates a permanent fund from concession lease revenue, it could add to the fund’s principal using revenue generated from natural gas leases or from other irregular revenue sources.

Additionally, Alaskans have benefitted from the fund due to higher personal income, higher employment, and mitigated recessions due to the regularity of the dividend payments (38). Because the Alaskan economy is highly dependent on crude oil and other resource prices, the legislature intended that the fund’s principal and dividends would grow to the point where they would be sufficient to help diversify the Alaskan economy (38). We next discuss several brownfield leases in the United States that serve as precedents for, and that hold lessons for, the implementation of an IP3.
IV. U.S. Precedents for the IP3

Key innovations in the IP3 relative to current proposals include placing lease proceeds into a principal-protected permanent fund and paying dividends directly to households. Although the IP3 is innovative in its approach to road pricing, three U.S. brownfield PPPs on already-priced facilities – two completed and one nearly completed – hold lessons for the use of an IP3 in the United States. The brownfield lease most similar in concept is the nearly completed lease of the Pennsylvania Turnpike. In May 2008, a group of investors led by Abertis (a Spanish toll road operator) and a Citigroup infrastructure fund offered the Commonwealth of Pennsylvania a concession fee of $12.8 billion for a seventy-five year lease of the 537-mile tolled Pennsylvania Turnpike, which represented the largest concession fee offered to date. The bid represented over one-fourth of the federal government’s entire annual highway construction budget for that year. Of the $12.8 billion fee, $2.3 billion would have been used to pay off existing turnpike bonds. The net fee received by the state would then have been invested through the state’s pension system and was, at the time, estimated to yield investment income of about $1.1 billion annually. Investment income would have been used to fund transportation improvements throughout the state.

Unlike the IP3, under the Pennsylvania lease, investment income would have been directed to transportation spending in the state rather than to dividends. Second, concession proceeds would have been invested through the state’s pension system rather than through an independent permanent fund. The IP3 has several advantages over this approach. Because citizens would not receive infrastructure-generated investment income, it is unlikely that the lease would have enhanced their perceived stake, and thus their attachment to and stakeholdership in, transportation infrastructure. The IP3 would also invest proceeds with a semi-independent public corporation, which enhances the perception of independence.
The second instructive transaction is the completed brownfield lease of the Indiana Toll Road. In 2005, the State of Indiana issued a request for proposals for a seventy-five-year concession lease. The winning offer was for $3.8 billion from the Indiana Toll Road Concession Company (ITRCC), a joint venture between Cintra and Macquarie. The state committed to using proceeds to fund a ten-year plan known as Major Moves, which would support about two hundred transportation projects around the state. The Indiana Toll Road lease differs from the Pennsylvania lease in that concession proceeds would not be invested in perpetuity but would have been spent over that ten-year period to fund the Major Moves program. Therefore, Pennsylvania citizens would not receive direct dividends and thus would not have had the degree of attachment to the program intended by Gov. Hammond in Alaska.

The third brownfield lease is the Chicago Skyway concession. This was the first modern lease of an existing U.S. toll road. In March 2004, the City of Chicago issued a request for qualifications from bidders interested in leasing the Skyway for a ninety-nine-year term. The high bid of $1.83 billion came from a partnership of Cintra Concesiones de Infraestructuras de Transporte S.A. (Cintra) of Madrid, Spain, and the Macquarie Infrastructure Group of Sydney, Australia, which cooperated to create the Skyway Concession Company LLC (SCC). Annual toll increases are capped at the greater of 2 percent, the rise in the Consumer Price Index, or the increase in U.S. gross domestic product per capita.

Lease proceeds were used in several ways. $825 million was used to pay off both outstanding Skyway and city debt; $500 million to create a reserve fund that will produce about $25 million annually for the city; $325 million invested in an annuity; and $100 million for a variety of projects, such as homeless shelters, facilities for senior citizens, and libraries. Proceed use for a reserve fund and an annuity are consistent with an IP3 in that they are invested in real
assets and generate investment income. To the extent that those uses are insulated from the political process, they reduce agency costs and are consistent with the IP3 approach. We next discuss the advantages of the IP3 approach relative to using tax-exempt debt to raise an upfront payment against the revenue stream.

