Transportation Infrastructure Investment: Macroeconomic and Industry Contribution of the Federal Highway and Mass Transit Program

Prepared for:

Transportation Construction Coalition

Submitted by:

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December 2014

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EXECUTIVE SUMMARY

Federal transportation spending expands the capital stock of the US economy, drives the production and delivery of goods and services, and positively affects business and household incomes. It also enhances the transportation system's operational capacity by reducing travel times and costs. This results in greater accessibility for individuals, households and businesses, more efficient delivery of goods and services, improved life styles and standards of living, and safer roadways.

IHS used two models to evaluate the macro and micro economic effects of Highway Trust Fund spending. Both showed the availability of funds delivered to state and local governments have far-reaching indirect effects – for every $1 of federal transportation investment returns between $1.80 - $2.00 of additional real goods and services produced in the economy.

Macroeconomic results revealed that current levels of federal spending on highway and mass transit contributes nearly 1% to the US production of goods and services. The current level of funding contributes on average 614,000 jobs per year over the 2014-2019 time period and adds an average of $410 to each US household's real income each year. A 5% increase in annual spending through 2019 would result in an average of 59,400 additional jobs per year and an annual average increase of $40 in real household income. Federal spending also produces indirect benefits and induces growth in key economic sectors. The sector that experiences the largest benefit, in terms of jobs created, is the Business and Professional Services sector. The Trade, Transportation and Utilities sector, which includes wholesale and retail companies, is a close second.

In summary, over the 2014 to 2019 time frame:

- Infrastructure spending has an amplified impact on the economy. It leads to overall productivity enhancements and creates jobs.
- Every $1 in federal highway and mass transit investment returns between $1.80 – $2.00 in goods and services produced.
- Current federal transportation spending contributes on average $410 to real income per households each year (which is comparable to a month's worth of groceries).[1]
- Current federal transportation spending supports an average of 614,000 employees each year in all sectors of the economy. It catalyzes dynamic effects of greater productivity, more efficient delivery of goods and services, and higher wages and salaries.
- For every 3 construction job created, 5 jobs are created in other sectors of the economy.
- Current federal transportation spending generates $31 billion in federal personal tax receipts per year and $6 billion in federal corporate tax receipts per year on average. Current federal spending also generates higher revenue for state and local budgets, which are, on average, $21.7 billion higher each year than they would be without the Federal Highway Program.
- Five percent annual increases in federal spending would create:
    - Between 78,000 and 122,000 new jobs by 2019 (includes direct, indirect, and induced jobs).

[1] Throughout the report, results are presented in constant 2009 US dollars unless otherwise noted.

- An additional $40 in real household income each year.
- An additional $9.6 billion in real value to the US economy by 2019.
- On average an additional $4.9 billion per year in federal, state and local government revenue, which covers more than 50% of the annual spending needed to cover the backlog in highway and bridge capital expenditures.[2]

Clearly, transportation infrastructure investment is critical to the economic wellbeing of the US.

[2] Based on the estimate of current backlog at http://www.dot.gov/briefing-room/new-department-transportation-report-highway-transit-conditions-points-need-more (retrieved 22 May 2014)

1. INTRODUCTION

It has been well documented that transportation investment fuels nation-wide economic growth, contributing significantly to the country's gross domestic product (GDP). Continued investment in the country's transportation system since the creation of the Highway Trust Fund (HTF) in 1956 has been widely accepted as a public good – one that is necessary for our country's economy to grow. Investment helps to ensure that our transportation system operates efficiently and safely, providing increased access for individuals, households and businesses. Since 1956, we have witnessed the build out of the nation's Interstate Highway System – expansion of our network of primary and secondary roadways, creation of intermodal connections, and re-investment in public transit. We also witnessed dramatic economic growth and increased engagement in an emerging global economy.

The Transportation Construction Coalition (TCC) engaged IHS Global Inc. (IHS) to estimate the economic impact of continued transportation investment funded by the federal Highway Trust Fund (HTF). The estimation of the contribution to the US economy includes annual spending for transportation construction, system-wide maintenance, and new transit vehicles and on and off-road construction machinery. IHS employed two models: its US Macroeconomic Model and a social accounting framework model to estimate direct, indirect and induced effects on the national economy and US industries from 2014 to 2019.

This assessment is timely for a number of reasons.

- **Aging Infrastructure.** The country's transportation system is growing old and more congested. It is increasingly in need of rehabilitation to improve levels of service, operating conditions and the safety of system-wide structures. At the same time, transportation funds have been declining in real terms, and, as a result, state departments of transportation have been deferring maintenance and are unable to work through their growing backlogs of projects.[3] The public has become more engaged in demanding projects that will expand capacity, improve mobility and decrease travel times, repave highways, rebuild bridges, and replace aging busses and heavy and light rail vehicles operating in our metropolitan areas.

- **Economic Growth.** There has been intensifying interest in transportation investment since the Great Recession of 2008 to spur employment and private sector investment. Even with the passage of the American Recovery and Reinvestment Act of 2009 (ARRA) (Pub.L. 111–5), which included $48 billion for transportation improvements, it is widely acknowledged that a broader program of transportation investment is necessary to continuously improve operational efficiencies and system-wide safety and to ensure our worldwide competitiveness.

[3] According to the American Society of Civil Engineers: "The united states carries a backlog of $3 trillion in unfunded surface transportation needs, including a $2.2 trillion backlog for highways and bridges and $86 billion in unfunded transit capital infrastructure needs" http://www.asce.org/uploadedfiles/infrastructure/report_card/asce-failuretoactfinal.pdf (retrieved 30 May 2014). See also http://www.nps.gov/transportation/maintenance_backlog.html.

- **Economic Competiveness.** It is increasingly important to be able to keep pace with the investments being made by emerging countries in building highways, subways, high speed rail, ports, airports and intermodal terminals.

- **Transportation Reauthorization.** Congressional reauthorization of the surface transportation provides the critical mechanism for the majority share of funds via different investment programs and matching formulas that pay for the construction and operational performance of our highway and transit systems. Moving Ahead for Progress in the 21st Century (MAP-21), which is the latest legislative bill reauthorizing transportation funding, is due to expire September 2014. Reauthorization of the legislation provides an opportunity to realign federal transportation goals and objectives and investment priorities to deliver those transportation services that will best serve national interests. It also provides an opportunity to debate how to best finance transportation and annual funding obligations usually up to five years into the future.

Background

Transportation infrastructure investment is critical to the economic well-being of the US. These investments enhance mobility and provide our citizens with increased business and work opportunities. Advancing integrated, multi-modal networks provides travel options that improve connectivity, affect the health and well-being of urban and rural communities, and contribute to creating "smart" cities through the 21st century. Also, continuous re-investment is important to sustaining and advancing the US's competitive advantage in the worldwide marketplace. It allows companies to establish lean supply chains and deliver competitively priced products and services, while at the same time achieving healthy profit margins. The multiplier effects are vast, stimulating expansion reinvestment by companies in all sectors, particularly those engaged in engineering and construction, manufacturing, and advanced information and communication technologies and systems.

Receipts into the federal Highway Trust Fund (HTF) are generated by a variety of taxes (e.g., fuel, tires, heavy vehicle use, and truck/trailer sales). The motor fuel excise tax is currently 18.4 cents per gallon for gasoline/gasohol and 24.4 cents for special fuel (primarily diesel) and accounts for the majority of revenue. Federal legislation generally requires that funds paid into the HTF be distributed among the states according to legislatively established formulas for various highway and transit programs.

The fuel tax rate has remained unchanged since 1993 and vehicle miles of travel have not grown proportionately in recent years. Without tax increases and vehicle miles of travel (VMT) growth, revenues available for highway and transit programs is limited and will constrain the capacity of state and regional transportation agencies to reinvest in existing infrastructure and expand capacity. State and regional transportation agencies are increasingly facing shortfalls and growing backlogs of projects for capital investment that would enhance mobility and safety. These challenges present important policy considerations for Congress as it addresses transportation reauthorization.

2. BROAD IMPACT ON THE US ECONOMY

The macroeconomic impact of federal highway and mass transit infrastructure spending from the HTF on the US economy was assessed using the IHS US Macro Model. IHS estimated the contribution of transportation infrastructure investment to the US economy from 2014 to 2019. This comprehensive model accounts for supplier and income effects, as well as the direct effects of spending on the broad aggregates of the US economy (GDP, employment, income, capital stock, etc.).

Two Impact Assessments Performed

The following two cases were developed for this study:

1. **Base Case**: estimates the economic impact of the current levels of the federal spending on highway and mass transit (through the Highway Trust Fund): $54-56 billion per year over the six year forecast horizon. [4]

2. **5% year over year (yoy) Growth in Funding (Scenario 1)**: estimates the economic impact of increasing federal spending for highways and mass transit by 5% each year starting in 2015: amounts to $24 billion more than baseline outlays over the 2015-2019 timeframe.

The table below details the inputs for these two cases. The federal Highway Trust Fund (HTF) provides the funds for both the federal highway program funding and the majority of mass transit program funding. [5]

Funding Assumptions for the Cases ($B)

		2014	2015	2016	2017	2018	2019
Scenario 1							
	Federal highway program funding	$40.3	$42.3	$44.4	$46.7	$49.0	$51.4
	Outlays	$46.0	$46.3	$47.2	$48.3	$49.5	$51.9
	Highway construction put in place	$80.1	$84.1	$88.3	$92.8	$97.4	$102.3
Base Case Funding							
	Federal highway program funding	$40.3	$41.1	$41.9	$42.8	$43.7	$44.7
	Outlays	$46.0	$46.0	$46.0	$46.0	$46.0	$47.0
	Highway construction put in place	$80.1	$81.6	$83.4	$85.1	$87.0	$88.9
Mass Transit Funding Program + General Fund							
	Scenario 1: Federal funding	$10.7	$11.2	$11.8	$12.4	$13.0	$13.7
	Base Case: Federal Funding	$10.7	$10.7	$10.7	$10.7	$11.7	$11.7

Source: Transportation Construction Coalition

For the Base Case, current and projected funding for highways and mass transit are used to impact the model. For the 5% HTF Growth Case (Scenario 1), we assume that current federal highway and mass transit program funding (that is, appropriations) grows by 5% year over year starting with the current funding amount in 2014 such that spending growth starts in 2015.

[4] This amount is estimated actual spending per year rather than the amount budgeted annually.

[5] An additional roughly $2 billion of mass transit funding comes from the federal governments general fund each year.

Methodology

IHS incorporated the expertise from its transportation and US macroeconomic groups to formulate and establish an integrated link between the federal highway and mass transit spending input data and the investment block of the IHS Macroeconomic Model.

