Calculating the Real Economic Payoff of Infrastructure

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Working Paper STP2013_02

First version: September 30, 2013

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Abstract

The purpose of this research is to verbalize a theory of why the performance of infrastructure matters for the economy. The primary goals are to identify the effect of transportation infrastructure performance on US competitiveness and to establish a framework for policy, regulation and investment. We use the Transportation Performance Index developed at the University of Delaware with financial support from the U.S. Chamber of Commerce (US Chamber 2010b and summarized in an appendix) in a model of economic growth based on the work of Xavier Sala-i-Martin at Columbia University, whose work is the basis for the Global Competitiveness Index published by the World Economic Forum. Using the result of a statistically significant 0.3% annual impact on the growth of GDP per capita, we are able to estimate the payback period (17 years) and internal rate of return (7%) for national investments in transportation.

About the Author

Dr. Trimbath is a former manager of depository trust and clearing corporations in San Francisco and New York. She is co-author of *Beyond Junk Bonds: Expanding High Yield Markets* (Oxford University Press, 2003; Chinese edition 2013), a review of the post-Drexel world of non-investment grade bond markets. Dr. Trimbath is also co-editor of and a contributor to *The Savings and Loan Crisis: Lessons from a Regulatory Failure* (Kluwer Academic Press, 2004). She worked with the University of Delaware to develop the Transportation Performance Index and, beginning in 2010, published several reports on the economic importance of transportation infrastructure in the United States. Send correspondence to Susanne@stpadvisors.com; comments are welcome. Dr. Trimbath currently teaches undergraduate economics and graduate finance.

Acknowledgements

The original project team for developing indices to measure the performance of infrastructure in the United States was led by Michael Gallis and Associates of Charlotte, NC. The *Let's Rebuild America* initiative at the US Chamber of Commerce is headed by Janet Kavinoky. Funding for the project was also provided by the National Chamber Foundation in Washington, D.C.

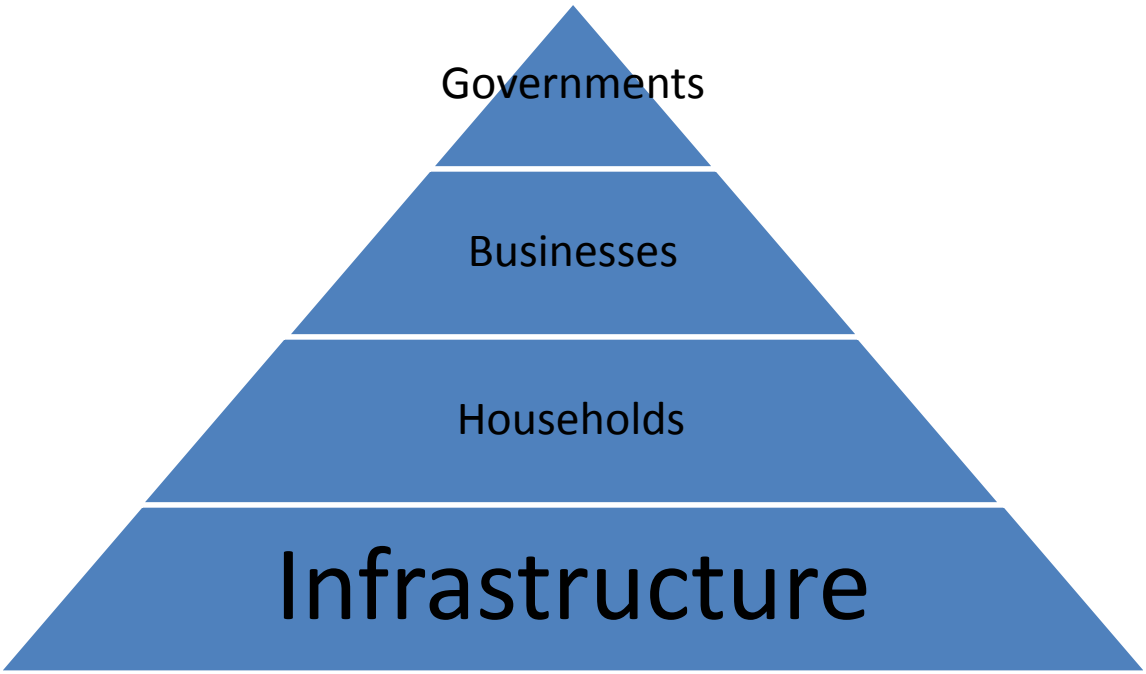
Executive Summary

The importance of infrastructure is best understood by focusing on performance – Does it do what we need it to do? In the case of transportation, it needs to provide the foundation for all economic activity. Transportation is used to bring labor and inputs to places of production, to deliver final goods and services to end users and to bring customers to the market place. The Transportation Performance Index (TPI) was designed to measure just this aspect of infrastructure – How well is it doing its job? Like any index, it is a relative measure benchmarked to a point in time in order to gauge changes from year to year. Indexes most people are familiar with – like the consumer price index – work in the same way. The TPI is also a representative index. It cannot measure every inch of road or every mile of railroad tracks. The TPI measures the performance of a sample of transportation infrastructure. One similar index that is widely understood is the Dow Jones Industrial Average (or simply "The Dow"). The Dow is the sum of the prices of the stocks of 30 companies selected to be representative of all the stocks traded on public exchanges in the United States. These companies are selected (and periodically revised) to coincide with the basic sectors that make up the US economy. These sectors include basic materials, services, consumer goods, etc. The TPI similarly samples the geographic areas of the US based on population and economic sectors. Just like The Dow, the sample underlying the TPI is designed to coincide with the structure of the entire system.

Taking the TPI as our representation of "infrastructure," we apply it in a well-grounded, long-standing model of economic growth. It is not our purpose here to initiate new theory on what causes growth. Rather our purpose is to advance the understanding of why the performance of infrastructure matters for growth. We identify the effect of positive improvements in the performance of transportation infrastructure as an increase in the growth of GDP per capita by 0.3%. In an economy the size of the US, this is not an insignificant number: $48 billion in 2012. Making the investment to improve transportation performance can result in a measurable return on investment (7%) with a payback period (17 years) that is well short of the life-expectancy of most transportation infrastructure.

Finally, with this economic and financial information in hand, we review the policy framework that would support the required investment. Transportation policy has been allowed to stagnate in the US: the strategic economic goals and performance measures in the Department of Transportation's 2014 performance plan are nearly identical to the 2002 plan. Yet, the world that business moves in has changed significantly as has the way that business moves. The service sector – the fastest growing part of the economy – is increasingly dependent on transportation. Despite repeated outcries for additional funding, transportation spending in the US was more than $100 billion under budget in the first decade of the new century. Clearly, what the US needs now is better planning and strategic project selection, plus streamlined delivery processes to increase the productivity of infrastructure investment.

Infrastructure Supports Economic Activity



Importance of Performance

Just as infrared is the invisible part of the spectrum of light, it often seems that infrastructure is the invisible part of the economy. Infrastructure refers to that which is below and contained within all the structures that support economic activity. It has been popular – especially since the turn of the century – to think of the economy as becoming increasingly dependent on the insubstantial and the ethereal – emailing, e-trading, e-commerce. The reality is that all commerce – even e-commerce – eventually depends on transportation infrastructure. After all, someone has to get the computer components from the factory to the e-business; and when the computer hardware breaks down, someone will likely use transportation infrastructure to get to the place of business to fix it. No e-commerce can occur until transportation infrastructure is used to get the equipment to the location where rare earth minerals are extracted and to take those minerals to the factory – usually on another continent – where workers arrive via transportation infrastructure to build the computers in the first place. In many ways, there can be no commerce – "e" or otherwise – without bricks-and-mortar infrastructure.

While the Transportation Performance Index (TPI) used in this analysis gives us an indication of the availability of infrastructure (supply), more importantly it tells us something about the current reliability, predictability and safety of our infrastructure (quality of service) and the potential to accommodate future growth (utilization or reserve capacity). Having infrastructure that performs well is more important than simply having infrastructure. Inefficient infrastructure adds a cost to every good and service, reducing the ability of American firms to compete in the global economy. It impacts more than our work – it impacts the personal lives of Americans, too. Poor performing infrastructure causes a drag on our standard of living and quality of life. As world policy makers search for better ways to measure "progress" and "well-being," five of the twenty measures under consideration for use as "Key Indicators" in the United States include transportation (GAO 2011). The mobility provided by transportation infrastructure is a central cross-cutting indicator for quality of life, sustainability, and diversity of opportunity. Infrastructure performance is vital to economic growth, national defense and global competitiveness.

> "How we as a nation choose to renew our infrastructure systems in the coming years will help determine the quality of life for future generations. It will also help determine our success in meeting other national challenges, including those of remaining economically competitive, reducing our dependence on imported oil, and dealing with issues related to global climate change, national security, and disaster resilience." NRC (2009)

Not "how much" but "how good"

Our analysis makes use of the Transportation Performance Index (TPI).[1] The TPI is designed to capture the performance of the vital systems that are used to deliver goods and services to customers and users throughout the US and around the world. By design, the TPI is generated from publicly available data using a transparent process that can be replicated by any interested party and used to benchmark and measure the improvement or decline in the performance of transportation infrastructure over time in any jurisdiction. As such, the TPI brings a rigorous, quantitative, and repeatable methodology to the assessment of infrastructure performance.

The TPI is designed to address an essential flaw in what we know about how infrastructure supports economic activity. About 140 transportation experts, users and service providers – from industry, government, business and academia -- engaged in discussions and provided input for the study on how to measure performance. In the end, the analysis relies on the numbers – measurements that indicate the performance of transportation infrastructure – to create the TPI. No other index or measure of infrastructure matches the TPI for scale and scope. The TPI combines over 10,000 statistics on performance covering all modes of the nation's transportation network (rail, road, transit, air, and water). The data are collected from a sample of Metropolitan Statistical Areas (MSAs) in 31 states representing 49 city/state combinations. A higher TPI means the infrastructure offers a better quality of service (safer, more efficient, and more reliable) with the capacity to accommodate economic growth. When the performance of the US transportation network improves, it is reflected in the TPI.

The TPI enables an economic analysis that differs from benefit-cost analysis, or analyses using engineering needs assessments or aggregate stocks of infrastructure typically applied in prior studies of the economic importance of infrastructure. Instead, the TPI can be used to address the World Economic Forum's lament over studies that fall short of "providing any reliable guidance on how much infrastructure is needed to achieve a given target for economic growth, development or productivity" (WEF 2010 Positive Infrastructure). The distinction here is only that we contend that it is "how good" and not "how much" infrastructure is needed. While other studies analyze what happens when infrastructure exists, the TPI allows us to analyze what happens when infrastructure *works*.

