TECHNICAL MEMORANDUM TASK 2:

THE ECONOMIC IMPACT OF THE INTERSTATE HIGHWAY SYSTEM

Acknowledgements

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Executive Summary

The economic impacts of the Interstate Highway System have been assessed through many previous studies, of which the most important and/or representative are highlighted in this white paper. The economic impact literature supports a strong conclusion that the development of the Interstate Highway System has had significant positive impacts on the nation's economic performance since 1956. The Federal Highway Administration (FHWA) utilizes a formal highway investment model, the Highway Economic Requirements System (HERS) to estimate the direct economic impacts of alternative levels of investment in capacity enhancements, operations enhancements, and pavement rehabilitations. Likewise, FHWA has a formal bridge benefit cost model, the National Bridge Investment Analysis System (NBIAS), to perform similar analyses for bridges on the existing system, including bridges on the Interstate System. These models and others are adequate to estimate the direct economic impacts of improvements to the existing Interstate Highway System highways and bridges, and these models will be utilized in the latter tasks of this study for the purpose of direct economic analysis, including the identification of needed investment levels. But these models, because they are oriented to analyzing incremental changes to existing highways and bridges, do not even begin to capture what the full economic impact was of the development of the Interstate Highway System. Some of the broader economic analyses, such as Nadiri and Mamuneas and others, do quantify the full economic impacts, but may not fully explain the reasons why such large benefits were achieved.

The Interstate Highway System represented an investment in a new, higher speed, safer, lower cost per mile technology which fundamentally altered relationships between time, cost, and space in a manner which allowed new economic opportunities to emerge that would never have emerged under previous technologies. The Interstate Highway System replaced a lower capacity, lower speed, less safe, and more expensive (per mile of travel) highway system. The Interstate System provided a new envelope of space, time, and cost, in which our economy could reorganize. A safer, 65 mile per hour system was overlaid onto a less safe, less well-maintained 20 to 40 mile per hour system which previously existed in urban and rural areas.

When the Interstate Highway System was proposed, its developers did understand and quantify what the system might do in terms of travel time savings, operating cost savings for users, and safety benefits. But, as the task one white paper notes, no one who designed the Interstate Highway System could have predicted exactly what would happen to the overall economy as a result of the investment in the Interstate System. National, multi-state, regional, and local economies were all empowered to reorganize to take advantage of new capabilities in terms of speed, capacity, and safety. Regions that were not part of the nation's economy became integrated through new opportunities to have longer distance links for goods movement and for personal travel. Urban areas were able to expand and grow, enabling more agglomerations of industries and skills within much larger urban boundaries. Not everyone who was witness to these impacts applauded all of the impacts. The Interstate System was identified as a cause of urban sprawl as well as an enabler of urban growth.

A close physical analogy to the difference between developing the Interstate System and making incremental highway investments is in the history of the universe as we now understand it. Current physics utilizes a theory which includes the "big bang" moment of creation for the

entire universe, which is followed very closely by an "inflationary period" in which the universe expanded rapidly in size, after which matter and energy continued to reorganize in accord with the laws of physics. At the time that we initiated the Interstate System, we also did not understand this part of the history of the universe. The Interstate System provided such a similar impact on the future economy, enabling it to develop within a much larger envelope of potential size and productivity. The economy has continued to grow and evolve in response to the new size allowed by the development of the Interstate Highway System. However, as the capacity and the performance of the current Interstate Highway System are used up, the system will no longer provide such an envelope that allows for additional reorganization and dynamic growth of the economy.

Because the sheer size of the literature is so great and the subject matter so broad, it is not possible to include all, or even most, studies. Instead, we have highlighted a selected handful of studies that approach the question of economic impact from different perspectives. The studies highlighted here are relatively recent, well documented and of high quality, and representative of the class of studies to which they belong.[1]

The best known and most consistently cited research are studies, usually employing sophisticated econometric methods, of the relationship between aggregate spending on highway investment and broad measures of national economic performance. Of these, the work of Nadiri and Manuneas is the best known. Nadiri and Manuneas, in "Productivity and the Highway Network: A Look at the Economic Benefits to Industry from Investment in the Highway Network", examined a range of economic impacts across 35 industry sectors, including impacts on business costs (cost elasticities), productivity, and net social rate of return. Key findings include the following:

- Industry Costs: Interstate highway investments have lowered production and distribution costs in virtually every industry sector. Cost elasticities – the percentage change in industry costs for a given percentage change in highway capital -- for each of the 35 industry sectors indicated that an increase in highway capital reduced costs in all but three industry sectors. On average, U.S. industries realized production and distribution cost savings averaging 24 cents annually for each dollar invested in the non-local road system.