V. The Role of Private Participation

One criticism of the IP3 approach is that private participation is unnecessary. Private participation can be broken down into different roles, including facility financing, design, construction, operation, and maintenance. We do not focus on design and construction because the private sector has long been involved in such infrastructure roles in the United States. There are several benefits stemming from private participation in facility operation and maintenance.

One consideration that applies to several potential private roles is the introduction of competition through competitive bidding. Bidding is likely to reduce the costs of providing a variety of key services, including facility financing, operation and maintenance. Competition is an important force for promoting social welfare, since it encourages firms to operate efficiently, to focus on customers, and to adopt new technologies (22). Competition also allows potential monopoly profits to be converted into resources to capitalize the permanent fund.

In addition to competition, private participation reduces opportunities for deferred maintenance because the private partner is contractually obligated to maintain the facility according to pre-defined, enforceable standards. Private partners can thus be incentivized to correctly maintain facilities, while standards can be defined in terms of outcomes, or maintenance quality, rather than through input use. Similarly, clear standards regarding facility operation and performance can be established and enforced.
Financing is a key private role under the IP3 approach. Without private financing, a newly priced road generates revenue that could be used to lever tax-exempt bond debt (i.e. revenue bonds), thus raising an upfront payment that in principle could be invested without private participation. There are several reasons why private financing is preferable to a tax-exempt-bond-only approach, however.

First, the inclusion of equity participants allows for a new type of capital to be included in infrastructure financing. Bonds are an inherently conservative method of finance that promises fixed repayment of principal plus interest to bondholders. Because payments are fixed, bondholders receive no additional return if a project performs well. Their focus is on minimizing the risk of default. Since a bond-only financing arrangement by definition provides no equity cushion to shield bondholders from potential losses, they will demand security through other means. One is to require the debt-coverage ratio—the percentage by which revenues generated by an asset must exceed debt payments—to be relatively high. To obtain an investment-grade rating, municipal bonds typically must have annual revenues between 25 percent and 100 percent more than the cost of annual debt service. This gives bondholders the financial cushion that equity would otherwise create, but it also mechanically limits the amount of capital that can be raised using bond financing for a given amount of toll revenue. Equity investment thus raises more capital not only through the additional supply of funds to which it has access, but also indirectly through the financial cushion it offers bondholders, which facilitates a lower debt-coverage ratio. The greater tolerance for risk associated with equity investment also allows for less conservative forecasts of revenue growth, and thus greater upfront value for households. By generating large upfront payments, the inclusion of private investors also increases dividend payment size.
This is consistent with experience. It was estimated that the Chicago Skyway lease, which generated a $1.83 billion toll concession fee, would have supported only about $800 million under traditional bond financing (16). The effects of brownfield leases are also reflected in improvements in bond ratings after lease completion. Moody’s Investor Service upgraded Chicago’s bond rating as a result of its improved fiscal position to the highest level in twenty-five years. Similarly, the Indiana brownfield concession led Standard & Poor’s to upgrade the state’s debt rating to AAA, its best rating ever, which will save the state millions of dollars in interest payments over time.

Finally, to the extent that bonds are backed by general revenues (or that toll revenue bonds receive an implicit taxpayer guarantee) the use of tax-exempt bond financing subjects taxpayers to uncompensated financial risk. When the government finances a risky investment, such as a road, by selling relatively safe taxpayer-backed securities, the risk associated with those investments is shifted onto future taxpayers. Those taxpayers effectively become the equity holders or the residual claimants in the project (44, 45, 46). One under-appreciated benefit of private participation is thus not only that private investors bear some of the risks inherent in infrastructure projects (often referred to as risk transfer), but that the cost of risk to residual claimants is made more transparent.

We next describe a model using traffic data from Columbus Ohio that allows estimation of the size of the upfront concession fee payments, and thus the likely size of the annual dividend. We first discuss the main inputs into the model and then estimated concession fee outcomes.