The TPI – like any model framework – was developed to address gaps in knowledge across modes and jurisdictions. In the absence of a nationally recognized framework, jurisdictions with decision making authority over infrastructure will be "developing their own tools with little or no knowledge of what exists elsewhere, spending limited resources, and ultimately

[1] Interested readers are referred to the Technical Report (US Chamber of Commerce 2010b), which documents the complete development of the Transportation Performance Index (and includes an analysis of the results for the initial time periods). A brief summary of the TPI methodology is included in this report as an appendix for the convenience of the reader.

making the roll-up at regional, [state] or national levels nearly impossible" (NRC/NRTSI 2009). What the states are measuring is not the same as the measurements made available by MSAs; further, some measures are only available on a national basis.[2] Transportation systems are critical to the National Infrastructure Protection Plan of the US Department of Homeland Security (US-DHS 2007). The protection plan requires cooperation between the federal government and the private sector, state and local governments, and business and social organizations. Until there is consistency in the definition, measurement and reporting of performance data, the TPI is the only consistently produced measure available.

The TPI can help assess the performance of transportation infrastructure at strategic and tactical levels. The TPI can serve as a national model framework for use by the people who are the managers of infrastructure (assets and services), those who develop policy for infrastructure, elected decision-makers, and the voting (and travelling) public. While the communication needs of these diverse stakeholders vary greatly -- from technical information at the asset management level, to a broad overview at the public level – the TPI can reach most of them. This is demonstrated by the production of 1) a technical report, 2) an economic analysis and 3) a public report written in plain business language.

One might consider, as Jiang (2001) does, that there are two approaches for examining infrastructure in order to study its effect on economy. One way is to focus on the quality of services and the potential utilization of existing transportation infrastructure. The other way is to focus on the future need for transportation infrastructure capital to grow the economy, and the distribution of economic activities. In the TPI, we have one time series that captures both. The TPI values from 2001 to 2011 are in the table below. Although the TPI wavered in 2010 and 2011, the improvements seen in 2009 (reported in the 2011 report) appear to be holding.

[2] When we try to compare the results of the national TPI to the state-by-state TPI (US Chamber 2010b and 2013), we see that differences arise for these reasons.

Table 1. Transportation Performance Index 2001-2011

Year	Transportation Performance Index
2011	57.26
2010	55.85
2009	56.60
2008	52.82
2007	50.74
2006	50.99
2005	50.42
2004	51.30
2003	52.99
2002	52.85
2001	51.90

Compared to the TPI in 2009 (the last release) the TPI in 2010 declined slightly (by less than 1) and increased in 2011 by about 1.5 – or just 0.66 above the 2009 TPI. The magnitude of these changes suggests a continuance of an upward trend in the TPI that appears to have started recently. Beginning in 2009 with the "Stimulus Package," there were significant investments in infrastructure fueled by the funding of "shovel-ready" projects. Meanwhile, passenger travel, as evidenced by vehicle miles of travel (VMT), began to climb out of a slump in 2009, as did freight traffic. The increasing pressure on the infrastructure appears to be somewhat balanced by the larger investments.

The Logistics Performance Index, issued bi-annually by the World Bank (Arvis, et. al., 2012) shows the US ranked 9th based on 2011 surveys, up from 14th in the prior report. US international port infrastructure ranked 4th in the world behind Germany, Singapore, and the Netherlands, an improvement from the 7th place in 2009. These improvements in port infrastructure are echoed in highway improvements in the 2013 TPI Update.

Despite these national improvements, the World Economic Forum's Global Competitiveness Index (GCI), created by Sala-i-Martin upon whose seminal economic growth research our own model is based, shows US transportation infrastructure performance falling further behind the rest of the world. As countries like the United States enter the innovation-driven stage of development, "they are able to sustain higher wages and the associated standard of living only if their businesses are able to compete" with the rest of the world (Sala-i-Martin 2012). Despite being at an advanced stage of development, every nation depends to some extent on the basic factors – including well-functioning infrastructure. The United States ranks only #14 for Basic Infrastructure (World Economic Forum, 2010). How the United States stacks up against our competitors among the top 20 for Basic Infrastructure is shown in Table 2 below.

Table 2 World Economic Forum, Global Competitiveness Report 2009-2010

Basic Infrastructure			Score (1 to 7) for Quality of:				Global Rank:	
Rank	Country	Overall Score	Roads	Railroads	Ports	Air Transport	GDP	per capita
1	Switzerland	6.8	6.7	6.8	5.4	6.5	38	19
2	Singapore	6.7	6.7	5.7	6.8	6.9	49	8
3	Hong Kong	6.7	6.6	6.5	6.8	6.9	39	15
4	Austria	6.6	6.4	5.5	5.0	6.2	37	21
5	France	6.6	6.6	6.5	5.9	6.3	9	40
6	Germany	6.5	6.5	6.3	6.4	6.6	6	37
7	Finland	6.5	5.9	5.9	6.5	6.3	55	36
8	Iceland	6.3	5.1	n/a	6.2	6.3	142	20
9	Denmark	6.3	6.1	5.4	6.2	6.4	53	31
10	Sweden	6.2	5.7	5.4	5.9	6.0	35	28
11	U.A.E.	6.1	6.2	n/a	6.2	6.7	52	17
12	Luxembourg	6.1	5.8	5.1	5.5	5.4	98	3
13	Canada	5.9	5.7	5.2	5.6	5.9	15	27
14	**USA**	**5.9**	**5.9**	**4.8**	**5.7**	**6.0**	**2***	**11**
15	Belgium	5.8	5.8	5.6	6.3	6.2	31	29
16	Barbados	5.8	5.1	n/a	5.5	6.1	157	64
17	Japan	5.8	5.6	6.6	5.2	5.1	4	41
18	Netherlands	5.8	5.4	5.6	6.6	6.4	22	22
19	Taiwan	5.8	5.8	5.8	5.6	5.5	20	47
20	South Korea	5.8	5.8	5.7	5.1	6.0	14	49

* The European Union economy is the largest in the world (CIA, 2013). Scores are the result of responses to questions in the format: "How would you assess the quality of [X] in your country? (1 = extremely underdeveloped; 7 = extensive and efficient by international standards)," where [X] is "Basic Infrastructure", "Roads", Railroads", etc. Scores for 2009-2010, US rank for transportation infrastructure was little change in 2012-2013 (13th). Details available at http://www.weforum.org/

Growth is Inevitable

By 2030, the world economy will double, air freight will triple and port handling will quadruple (OECD 2012). Forbes columnist Robert Lenzner wrote in 2013[3]: "I am sure there is an enormous amount of infrastructure that needs to be modernized, freshened up, holes repaired in highways, subway stations cleaned, bridges strengthened. All without building a single new … project that requires environmental and local political approval." In addition to those projects, we are quickly approaching a point where we will simply need more. The extent to which we fully utilize our existing infrastructure – a performance measure captured in the TPI – is an indication of how much the economy can grow before we need to invest in more infrastructures.

Worldwide, air passenger traffic could double in 15 years; air freight could triple in 20 years; port handling of maritime containers worldwide could quadruple by 2030 (OECD 2007). Most of the existing transportation infrastructure could not handle the coming surge in

[3] Forbes Online, 7/29/2011 @ 1:52PM Infrastructure Spending Is Crucial For Jobs and Growth

demand. The surge is not only the result of organic growth in the size of the country, but also from an increase in the fundamental reliance of our economy on the use of transportation infrastructure. Spending on transportation services increased 215% in the construction industry – the biggest increase from 1992 to 1997. According to the most recent data (DOT-RITA 2011), the service sector replaced manufacturing as the sector using the most transportation services in 1997. The retail and wholesale trade sector still uses more transportation services than the construction industry. Believing that we will use less transportation infrastructure in a post-industrial, service-centered economy is false. The services sector has the second fastest growing usage (after construction) and remains the fastest growing sector in the US economy.[4] The service sector makes up nearly 80% of the US economy (as percent of GDP, 2012).

Table 3 Total use of Transportation (Billions, 1997 dollars)

Sector	1997	1992	% increase	Avg Annual growth
Services	166.0	113.5	46%	9.2%
Manufacturing	148.9	134.0	11%	2.2%
Trade	121.1	88.0	38%	7.6%
Construction	109.3	34.7	215%	43.0%

Top four users of transportation services in 1997. Source: US Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics (DOT-RITA, 2011).

[4] According to ww.trade.gov, services grew from 60% of the US economy in 1950 to 80% by 2000.

© STP Advisory Services, LLC 2013. Museum of Nebraska Art exhibit "Lincoln Highway Centennial: Wright Morris and America," featuring "a selection of photographs created between 1941 and 1954 – depicting locations along or near the famous highway."

Other Research on Infrastructure and Economy

PAST SUMMARIES

We begin this section with a summary of the articles discussed in our three previous reports on infrastructure and the economy before proceeding to discuss articles published since the last update.

Economic Infrastructure: Building Prosperity (Trimbath 2011a) included a broad review of literature on economic growth and infrastructure with an emphasis on Water, Energy and Transportation. With a focus on building the model and methodology for the series of reports, this earlier research summarized "differences in the way that 'infrastructure' is treated and in the methodologies applied in the analyses." The best results were obtained when "infrastructure" is measured with multiple indicators based on physical measures – organized into indexes like the TPI. OECD (2006) emphasizes the need to consider the performance of infrastructure – not just the quantity: low economic returns will result from "poorly managed or poorly conceived infrastructure." Economic growth and infrastructure were studied separately until about 1995 (Holtz-Eakin and Schwartz). Over the next decade, most research was done as policy studies seeking to understand why some countries grow faster than others (e.g., Henderson, Shalizi and Venables, 2000; Gausch and Kogan 2001). Calderon and Serven (2008a) summarized the literature on the inequality effects of infrastructure. Problems in measurement (of infrastructure and economy) and modeling are discussed in Aschauer (1990), Torrisi (2009) and Sanchez-Robles (1998). (See also *The Role of Infrastructure in Economic Prosperity Initiation Stage Report, Trimbath, 2010a*).

The Economic Importance of Transportation infrastructure (Trimbath 2010b) provided a review of the literature on the economic benefits of transportation infrastructure (or the damage done by the lack thereof) with a breakdown by mode, including the impact on global competitiveness. Table 4 lists the reports discussed by category.

Table 4 Beneficial and Damaging Infrastructure Performance

Mode	Damage if not performing	Beneficial if performing
Highways	Taylor 2007, Colorado Legislative council 2008	Taylor 2007, Cervero 2006, Harvard Business Review 2009
Ports	Blonigen and Wilson 2008	
Multi-Modal	Richardson 2009	
Airports		Cervero 2006, Green 2007
Transit		Taylor 2007

Generally, research on transportation infrastructure and economic development is covered by studies in four areas: public finance, economic development, urban studies and mode-

specific literature. Most published reports cover only one or two modes of transportation; they usually measure "infrastructure" either with spending or by counting quantity (e.g., miles of road in a geographic space).

Transportation Infrastructure: Paving the Way (Trimbath 2011b), the first update to the initial release of the TPI, summarizes four specific reports published in 2011. McKinsey (Manyika, et. al. 2011) released a report entitled *Retooling America's Economic Engine* that includes a section on infrastructure. This was "more a report on funding than fixing" infrastructure problems. The Organization for International Investment released a report (Slaughter 2011) that highlights some best practices being implemented in the US by their multi-national membership. We highlighted an example of a shovel-ready project in Maine that deployed portable asphalt-production and drying equipment to meet tight construction deadlines despite near-record rainfall. The RAND Corporation released a meta-study (Shatz et. al. 2011) – a study of other studies – examining what is being measured and analyzed in regard to highways and the US economy. As we did, they found that most studies measured investment in infrastructure and concluded that studies using measures of performance could be critical to advancing our knowledge in this area. Finally, the Congressional Budget Office submitted Congressional testimony on funding (Kile 2011) which addressed some issues of performance and clearly summarized the options for action at the federal level. They concluded that the primary deterrent to funding infrastructure improvements with tax increases could be efficiency losses resulting from "reductions in work and saving, shifting of income from taxable to nontaxable forms and shifting of spending from ordinary to tax-deductible goods and services." In reference to the hearings, then Senator John Kerry (D-MA) was quoted by the Washington Times (May 20, 2011, p1-1) as saying that the nation is in a "crazy place right now" – "we no longer have the will to build anything."