- Productivity: The term refers to the value of output per dollar of input for all factors of production. Interstate highway investments have made significant contributions to U.S. productivity growth, but the magnitude of the impacts have declined over time. During the 1950s, highway network investments' contribution to annual productivity growth was 31 percent; it averaged 25 percent in the 60s; by the 1980s, it contributed 7 percent to U.S. productivity growth in the 1980s.

- Net Social Rate of Return: This term refers to the net benefits to private industries (net of depreciation of highway capital stock) that share use of the public highway or non-local road

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network. The term "social" refers to the fact that the highway network is a shared investment by all industries in the economy. Net rate of social return on highway capital was about 35% in the 1950s and 60s; it declined to about 10% in the 1980s, or just about equal to rates of return on private capital. Nonetheless, the overall contribution to social welfare from Interstate highway investment has been enormous over the life cycle of the interstate system.

Introduction

The economic impacts of the Interstate Highway System have been assessed through many previous studies, of which the most important and/or representative are highlighted in this white paper. The economic impact literature supports a strong conclusion that the development of the Interstate Highway System has had significant positive impacts on the nation's economic performance since 1956. In this introduction, we define what the investment in the Interstate Highway System actually did that has resulted in the extraordinary economic benefits that it has produced. It is the inherent nature of the Interstate Highway System itself that explains its extremely positive economic impact. The later parts of this white paper then summarize the most important findings of all the research on the economic impacts of the Interstate Highway System.

The studies reviewed here are diverse - they span a range from the measurement of the most direct economic impacts of individual highway investments, such as the travel time and operating cost savings for highway users, to the most broad economic impacts, such as those studies which analyze the economic impacts of aggregate highway investment on the overall economy and its productivity. The methodologies for both the direct studies and the broader studies have evolved over time. Therefore, the emphasis in this white paper is placed on the most evolved, and generally the latest, studies of both the direct impacts and the broader impacts.

Not all transportation investments and not all highway investments will have the same economic impacts, whether the most direct impacts or the broadest impacts. Agencies have design standards, planning procedures, capacity analysis procedures, pavement and bridge models, and benefit-cost analysis procedures to assist in estimating the economic impacts of their highway investments. The Federal Highway Administration (FHWA) utilizes a formal highway investment model, the Highway Economic Requirements System (HERS) to estimate the direct economic impacts of alternative levels of investment in capacity enhancements, operations enhancements, and pavement rehabilitations. The model is applied to existing segments of highways, including the existing segments of Interstate Highways. Likewise, FHWA has a formal bridge benefit cost model, the National Bridge Investment Analysis System (NBIAS), to perform similar analyses for bridges on the existing system, including bridges on the Interstate System.

These models and others are adequate to estimate the direct economic impacts of improvements to the existing Interstate Highway System highways and bridges, and these models will be utilized in the latter tasks of this study for the purpose of direct economic analysis, including the identification of needed investment levels. But these models, because they are oriented to analyzing incremental changes to existing highways and bridges, do not even begin to capture what the full economic impact was of the development of the Interstate Highway System. Some of the broader economic analyses, such as Nadiri and Mamuneas and others, do quantify the full economic impacts, but may not fully explain the reasons why such large benefits were achieved. Moreover, the results of these aggregate studies do not necessarily provide much insight into the role of future investments in the Interstate System. For the most part, the Interstate System is now "built out", although there remain some regions – particularly rural or underdeveloped regions or newly emerging "exurban areas" - which are

underserved. By contrast, most investments in the Interstate System in the future will be needed to maintain and improve the condition of existing networks, enhance existing capacity, and serve newly emerging functions such as intermodal connections and dedicated truck corridors.