In order to estimate the impact of current federal HTF spending (the Base Case), the current amount was removed from state and local construction spending was over the forecast period -- $54 billion from 2014 to 2017, $55 billion in 2018, and $56 billion in 2019. Additionally, the model was adjusted to target reduced construction spending on public transportation – an $8 to $9 billion removal of federal mass transit outlays and a $46 to $47 billion removal of spending on highways and streets.[6]

To estimate the impact of increased spending (the 5% HTF Growth Case), state and local construction spending was increased by 5% year over year starting from the current level of funding. Additionally, the allocations of construction spending to the public transportation and highways and streets variables in the Macro model were targeted to receive these higher allocations to simulate the increases to mass transit funding and funding for public highways and streets.

Macroeconomic Results

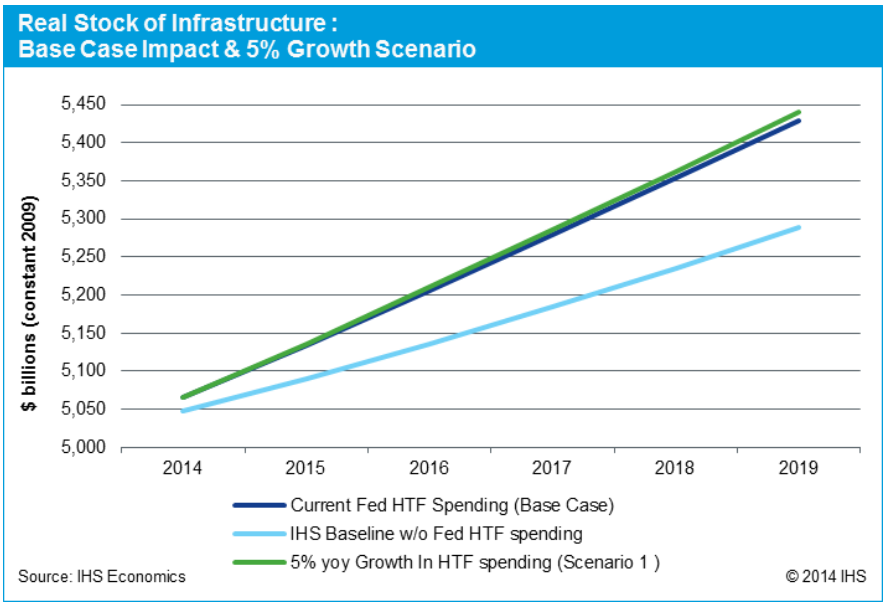
Transportation infrastructure improves the overall performance of the US economy by enhancing the capital stock of the US. This increases the ability of the economy to produce more goods and services (potential GDP), and thus generating economic growth above what would have existed with lower or no federal transportation infrastructure spending.. These investments in transportation infrastructure earn a positive return in the macro-economy in terms of expanding employment opportunities, increasing goods and services that households can consume, and raising income per household each year.

The Macro Model dynamically estimates the aggregate direct, indirect and induced effects on the economy over time. The full effects of the impacts take time to work through the economy before reaching its peak impact. Then, as typical of dynamic equilibrium models, the effects lessen after the peak as the model seeks its long-term full employment equilibrium by having feedback effects adjust other parts of the economy (e.g., price and interest rate effects). The benefit of utilizing a dynamic equilibrium growth model is to gain insight into short-run the dynamic effects as they ripple through the economy, and in particular, to estimate the extent to which the investment cost pays off in terms of higher economic and employment growth over a relatively short period of time. A dynamic model can also help gain insight into any potential indirect effects that can occur in a highly interdependent complex economy. In the economy all sectors, businesses, and consumers are linked either directly or indirectly, thus impacts can occur in ways that are difficult to predict without the aid of a model.

[6] See Appendix A for details on the methodology and results. State and Local Construction Spending, State and Local Investment in Highway and Streets and State and Local Investment in Transportation are targeted because these variables are affected by federal dollars.

US Stock of Infrastructure

The current federal spending on transportation infrastructure increases the capital stock in the US economy. This has a positive impact on US economic growth. Increasing investment in infrastructure by 5% per year would fuel even higher levels of transportation infrastructure such that by 2019, there would be $11 billion more in net new infrastructure than there would be under current federal spending levels. This would further expand the potential amount of goods and services that could be produced domestically each year.



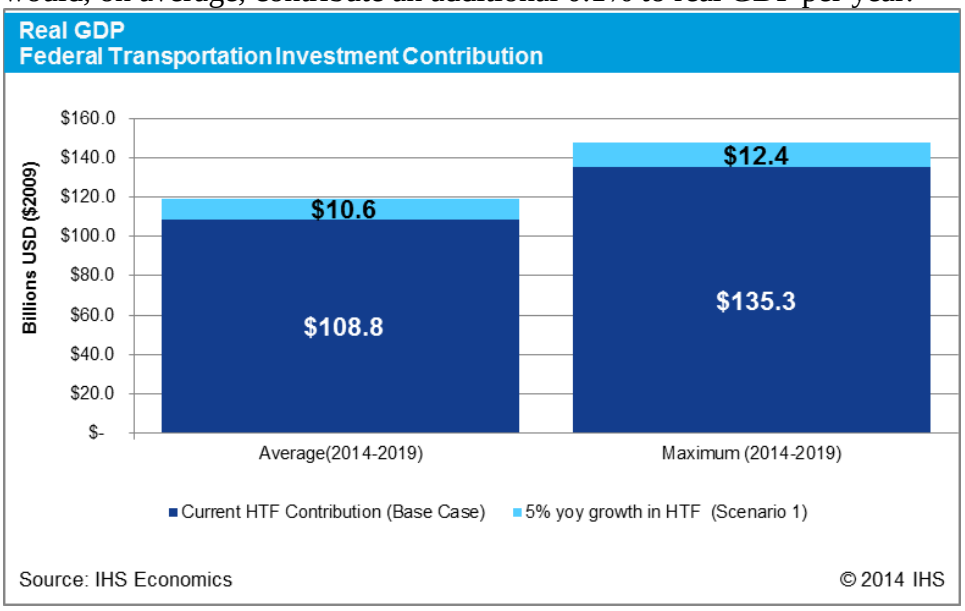
Because transportation infrastructure as a vital lifeline good, investment in infrastructure also has an impact on other types of investment in the Base Funding Case: nonresidential fixed investment is 0.8% higher on average per year, equipment and software investments are 0.9% higher on average per year, and residential fixed investment is 0.6% higher on average per year than it otherwise would be without current levels of transportation spending. The 5% annual growth (year over year) in spending in the 5% HTF Growth Case (Scenario 1) would induce 0.06%, 0.07% and 0.05% average increases in these investment categories (respectively).

Gross Domestic Product

The dynamic effects of these higher investment levels that grow the capital stock of the US economy have a pay-off (return) in terms of more goods and services produced each year than the economy would otherwise generate.

The results show that current federal funding levels for highways and mass transit contributes an average $109 billion to real economic activity per year. The 5% HTF Growth Case (Scenario 1) would add an additional average of $10.6 billion per year to real GDP. Over the 2014-2019 time period, every $1 of federal transportation infrastructure investment generates approximately $1.80 - $2.00 of additional real goods and services produced for both cases. In percentage terms, the current level of federal transportation spending contributes, on average, about 0.7% to real

GDP per year. Allowing this spending to grow by 5% each year for the next 5 years (2015-2019) would, on average, contribute an additional 0.1% to real GDP per year.



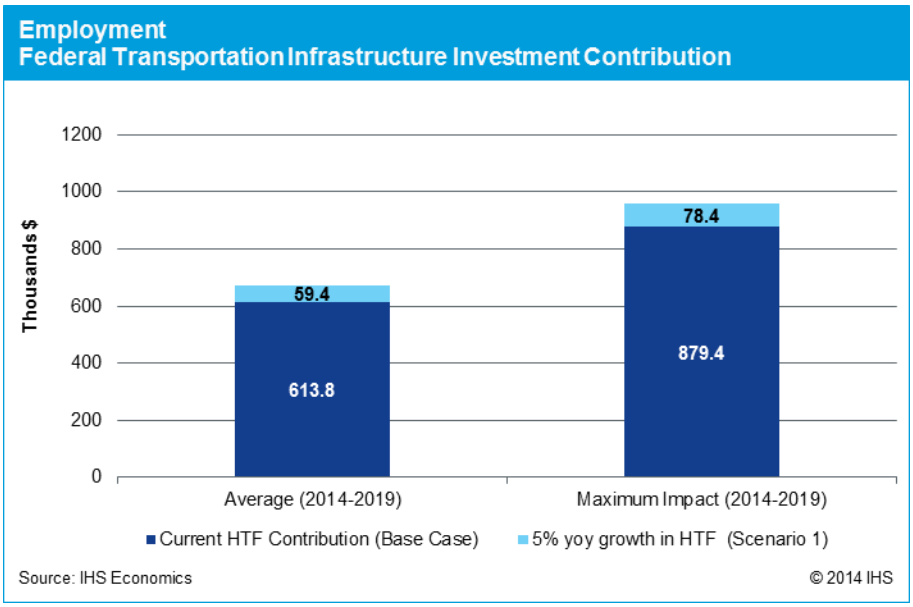
Employment and Productivity

As transportation infrastructure spending grows the capital stock, more goods and services can be produced. Additionally, more value is created that can be saved and re-invested back into the economy to fuel growth, enabling greater demand for goods and services. All of this activity leads to higher employment to fulfill demand.

The macroeconomic results show that current levels of federal transportation infrastructure spending support an average of 614,000 additional jobs per year, with maximum impact of 879,000 jobs in 2016.[7] Estimates of the 5% HTF Growth Case (Scenario 1) shows an additional average increase in employment of 59,400 jobs per year, peaking at 78,400 additional jobs in 2017.[8]

[7] This gives a range of approximately 11,000 – 16,000 employees per $1 billion spent by the federal government for highway and mass transit infrastructure. Many studies have estimated the jobs impact of federal dollars, most of which fall into this range. (For example, the CEA estimates that $1 billion of federal spending supports 13,000 jobs but is not specific to what is funded; the Economic Development research group, in 2009, estimated that $1 billion of federal spending on public transportation supports 30,000 jobs http://www.apta.com/gap/policyresearch/Documents/jobs_impact.pdf.) In IHS macroeconomic model, the number of additional jobs captures additional people employed. In IHS I/O model and in the CEA and Economic Research study the number of jobs captures the job (part-time, full-time, etc.) rather than the number of people employed. Since one person can hold more than one job, measuring the number of jobs versus the number of people employed generally results in a higher number.