RECENT ADDITIONS

With the 2013 update to the TPI, we identify four recent publications on the relationship between transportation infrastructure and the economy. The Bureau of Transportation Statistics (DOT-RITA, 2011) published a comprehensive review of the 1997 Transportation Satellite Accounts (TSA), data which are only collected every 5th year. By way of comparison, a commonly examined data series, the Transportation Services Index (TSI) is released monthly but measures only the "volume of services performed by the for-hire transportation sector."[5] TSAs, on the other hand, include everything from home-delivery provided by retail stores to construction companies that move steel beams to their own job sites. As such, the TSAs overcome a serious weakness in the standard Input-Output accounts available from the Bureau of Economic Analysis – the TSAs include the transportation of goods and people provided by non-transportation businesses. Therefore, TSAs are helpful for measuring the total contribution of transportation services to the economy.

[5] See more on the TSI below in our review of Lahiri and Lao (2012).

Next, we review a publication which uses data on multi-modal transportation infrastructure to examine the question of which comes first, economic growth or infrastructure. Although the results are only applicable to the Northeast Corridor from 1991 to 2009, the result in Chen and Haynes (2012) that transportation infrastructures "cause" growth in employment and personal income is relevant to our analysis.

We found two published reports that build on the close connection between infrastructure and the economy but to very different ends. The first, Lahiri and Yao (2012), suggests that transportation should be used by the National Bureau of Economic Research (NBER) to predict the economic peaks and troughs that define recession and recovery. The other, published by RAND (Ecola and Wachs, 2012), examines ways to separate transportation usage from economic growth in the interest of reducing the impact on air quality from increasing vehicular pollution. That economic activity causes growth and that growth causes pollution is a well-known "Catch-22" which has been discussed seriously in development studies since at least the early 1990s. Pollution as a bi-product of economic activity has been at the center of the climate change debate since before it was called "climate change."[6] Grossman and Krueger (1994) reported that pollution initially increases in developing nations until they reach about $8,000 per capita income; pollution then declines with growth as more developed economies can "afford" pollution control mechanisms. More recently, however, Dasgupta et. al. (2004) say that the earlier approach is too simplistic – that geography and governance play bigger roles in pollution than the level of economic activity. We review the RAND report (Ecola and Wachs, 2012) because of its assumption of the close connection between transportation infrastructure usage and the economy.

Finally, we review an academic publication that supports the same basic thesis found in the most recent Enterprising States report from the National Chamber Foundation (Praxis and Kotkin 2013): small business is the backbone of economic growth. Albarran, Carrasco and Holl (AHC, 2013) report that reductions in the domestic portion of "travel time to international markets can lower threshold costs, to a level where exporting also becomes a viable strategy for smaller firms."

We report the results of each of these new research publications in detail below.

DOT-RITA (2011) uses the 1997 Transportation Satellite Accounts (TSAs) – the most recent available. Although TSAs were generated for 2002, they are not yet available for analysis.

[6] See, for example, the discussion surrounding Larry Summers infamous 1991 memo on Africa, where the then-World Bank Chief Economist equated "under-populated" to "under-polluted" in "under-developed" countries. A summary of the discussion is provided in "The Summers Conundrum," The Nation, November 10, 2008, by Mark Ames. The leaked memo is available online at http://www.whirledbank.org/ourwords/summers.html [Accessed August 2, 2013]

Methodological and classification changes make it difficult to compare results across time, so the authors of this report – principally Theresa Firestine – did the yeoman's work of rigorous adjustments that make it possible to draw reasonable conclusions from the available data. Most importantly for our purposes, they are able to show that the use of in-house transportation services[7] increased from 1992 to 1997. This increasing reliance on transportation infrastructure is echoed in other recent reports (e.g., Ecola and Wachs, 2012, reviewed below).

DOT-RITA uses the TSAs to measure the size of total transportation in the economy at about 4.4% of GDP (in 1997). This number may naturally rise if infrastructure is more inefficient because it is measured in dollars; however, the focus of this examination was not on performance but only on usage (by economic sectors). Our analysis (below) could be used to distinguish between increases in actual use of transportation services and increases due simply to poor infrastructure performance (see our 2011 economic analysis for some discussion of the cost to business of poor infrastructure). We can safely make the 1992 to 1997 comparison because the accounts are all on the same scale. Compare the total 4.4% of GDP to the approximately 1.5% of GDP that represents transportation services provided by "for-hire" businesses only; this demonstrates how the standard I-O tables understate the use of transportation infrastructure.[8] Most in-house transportation (95%) was provided by truck – compared to only 33% of for-hire. So, companies that deliver for themselves are more impacted by congestion, road conditions, etc. than transportation companies.

Ranked by total usage of transportation services in production (cents per dollar of output, 1997), industries you would normally think of as "transportation heavy" will rise to the top. Construction, utilities and mining input around 10 to 15 cents worth of transportation for every dollar of output that they sell. Financial services, education and the information sector use only a few pennies worth. Another way to look at this is to examine the amount of transportation needed to meet a dollar increase in the demand for the output of an economic sector. For example, a $1 increase in demand for construction output (housing, highways, etc.) requires an increase of 20.2 cents in transportation services. That increase is made up of 14.8 cents of in-house and 3.9 cents of for-hire air, rail, truck and water transportation, (plus some "other").

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[7] "In-house transportation consists of the services provided by non-transportation industries for their use. It includes privately owned and operated vehicles of all body types, used primarily on public rights of way, and the supportive services to store, maintain, and operate those vehicles." The TSAs cover air, rail, truck and water transportation.

[8] We initially sought to use the TSAs in our analysis, but in the end it didn't make sense because of the age of the releases – 2002 is yet to be made available. We are also working with annual data. We did make use of the Input-Output (I-O) accounts to determine the sector composition of the US economy in our sampling strategy for the MSAs (see US Chamber of Commerce 2010a for specifics). The TSAs differs from I-O accounts: "if a for-hire truck carries wheat from a farm to a mill, the I-O use table credits this activity to the mill, even though the farm may have purchased the transportation service. However, if an in-house truck of the mill transports the wheat from the farm, the TSAs use table shows the mill as providing the services and credits the activity to the farm only when an in-house truck of the farm transports the wheat to the mill." (DOT-RITA 2011).

These statistics enhance our understanding of how changes in the economy are reflected in the demand for transportation. How transportation infrastructure is used vis-à-vis economic recession or expansion will depend on how the downturn/upturn is spread across industries. For example, the recent increase in oil exploration will have a bigger impact on the use of transportation infrastructure (by requiring more transportation services which use that infrastructure) than an upswing in the stock market that increases the demand for financial services. Wholesale and retail trade have a bigger impact on the demand for transportation than tourism (leisure and hospitality).

Finally, DOT-RITA provides a way to rank the impact on the economy from equally sized changes in industries. Using multipliers to measure the economy's response to a change in the demand for transportation services, DOT-RITA conclude that "an investment in either for-hire or in-house transportation will have a greater economic impact than an equally sized investment in trade or utilities." Of the transportation services listed in Table 5, investments to improve air transportation services would have the biggest economic impact. Except for rail transportation, the impact is also bigger than investments in government and information services.

Table 5 Economic Response to Change in Sector use of Transportation, 1997

Output	Multiplier
Manufacturing products	2.469
Natural resources and mining	2.362
Construction	2.318
In-house Air transportation	2.167
In-house Truck transportation	2.119
For-hire Water transportation	2.110
For-hire Air transportation	2.031
For-hire Transit transportation	2.025
For-hire Truck transportation	1.965
Leisure and hospitality	1.937
In-house Water transportation	1.927
Government, etc.	1.847
For-hire Rail transportation	1.835
Information	1.824
In-house Rail transportation	1.819
Utilities	1.793
Education and health services	1.712
Trade	1.666
Professional and business services	1.580
Financial services	1.483

Combined with "greater dependency on transportation services [in 1997 compared to 1992] in the production process" the authors suggest that investments in air, highway and water transportation infrastructure could have "greater economic impact" than rail or transit. Unfortunately, the TSAs do not yet include some transportation services (e.g., corporate and personal use of automobiles), so the picture is not complete. Estimates of vehicle miles travelled in the US by automobile range from 85% to 95% (various sources).

Table 6 Sectors Ranked by total (dollar) usage of transportation

Sector	**Total use**	**In-house truck use**		
	1997	*1992*	*1992*	*1997*
Services	1	2	3	2
Manufacturing	2	1	5	4
Trade	3	4	2	3
Construction	4	3	1	1
Natural resources and mining	5	5	4	5
Utilities & communication	6	6	6	6

The services sector used more in-house truck transportation in 1997 (increasing by $26 billion real 1997 dollars) than in 1992 while their use of for-hire truck transportation declined slightly (by $6.3 billion). This suggests that the services sector (along with trade and construction) rely increasingly on in-house trucking. In 1997, the services sector replaced manufacturing as the number 1 user of total transportation services largely as a result of its growing share of all economic activity.

Next, Chen and Haynes (2012) provide a rigorous examination of the relationship between the presence of transportation infrastructure and economic activity. Their finding, that "[t]ransportation infrastructures are found to 'Granger cause' the change of employment and personal income per capita" (but not the other way around) is strictly-speaking applicable only to the Northeast Corridor and only for the years 1991 to 2009. This caveat is based on findings in other published studies that identified changes across time and across geographic regions in the transportation/economy connection. Unfortunately (for our purposes), they measured transportation input as investment in infrastructure which would most obviously affect the economy as spending.[9] They created "a transportation financial dataset which includes the capital stocks of public rail, highway and transit" based on financial data from Amtrak, APTA and NTD. The multi-modal data allows them to provide "disaggregated information on the impact of transportation infrastructure from different mode [*sic*]." Still, the results are interesting as they provide a viewpoint on the economy/infrastructure nexus.

[9] See Trimbath 2011 for detailed discussion of the problems created by using "spending" to measure both infrastructure and the economy.