The research by Nadiri and Mamuneas is now the most widely accepted formulation in a large body of research on the macroeconomic impacts of investment in highways, and specifically of investment in the Interstate. Previous work by Aschauer, Munnell, and others identified the linkages between highway investments and overall economic outcomes. The results of such broader highway economic analysis will be very dependent on what the highway economic investment actually does. In this respect, to understand the results of the research on the economic impacts of the development of the Interstate, it is very important to understand that the initial development of the Interstate System was not about incremental change such as those analyzed by these current investment models, but rather generated a very fundamental change in the relationship of the highway system to national, regional, state, and urban area economies.

The Interstate Highway System represented an investment in a new, higher speed, safer, lower cost per mile technology which fundamentally altered relationships between time, cost, and space in a manner which allowed new economic opportunities to emerge that would never have emerged under previous technologies. The Interstate Highway System replaced a lower capacity, lower speed, less safe, and more expensive (per mile of travel) highway system. The Interstate System provided a new envelope of space, time, and cost, in which our economy could reorganize. A safer, 65 mile per hour system was overlaid onto a less safe, less well-maintained 20 to 40 mile per hour system which previously existed in urban and rural areas.

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A close physical analogy to the difference between developing the Interstate System and making incremental highway investments is in the history of the universe as we now understand it. Current physics utilizes a theory which includes the "big bang" moment of creation for the entire universe, which is followed very closely by an "inflationary period" in which the universe expanded rapidly in size, after which matter and energy continued to reorganize in accord with the laws of physics. At the time that we initiated the Interstate System, we also did not understand this part of the history of the universe. The Interstate System provided such a similar impact on the future economy, enabling it to develop within a much larger envelope of

potential size and productivity. The economy has continued to grow and evolve in response to the new size allowed by the development of the Interstate Highway System. However, as the capacity and the performance of the current Interstate Highway System are used up, the system will no longer provide such an envelope that allows for additional reorganization and dynamic growth of the economy.

Other analogies to the Interstate System within transportation are the development of the railroads in the 19th century, which also more than doubled the speeds and capacities of connections between places, the development of light rail, heavy rail, and commuter rail in urban areas in the early twentieth century, which vastly expanded the size possible for those urban areas, and the development of jet aircraft, which tied together the nation and the world for business and leisure travel.

The Interstate Highway System, and these other technologies in transportation, continues to exert very strong impacts both in terms of the direct and broader types of impacts. In the case of the Interstate Highway System, we have still not used up the all of new capacity that it has provided in urban areas, and the existing Interstate System has much remaining capacity in rural areas. The existing more direct models such as the HERS, the NBIAS, and others can continue to deal with the direct economic impacts of incremental investments in the existing system. These models cannot deal with the overall economic impacts. FHWA and Cambridge Systematics have done exploratory research on linking these methods, but there are no integrated approaches that bring the micro and macro economic analyses together.

The Nadiri and Mamuneas results, as interpreted by FHWA, quantify the overall economic impacts of the Interstate and other highway investments. These analyses show that the impacts of initially developing the Interstate were measurably different than the impacts of investments in less systematic and lower capacity and speed highways, such as those that characterized the pre-Interstate period. Equally important, although not surprising, Nadiri and Mamuneas found that the marginal impacts of Interstate system investments on overall economic productivity and social rates of return have declined – i.e., they have “normalized” over time. For example,, the authors determined that the net social rate of return for the highway network in the 1950’s and 1960’s was about 35 percent. This period coincides with the Interstate expansion era, when quantum expansion in accessibility was being provided. As the highway network expanded and filled out, the very high social rate of return began to resemble general rates of return in the economy. The net social rate of return for non-local roads in the 1980’s was 16 percent. The net social rate of return to the entire highway network has declined to 10 percent in 1989, which is comparable with the prevailing rate of return on private capital and the long-term interest rate.

The challenge that these different rates of return pose for the future of the Interstate is twofold. First, the issue is whether there are investments that can be made that will be similar in terms of their impact as the impacts of the initial years of Interstate investment. A return of 35 percent per year is so high that it can drive virtually the entire economy by itself. Each year, it generates massive new amounts that can be reinvested in either highways or other sectors. If such returns can be achieved again, these would be the best use of resources available to our society.

The second side of this picture is the downside. If the existing Interstate Highway System deteriorates in condition and performance, to where it is no different in performance than the old technology it replaced, then the productivity benefits that were initially accrued can be rolled back. In effect, we can lose the productivity benefits that were once gained. This could conceivably occur if the speeds and service levels of the Interstate deteriorated to the point where the speeds and service levels were no better than those on other arterials. This outcome is troubling in that it suggests that the past productivity benefits of a faster, safer system might be rolled back as the performance of that system deteriorates. Lack of system investments to maintain performance will thus be equivalent to disinvestments.