**Estimation of Likely IP3 Concession Fees**
To give an estimate for the likely up-front concession payment, we calculated the NPV of cash flows from leasing the major roads of a congested urban area for a period of 5, 10 and 15 years. Our simple financial model made revenue and cost projections for each year of the concession. Revenues (from toll collection) were modeled, using the following inputs:

- Pre-toll traffic demand, based on the highly detailed traffic volume data on Columbus, OH (47, 48)

- Elasticity estimates throughout the concession: to account for the change in traffic demand over time from tolling Columbus motorists, elasticity estimates were taken from an extensive Singapore elasticity study on congestion-pricing of several major urban expressways (49). The study accounts re-routing, re-timing and changing modes of transportation. Using these estimates makes our model conservative, because Singapore has superior public transportation (compared to Columbus) and thus a higher price elasticity of traffic demand. To account for citizens’ long-term adjustment to tolling we assumed elasticity rises by 50 percent in the third year. (50).

- Toll rates throughout the concession: to account for a wide range of NPV outcomes we modeled three price scenarios – Low, High and Medium (average of the two extremes):

  > Low: the valued-added tolling approach we used for this scenario advocates that prices should offset only the added value for the end users - construction, operation and maintenance work. This means little to none excess of revenues beyond operation costs, which leads to a low NPV and low dividends for this scenario of our model. We applied $0.05/0.15 and $0.12/0.20 off-peak/peak per-mile rates to cars and trucks accordingly. (51).

  > High: we applied the rates from the Dulles Greenway (Washington, DC) which reflect not only maintaining/operating costs for the facility, but also multiple social costs inflicted by drivers –
congestion, environmental, health externalities etc. (52). We used $0.31/0.37, $0.68/0.81 and
$0.99/1.17 off-peak/peak per-mile rates for cars, light trucks and heavy trucks, accordingly.
Because of little traffic, early AM/late PM hours are toll free under this scenario (53). The toll
rates were assumed to increase annually by the expected long-term annual CPI inflation – 2.5
percent (54).

The cost side of our model is based on averaging the per-lane-mile operation costs, extracted
from the 2010 financial reports of four major toll-road infrastructure projects in the USA -
Indiana Toll Road, OH Turnpike, PA Turnpike, WV Turnpike (55, 56, 57, 58):

- Maintenance/Construction costs $ 30,082 - inflated yearly by a “construction cost
  inflation forecast” (60, 61)
- Administration costs $ 49,232 - negligible to no change over the concession period
- Capital costs $ 83,138, - increase annually by the CPI inflation rate.

Netting the revenue and cost sides, we came up with the following final NPV estimates. We
examine three concession length (5, 10 and 15 years) and three toll rate scenarios (Low, Medium
and High) for a total of 9 NPV scenarios. Calculations are available for 6 and 9 percent discount
rates:

| TABLE 1: Concession Payments under Alternative Discount Rates and Concession Payments |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Duration of concession          | Low toll rates (6% discount rate) | Medium toll rates (6% discount rate) | High toll rates (6% discount rate) | Low toll rates (8% discount rate) | Medium toll rates (8% discount rate) | High toll rates (8% discount rate) |
| 5 years                         | $81,448,204                      | $2,308,086,460                     | $3,604,998,893                     | $77,304,538                      | $2,186,355,049                     | $3,414,722,195                     |
| 10 years                        | $121,556,725                     | $4,168,420,874                     | $6,532,863,182                     | $112,094,499                     | $3,791,478,027                     | $5,940,769,066                     |
| 15 years                        | $127,784,098                     | $5,660,890,583                     | $8,902,997,756                     | $117,159,351                     | $4,964,335,110                     | $7,803,203,458                     |