The theoretical assertions in Chen and Haynes are familiar: Transportation networks connect entities within a region which facilitates both freight and passenger movement; improving the performance of that network generally reduces transportation costs. The improvement of economic activity may, as a consequence, lead to an increase in the demand for both passenger and freight usage of infrastructure. This is generally referred to as an "endogenous issue" – in layman's terms it is a somewhat circular argument that relies on part of the context to explain the outcome. Chen and Haynes tested for and found no problems with endogeneity in their statistical specification.[10]

Chen and Haynes tested various lead and lag specifications – allowing for a delay in the connection between the presence of transportation infrastructure and the time that it impacts the economy. They report the most robust results for causation when the economy is examined 3 years after changes in infrastructure, a result that is similar to ours.[11] By mode, the connections are only slightly different. Changes in highway capital stock are most effective with 3 or 4 years lag. Rail and transit infrastructure are most robustly connected to changes in employment, but highway infrastructure is only causally connected to the economy with a 1 year lag. Chen and Haynes suggest that personal income changes are associated with changes in rail (all lags) and transit (with 3 to 5 year lags) infrastructure over the longer term (i.e., have a less immediate impact). Highway infrastructure has the most significant impact on employment (especially in the short-term). Though they don't make it explicit, it would seem difficult to dismiss the possibility that this employment effect could result from the building and operation of infrastructure since they use spending to measure infrastructure. Chen and Hayne report that rail and transit have a more significant causal effect on changes in personal income, though they provide no explanation for why they believe that rail and transit "have a positive influence on individual's productivity." As we will see in the following reviews, the relationship of the economy and transportation infrastructure is significantly complex.

Lahiri and Yao (2012), recipients of a Bureau of Transportation Statistics (BTS) research grant on "Leading Economic Indicators for the Transportation Industry," developed the transportation services output index (TSI). Since 2002, the BTS has released values for the TSI monthly.[12] In this 2012 publication for the OECD, Lahiri and Yao suggest that the TSI has "advantages over the composite index of coincident indicators used by NBER to determine peaks and troughs of US economy in identifying turning points." Their primary finding on this point is that "TSI can give early signals to the onset of economic recessions while being contemporaneous to economic recoveries."

Their report also confirms the increasing importance of transportation in the economy. In 2009, the share of goods in the economy was 33% (of GDP, down from 54% in 1953) while

[10] In our model, we avoid endogenous issues by NOT using dollar-denominated measures in the TPI.
[11] Our model also uses a 3-year lag between changes in the TPI and the economy.
[12] For more information, see answer to Frequently Asked Questions at http://www.rita.dot.gov/bts/help_with_data/transportation_services_index.html

the share of services was 58%. Yet among indicators used by the National Bureau of Economic Research (NBER) to date peaks and troughs in business cycles "none specifically represents the service providing sectors." Combined with the finding in USDOT-RITA (2011) on the increasing reliance of the service sector on transportation, this could be a significant oversight.

The TSI covers 90% of for-hire transportation usage (but, as mentioned earlier, none of transportation services provided "in-house" by non-transportation sector firms for their own use). We are mildly concerned about measuring transportation by value (cost) since poor performing infrastructure increases the cost – and hence the contribution to GDP and the total value of the TSI. The use of transportation is so widespread that it raises the cost of everything and so may be offset in ratios. Still, even this research by the "creators" of the TSI shows that the 2007/8 recession was not predictable by any formula.

Ecola and Wachs (2012), in a report prepared at RAND for the Federal Highway Administration (FHWA), review the literature on ways to separate ("decouple") increased use of transportation from economic growth. Transportation in these studies is measured as total vehicle miles travelled (VMT, or VKT using metric kilometers). The purpose for the FHWA was to identify local, state or regional policies that have been successful at discouraging the use of vehicle travel without discouraging economic activity. Policymakers may want to understand ways to reduce the pollution and other environmental problems created by vehicle travel without harming economic growth. So far, policies considered to reduce traffic (e.g., encourage the use of bicycles, transit, etc.) have not been examined for potentially damaging economic consequences. Most studies have been done in the other direction: how economic activity may damage the environment.

According to their review, VMT and gross domestic product (GDP) in the US moved consistently together after the end of World War II until about 2003, although the relationship is neither stable nor consistent over the long-run. Ecola and Wachs report results from Pozdena (2009) finding a one percent change in VMT per capita resulting in a 0.9 percent change in GDP per capita within two years, and a 0.46 percent change after 20 years. However, both travel and the economy are affected by changes in population, the cost of fuel, job losses, etc. so that the size and direction of the connection depends on time and location. There is some speculation that the link between 1949 and 1981 resulted from the construction of the interstate highway system whereas after 1982 no causal relationship could be identified. We see this as further evidence of the importance of measuring performance in economic studies of infrastructure.

Studies that combine energy, transportation and the economy sometimes "argue that reducing travel will have positive economic development implications." The reasoning is that investing in infrastructure that makes travel more efficient which could, in the short run, improve economic growth and reduce VMT by making travel less circuitous while increasing economic efficiency. In contrast to this suggestion, Duranton and Turner (2011) point out

that the "Fundamental Law of Road Congestion" means that more roads simply lead to more travel – regardless of efficiency of travel. Although there are problems in measuring both "travel" (VMT includes travel by children and retirees that may not result in measurable contributions to the economy) and "economy" (see GAO (2011) for information on a Congressional mandate to study alternatives to "GDP"), congestion and noise "remain tightly linked with changes in VMT."

Despite this complex, non-linear and non-constant relationship, Ecola and Wachs conclude that it could be possible to reduce greenhouse gas emissions by reducing VMT without wrecking the economy under "normal circumstances" and "in well-developed urban areas" where substitute means of mobility are available. They say, "The critical issue for policy is not the level of economic activity as measured by economic growth, nor the amount of VMT, but the efficiency embodied in the relationship between them. That has rarely been considered in the literature."

Our review of the literature found reports that contradict the suggestion in Ecola and Wachs (Appendix A) that VMT and the economy are decoupling "naturally, as a result of macroeconomic changes such as the US shift from an economy based on manufacturing and agriculture to service specific industries." Instead, DOT-RITA (2011) and Lahiri and Yao (2012) show that the service sector demand for transportation services is *growing*. Our analysis using the TPI – with its focus on *performance* – allows us to steer clear of these and other pitfalls. The TPI measures whether or not transportation infrastructure does what we need it to do rather than how much infrastructure we have or how much we use it.

Finally, we read **Albarran, Carrasco and Holl (ACH, 2013)** which reports a positive effect on exports by small and medium-sized firms from improvements in domestic transportation infrastructure. Infrastructure quality (and distance) is used to empirically specify transportation costs across product types and geographic locations. International markets are particularly cost-sensitive, assessing a penalty on the firms' ability to compete if increased costs result from poor-performing transportation infrastructure. Specifically, ACH combined firm-level data (from a panel of Spanish manufacturing firms) with geographic information system (GIS) analysis to calculate "travel times to the nearest international border crossing and main seaports based on the real transport network." ACH write, "Using the real transport network and its improvements permits the quality and density of infrastructure to be taken into account, and also directly assesses the impact of domestic transport improvements through travel time reductions, rather than through the effect of location on export participation." This is one of the few export-participation studies focused on the domestic transportation system rather than the international linkages (port-to-port). Thus, ACH demonstrate one mechanism through which investments in transportation infrastructure create economic benefits. Quite simply, ACH show that improvements in transportation infrastructure performance which reduce domestic travel time to international markets can lower costs to a point "where exporting becomes a viable strategy for smaller firms."

Smaller firms are the central theme of this year's edition of *Enterprising States* ("ES", Praxis and Kotkin, 2013) from the National Chamber Foundation. Exports and international trade (along with Infrastructure) are included in the five policy areas used in the ES report to rank the states for policy performance. Small and mid-sized firms account for 34% of overall U.S. exports (2010). The importance of competing in a global economy is made clear:

> "Outside our borders are markets that represent 80% of the world's purchasing power, 92% of its economic growth, and 95% of its consumers. … International trade supports 28 million American jobs today. One in three manufacturing jobs depends on exports, and one in three acres on American farms is planted for hungry consumers overseas. … Ninety-eight percent of America's exporters are small business from every state in the country." (ES 2013)

That transportation infrastructure supports small business exporters and that small businesses support economic growth is one more way in which well-performing infrastructure supports the economy.

Before proceeding, we would be remiss if we did not discuss the use of GDP to measure "prosperity." GAO (2011) reports the results of a study on "Key Indicator Systems" in use that might "offer insights for the United States." The report was produced under Congressional authorization included in the Patient Protection and Affordable Care Act of 2010 (sometimes called "Obama-Care"). Although this report was published a few months before our last analysis with the TPI, it did not come to our attention until recently.

Nevertheless, we had been aware for some time of the movement in Europe to replace "Gross Domestic Product" (or "GDP") as a measure of economic prosperity.[13] Some studies in the past have used personal income or national income per capita as substitutes for GDP. Similar to measures of "infrastructure" in use before the TPI, GDP is an imperfect metric for what it is intended to measure. As a measure of "economic activity" GDP fails on several counts: for example, it does not include household production, or the underground economy. As a measure of "well-being" GDP also fails on several counts: it does not "subtract" crime or other social problems, or pollution or the loss of leisure that comes from increased production. Finally, GDP does not include any measure of the distribution of income – that is, GDP measures the size of the pie but not how the pie is divided among the population.

Many people think GDP is like an accounting statement – an exact reconciliation of all the income and output generated by United States citizens and companies in a year. If it were, then the two columns of money earned and money spent would be equal – but they aren't. In the first quarter of 2011, the Bureau of Economic Analysis (BEA) reported a discrepancy between the two of $180 billion or 1.3% of total GDP. In the period covered by the TPI

[13] Nicolas Sarkozy broached the subject at the 2009 meetings of the G-20. See, for example, Telegraph.co.uk, September 14, 2009, "Nicolas Sarkozy wants 'well-being' measure to replace GDP. Nicolas Sarkozy, the French President, has called on politicians to ditch GDP as a measure of national wealth and replace it with one that quantifies well-being alongside economic strength."