The following section provides a summary review of all of the most important findings about the economic impacts of the Interstate Highway System.

Highlights of the Literature Survey

Our survey of the economic impact literature is summarized in Table xxx. Because the sheer size of the literature is so great and the subject matter so broad, it is not possible to include all, or even most, studies. Instead, we have highlighted a selected handful of studies that approach the question of economic impact from different perspectives. The studies highlighted here are relatively recent, well documented and of high quality, and representative of the class of studies to which they belong.[2]

Aggregate National Studies: As noted above, the best known and most consistently cited research are studies, usually employing sophisticated econometric methods, of the relationship between aggregate spending on highway investment and broad measures of national economic performance. Of these, the work of Nadiri and Manuneas is the best known. Nadiri and Manuneas, in "Productivity and the Highway Network: A Look at the Economic Benefits to Industry from Investment in the Highway Network", examined a range of economic impacts across 35 industry sectors, including impacts on business costs (cost elasticities), Productivity, and Net Social Rate of Return. Key findings include the following:

- Industry Costs: Interstate highway investments have lowered production and distribution costs in virtually every industry sector. Cost elasticities – the percentage change in industry costs for a given percentage change in highway capital -- for each of the 35 industry sectors indicated that an increase in highway capital reduced costs in all but three industry sectors. On average, U.S. industries realized production and distribution cost savings averaging 24 cents annually for each dollar invested in the non-local road system.
- Productivity: The term refers to the value of output per dollar of input for all factors of production. Interstate highway investments have made significant contributions to U.S. productivity growth, but the magnitude of the impacts have declined over time. During the 1950s, highway network investments' contribution to annual productivity growth was 31

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percent; it averaged 25 percent in the 60s; by the 1980s, it contributed 7 percent to U.S. productivity growth in the 1980s

- Net Social Rate of Return: This term refers to the net benefits to private industries (net of depreciation of highway capital stock) that share use of the public highway or non-local road network. The term "social" refers to the fact that the highway network is a shared investment by all industries in the economy. Net rate of social return on highway capital was about 35% in the 1950s and 60s; it declined to about 10% in the 1980s, or just about equal to rates of return on private capital. Nonetheless, the overall contribution to social welfare from Interstate highway investment has been enormous over the life cycle of the interstate system.

Impacts of New Highway Links in Rural and Underdeveloped Areas

A substantial amount of research has been conducted in recent years to determine the extent to which new highway links stimulate economic development in rural and underdeveloped areas. A number of these studies were conducted in the Appalachian Region of the U.S., where focused government investment has often been looked upon as the path to development of this chronically poor region. Such focused studies become particularly relevant now, since the Interstate System is largely built out, and opportunities for major new Interstate links are relatively few, and largely restricted to underdeveloped areas. In general, the research indicates that new interstate links can have positive economic impacts in lagging economic areas, but they are not a sufficient condition for economic growth. Areas that have aggressive economic development programs, and that have some degree of urbanization already, are most likely to experience significant economic expansion from well planned Interstate links. Highways "to nowhere" are not effective, and the adage "build it and they will come" is demonstrably false. Selected results from the studies surveyed include the following:

Survey research conducted by **Jack Faucett and Associates** looked at a number of new highway corridors, finding that:

- Wisconsin I-43 Corridor - manufacturing employment increased by about 30% in corridor counties.
- Virginia I-81 Corridor – there was about an 18% increase in manufacturing employment between 1971 and 2000 in the corridor.
- I-16 - Laurens County Georgia (between Savannah and Macon) - 40% increase in population and 100% increase in employment between 1969 and 2002 was observed. The area developed as major logistics and warehousing center.

Rephann and Isserman, in *New Highways as Economic Development Tools: An Evaluation Using Quasi-Experimental Matching Methods,* utilized statistically controlled comparisons of areas with and without new highway developments. Areas were formally matched across a range of economic, land use, and demographic criteria. The study found that:

- Interstate highways have a positive economic impact on urbanized counties (i.e., counties w. cities of 25,000 or more)
- The largest impacts occur in what the authors term "spillover counties" -- i.e., counties near or containing large cities. Initial impacts were found to center on population growth; over

time, the increased population stimulates industrial development, and these areas develop viable economic bases centered on primary and secondary industries.
- Counties without a city or nearby metropolitan area exhibit little effect on total income or earnings.