[8] The impact from the macroeconomic model peak in 2016 (in a 2014-2019 analysis timeframe) is typical of macroeconomic forecasting models. The model is both forward and backward looking such that anticipated impacts can induce changes in the economy before an impact occurs and over time the impacts compound. The combined effect of the anticipated and ripple effects cause peaks generally to occur in the middle of the analysis time-frame. Because it is a general equilibrium model, the model seeks to find a long-term equilibrium. This requires all parts of the economy to adjust, such as prices, resource utilization, consumption patterns, saving and investment patterns, etc. that have off-setting effects on the impact in the later years. (See the appendix for an overview of the model and its theoretical position.)



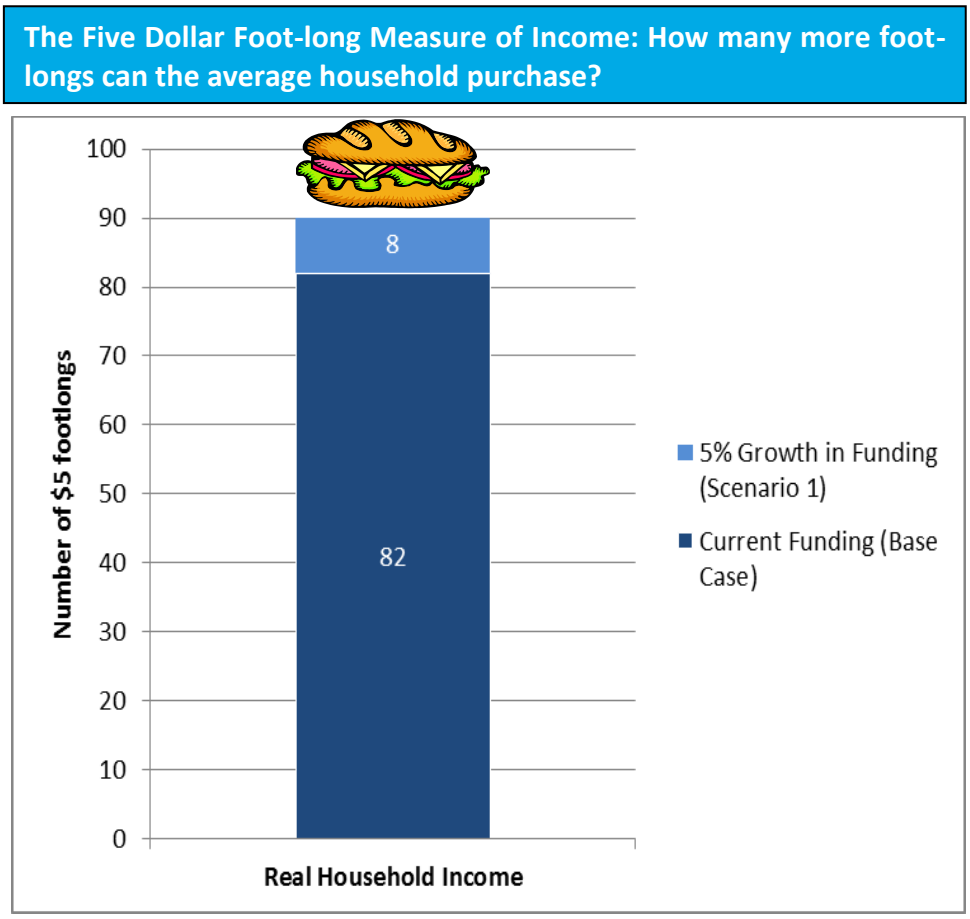
A higher level of capital increases the potential growth of the economy because it allows more output to be produced per worker. Higher levels of transportation infrastructure capital raise the nonfarm productivity index by 0.2% on average over the forecast period (2014-2019) in the Base Case (current spending levels). A 5%increase in spending per year would increase productivity by another 0.01% on average.

Income per Household

Higher productivity and more goods and services translate into higher wages and income for households. Real personal income per household is on average $410 more per year than it would be without the current federal infrastructure investment. For an average household, this pays for about one month of groceries, enabling families to have those resources for other household priorities.[9]

With a 5% year over year increase in spending, an additional $40 of real income would be added annually to each household. Higher dollar incomes can perhaps better be expressed in terms of what that income can purchase. The differences in household income can be translated into every day goods and services people need and want. For example, $40 of income can buy the equivalent of 8 five-dollar footlongs – an additional week and a half of workday lunches – that would otherwise not have been bought or would have required the person to forego some other good or service.

[9] Real Income is in 2009 dollars. The 2009 Consumer Expenditure Survey http://www.bls.gov/cex/2009/Standard/cucomp.pdf reports that the average "Husband and Wife Consumer Units", which includes two adult households, two adults with children and other two adult households, spends $4,827 per year on food at home.



Average Contributions to Annual Household Real Income 2014-2019

Government Revenues

Higher productivity and economic growth that drives higher wages and business profits leads to increases in the amount of taxable income, therefore increasing the revenue to the federal government. The analysis of the current level of federal spending on highways and mass transit drives an annual average of $25 billion in federal personal tax receipts and $6 billion in federal corporate tax receipts.

The higher tax base also benefits state and local revenues. State and local revenue from personal and corporate tax receipts is estimated to be $16 billion higher per year, on average, due to current federal transportation infrastructure spending.

If federal funding were to increase by 5% per year, federal personal and corporate tax receipts would increase by an additional $3.4 billion per year while state and local personal and corporate receipts would increase by $1.5 billion. The *2013 Status of the Nation's Highways, Bridges and Transit: Conditions and Performance Report* finds that "[a]n additional $8.2 billion over current spending levels from all levels of government is needed annually to spend down the current backlog over the next 20 years." Thus, the estimated $4.9 billion of additional government

revenue from the growth effects of the investment in transportation infrastructure would cover more than half the backlog spending each year.[10]

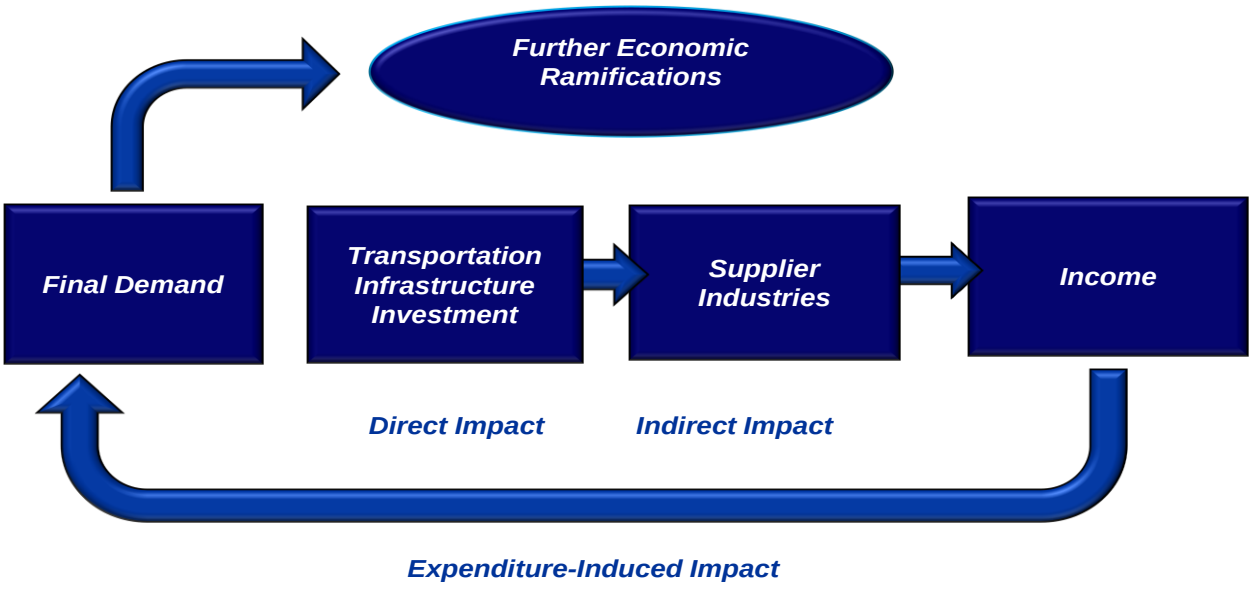
[10] http://www.dot.gov/briefing-room/new-department-transportation-report-highway-transit-conditions-points-need-more (retrieved 29 April 2014).

3. ECONOMIC IMPACT ON INDUSTRIAL SECTORS

IMPLAN, a social accounting modeling system, was used to assess the direct, indirect, and induced contribution of transportation infrastructure investment on the US industrial economy. The metrics include GDP, employment and labor income. Using classic input-output analysis, the models provide a highly accurate and adaptable assessment of industrial impacts. The model database contains detailed national economic statistics and follows the accounting conventions used in the "Input-Output Study of the US Economy" by the Bureau of Economic Analysis and the rectangular format recommended by the United Nations. The social accounting model segments the contribution of transportation infrastructure investment by direct, indirect, and induced contributions. The descriptions of the direct, indirect, and induced contributions used for this study are as follows:

- **Direct contributions** are generated by activity directly associated with increased capital and construction spending related to transportation infrastructure.
- **Indirect contributions** are generated by the increase in activity from the suppliers of goods and services to direct sectors and its critical suppliers.
- **Induced contributions** are solely due to changes in income, i.e. from the impacted workers from both the direct and indirect industries spending their additional income on food, housing, and other consumer goods and, thereby, contributing more to the US economy.