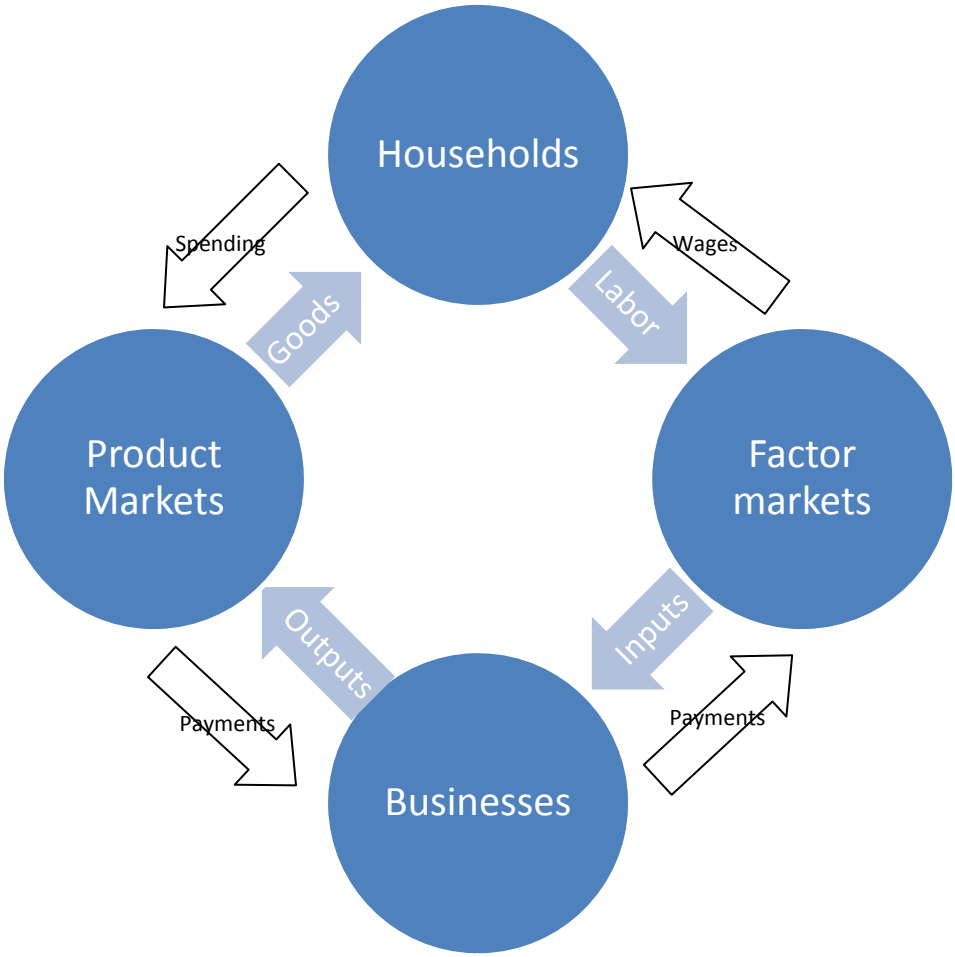
(1990-2011), the annual statistical discrepancy ranged from -1.55% of GDP to +2.21% (about $200 billion in either direction), with an average discrepancy of 0.29% ($12 billion). The BEA strives continuously to improve their measurement of the economy. A recent examination by BEA found the main causes of the discrepancy to be (1) misreporting by sources, (2) accounting for capital gains and losses, and (3) employee stock options, plus (4) the valuation of intangibles assets (Rassier, 2012).[14]

GDP and the TPI have a few things in common: Both are based on a random sample of reporting entities. GDP comes from surveys done by the Census Bureau; the TPI samples the metropolitan areas that collect data on roads, airport, etc. in their jurisdiction. Both GDP and TPI are based on expert knowledge of what matters – in GDP for production and in the TPI for the performance of infrastructure. The BEA created concepts and a structure of accounts to generate estimates for GDP. The TPI was conceptualized as a hierarchical framework based on input from users, policy makers and other stakeholders.

Since some data is simply not available, BEA has to make some assumptions about the direction of the changes that they cannot record. This is one area where the TPI is more accurate than GDP, as we make no assumptions about the direction of change but only let the data speak for itself. On the other hand, the TPI does not pretend to measure every inch of road and rail in the nation, nor does the BEA set out to count every dollar of production and consumption in the economy.

In the US, a system of measurements, called "State of the USA," has been introduced to overcome what are perceived to be problems stemming from the limited range and scope of GDP by broadening the dimensions considered to include the measurement of social conditions and "wellbeing." So far, no one has achieved a more accessible, understandable and usable measure. Until then, we continue to use GDP in our studies of the economy.

[14] Trimbath (2013) reviews these and other issues about GDP in detail and draws comparisons with the TPI to demonstrate how improvements could be made.



Economic Flow of Goods and Income

Economic Analysis Using the TPI

The purpose of this analysis is to demonstrate a theory of why infrastructure ***performance*** matters for the economy. Doing so enables a discussion of the impact that good-performing infrastructure has on US competitiveness while shedding light on a framework for policy and investment. Our model of economic growth – based on the work of Sala-i-Martin (2002) – has proven stable with the addition of new observations on the TPI and the economy. Before we re-present the results, we first describe the model and summarize the discussions from our two earlier reports on the statistical link between the TPI and economy.

Model of Economic Growth

The World Economic Forum's Global Competitiveness Index (GCI) was created by Sala-i-Martin upon whose seminal economic development research our own model is based. Our model incorporates some basic requirements of the "12 pillars of competitiveness" (Sala-i-Martin 2012) which form the foundation of the GCI.[15]

The key determinants of economic growth, based on decades of empirical analysis (Sala-i-Martin 2002), are 1) the initial level of the economy; 2) the "quality of government;" 3) health of the population; 4) free market institutions; and 5) open economies. In our case, we are concerned with only the first three. Free market institutions are widely available in the U.S. Further, in addition to being a globally open economy, advances like the Uniform Commercial Code have made U.S. markets open across state borders for decades.

Therefore, our model takes the form:

GDP per capita = f (TPI, GDP (level), Government policy, Population health)

A complete set of data definitions and sources is provided in Table 7.

[15] These are placed in 3 groups of 1) Basic requirements for factor-driven economies: Institutions, Infrastructure, Macroeconomic stability, Health and primary education, 2) Efficiency enhancers for efficiency-driven economies: Higher education and training, Goods market efficiency, Labor market efficiency, Financial market development, Technological readiness, and Market size, and 3) Innovation and sophistication factors for innovation-driven economies: Business sophistication, and Innovation. (Sala-i-Martin, 2012)

Table 7 Data Acronyms, Definitions and Sources

Variable	Definition and Source
GDPpc	Log GDP per Capita (in 2000 dollars). Bureau of Economic Analysis, United States Department of Commerce.
TPI	Transportation Performance Index (lagged 3 years), US Chamber of Commerce (forthcoming).
GDP	Real GDP (level, 2000 dollars). Bureau of Economic Analysis, United States Department of Commerce.
Debt	Federal debt as a percent of GDP. Bureau of Economic Analysis, United States Department of Commerce.
LifeE	Life Expectancy (at birth). Centers for Disease Control.

See Trimbath (2010b) for results of statistical testing on the lag of 3 years and results for building the model incrementally and with alternative indicators for the four variables of interest.

2010 Results

For the initial examination (*The Economic Importance of Transportation Infrastructure*), we limited our focus to two specific ideas: First, that US business efficiency a) improves the domestic standard of living and b) makes U.S.-produced products and services globally competitive; and secondly that foreign direct investment – especially the inflows that result in new establishments and create jobs – is dependent on transportation infrastructure. We also demonstrated that federal spending on transportation infrastructure is not correlated with performance. This confirms the results other researchers found when using spending instead of performance to measure the impact of transportation infrastructure on economy. It seems clear that spending alone is not a useful topic for discussion for many reasons. One dollar will not pay for the same quantity or quality of transportation infrastructure across time or across geography. More important is our understanding of the changes in performance that result from real investments in infrastructure.

2011 Results

The first follow-up report (*Transportation Infrastructure: Paving the Way*) provided several sidebars with examples of "Real Companies, Real Costs" and "Real Projects, Real Improvements" with the conclusion pointing to the advantages of a Stakeholder-Centric Approach to developing and improving transportation infrastructure. Along the way, we highlighted some of the innovative ways that US businesses continue to find their way through transportation obstacles and a few real-life examples of transportation projects that contribute to improved performance. Departments of transportation (DOTs) and metropolitan transit authorizes (MTAs) "are not in the business of building roads or running transit railcars…. The product of DOTs and MTAs is to deliver inputs and labor to the place of production; to deliver goods and services to customers; and to bring customers to the retail marketplace." Finally, we discussed some of the possible solutions being put forward in theory and in practice around the world.

2013 Results

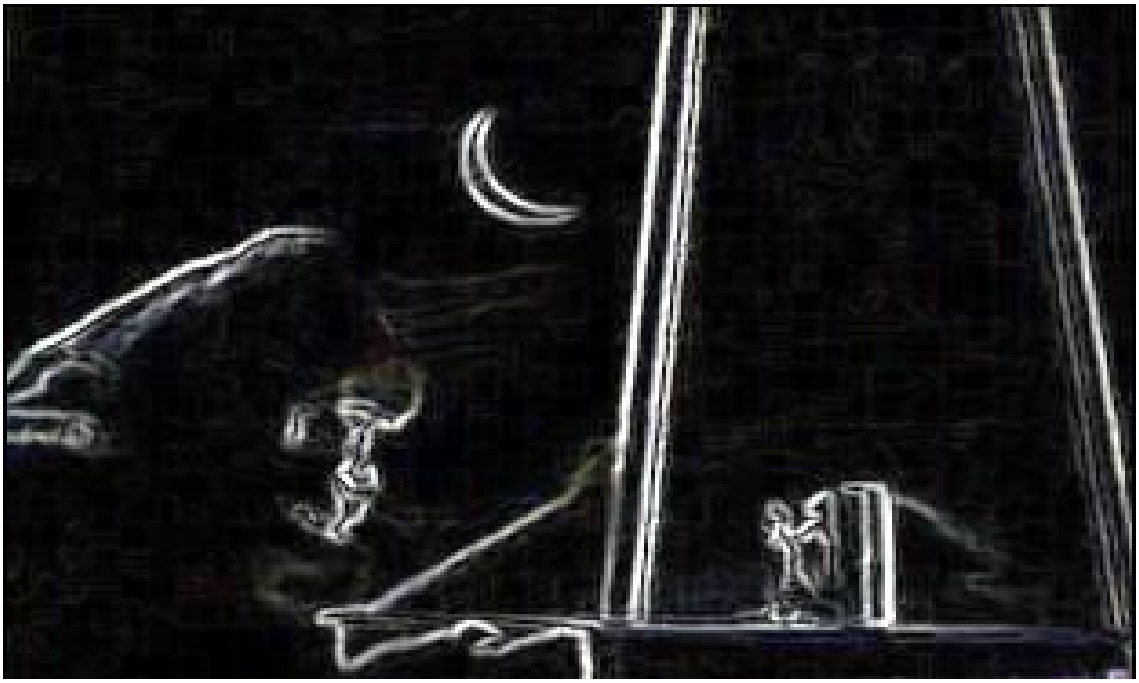
Table 8 Regression Results (Coefficients)

GDPpc	Coef.
TPI	0.0042*
GDP	2.37E-14**
Debt	-0.1822**
LifeE	0.0449**

*Coefficient statistically significant at 90% level. ** Coefficients statistically significant at 99% level. See Appendix for methodology, formulas and more technical regression results.

Our most recent regression results are show in Table 8. These results are roughly consistent with our earlier findings of a 0.3% change in the economy associated with a 1-point change in the TPI. Although the coefficient has risen from 0.3 to 0.4, we retain the use of a 0.3% change in the growth of GDP per capita in the following analysis to remain consistent with our earlier publications. The confidence interval narrowed slightly – meaning that the coefficient on the TPI is statistically significant at a higher percentage level than in our last analysis. We believe this strengthening is largely due to the increase in the number of observations.

While some policymakers and academics believe that "nothing matters" when it comes to infrastructure and economic growth, business behavior demonstrates that infrastructure is influential to their decision making (Trimbath 2010b). In the following sections we demonstrate the financial benefit to the US economy – and infrastructure funding agencies – of improvements in the performance of transportation systems.



"Hey, ya' big ape! You know who has to pay for this mess?!"

(Source: Author, based on a 1986 Transamerica Corporation television ad showing King Kong climbing the Transamerica Pyramid. After Kong steps on her patio, breaking a planter, the apartment resident reproaches him.)

Making It Payoff and Paying For It

What will it cost?

The US has more airports, roads and railways than any other country in the world – only Russia, China and Brazil have more waterways. However, the US is not alone in needing massive investments in infrastructure. The only disagreement is on exactly what it will cost.