Impacts of Highway Investment on Congestion Related Economic Factors

As the Interstate Highway System has matured, the investment emphasis has shifted from new construction to achieve system connectivity toward maintenance and capacity expansion, particularly in metropolitan areas, where highway congestion is the overwhelming transportation problem.

The literature on the costs of highway congestion is, of course, wide ranging and extensive. Most of the work in this area is highly applied, focusing on estimation of the direct user costs – the value of travel time savings for auto users, vehicle operating cost and fuel consumption -- as well as various external costs, including air quality, noise, ground and water pollution, etc. Much of the related research and debate centers on the value of travel time. A variety of approaches have been applied to valuation of personal travel time – most typically some percentage of average wage rates, with upward or downward adjustments for time spent on non-business travel, or differentials in the value of time while idling in traffic. A few studies have begun to consider the costs associated with the uncertainty that congestion introduces into highway travel, and the need to compensate for these uncertainty losses when valuing the costs of congestion.

Many of these same studies also consider – to the extent data permit – the direct savings for commercial vehicles. At a minimum, this will include the direct operating costs (driver wages and possibly some premium for excess fuel consumption), and less often, the time value of the cargo in transit.

Less commonplace are studies which look beyond the direct user costs and environmental impacts, to consider how congestion may affect business costs and productivity over mid to long term periods of market adjustment. For example, to what extent are excess commuter costs capitalized into higher wage levels and thus increased employer costs? How do increased trucking costs impact businesses productivity, cost structures, input substitution (e.g., between transportation and inventory), profitability and output? How does congestion effect the long term location decisions of firms, and thus the economic competitiveness of particular metropolitan areas?

For this review, we focus on a few representative studies or research surveys that help shed some light on these more important economic questions.

NCHRP Report 463, *Economic Implications of Congestion*, examines how urban traffic congestion affects producers of economic goods and services. Business production function models were developed to relate levels of business activity to differences in relative costs of labor and materials, including worker commuting and business product/service delivery costs. Key findings include the following:

- Business cost impacts were most concentrated within the CBD; by contrast, reduced truck delivery delay in outlying industrial zones had economic impacts that were dispersed throughout the region.
- Reductions in commuter congestion and delay were partially capitalized into reduced worker wages and thus business costs. Costs of excess delay have the greatest impact on high value-added, skilled labor occupations, where labor demand elasticities are high, and workers are better able to extract wage concessions from employers. Capitalization effects up to one-half the personal value of time.

The Cost of Congestion to the Economy of the Portland Region

This case study, conducted by Economic Development Research Group (EDRG), compares planned regional transportation investments (baseline) in Portland against a doubling of transportation investments over the next 20 years. The study results are not derived from ex-poste empiral analyses, but rather the results of modeling. Improvements modeled included major highway expansions, arterial street expansions, improved highway connectivity, and transit improvements. Benefit measures included congestion-related travel time savings and vehicle operating costs for households and businesses, safety, and business access improvements. Based on the estimates from the case study, the author concludes that:

- Targeted highway investments which effectively relieve congestion in metropolitan areas such as Portland can yield an economic return on investment of about 2 dollars for every dollar invested

FHWA Office of Freight Management and Operations, *Public Policy Impacts on Freight Productivity.* This is a literature survey from the Office of FMO, focusing on statistically observed relationships between congestion-related freight delay (CVO delay) and economic performance. The survey identified four key questions emerging from the literature. These questions, and their corresponding answers, are summarized below.

- What is the relationship between highway investment and freight productivity? The survey suggests that motor freight (as well as railroads) experienced the highest direct productivity gains from highway investment. Gains for the motor carrier industry were primarily in the form of improved labor productivity. The gains in the motor freight industry were greatest in the period 1950 to 1973; since then, the benefits have been close to normal for the economy.

- What is the relationship between highway investment and industrial productivity? The survey notes the aggregate national studies, such as by Aschauer, Munnel, and Nadiri and Mamuneas. A number of other studies are cited, with results similar to the Nadir study. As in the Nadiri study, the largest impacts occurred prior to 1973; thereafter, productivity effects were closer to normal rates of return.