Defining the Economic Contribution



Assumptions

The same assumptions used for the macroeconomic analysis were used for the sector analysis. Namely, for the Base Case, the impact of federal funds for highway and public transit of $54 to $56 billion was used over the 2014-2019 timeframe. For the 5% HTF Growth Case (Scenario 1),

federal spending for highways and public transit was increased from $1.7 in 2015 to $7.9 billion in 2019, to reflect the 5% year over year growth changes starting from the current funding.[11]

Additionally, to perform the simulations in the IMPLAN model, both cases assume spending was allocated between new construction and maintenance and repair. In the IMPLAN model, new construction accounts for the majority of capital expenditures (expanding capacity, rebuilding, etc.); however, some of the spending was also re-directed to light and heavy duty trucks and construction machinery because equipment investment is not directly linked in the model framework. The allocations were based on an internal IHS dataset – Business Market Insight. Lastly, the production function of the construction industry was customized to reflect the productivity differential of the highway and mass transit programs relative to the total construction sector.[12]

Sector Level Results

The sector impact analysis shows that federal highway and mass transit infrastructure spending affect all major sectors in the US economy. The sector analysis confirms the effects found in the macroeconomic model and reveals the micro level effects. It finds that 62% of the jobs created are indirect and induced. In other words, for every construction job created, roughly two more jobs are created elsewhere in the economy. Service industries such as health, education, travel & tourism, and professional and business services, for example, experience approximately 40% of the overall employment increases. Similar to the Macro Model, the IMPLAN model finds these employment effects translate into higher real labor income per household of $389 in 2014.[13]

As discussed previously, the productivity improvements due to a higher stock of transportation infrastructure allow for the US economy to expand and create more value added and employment opportunities. Using a social accounting modeling framework, one can see contribution of each sector to the overall total value added and employment enabled by the investments. The results show that for every $1 of value-added by the construction industry, another $2.50 in new value is added from other sectors of the economy.[14]

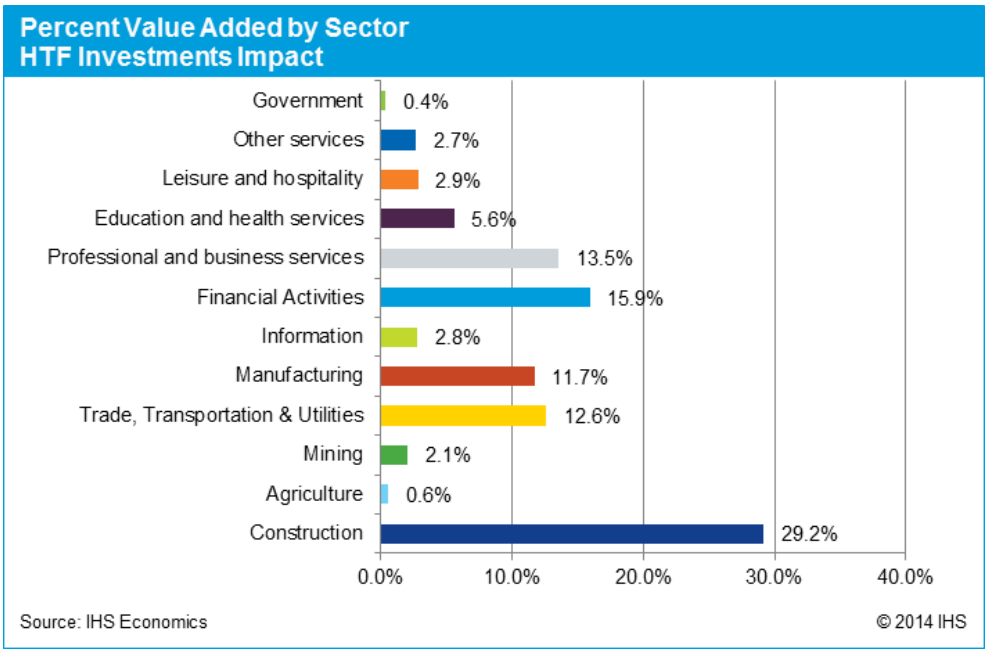
[11] These assumptions were based on data provided by the Transportation Construction Coalition.

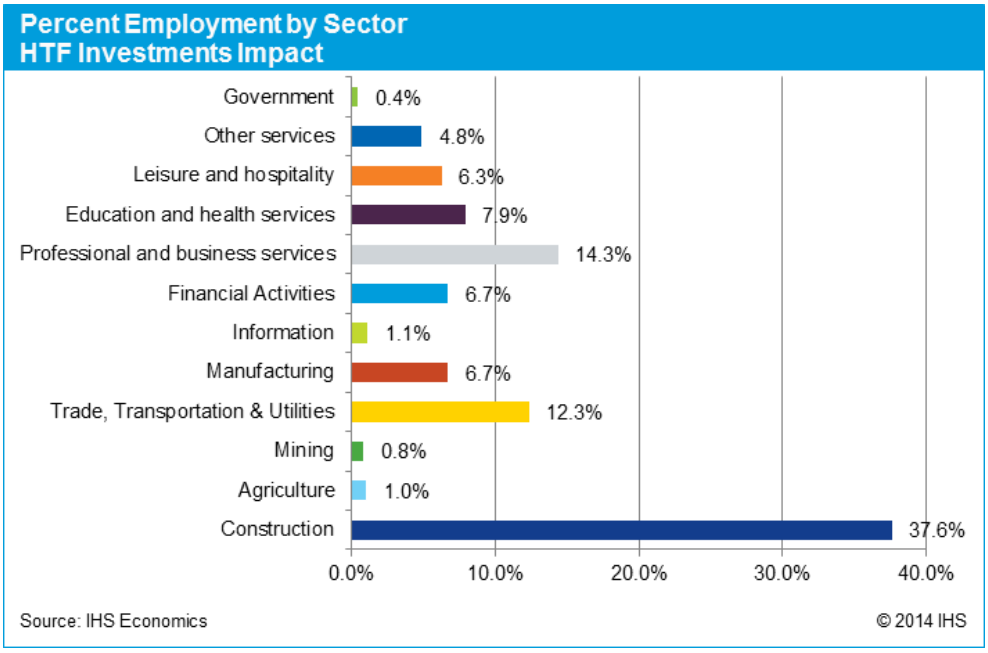
[12] See Appendix B for full details on the assumptions and methodology.

[13] This is labor income only. The macro model estimated total household income (from labor and capital (e.g., interest and dividends).

[14] Value-added measures all contributions to the production of goods and services throughout the process (raw materials, intermediate and final goods) versus GDP, which measures the market value of final goods and services produced. This is why the value-add multiplier is larger than the GDP multiplier.

Sector Results: Both Base and 5% HTF Growth Cases

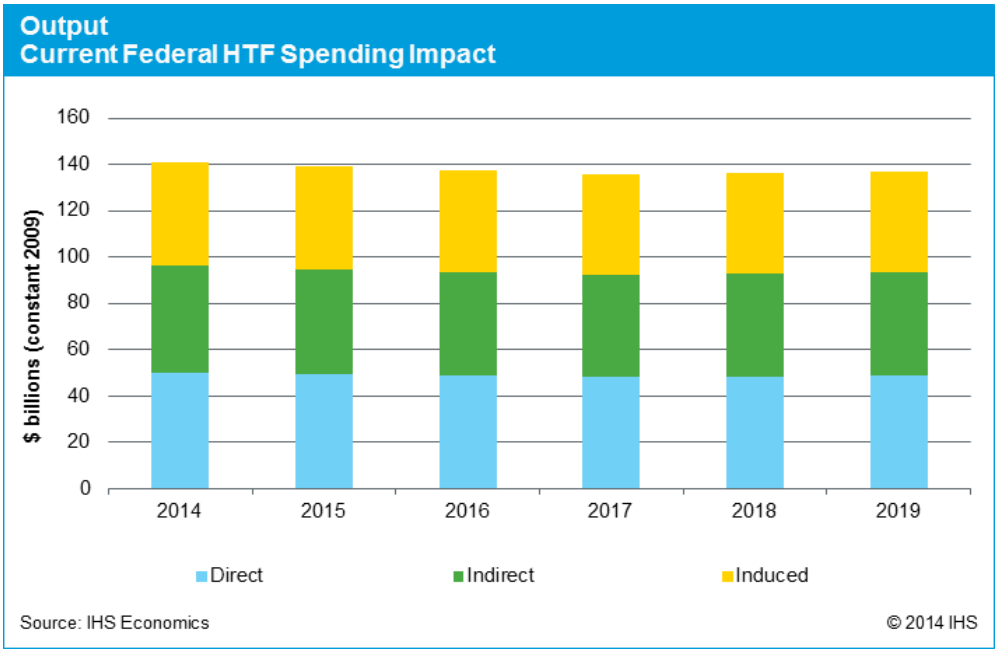


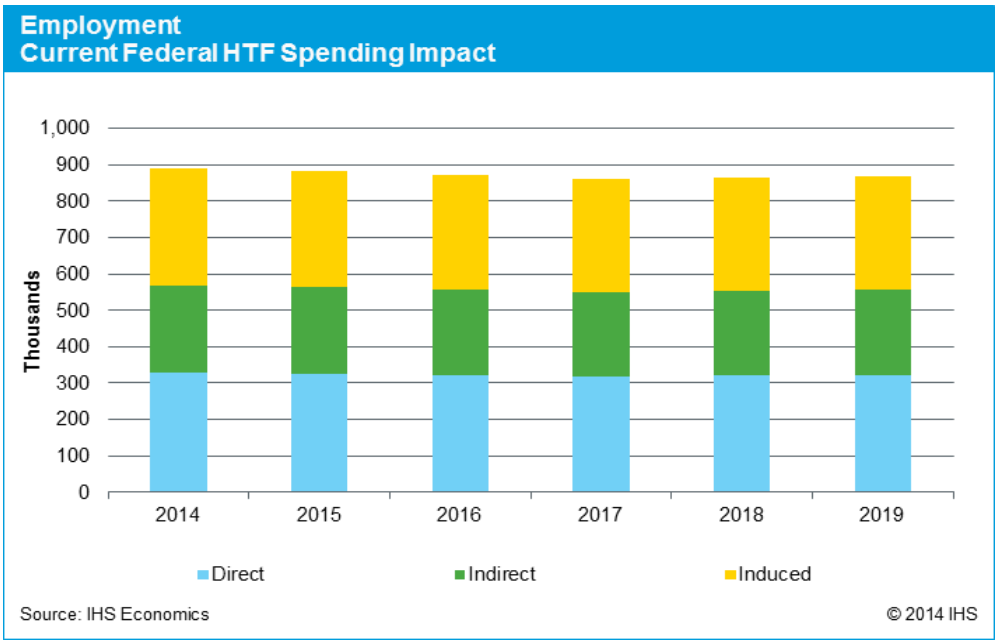


Direct, Indirect and Induced Employment Impact

The sector breakdowns and the charts below show that approximately three-fifths of the jobs created from federal transportation infrastructure spending are indirect and induced. That is, for every 2 jobs created in the construction industry, 3 jobs are created in other industries in the economy. After the construction industry, the sector most impacted is professional and business services. This makes sense because much of the supporting work for any new construction involves professional engineering, legal and planning services. Following closely is the trade,