The total investment needed for all infrastructures worldwide is estimated at $53 trillion through 2030, with a total of $15.5 trillion just for transportation.[16] OECD (2012) and others estimate a cost equivalent to 3.5% of GDP to improve infrastructure across all sectors – water, energy and transportation. A report from McKinsey (2013) calculates that this investment is 60% more than all spending in the last 18 years; and more than the estimated value of today's worldwide infrastructure. For our current purposes, we need an estimate that is just for transportation in the US. Consulting firm Booz Allen (Doshi, Schulman and Gabaldon, 2007) projects the cumulative infrastructure spending needs for the US (and Canada) from 2005 to 2030 to be $936 billion for road and rail and $432 billion for airports and seaports (about $1.4 Trillion total). Dividing this up between the US and Canada in proportion to real GDP, about 91% of this need is in the U.S. – or just over $1.2 Trillion to upgrade the performance of US transportation infrastructure to "first class" (Zupan 2013). We will use 3.5% of US GDP and $1.2 trillion in the following analysis. [17]

Measuring the Payoff

In this section, we examine the financial aspects of the required investment in infrastructure. There are two ways to make this examination. One is to calculate the payback period; the other is to determine the rate of return that the nation can expect to earn on the investment. We do both calculations below.

Here is a simple way to think about how long it would take to pay back an investment in infrastructure. (The following is drawn from Trimbath (2011a), an economic analysis using an index of the performance of US transportation, energy and water infrastructure; refer to that report for more on this topic.) If the investment need is 3.5% of GDP, we can illustrate the process by imagining an economy with a GDP of $100. Quite simply, the required investment would be $3.50. We ignore scale here and focus on the ratios – spending equivalent to 3.5% of GDP is required to bring infrastructure performance up to an acceptable level. In the natural world, spending this $3.50 would be spread out across

[16] Estimates vary depending on source and what is included. For example, this estimate includes $7.5 trillion for roads, $5.0 trillion for new rail, $2.2 trillion for airports and $800 billion for ports. Another estimate for "land transport only" investment needs from 2000 to 2030 is $71 trillion globally. Regardless of the exact dollar requirements, no one denies either the need for the investment or the staggering costs.

[17] American Society of Civil Engineers puts the number at $1.99 Trillion by 2020. We confirm our payback analysis with the higher estimate below. The use of 3.5% of GDP is consistent with our earlier publications.

several years, which would require that we account for the time value of money. However, infrastructure costs and GDP don't necessarily "inflate" at the same rate over time. But this is an unnecessary complication for our illustration. Let us say that the entire $3.50 is invested in the first year – with the result of significantly improved performance for the transportation infrastructure system. Next we calculate the inflows to the economy that can be expected from that investment. The cumulative sum of the inflows will tell us how long it takes before the investment pays for itself.

The inflows will be the same proportion every year (as a percentage of GDP) – in our case, the gain in growth is estimated to be 0.3% of GDP for every 1 point increase in the TPI. The TPI is scaled in a way that a 2.5 point increase would represent a "significant" improvement in transportation infrastructure performance. That results in a 2.5*0.3% = 0.75% increase in the growth of the economy if transportation infrastructure performance is improved significantly. Since our economy is $100, that translates to a gain of $0.75 in the first year. Through compounding, the gain grows even faster as the economy grows – 0.75% of 100.75 is now $0.76 in the second year after the infrastructure improvements. This is what Albert Einstein called "the magic of compounding" – we gain 0.3% in year two on the 0.3% gain from year one.

For the purpose of demonstration, let's assume that the entire $1.2 trillion is invested in the US in 2014 – this simplifies our payback analysis by allowing us to work with real GDP, thereby avoiding the complication of using one inflator for output and another for the cost of construction. If all the spending is done in 2014, and all the construction is completed in 2014 – again, this is only for demonstrating the financial point – then our model demonstrates that the economic gains begin to appear in 2017 (recall that our model specifies a 3 year lag between improved performance and improvements in the economy). The gain in 2017 is recognized as higher GDP per capita in 2018 (end of the period 2017). The economy starts 2018 at a level that is higher than it would have been without the investment in infrastructure. (See Table 9 below.)

By 2025, the economy is larger than it would otherwise have been by an amount greater than the initial investment to improve the performance of transportation infrastructure in 2014. In financial terms, the investment has a 12 year payback period. Taking only 25% of the gain each year as government revenue (see Table 10 below), the cumulative increased tax revenue will also exceed the cost by 2025. A standard, basic financial analysis well-understood by both business executives and policy-makers shows a 7% internal rate of return – a number significantly higher than the borrowing costs for most entities currently financing transportation infrastructure investments in the United States.[18] Even using the larger investment need of $1.9 trillion suggested by the ASCE, the payback period is less

[18] For example, as of August 2013, the US Federal government was paying 1.97% on all marketable debt, and 2.42% on all interest bearing debt (source: US Department of the Treasury). Depending on implementation of Federal Reserve policy to reduce monetary easing, there rates could be substantially different in the future.

than 15 years – still substantially less than the average life expectancy of transportation infrastructure (NCHRP 2012).

Table 9 Payback Period Analysis

	Projected US real GDP per capita			
Year	Without investment	With investment	Cost	Tax Revenue Gain
2014	$50,800	$50,800	-$1,200,000,000,000	
2015	$51,943	$51,943	$0	
2016	$52,969	$52,969	$0	
2017	$54,019	$54,019	$0	
2018	$55,038	$55,443	$0	$33,308,352,678
2019	$56,079	$56,908	$0	$68,646,698,398
2020	$57,143	$58,414	$0	$106,108,510,435
2021	$58,230	$59,963	$0	$145,789,047,202
2022	$59,340	$61,557	$0	$187,785,941,093
2023	$60,475	$63,195	$0	$232,199,617,383
2024	$61,616	$64,862	$0	$279,060,634,901
2025	$62,779	$66,572	$0	$328,502,907,722
2026	$63,963	$68,327	$0	$380,624,264,282
2027	$65,170	$70,129	$0	$435,521,616,592
2028	$66,400	$71,978	$0	$493,299,088,013
2029	$67,652	$73,876	$0	$554,060,930,815
2030	$68,929	$75,824	$0	$617,916,830,835
2031	$70,229	$77,823	$0	$684,945,639,512
2032	$71,557	$79,878	$0	$755,276,101,068

2012 real GDP per capita from World Bank; 2013-2031 growth rate for real GDP per capita from USDA used for current projections. Revised projected US real GDP per capita includes gain of 0.75% from significantly improved transportation infrastructure performance. 2015-2032 population from Bureau of the Census forecasts. Tax revenue gain uses 25% tax as a percent of GDP based on Heritage Foundation estimate of 26.9% and OECD estimate of 24% for all levels of government. Growth in each year is recognized as increased GDP for the next year (end of period).

Table 10 Government Revenue as percent GDP

Year	Federal, state and local	Federal Only
2013	34	16.7
2012	33	15.8
2011	34	15.4
2010	32	15.1

Data Sources: GDP from Bureau of Economic Analysis; Federal Revenue from Office of Management and Budget, Federal Budget, Historical Tables; state and local revenue from Census Bureau, State and Local Government Finances.

Paying For It

Our payback analysis demonstrates the way in which the investment that would improve the performance of transportation infrastructure pays off for the economy by increasing the rate of growth. In this section we present the rest of the story by addressing the question raised in the Transamerica ad on the cover page to this section: who is going to pay for the needed performance improvements? The options currently under discussion among researchers and policy makers in the United States are:

1. Maintaining the current process of financing transportation infrastructure with public money from all levels of government; including recently introduced requirements for measurable performance improvements to justify spending decisions.

2. Reducing demand in the most heavily populated areas to slow down the wear-and-tear on the existing system.

3. Increasing existing user fees and/or implementing new user fees.

4. Creating incentives for private capital to finance public goods.

There is no "free ride" here – the construction and renovation of transportation infrastructure carries a hefty price tag that has to be paid one way or another. Clearly, it would be more difficult to do things like build a transcontinental highway in 2013 than it was when the Lincoln Highway was constructed in 1913.[19] Among the multitude of reasons that make this true are "constraints on public-sector budgets and commercial debt in the wake of the financial crisis, higher and more volatile resource costs, and the additional costs of making infrastructure resilient to climate change and less harmful to the environment" (McKinsey 2013).

We cannot offer a comprehensive review of any one of these options – or every possible combination among them – in the space available. Below we offer an overview and some important points about how each can be used to generate revenue streams that can be used to reward the investment necessary to make the improvements in performance that will result in the economic payoff.

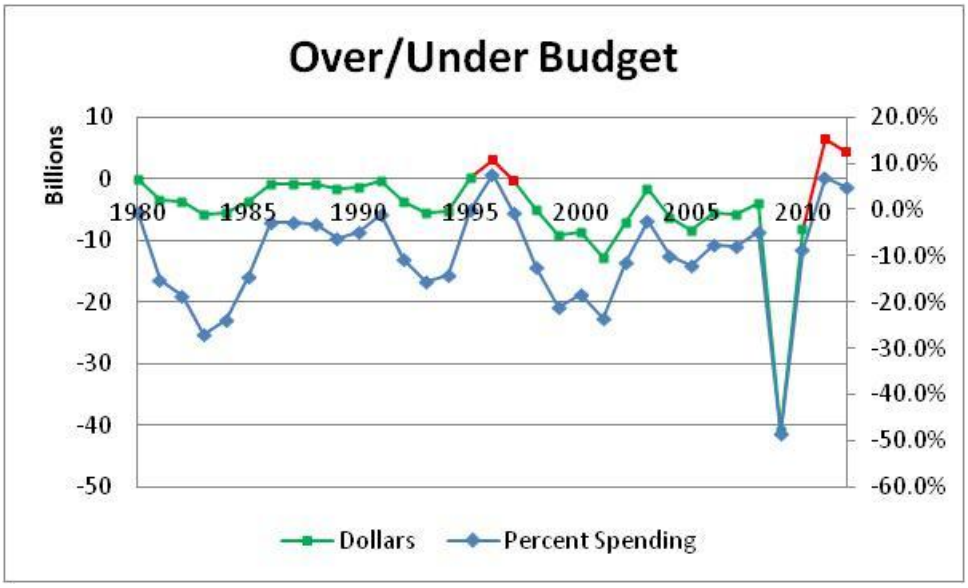
1. The Status Quo

Fuel taxes, borrowing where allowed, general government revenues, all are current sources of financing for transportation infrastructure at all levels of government. Historically, about 45 percent comes from the federal government. While there is much debate about how much to spend on transportation, since 1980 (1990), federal spending on transportation in

[19] "Celebrating the road that got Americans moving," Paul Hammel, Omaha World Herald, June 23, 2013. See the graphic on the cover page to the earlier section "Other Research on Economy and Infrastructure".

the US has been $152.3 billion ($125.5B) *less* than budgeted.[20] Average under-spending since 1980 (1990) has been $4.6 billion ($5.5 billion) per year.

Figure 1 Federal Spending Over/Under-Budget 1980-2012



Data Source: Budget of the United States, Transportation Budget Authority FY 2011, Table 3.1 Outlays by Superfunction and function, updated with Table 5.1 from FY2014 tables; actual spending through 2012. Author's calculations.