Dividend Distribution and Reinvestment of the Concession Payment
In order to assure the political and public acceptability of such a project, we assume that 60 percent of the concession payment will be placed in a fund. The principal is then invested in a safe and diversified portfolio and proceeds are used for covering fund operation costs and paying annual dividends to all 318,454 Columbus households (62). To model the fund operating expenses we used the average annual expense ratio (total operating expenses divided by net assets) of the Alaska Permanent Fund over the last 4 years – 0.24 percent (63, 64, 65, 66). The expected annual investment ROR of our modeled fund is the average of the 5 percent target ROR and the 10.34 percent historical annualized ROR over the long run of the APF (67, 68). We applied two different investment fund schemes that result in different estimates for the dividend amount:

- Alaska Permanent Fund approach: dividends (calculated, using the APFC formula) and operation expenses are covered only with the proceeds from investing the protected principal. Left-over amount is added to the principal and reinvested each year, which results in perpetually increasing dividends (69).

- “Declining Principal” approach: dividends and operation expenses are covered with funds from both the principal and the investment proceeds. Dividends are calculated so that the principal is depleted (zero) at the end of the concession. This results in higher annual dividend, distributed only for the duration of the concession.

**TABLE 2. Annual Dividends per Household**

<table>
<thead>
<tr>
<th>Concession Length Scenario (years)</th>
<th>Year of the Concession</th>
<th>APF Approach - Dividend ($)</th>
<th>&quot;Declining Principal&quot; Approach - Dividend ($)</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>163</td>
<td>1072</td>
</tr>
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*Medium toll rate scenario and 6% discount rate are applied*

We rely on 60 percent to ensure conservative estimates, but if more of the concession payment were placed in the fund, dividends would be higher. **Improvement in traffic conditions**

Congestion-based pricing, as a crucial aspect of the IP3, leads to notable improvement in traffic conditions. After calculating level of service (LOS) grades for each Columbus road, using the Highway Capacity Manual instructions (70) and Columbus road capacity data (71), we observed a trend of improvement in traffic quality over the duration of the modeled concession.
TABLE of Hourly LOS Grades. Yearly Projections (Road 33 - Columbus, OH)

<table>
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<tr>
<th>time of day</th>
<th>2010 (pre toll)</th>
<th>2011</th>
<th>2015</th>
<th>2025</th>
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</table>

* “A” - Free-flow conditions with unimpeded maneuverability; “F” - extremely low speeds, high delay, extensive queuing (63).

Background materials – detailed calculations of concession NPV, dividends and LOS grades are available from the author.

VI. Summary and Conclusions
The IP3 approach has a number of benefits. First and foremost, it facilitates variable pricing of transportation facilities, which both regulates demand for the use of those facilities and generates new facility-specific revenue that can be used to renovate and expand those facilities as needed. Infrastructure use will thus become more sustainable. Second, it provides an equitable solution to the problem of facility pricing by recognizing that all citizens are owners of a jurisdiction’s infrastructure, and should receive some of the value from lease payments. Third, because the IP3 provides a fixed annual payment in perpetuity, it will be substantial help to those on fixed incomes, such as retirees. It will also reduce income inequality because everyone gets the same payment fixed payment. Finally, by reducing political resistance to tolling and facilitating new, large private investment in transportation infrastructure, the use of an IP3 will create additional jobs in transportation facility construction, expansion, and operation.
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33. ??? Mohring and Anderson 1994


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Footnote pp. 7: Government Accounting Standards Board (1999), Summary of Statement No. 34 Basic Financial Statements—and Management’s Discussion and Analysis—for State and Local Governments.

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Footnote pp. 5: Litman, Todd, Using Road Pricing Revenue: Economic Efficiency and Equity Considerations, Victoria Transport Policy Institute, 2011.


Not used: Meeting U.S. Transportation Infrastructure Needs, American Road & Transportation Builders Association White Paper.

Not used: Prud’homme and Lee (1999)


Footnote pp.5: Taylor, Brian, Rebecca Kalauskas, and Hiroyuki Iseki, Addressing Equity Challenges to Implementing Road Pricing, California PATH Research Report UCB-ITS-PRR-2010-6, California Path Program, Institute of Transportation Studies, University of California, Berkeley, 2010.