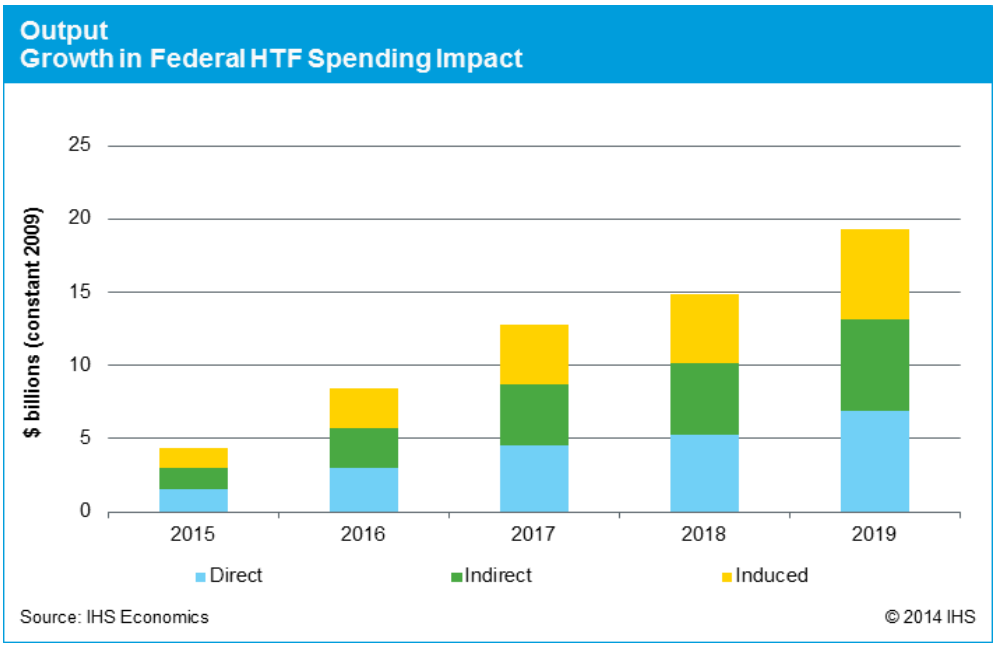
transportation and utilities sector that receives the third largest impact. Education and health services, financial activities, manufacturing and leisure and hospitality also see a large portion (28% combined) of the benefit. In the case of federal funding of the Highway Program growing each year by 5% (Scenario 1), employment gains would also continue to grow. While these employment estimates are somewhat larger than the macroeconomic analysis, it can be explained by the difference in employment concept. The macroeconomic model counts employees (people), while the IMPLAN model counts jobs. Thus one employed person could feasibly have two jobs.

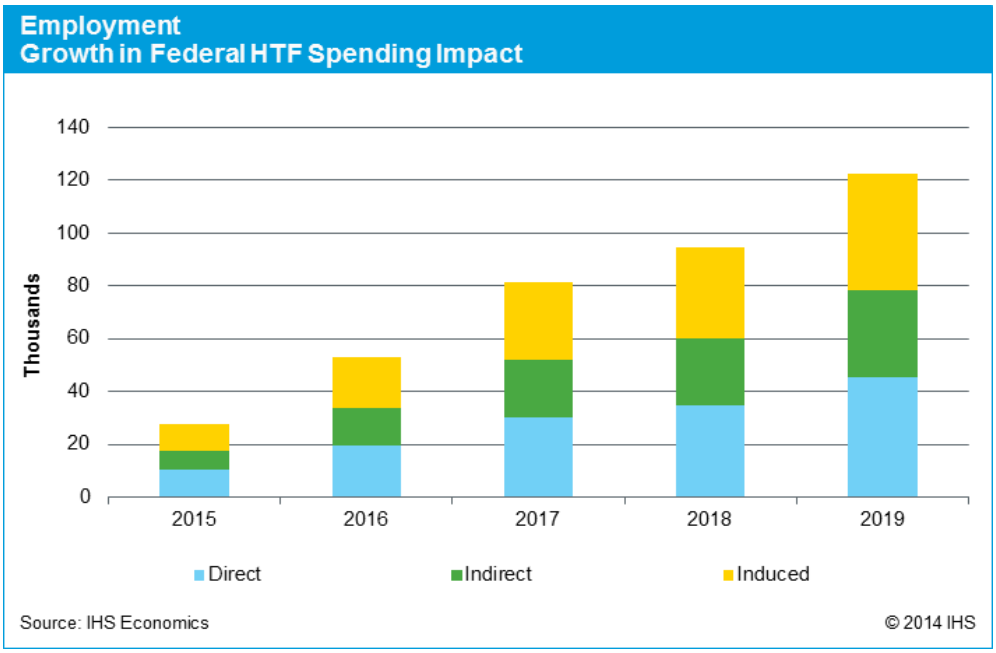




Direct, Indirect and Induced Impact on Output

Similar to the Macro Model results, which found for every $1 of federal highway investment approximately $2 of real GDP is produced, the IMPLAN model shows similar returns: every dollar of real current direct federal spending on output returns $1.82 in real output through indirect and induced effects.





4. CONCLUSION

Both the macroeconomic and sector analysis show that there are substantial benefits to the US economy from the federal investment in highways and mass transit (funded via the Highway Trust Fund). These benefits accrue because federal spending on transportation infrastructure invests in the capital stock of the US economy, which increases the economy's ability to produce goods and services (a larger capital base). Transportation infrastructure investment, though, is a particularly valuable form of capital because it enables all other sectors to be more efficient by connecting key suppliers more quickly, reducing employee commute times by alleviating congestion and making travel safer, and allowing other transportation capital to be more productive by reducing downtime for maintenance from traveling on poor quality roads.

The benefits of this investment can be quantified in terms of the additional output created by higher productivity. Both the macroeconomic and sector analysis estimated approximately $1.80 to $2.00 in additional real goods and services for every $1 spent. The benefits can also be seen in the labor market as the analysis shows that the current federal highway and mass transit program supports more than 870,000 jobs at peak and 614,000 more jobs per year on average.

The increased employment and output that the higher productivity of the capital stock enables allows for larger incomes for households. The average household earns approximately $410 more real dollars each year than they otherwise would without the federal highway and mass transit funding. If this funding were increased by 5% per year, households would see, on average, an additional $40 per year in real income, thus helping to improve the standard of living for U.S. households.

APPENDIX A - Macroeconomic Methodology and Detailed Results

The Macroeconomic model was run under the base case assuming no current (and projected) levels of federal highway spending in order to estimate the contribution of current spending to the baseline forecast.

The current spending levels for the Highway and Mass Transit funding were provided by the client. Spending levels ranged from $54 - $56 billion (current) dollars under the Base Case. In Scenario 1, investment variables were targeted to grow at 5% per year. In the Macro Model, federal dollars are already captured in state & local construction. Therefore, the major entry point to assess the federal highway and mass transit infrastructure investment impact is Real State & Local Construction Spending. State and Local Investment in Highway & Streets and State and Local Investment in Public Transportation were also targeted to achieve the assumed spending changes specifically in the Highway and Streets and Mass Transit construction sectors.

Since the inputs were given in nominal dollars and the targeted variable is real, the inputs were adjusted by the construction sector pricing variable to estimate real spending amounts for application in the model.

The tables below provide the details of the key indicators from the Macro Model. The "Baseline" in the tables is the IHS baseline without current federal highway and mass transit funding. The Base Case is the impact of the federal highway and mass transit funding on the baseline and Scenario 1 is the 5% year over year growth in federal highway and mass transit funding on the current (Base Case) level of funding.

Macroeconomic Results: Key Indicators

Key Macroeconomic Indicators	2014	2015	2016	2017	2018	2019
Gross Domestic Product (Billion of 2009 $)						
Baseline (less federal infrastructure spending)	16,105	16,595	17,158	17,714	18,235	18,733
BASE CASE (current federal infrastructure spending)	16,196	16,726	17,293	17,833	18,330	18,815
Scenario 1: 5% increase in federal infrastructure	16,196	16,734	17,305	17,846	18,341	18,824
Current Contribution, $	90.6	131.4	135.3	119.1	95.1	81.4
Scenario 1 Contribution, $	0.0	7.8	11.8	12.4	11.3	9.6
Industrial Production						
Baseline (less federal infrastructure spending)	102	106	110	113	116	119
BASE CASE (current federal infrastructure spending)	103	107	111	114	117	119
Scenario 1: 5% increase in federal infrastructure	103	107	111	114	117	119
Current Contribution	0.70	0.87	0.72	0.54	0.33	0.18
Scenario 1 Contribution	0.00	0.06	0.08	0.07	0.05	0.04
Real Disposable Income (Billion 2009 $)						
Baseline (less federal infrastructure spending)	11,940	12,353	12,817	13,314	13,739	14,095
BASE CASE (current federal infrastructure spending)	11,961	12,389	12,858	13,352	13,770	14,130
Scenario 1: 5% increase in federal infrastructure	11,961	12,391	12,862	13,355	13,773	14,133
Current Contribution, $	20.3	35.4	41.4	37.8	31.4	34.7
Scenario 1 Contribution, $	0.0	1.8	3.3	3.2	3.2	2.9
Unemployment Rate (%)						
Baseline (less federal infrastructure spending)	6.66	6.17	5.72	5.34	5.13	5.03
BASE CASE (current federal infrastructure spending)	6.46	5.82	5.38	5.07	4.96	4.93
Scenario 1: 5% increase in federal infrastructure	6.46	5.80	5.35	5.04	4.93	4.91
Current Contribution	-0.19	-0.35	-0.35	-0.27	-0.17	-0.10
Scenario 1 Contribution	0.00	-0.02	-0.03	-0.03	-0.03	-0.02
Total Employment (Millions)						
Baseline (less federal infrastructure spending)	138	140	143	146	148	149
BASE CASE (current federal infrastructure spending)	138	141	144	147	148	149
Scenario 1: 5% increase in federal infrastructure	138	141	144	147	148	150
Current Contribution	0.38	0.76	0.88	0.76	0.53	0.34
Scenario 1 Contribution	0.00	0.03	0.07	0.08	0.07	0.05
Real Stock of Infrastructure (Billion of 2009 $)						
Baseline (less federal infrastructure spending)	5,047	5,090	5,136	5,185	5,236	5,288
BASE CASE (current federal infrastructure spending)	5,065	5,135	5,206	5,279	5,353	5,429
Scenario 1: 5% increase in federal infrastructure	5,065	5,136	5,210	5,285	5,362	5,440
Current Contribution, $	17.5	44.3	69.8	94.1	117.8	140.9
Scenario 1 Contribution, $	0.0	1.5	3.8	6.2	8.6	10.9