Table 11 Federal Spending Under-Budget by Decade

Decade	Total under spending
1980-1989	$26.9B
1990-1999	$27.5B
2000-2009	100.7B ($60B w/o 2009*)

*Distribution of some 2009 federal stimulus spending continued into 2013.

[20] Federal spending on transportation exceeded budget in only four years: 2011 by $6.5 billion (the most ever), 2012 by $4.4 billion, 1996 by about $3 billion, and 1995 by $50 million. The $10.9 billion spending over-budget in 2011 and 2012 may have been to fulfill commitments from 2009, when spending was under-budget by an extraordinary $40.7 billion. Excluding 2009, the average annual under budget since 1980 (1990) was $3.5 billion ($3.8 billion).

2. Reduce demand

One way to improve performance is to discourage the use of transportation infrastructure – we saw some gains in the TPI during the 2007-2009 recession as a result of reduced congestion during the economic downturn. In an article on NewGeograph.com, historical commentator Joel Kotkin reports the work of demographer Wendell Cox on the new migration to America's "Efficient Cities" – resulting in net outmigration from America's most congested cities. "Between 2000 and 2008…, metropolitan areas of more than 10 million suffered a 10% rate of net outmigration. The big gainers were generally cities with 100,000 to 2.5 million residents." [21] Smaller populations are one way that the demands on infrastructure may fall naturally – but with undesirable consequences for economic growth.

The World Economic Forum suggests several strategies for reducing the demand for transportation, including "alternatives like walking and biking for roads; transit for cars; regional airports for congested major hubs" (WEF 2010). While American's do more driving than any other nation on earth, there is some new evidence that the long standing trend of increasing driving is tailing off (Baxandall 2013). Under the following item, we'll see that another option may have a side-effect of also reducing demand.

3. User Fees

One way to raise additional revenues for maintenance and operation of infrastructure is through user fees. These include road and bridge tolls, some of which vary during periods of high demand. While user fees alone will not improve performance, a dramatic increase in user fees will decrease demand, improving utilization and quality of service and improving some criteria of performance as measured by the TPI. Ultimately, increased user fees (if sufficient to offset the decrease in demand, see box below) could generate much needed investment monies. The solution – if there is one – lies in establishing an accurate elasticity of demand so that fees can be set at a level where the offset in demand does not inhibit driving (fee avoidance) to the point where revenues actually decline.

> A Circular Argument for User Fees to Improve Infrastructure Performance: The Federal Highway Administration (FHWA) defines system performance in terms of user costs. Costs include user fees such as tolls, fuel tax, or tax based on vehicle-miles traveled. These fees would all increase the costs that lead to a reduction in defined performance. The TPI avoids this problem by measuring performance without resorting to costs.
>
> Source: Department of Transportation, FHWA and Federal Transit Administration, *2008 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance*, pp. ix, xii. Cited in CBO (2011).

Unfortunately, user fees are wrought with difficulties. First, fees are most frequently discussed in the context of "congestion pricing" – that is fees are being discussed as a way to reduce demand rather than as a way to generate a revenue stream (with the obvious

[21] http://www.newgeography.com/content/001891-the-rise-efficient-city

exception of some toll roads).[22] However, congestion pricing is being used on less than 1% of congested roads in the US (CBO 2009). There are several specific challenges: federal barriers to implementing fees and transaction costs are the most obvious. Just as important, but perhaps not as obvious are the equity issues (CBO 2009). While the impact of fees as a revenue mechanism may be modest (ULI 2013), there are additional implications for land use patterns and policies. With careful coordination, user fees can support growth and development.

ULI (2013) provides an important cautionary note on tolling that could be applied to user fees in general. If the fees are permanent and not limited to rewarding investors in a particular facility, local policies will need to be established regarding the distribution of income beyond the designated payback period. The alternative, of course, is to tie the period of the fees to the reward and repayment of investors.

4. Public-Private Partnerships

Public-private partnerships – also known as PPP or P3 – cover a spectrum of financing options ranging from private concession operators to privately owned roads (see "Models of Financing" in OECD 2012b). At the lowest level on the PPP spectrum are private operators who raise their own financing for upfront costs and ongoing operations for concessions such as food service on highway plazas or newspaper stands inside train stations. Their revenue generally comes from sales. At a higher level ("Model 3" in OECD 2012b) risk is allocated "between public and private partners (e.g., public carries demand risk, private carries construction risk)." Financing is often shared and comes in the form of both equity and debt. The revenue stream to repay debt (or reward equity investors) comes from user fees. In "build, operate, transfer" (BOT) cases, the "government's role [is] transformed from manager, operator and financier to one of regulator – overseeing development and operation" of infrastructure. Effective government controls on safety and security, anti-competitive behavior (access, pricing, service quality, etc.) are critical to the success of these projects.

The final level is a purely private project which is used for public purposes. The private owner/operator builds the facility. The revenue stream generally "comes via user charges, with revenues raised used to service debt, repay financial loans/borrowings, and reward capital investment." Freight railroads in the US are a good example of privately financed infrastructure in the US (see box below).

[22] Sorensen, Ecola and Wachs (2012) survey mileage fees in the US, though their emphasis is on reducing demand with limited coverage of revenue streams except as they may be more stable than fuel taxes in the future. They do, however, discuss the potential for mileage fees to reduce the cost of collection over other revenue mechanisms.

Statement of the U.S. Chamber of Commerce [Excerpt]
ON: The Federal Role in America's Infrastructure
TO: U.S. House of Representatives Committee on Transportation and Infrastructure
DATE: February 13, 2013

"[N]ot all transportation infrastructure is 'public.' America's freight railroads operate almost exclusively over infrastructure that they build and maintain with their own private funds. And they are investing in their infrastructure. From 1980 to today freight railroads invested $500 billion — more than 40 cents out of every rail revenue dollar — in corridors, rail terminals, intermodal facilities, to maintain and improve their rail network infrastructure and equipment and anticipate economic growth."

There is no lack of private money – especially under the current conditions of Federal Reserve intervention in the economy. According to a recent study by consulting firm McKinsey (2013), an additional $2.5 trillion will be made available for infrastructure financing by 2030 if institutional investors meet their target allocations. (See box below for US Chamber of Commerce statements on private capital investments in infrastructure.)

Statement of the U.S. Chamber of Commerce [Excerpt]
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What the Chamber is Willing to Do

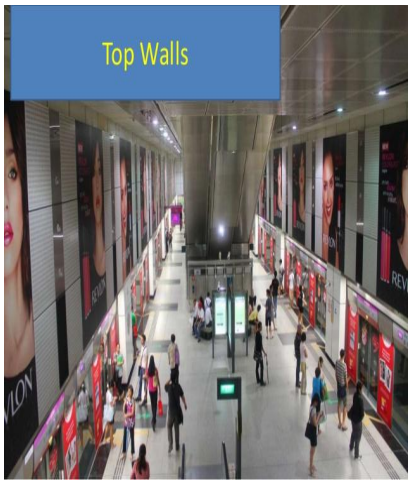
The private sector can help in four significant ways.

First, we're willing to pay to support public infrastructure. This includes paying more in user fees to shore up the Highway Trust Fund and ensure adequate investment. The money is running out, so we need to phase in a moderate increase in the gas tax over a number of years and index it to inflation. Shippers and truckers are all on board to pay a little more as long as the money goes to where it's needed.

Second, we're prepared to invest private capital. When it comes to private investment in public infrastructure, we are prepared to pump as much as $250 billion in private capital into public-private partnerships.

Third, we can provide our expertise and innovations to make infrastructure work better for travelers, businesses, shippers and carriers. It's not all about the money. We must make the transportation infrastructure that exists today work most efficiently, in the most cost-effective way.

And fourth, we're putting in the sweat equity to build the case for a world-class infrastructure system that will put Americans back to work, spur our economy, enhance our global competitiveness, reduce congestion and improve mobility and safety, and prove that American can still get big things done. We're launching a new project, the *Prospectus for Investing in America's Infrastructure,* to engage the larger business community in the effort to articulate what the future of infrastructure needs to look like so that we can expand coalition of supporters and build the political will to reform, reinvent and reinvest in infrastructure.

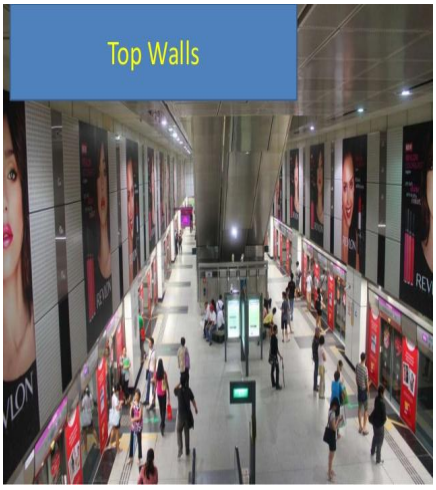


Other Revenue Streams

What is scarcer than good examples of P3 models – and scarcely talked about – is how to create the revenue stream that is necessary to attract private investment into public infrastructure? We discussed user fees (like tolls and mileage fees) above. But Americans are notoriously opposed to paying for public goods. Other options, which are just coming on the table in the US, have been used wide and far in other countries. These include both non-branded and branded revenue opportunities, which we discuss below.[23]

Non-branded revenue streams come from a multitude of concessions which can be operated on a lease basis by private businesses or offered in automated (non-manned) services by public agencies. Non-branded concessions are no longer limited to renting space for a newspaper stand in the subway or a flower stall in the metro entry hall or allowing bank ATMs near the ticketing machines. Many more opportunities are available as automated services, like music kiosks, mobile phone recharging stations (fee-based). Even the current self-ticketing machines – long thought of only as a cost-saving measure – can be used to promote other services. Today, there are "buskers" – individuals, small groups, or other street performers – in many public spaces in the US. Public agencies could establish pricing for the use of floor space for specific promotion events (e.g., commercial brand "activations") or other branded uses rather than letting this space flounder.

A more modern source of non-branded revenue comes from the ubiquitous mobile phone. Public agencies can garner revenue from mobile phone apps with embedded advertisements which promote tourism. The app would include schedules, routes, traffic updates, and SOS services. Other ideas associated with consumer communication devices include mobile WAP sites and fee-based access to Wi-Fi while using infrastructure. Red Rose Transit Authority (Lancaster County in Pennsylvania) earns $20,000 per year from leasing its radio tower to cell phone companies.



Branded revenue streams – or private advertising in public spaces – has come a long way since realtors put their faces on benches or lawyers put their names on the

[23] The author is grateful to Kamna Pandey in New Dehli (India) for permission to liberally paraphrase her slide show on revenue streams. The entire presentation is available online for free [last accessed September 24, 2013] at http://www.slideshare.net/kamnapandey/revenues-streams-metro

backs of city buses. Branding now extends to the infrastructure itself. New York City's Metropolitan Transit Authority added branding to turnstiles and train doors. More opportunities exist, including entrances, escalators, stairs, trains, overpasses, poles, walls, and even floors. Phoenix and Denver expect to earn up to $1 million in annual revenue from wrapping light rail trains in advertisements. [24]

Branding is not limited to print, either. New York, Chicago and Santa Monica are exploring LED advertising on the sides of busses. Dayton, Champaign-Urbana, Toledo (TARTA) and Kansas City (KCATA) have audio ads timed to promote businesses along routes. [25]

Just as advertising in metro transit is no longer limited to framed posters on subway platforms, highway advertising is no longer just for billboards. Why not, as pictured here in India, allow branding on overpasses? In November 2010 (USA Today November 22), cash-strapped California considered generating a much-needed revenue stream by allowing advertisements on emergency ("Amber-alert") highway signs. But even these signs are virtual antiques. Ideas for where and what can accommodate an attractive yet discrete opportunity for a branded revenue stream are only limited by the number of pixels that can be used in an electronic display.