- Within what sectors has the productivity effect been most pronounced? As noted, the impacts are largest for industrial sectors that are most transportation intensive. A number of

sector firms took advantage of highway investments to restructure their logistics practices in order to take advantage of improved transportation. In general, restructuring of logistics practices – i.e., from push to pull and to JIT logistics practices – have been a result of investment in the Interstate System. On average, the industrial rates of return from logistics restructuring are within the range of 14 to 64 percent – substantially higher than conventional benefits.

- What is the nature of the productivity effect (e.g., time savings, logistics restructuring, network effect, externalities effect). Productivity effects were concentrated in the form of direct savings (direct travel time and cost savings for trucks); logistics restructuring (less inventory and warehousing, more transportation, increased JIT supply chaining); and network effects (e.g., economies from increased density in input and consumption markets; development of new consumption and production structures.)

Framework for Economic Impacts of Future Investments in the Interstate Highway System

Future investments in the Interstate Highway System will have substantial economic impacts. Looking ahead is of course more problematic than looking back, and it has required considerable effort to develop the results presented here about the economic impacts of past Interstate Highway System investments. In this project, the future scenarios for the Interstate Highway System will be generically defined. The final tasks of this project will apply the available tools for analyzing the options for the future Interstate Highway System. As was the case when the Interstate System was initiated in 1956, those tools do not include any ability to predict what exactly will happen to the economy over the next fifty years.

For this project, the economic impacts of future Interstate investments will not be quantified. There are no known available tools or models to provide comprehensive results, and the scope of this project does not provide for their development and application of such models. Rather, for this project, a framework is described here for understanding the economic impacts of future Interstate System investments, and the available results from the available models will be provided as a way of very partially filling in the likely economic impacts of future Interstate investments.

This framework provides two methods of taking prospective views of the likely potential benefits of future investments in the Interstate Highway System. The first part of the framework utilizes the available national model systems of the HERS and the NBIAS, with extrapolations over a fifty year period, to evaluate options in the same manner in which we currently evaluate national levels of investment in overall highway programs. That part of a framework is limited to the user and agency benefits in terms of user operating costs, travel time costs, safety impacts, air quality impacts, and agency maintenance and investment costs.

An application of this initial part of the framework was utilized by FHWA in the 2004 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, in its analysis of Interstate investment levels and the consequences of different investment levels. For both the existing Rural and existing Urban Interstate System, FHWA related alternative investment levels

to measures of average pavement condition and average delay. These analyses show the investment levels that are estimated to be needed to achieve various levels of pavement condition and delay, which are surrogates for the performance of the system.

The scenarios that FHWA and AASHTO have identified as "Need To Improve" scenarios also provide an estimate of the levels of investment that will be economically beneficial, at least in terms of the limited parameters of user costs. It is likely that somewhat higher levels of or types of investment would be needed to achieve the same types of productivity improvements that characterized the early years of the Interstate System development. FHWA's 2004 C&P report estimated that about $6.4 billion per year of investment on the rural Interstate was needed to improve conditions and performance in accord with the definition of this scenario, and that $6.6 billion was being spent on the rural Interstate in 2002 (which was $2.1 billion more than in 2000). Thus, the rural Interstate was apparently not under funded, at least for that year. For the Urban Interstate, the need to improve estimate was $24.9 billion per year, and expenditures were $10.5 billion in 2002, and thus only 40 percent of the need to improve the Urban Interstate was funded.

The need to improve scenario is based, by definition, on the level of funding which is cost-effective, primarily driven by the results of applying the HERS model, and considering only the user and agency benefits. Thus, the amount of the funding shortfall for the need to improve scenario is indicative of at least that much lost economic benefit per year in comparison to higher funding levels. The economic benefit of higher Interstate investment levels can be approximated from the HERS analyses, but this will be an approximation of only the user portion rather than of the broader benefits.

The second part of the framework for future economic impacts is to note the analogies between the future investments in the Interstate, and the past investments in the Interstate, in terms of what the results were for impacts on the overall economy. This will of course be very approximate. A range of potential economic impacts of Interstate Highway System investment might be defined in parallel to the findings of Nadiri and Mamuneas for the various periods of time over which they evaluated past economic impacts.