Source: IHS Economics

Key Macroeconomic Indicators (Continued)	2014	2015	2016	2017	2018	2019
Employment -Trade, Transportation and Utilities (Millions)						
Baseline (less federal infrastructure spending)	26	27	27	28	28	28
BASE CASE (current federal infrastructure spending)	26	27	27	28	28	28
Scenario 1: 5% increase in federal infrastructure	26	27	27	28	28	28
Current Contribution	0.05	0.07	0.10	0.09	0.06	0.02
Scenario 1 Contribution	0.00	0.00	0.01	0.01	0.01	0.01
Investment in Nonresidential Land Transportation (Billion $)						
Baseline (less federal infrastructure spending)	13	12	12	11	12	12
BASE CASE (current federal infrastructure spending)	13	12	12	11	12	12
Scenario 1: 5% increase in federal infrastructure	13	12	12	11	12	12
Current Contribution, $	0.01	0.03	0.04	0.06	0.09	0.13
Scenario 1 Contribution, $	0.00	0.00	0.00	0.00	0.01	0.01
Investment in Transportation Equipment (Billion $)						
Baseline (less federal infrastructure spending)	225	234	247	258	267	274
BASE CASE (current federal infrastructure spending)	231	243	253	260	268	275
Scenario 1: 5% increase in federal infrastructure	231	243	254	261	268	276
Current Contribution, $	5.9	8.6	5.9	2.5	1.0	1.9
Scenario 1 Contribution, $	0.0	0.5	0.8	0.6	0.3	0.2
State and Local Investment in Transportation Facilities (Billion $)						
BASE CASE (without current federal infrastructure spending)	16	18	19	20	20	22
Baseline (current federal infrastructure spending)	24	26	27	28	29	31
Scenario 1: 5% increase in federal infrastructure	24	26	27	29	30	31
Current Contribution, $	8.0	8.0	8.0	8.0	9.0	9.0
Scenario 1 Contribution, $	0.0	0.4	0.4	0.5	0.5	0.5
State and Local Investment in Highways and Streets (Billion $)						
BASE CASE (without current federal infrastructure spending)	36	40	44	48	52	53
Baseline (current federal infrastructure spending)	82	86	90	94	98	100
Scenario 1: 5% increase in federal infrastructure	82	88	92	96	99	102
Current Contribution, $	46	46	46	46	46	47
Scenario 1 Contribution, $	0	1	2	2	2	2
State and Local Construction Spending (Billion $)						
BASE CASE (without current federal infrastructure spending)	216	231	246	261	273	285
Baseline (current federal infrastructure spending)	270	285	300	315	329	341
Scenario 1: 5% increase in federal infrastructure	270	289	305	320	334	346
Current Contribution, $	54	54	54	54	56	56
Scenario 1 Contribution, $	0	5	5	5	5	6

Source: IHS Economics

APPENDIX B - Sector Impact Methodology and Detailed Results

Methodology

For each year of the analysis, federal spending was allocated to the new construction sector (96%) and maintenance and repair sector (4%) in the IMPLAN model. In the IMPLAN model new construction encompasses the capital expenditures of improving and expanding highway and mass transit capacity. Further allocation was made from each of these sectors to machinery and trucks. The relative proportion of Highway and Mass Transit construction spending that goes to machinery and trucks was calculated from IHS' internal Business Market Insight (BMI) database. The proportion of spending was subtracted from the construction sector and passed to the three machinery and truck sectors. The three sectors for machinery and trucks investment were targeted directly to better capture their impact as the inter-industry table does not include industry capital flow estimates.

Additionally, the construction productivity ratio in the model was adjusted to account for calculated productivity specific to Highway and Mass Transit construction. In this way, the production function in the model was customized to take specific account of the type of construction being impacted in the model.

Spending Changes to estimate Sector Impacts

Base Case Assumptions ($M)

IMPLAN Sector		2014	2015	2016	2017	2018	2019
36	Construction of other new nonres structures	49,830	49,953	50,109	50,159	51,127	52,046
39	Maintenance and repair construction of nonres structures	2,076	2,081	2,087	2,089	2,130	2,168
205	Construction machinery manufacturing	1,123	1,073	1,040	1,066	1,113	1,168
277	Light truck and utility vehicle manufacturing	764	701	594	527	474	461
278	Heavy duty truck manufacturing	204	189	167	156	153	155
Total		**54,000**	**54,000**	**54,000**	**54,000**	**55,000**	**56,000**

Source: IHS Economics

Scenario 1 Assumptions ($M)

IMPLAN Sector		2014	2015	2016	2017	2018	2019
36	Construction of other new nonres structures	-	1,572	3,062	4,737	5,577	7,342
39	Maintenance and repair construction of nonres structures	-	65	127	197	232	305
205	Construction machinery manufacturing	-	33	63	100	121	164
277	Light truck and utility vehicle manufacturing	-	22	36	49	51	65
278	Heavy duty truck manufacturing	-	5	10	14	16	21
Total		**-**	**1,700**	**3,300**	**5,100**	**6,000**	**7,900**

Source: IHS Economics

Detailed Results: Base Case

Employment Contribution - Base Case

(Number of Workers)

	2014	2015	2016	2017	2018	2019
Construction	333,933	330,462	327,240	323,373	325,398	327,019
Agriculture	8,777	8,674	8,574	8,467	8,515	8,557
Mining	7,275	7,191	7,111	7,024	7,065	7,100
Trade, Transportation and Utilities	110,210	108,837	107,496	106,129	106,715	107,249
Manufacturing	60,559	59,588	58,583	57,739	57,978	58,266
Information	9,766	9,646	9,531	9,411	9,463	9,511
Financial activities	59,764	59,052	58,365	57,637	57,966	58,255
Professional and business services	127,911	126,394	124,929	123,369	124,073	124,691
Education and health services	70,259	69,427	68,625	67,770	68,159	68,499
Leisure and hospitality	55,749	55,085	54,444	53,764	54,071	54,341
Other services	43,157	42,657	42,176	41,655	41,898	42,107
Government	3,917	3,869	3,823	3,775	3,796	3,815
Total	**891,276**	**880,882**	**870,897**	**860,112**	**865,098**	**869,410**
Direct	328,478	324,980	321,724	317,907	319,890	321,496
Indirect	240,328	237,247	234,198	231,154	232,373	233,519
Induced	322,470	318,654	314,974	311,051	312,835	314,395
Total	**891,276**	**880,882**	**870,897**	**860,112**	**865,098**	**869,410**

Source: IHS Economics

Value Added Contribution - Base Case

($M)

	2014	2015	2016	2017	2018	2019
Construction	20,287	20,076	19,880	19,645	19,768	19,867
Agriculture	415	410	406	401	403	405
Mining	1,453	1,436	1,419	1,402	1,410	1,417
Trade, Transportation and Utilities	8,779	8,667	8,555	8,445	8,490	8,532
Manufacturing	8,196	8,062	7,927	7,818	7,855	7,898
Information	1,960	1,936	1,913	1,889	1,900	1,909
Financial activities	11,096	10,964	10,837	10,702	10,764	10,817
Professional and business services	9,428	9,314	9,204	9,088	9,139	9,184
Education and health services	3,905	3,859	3,814	3,767	3,788	3,807
Leisure and hospitality	1,996	1,972	1,949	1,925	1,936	1,946
Other services	1,861	1,839	1,819	1,797	1,807	1,816
Government	263	260	257	253	255	256
Total	**69,638**	**68,795**	**67,981**	**67,131**	**67,515**	**67,854**
Direct	20,170	19,940	19,726	19,491	19,613	19,715
Indirect	23,203	22,901	22,601	22,305	22,421	22,532
Induced	26,265	25,954	25,655	25,335	25,480	25,607
Total	**69,638**	**68,795**	**67,981**	**67,131**	**67,515**	**67,854**

Source: IHS Economics

Labor Income Contribution - Base Case

($M)

	2014	2015	2016	2017	2018	2019
Construction	18,716	18,522	18,341	18,124	18,238	18,329
Agriculture	346	342	338	334	336	337
Mining	532	526	520	513	516	519
Trade, Transportation and Utilities	5,273	5,206	5,140	5,073	5,101	5,126
Manufacturing	4,099	4,030	3,959	3,901	3,917	3,936
Information	863	852	842	831	836	840
Financial activities	3,356	3,316	3,277	3,236	3,255	3,271
Professional and business services	7,700	7,608	7,518	7,424	7,466	7,503
Education and health services	3,477	3,436	3,396	3,354	3,373	3,390
Leisure and hospitality	1,334	1,318	1,303	1,287	1,294	1,300
Other services	1,656	1,637	1,618	1,599	1,608	1,616
Government	268	264	261	258	259	261
Total	**47,619**	**47,056**	**46,513**	**45,934**	**46,198**	**46,428**
Direct	18,465	18,264	18,077	17,862	17,973	18,064
Indirect	14,460	14,271	14,083	13,898	13,970	14,038
Induced	14,694	14,520	14,353	14,174	14,255	14,326
Total	**47,619**	**47,056**	**46,513**	**45,934**	**46,198**	**46,428**

Source: IHS Economics

Output Contribution - Base Case

($M)

	2014	2015	2016	2017	2018	2019
Construction	49,162	48,652	48,177	47,608	47,906	48,145
Agriculture	1,117	1,104	1,092	1,078	1,084	1,090
Mining	2,332	2,304	2,278	2,250	2,263	2,274
Trade, Transportation and Utilities	13,421	13,248	13,077	12,908	12,976	13,041
Manufacturing	29,391	28,843	28,256	27,807	27,886	28,020
Information	3,596	3,553	3,511	3,467	3,486	3,504
Financial activities	16,061	15,871	15,687	15,491	15,580	15,658
Professional and business services	13,294	13,134	12,978	12,815	12,887	12,951
Education and health services	5,944	5,873	5,806	5,733	5,766	5,795
Leisure and hospitality	3,384	3,343	3,304	3,263	3,282	3,298
Other services	2,815	2,783	2,752	2,718	2,734	2,747
Government	601	594	586	579	582	585
Total	**141,118**	**139,301**	**137,504**	**135,716**	**136,432**	**137,107**
Direct	50,104	49,456	48,818	48,187	48,445	48,687
Indirect	46,113	45,475	44,827	44,217	44,428	44,643
Induced	44,902	44,370	43,858	43,311	43,560	43,777
Total	**141,118**	**139,301**	**137,504**	**135,716**	**136,432**	**137,107**

Source: IHS Economics

Detailed Results: 5% HTF Growth (Scenario 1)

Employment Contribution - Scenario 1

(Number of Workers)

	2014	2015	2016	2017	2018	2019
Construction	-	10,403	19,998	30,541	35,498	46,133
Agriculture	-	273	524	800	929	1,207
Mining	-	226	435	663	771	1,002
Trade, Transportation and Utilities	-	3,426	6,569	10,023	11,642	15,130
Manufacturing	-	1,876	3,580	5,453	6,325	8,220
Information	-	304	582	889	1,032	1,342
Financial activities	-	1,859	3,567	5,443	6,324	8,218
Professional and business services	-	3,979	7,635	11,652	13,535	17,590
Education and health services	-	2,186	4,194	6,401	7,436	9,663
Leisure and hospitality	-	1,734	3,327	5,078	5,899	7,666
Other services	-	1,343	2,577	3,934	4,571	5,940
Government	-	122	234	357	414	538
Total	-	**27,731**	**53,221**	**81,233**	**94,374**	**122,649**
Direct	-	10,231	19,661	30,025	34,897	45,354
Indirect	-	7,469	14,312	21,831	25,350	32,943
Induced	-	10,032	19,248	29,377	34,127	44,352
Total	-	**27,731**	**53,221**	**81,233**	**94,374**	**122,649**