Even small transportation agencies can generate branded revenue streams to support investments in infrastructure. According to John Flynn, general manager at OnCity Advertising in Boston, while the transit authority in a major American city might earn $20 million to $30 million per year, even a relatively small system (10 million or fewer riders per year) can earn between $200,000 and $400,000 in branded revenues. High-end product advertisers are willing to attach their name to high-visibility infrastructure, boosting the perception of a transportation system while generating revenues that can be used to repay or reward private investment that improves performance – a triple win.

[24] Managing During Hard Times – Lessons Learned in Transit Efficiencies and Revenue Generation, Joel Volinski, Director, National Center for Transit Research, University of South Florida, presentation posted by New York Public Transit Association for conference on Lessons Learned in Transit Efficiencies, Revenue Generation and Cost Reductions. [Accessed September 23, 2013, http://www.slideshare.net/NYPTA/joel-volinski-1130-1230am-6211]
[25] Ibid.

The Way Forward

In the US today, human resources departments, employment laws and regulations are still largely based on the assumption that those who work for an organization are full-time employees. World-renowned management guru Peter Drucker wrote (2001) that by 2025 – just a dozen years from now – "perhaps as many as half the people who work for an organisation will not be employed by it, and therefore won't need to commute to the office or factory every day." This idea, which seems so simple on the surface, holds enormous importance for US transportation infrastructure policy.

The TPI results suggest that there is a new, rising trend in the performance of transportation infrastructure in the United States. These improvements are a reflection of broad-based initiatives on both the supply and the demand sides. Meanwhile, the US continues to decline in the global rankings for poor transportation infrastructure (World Economic Forum, Global Competitiveness Index, shown earlier). Although US road, rail and even port rankings manage to stay in or near the top 20 in the world in the rankings, the US airport infrastructure quality ranking fell from 9th in the world in 2007-2008 to 32nd in 2010-2011 (currently at 30th).

Spotlight on Airports

According to World Bank research (Arvis 2012), of the top five air transportation systems in the world only China ranks substantially worse than the US for quality. Does this mean people will stop coming to the United States because the airports are failing? Of course not: the fact that they will keep coming only makes the system worse for wear.

Table 12 Quality of Top 5 Air Transportation Systems

Quality	Quantity	Country	Airline Seat Kilometers
30	1	United States	32,294,300
70	2	China	11,685,500
12	3	United Kingdom	6,269,500
31	4	Japan	5,097,200
7	5	Germany	4,754,700

Source: World Bank Trade Logistics Rankings (Arvis 2012)

Furthermore, inter-American air travel is declining (see table below) and being replaced increasingly with air traffic from Europe, Asia and the Middle East. The nation's ability to compete globally may become increasingly dependent upon well-performing airports.

Table 13 Shifting Patterns: Percent of Traffic to, from and within North America

	2012	2032
North America	50	40
Europe	22	23
Asia Pacific	15	18
Latin America	10	13
Middle East	3	5
Africa	1	1

Source: Boeing Market outlook

In 2012, four of the world's ten busiest airports by passengers and three of the world's ten busiest airports by cargo were located in the United States (Table 14). Airline capacity in the US (available airline seat kilometers per week) is the highest in the world. Pressure on aging airport infrastructures will continue to mount: About half of the 23 cities in the Americas with forecasted populations greater than 5 million by 2025 are in the US (11 of them) – four more are in neighboring Mexico (3) and Canada (1) (Urban Land Institute and Ernst & Young, 2013). Connecting these large population centers is critical to American economic progress.

Table 14 2012 Busiest airports

Rank	Most passengers	Most cargo
1	**Atlanta (ATL)**	Hong Kong (HKG)
2	Beijing (PEK)	**Memphis (MEM)**
3	London (LHR)	Shanghai (PNG)
4	**Chicago (ORD)**	Seoul (ICN)
5	Tokyo (HND)	**Anchorage (ANC)**
6	**Los Angeles (LAX)**	Dubai (DXB)
7	Paris (CDG)	**Louisville (SDF)**
8	**Dallas (DFW)**	Paris (CDG)
9	Jakarta (CGK)	Frankfurt (FRA)
10	Dubai (DXB)	Tokyo (NRT)

US airports in **bold**. Source: Boeing Commercial Airplanes, Current Market Outlook 2013-2032, Available online at www.boeing.com/cmo

A massive study for the Regional Plan Association, funded by the Port Authority of New York and New Jersey (Zupan, Barone and Lee, 2011 and Zupan 2013), identified "serious capacity and delay problems at the three major airports in New York:" John F. Kennedy (JFK), Newark Liberty (EWR) and LaGuardia (LGA) International Airports. Note that none of these airports is ranked globally for size despite the fact that the New York City metropolitan areas is ranked 8th in the world for population. The combined demand at the three Port Authority airports was 53 million, a combined total that would put them at the top of the list

for the world's busiest airports – if any one of them had the capacity.[26] For comparison, the busiest airport in the world, Atlanta, handled about 46 million passengers in 2012 (with a population less than 30% that of New York). Demand for passenger travel at the New York airports is expected to increase by nearly 50% as early as 2030 – requiring at least a 30% increase in flights per hour. Even with NextGen air traffic control technology[27] and encouraging a shift in demand to outlying airports or intercity rail service, meeting this demand will require expanding runway capacity at both Kennedy and Newark. No workable design has been identified for new runway capacity (Zupan 2013).

The Department of Defense spends hundreds of millions of dollars on commercial cargo and passenger movements. For example, in 2009, the US military moved 171,000 tons of cargo under commercial aircraft charters (McGarvey, et. al., 2013). Transportation infrastructure is one of four major networks in the US Department of Defense's Joint Deployment and Distribution Enterprise (JDDE).[28] In particular, responsiveness and adaptability of the JDDE require:

- Speed
- Cost efficiency
- On-time delivery
- Stability and resilience in transportation networks (low congestion)

This network is not limited to military transport.

Policy Critical

Economic competitiveness is one of the strategic goals set by the US Department of Transportation (Performance Plan FY2014, available at www.dot.gov).[29] By their definition, economic competitiveness means maximizing the economic returns of the network and keeping the transportation system responsive to consumer needs. This may sound like the kind of initiative that would allow the US to stay globally competitive. However, these strategic goals are little changed from ten years ago; and most of the performance measures in the 2014 economic strategy were the same in 2002.[30] Each strategic goal is

[26] Anyone who flies there regularly knows that the three airports are somewhat interchangeable for travel to New York City. All three are connected to Manhattan to some extent by rail, transit and/or taxi fares under $50. On the other hand, the combined passenger demand (2012) for the three southern California airports' is about 39 million passengers (2012); Los Angeles, Burbank, Ontario and Orange County are not nearly as interchangeable for accessing downtown Los Angeles, based on my experience as a passenger. Despite flat-rate taxi fares, the travel times vary widely. Zupan (2013) discusses the topic more formally for the three Port Authority airports, including a discussion from the airlines' perspective.

[27] NextGen is the Federal Aviation Administration's program of new technologies to track and guide aircraft, plus operational and procedural changes. NextGen is being deployed by the FAA to reduce delays and expand airport landing and takeoff capacity. Full implementation is expected by 2018.

[28] The JDDE consists of four major networks: The physical network (which includes infrastructure), the financial network, the information network and the communications network. More information about JDDE is available online at http://www.ustranscom.mil/.

[29] For Fiscal Year 2014 the other strategic goals are Safety, State of Good Repair, Livable Communities, and Environmental Sustainability.

[30] For Fiscal year 2002, the other strategic goals were Safety, Homeland and National Security, Human and Natural Environment, and Organizational Excellence.

also associated with a line-item in the federal budget, making them more than just slogans, making them actual cost centers.

Figure 2 Department of Transportation Performance Plans

2014 Strategic Goal: Economic competitiveness	**2002 Strategic Goal: Mobility and Economic Growth**
Maximize Returns on policies and investments	
Increase travel time reliability in urban areas	Highway Congestion: *Reduce travel in congestion in urban areas*
Maintain travel time reliability in freight corridors	
Achieve initial construction on corridor programs	
	Highway Infrastructure Condition: *Maintain pavement performance standards*
Update air traffic control centers	*Commercial airline safety*
Maintain airport capacity	
Maintain Seaway system and lock availability	Maritime Navigation: *Seaway system and lock availability*
Competitive Air Transportation System: *Maintain on-time arrival rate*	*Maintain on-time arrival rate*
Advance US transportation interest abroad: *International trips for DOT secretaries, technology transfer*	*Number of passengers in international markets with open skies agreements*
Expand opportunities for Businesses in the Transportation Sector: *Contract awards for small, disadvantaged and women-owned businesses*	
	Transit Ridership: *Rail stations and bus fleets ADA compliant; employment sites accessible*

Performance measures in italics.

Conclusions and recommendations

Analysts at McKinsey (2013) agree with us: the underlying question is not how much to invest it is how that investment can deliver improvements in infrastructure. In their words, there are "three main ways to achieve an improvement in infrastructure: selecting projects more carefully, delivering them more efficiently, and getting more out of existing assets as an alternative to building new ones." They estimate that streamlining infrastructure delivery could generate 15% in cost savings. McKinsey analysts project that "if infrastructure owners around the world were to adopt proven best practice, they could increase the productivity of infrastructure investment to achieve savings of 40%."

Keys for Achieving Infrastructure Improvements

Project Selection: address clearly defined needs; prioritize projects at a system level using transparent, fact-based decision making.

Streamlined Delivery: speed up approval and land acquisition; invest in early-stage planning and design to reduce costs of changes, delays; contract to encourage cost-savings, advanced construction techniques.

Making The Most Of What You Have: boost asset utilization, optimize maintenance planning, use demand management measures (e.g. congestion pricing).

(McKinsey 2013)

Clearly, additional funding alone will not improve the performance of transportation infrastructure. We also need innovative ways to fund, build, maintain and operate the vital transportation structures that support economic activity.

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ON: The Federal Role in America's Infrastructure
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DATE: February 13, 2013
The management and planning of the nation's transportation system is decentralized, and often localized, and is both public and private. The federal role is to make sure that this system functions well as a whole to support growth, competitiveness and a high quality of life. The federal role is also to look ahead and prepare for the future: the Chamber's business members large and small engage in long-term planning that relies on assumptions about the physical platform of our economy.

Technical Appendices with a description of the methodology in the Transportation Performance Index and the formulas used in the economic models for this research will be made available on the Social Science Research Network in December 2013. Go to http://papers.ssrn.com/Author=272819

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