Source: IHS Economics

Value Added Contribution - Scenario 1

($M)

	2014	2015	2016	2017	2018	2019
Construction	-	632	1,215	1,855	2,157	2,803
Agriculture	-	13	25	38	44	57
Mining	-	45	87	132	154	200
Trade, Transportation and Utilities	-	273	523	798	926	1,204
Manufacturing	-	254	484	738	857	1,114
Information	-	61	117	178	207	269
Financial activities	-	345	662	1,011	1,174	1,526
Professional and business services	-	293	562	858	997	1,296
Education and health services	-	121	233	356	413	537
Leisure and hospitality	-	62	119	182	211	274
Other services	-	58	111	170	197	256
Government	-	8	16	24	28	36
Total	**-**	**2,166**	**4,154**	**6,340**	**7,365**	**9,572**
Direct	-	628	1,205	1,841	2,140	2,781
Indirect	-	721	1,381	2,107	2,446	3,179
Induced	-	817	1,568	2,393	2,780	3,612
Total	**-**	**2,166**	**4,154**	**6,340**	**7,365**	**9,572**

Source: IHS Economics

Labor Income Contribution - Scenario 1

($M)

	2014	2015	2016	2017	2018	2019
Construction	-	583	1,121	1,712	1,990	2,586
Agriculture	-	11	21	32	37	48
Mining	-	17	32	48	56	73
Trade, Transportation and Utilities	-	164	314	479	556	723
Manufacturing	-	127	242	368	427	555
Information	-	27	51	79	91	119
Financial activities	-	104	200	306	355	461
Professional and business services	-	240	459	701	814	1,058
Education and health services	-	108	208	317	368	478
Leisure and hospitality	-	41	80	122	141	183
Other services	-	52	99	151	175	228
Government	-	8	16	24	28	37
Total	**-**	**1,481**	**2,842**	**4,338**	**5,040**	**6,550**
Direct	-	575	1,105	1,687	1,961	2,548
Indirect	-	449	861	1,313	1,524	1,980
Induced	-	457	877	1,339	1,555	2,021
Total	**-**	**1,481**	**2,842**	**4,338**	**5,040**	**6,550**

Source: IHS Economics

Output Contribution - Scenario 1

($M)

	2014	2015	2016	2017	2018	2019
Construction	-	1,532	2,944	4,496	5,226	6,792
Agriculture	-	35	67	102	118	154
Mining	-	73	139	212	247	321
Trade, Transportation and Utilities	-	417	799	1,219	1,416	1,840
Manufacturing	-	908	1,727	2,626	3,042	3,953
Information	-	112	215	327	380	494
Financial activities	-	500	959	1,463	1,700	2,209
Professional and business services	-	413	793	1,210	1,406	1,827
Education and health services	-	185	355	541	629	817
Leisure and hospitality	-	105	202	308	358	465
Other services	-	88	168	257	298	388
Government	-	19	36	55	64	83
Total	**-**	**4,385**	**8,403**	**12,818**	**14,884**	**19,342**
Direct	-	1,557	2,983	4,551	5,285	6,868
Indirect	-	1,432	2,739	4,176	4,847	6,298
Induced	-	1,397	2,680	4,091	4,752	6,176
Total	**-**	**4,385**	**8,403**	**12,818**	**14,884**	**19,342**

Source: IHS Economics

APPENDIX C - Model Documentations

IHS US Macroeconomic Model

The Model's Theoretical Position

As an econometric dynamic equilibrium growth model, the IHS model strives to incorporate the best insights of many theoretical approaches to the business cycle: Keynesian, New Keynesian, neoclassical, monetarist, and supply-side. In addition the IHS model embodies the major properties of the neoclassical growth models developed by Robert Solow. This structure guarantees that short-run cyclical developments will converge to robust long-run equilibrium.

In growth models the expansion rate of technical progress, the labor force, and the capital stock determine the productive potential of an economy. Both technical progress and the capital stock are governed by investment, which in turn must be in balance with post-tax capital costs, available savings, and the capacity requirements of current spending. As a result monetary and fiscal policies will influence both the short- and the long-term characteristics of such an economy through their impacts on national saving and investment.

A modern model of output, prices, and financial conditions is melded with the growth model to present the detailed, short-run dynamics of the economy. In specific goods markets the interactions of a set of supply and demand relations jointly determine spending, production, and price levels. Typically the level of inflation-adjusted demand is driven by prices, income, wealth, expectations, and financial conditions. The capacity to supply goods and services is keyed to a production function combining the basic inputs of labor hours, energy usage, and the capital stocks of business equipment and structures, and government infrastructure. The "total factor productivity" of this composite of tangible inputs is driven by expenditures on research and development (R&D) that produce technological progress.

Prices adjust in response to gaps between current production and supply potential and to changes in the cost of inputs. Wages adjust to labor supply-demand gaps (indicated by a demographically adjusted unemployment rate), current and expected inflation (with a unit long-run elasticity), productivity, tax rates, and minimum wage legislation. The supply of labor positively responds to the perceived availability of jobs, to the after-tax wage level, and to the growth and age-sex mix of the population. Demand for labor is keyed to the level of output in the economy and the productivity of labor, capital, and energy. Because the capital stock is largely fixed in the short run, a higher level of output requires more employment and energy inputs. Such increases are not necessarily equal to the percentage increase in output because of the improved efficiencies typically achieved during an upturn. Tempering the whole process of wage and price determination is the exchange rate; a rise signals prospective losses of jobs and markets unless costs and prices are reduced.

For financial markets the model predicts exchange rates, interest rates, stock prices, loans, and investments interactively with the preceding GDP and inflation variables. The Federal Reserve sets the supply of reserves in the banking system and the fractional reserve requirements for deposits. Private sector demands to hold deposits are driven by national income, expected inflation, and by the deposit interest yield relative to the yields offered on alternative

investments. Banks and other thrift institutions, in turn, set deposit yields based on the market yields of their investment opportunities with comparable maturities and on the intensity of their need to expand reserves to meet legal requirements. In other words the contrast between the supply and demand for reserves sets the critical short-term interest rate for interbank transactions, the federal funds rate. Other interest rates are keyed to this rate, plus expected inflation, US Treasury borrowing requirements, and sectoral credit demand intensities.

The old tradition in macroeconomic model simulations of exogenous fiscal or environmental policy changes was to hold the Federal Reserve's supply of reserves constant at baseline levels. While this approach makes static analysis easier in the classroom, it sometimes creates unrealistic policy analyses when a dynamic model is appropriate. In the IHS model, "monetary policy" is defined by a set of targets, instruments, and regular behavioral linkages between targets and instruments. The model user can choose to define unchanged monetary policy as unchanged reserves or as an unchanged reaction function in which interest rates or reserves are changed in response to changes in such policy concerns as the price level and the unemployment rate.

Monetarist Aspects

The model pays due attention to valid lessons of monetarism by carefully representing the diverse portfolio aspects of money demand and by capturing the central bank's role in long-term inflation phenomena.

The private sector may demand money balances as one portfolio choice among transactions media (currency, checkable deposits), investment media (bonds, stocks, short-term securities), and durable assets (homes, cars, equipment, structures). Given this range of choice, each medium's implicit and explicit yield must therefore match expected inflation, offset perceived risk, and respond to the scarcity of real savings. Money balances provide benefits by facilitating spending transactions and can be expected to rise nearly proportionately with transactions requirements unless the yield of an alternative asset changes.

Now that even demand deposit yields can float to a limited extent in response to changes in Treasury bill rates, money demand no longer shifts quite as sharply when market rates change. Nevertheless the velocity of circulation (the ratio of nominal spending to money demand) is still far from stable during a cycle of monetary expansion or contraction. The simple monetarist link from money growth to price inflation or nominal spending is therefore considered invalid as a rigid short-run proposition.

Equally important, as long-run growth models demonstrate, induced changes in capital formation can also invalidate a naive long-run identity between monetary growth and price increases. Greater demand for physical capital investment can enhance the economy's supply potential in the event of more rapid money creation or new fiscal policies. If simultaneous, countervailing influences deny an expansion of the economy's real potential, the model will translate all money growth into a proportionate increase in prices rather than in physical output.

"Supply-side" Economics

Since 1980, "supply-side" political economists have pointed out that the economy's growth potential is sensitive to the policy environment. They focused on potential labor supply, capital

spending, and savings impacts of tax rate changes. The IHS model embodies supply-side hypotheses to the extent supportable by available data, and this is considerable in the many areas that supply-side hypotheses share with long-run growth models. These features, however, have been fundamental ingredients of our model since 1976.

Rational Expectations

As the rational expectations school has pointed out, much of economic decision-making is forward looking. For example the decision to buy a car or a home is not only a question of current affordability but also one of timing. The delay of a purchase until interest rates or prices decline has become particularly common since the mid-1970s when both inflation and interest rates were very high and volatile. Consumer sentiment surveys, such as those conducted by the University of Michigan Survey Research Center, clearly confirm this speculative element in spending behavior.

However, households can be shown to base their expectations, to a large extent, on their past experiences: they believe that the best guide to the future is an extrapolation of recent economic conditions and the changes in those conditions. Consumer sentiment about whether this is a "good time to buy" can therefore be successfully modeled as a function of recent levels and changes in employment, interest rates, inflation, and inflation expectations. Similarly inflation expectations (influencing financial conditions) and market strength expectations (influencing inventory and capital spending decisions) can be modeled as functions of recent rates of increase in prices and spending.

This largely retrospective approach is not, of course, wholly satisfactory to pure adherents to the rational expectations doctrine. In particular this group argues that the announcement of macroeconomic policy changes would significantly influence expectations of inflation or growth prior to any realized change in prices or spending. If an increase in government expenditures is announced, the argument goes, expectations of higher taxes to finance the spending might lead to lower consumer or business spending in spite of temporarily higher incomes from the initial government spending stimulus. A rational expectations theorist would thus argue that multiplier effects will tend to be smaller and more short-lived than a mainstream economist would expect.

These propositions are subject to empirical evaluation. Our conclusions are that expectations do play a significant role in private sector spending and investment decisions; but until change has occurred in the economy, there is very little room for significant changes in expectations in advance of an actual change in the variable about which the expectation is formed. The rational expectations school thus correctly emphasizes a previously understated element of decision making, but exaggerates its significance for economic policy-making and model building.

The IHS model allows a choice in this matter. On the one hand, the user can simply accept IHS's judgments and let the model translate policy initiatives into initial changes in the economy, simultaneous or delayed changes in expectations, and subsequent changes in the economy. On the other hand, the user can manipulate the clearly identified expectations variables in the model, i.e., consumer sentiment, and inflation expectations. For example if the user believes that fear of higher taxes would subdue spending, the consumer sentiment index could be reduced accordingly. Such experiments can be made "rational" through model iterations that bring the

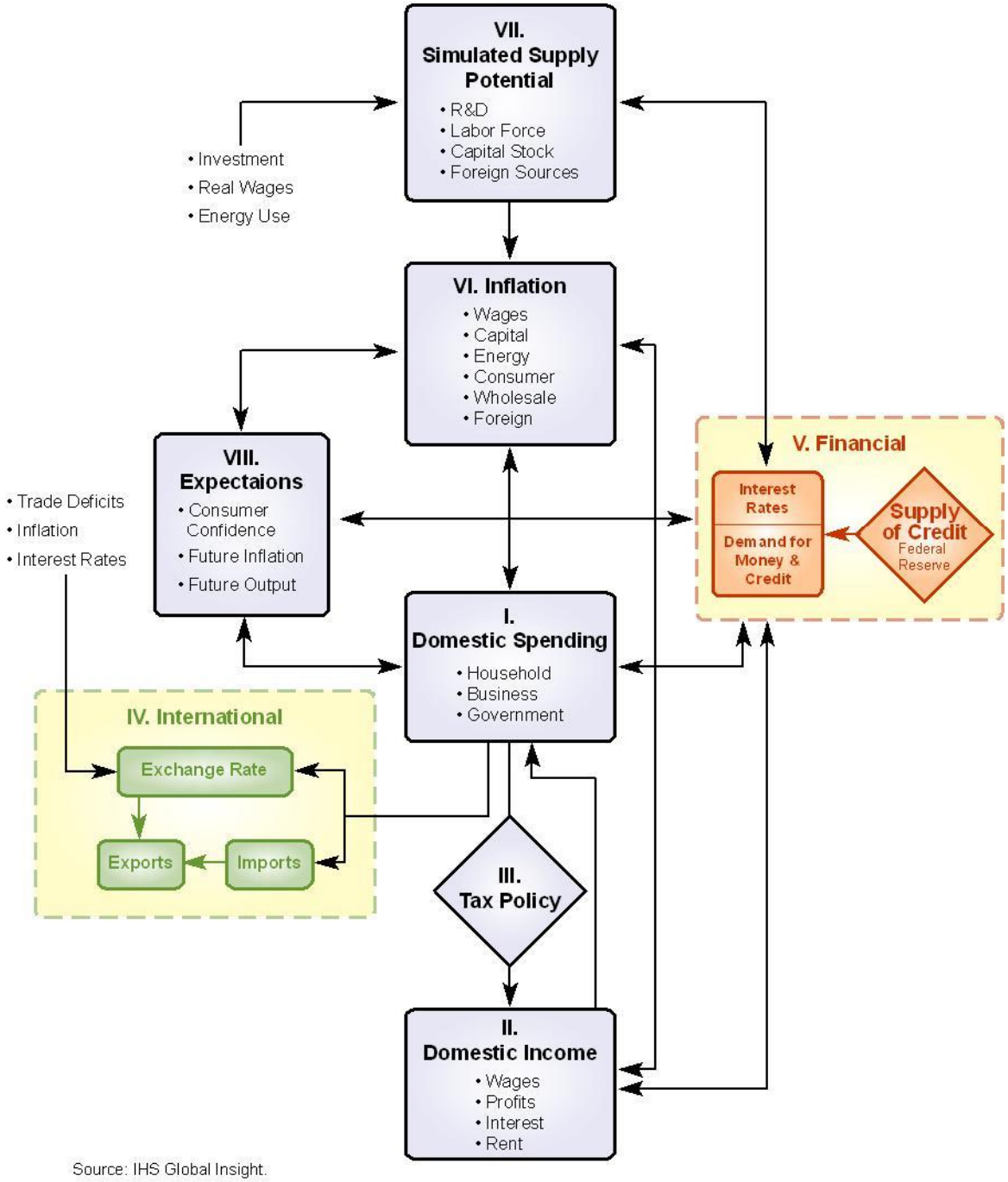
current change in expectations in line with future endogenous changes in employment, prices, or financial conditions.

Theory as a Constraint

The conceptual basis of each equation in the IHS model was thoroughly worked out before the regression analysis was initiated. The list of explanatory variables includes a carefully selected set of demographic and financial inputs. Each estimated coefficient was then thoroughly tested to be certain that it meets the tests of modern theory and business practice. This attention to equation specification and coefficient results has eliminated the "short circuits" that can occur in evaluating a derivative risk or an alternative policy scenario. Because each equation will stand up to a thorough inspection, the IHS model is a reliable analytical tool and can be used without excessive iterations. The model is not a black box: it functions like a personal computer spreadsheet in which each interactive cell has a carefully computed, theoretically consistent entry and thus performs logical computations simultaneously.

Figure C-5

The IHS Global Insight Macroeconomic Model of the US Economy



Source: IHS Global Insight.
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The IMPLAN Model

To assess the direct, indirect, and induced economic impacts of the investment in transportation infrastructure, IHS used a customized version of the IMPLAN modeling environment. The base IMPLAN model closely follows the accounting conventions used in the US Bureau of Economic Analysis study, *Input-Output Study of the US Economy*, and is flexible enough to evaluate changes via the value of output or employment from the source industry. IHS customized the environment by updating worker productivity rates based on its proprietary Business Market Insights database, which IHS economists believe produces more conservative estimates of employment impacts.

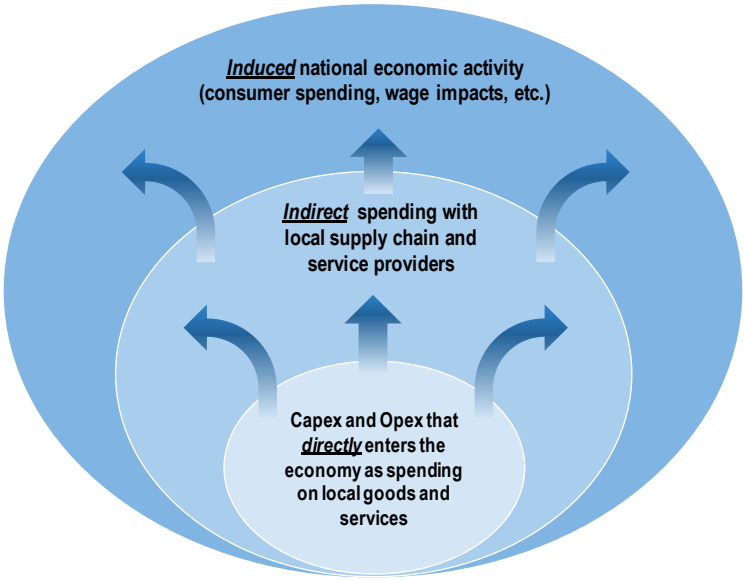
Input-Output Modeling Frameworks

IMPLAN, short for "Impact Analysis for Planning," is a widely used, commercially available model for conducting input-output analysis. Based on a social account matrix framework, IMPLAN provides a balanced set of 440-industry sector matrices that map the buy-sell dyads of inter-industry transactions and consumer-to-industry transactions. When additional transactions occur, IMPLAN rebalances the matrices, therein estimating how transactional activity ripples through the economy. The additional activity, in turn, drives changes in employment, wages, GDP contribution and government revenues.

The economic ripples fall into three main categories, as defined below:

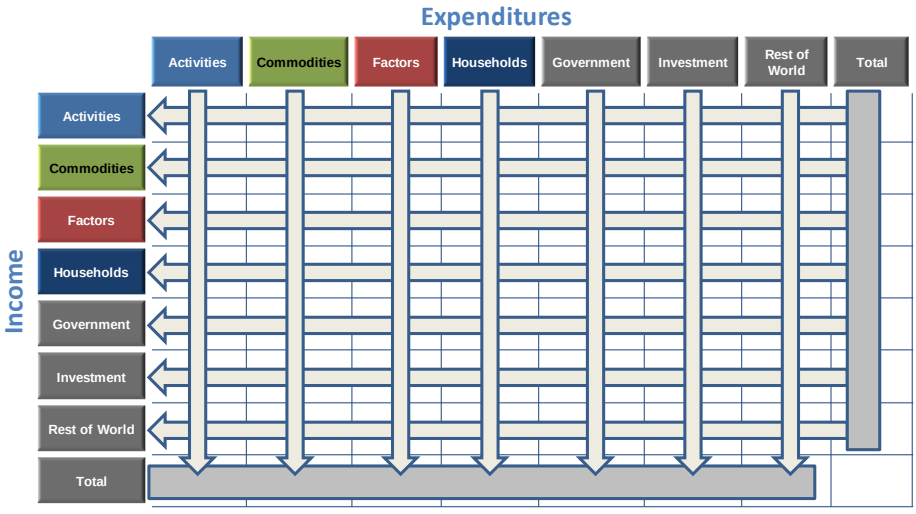
- **Direct Effects:** are the direct responses of an economy to changes in the final demand of a given industry or set of industries. In the model developed for this project, direct effects capture the impacts of direct employment and production associated with transportation infrastructure spending.
- **Indirect Effects** (also known as **Supplier Effects**): refer to the "ripple responses" of an economy to subsequent final demand shifts within industries that serve the direct industries. In essence, the indirect effects capture the response of extended supply chains.
- **Induced Effects** (also known as **Income Effects**): refer to the response of an economy to changes in household spending attributable to income generated by the direct and indirect effects. Employees within the direct and indirect industries also act as consumers in the general US economy. Induced effects capture the impacts of this consumer activity

Three Levels of Economic Impact



The figure below shows the structure and fiscal flows of a typical Social Account Matrix (SAM), which presents the transactions that occur within an economy as a matrix. The columns of a SAM represent expenditures (or spending), while the rows represent income. The key components (or accounts) appear in both the Columns and the Rows of the SAM, representing the dual role each account plays in the economy. As such, a SAM not only captures the transactional activity within an economy, but all of the linkages between industrial sectors, households and institutions as well.

Social Accounting Matrix Captures Expenditure-to-Income Flows



A Social Accounting Matrix (SAM) provides a complete, consistent and balanced representation of all activity within an economy. An ***Expenditure*** (or spending) within an economy flows down a column and then leftward along the corresponding ***Income*** row. For example, consider

Consumer Spending. Expenditures flow down the "Household" column and then left across the appropriate "Commodity" row.

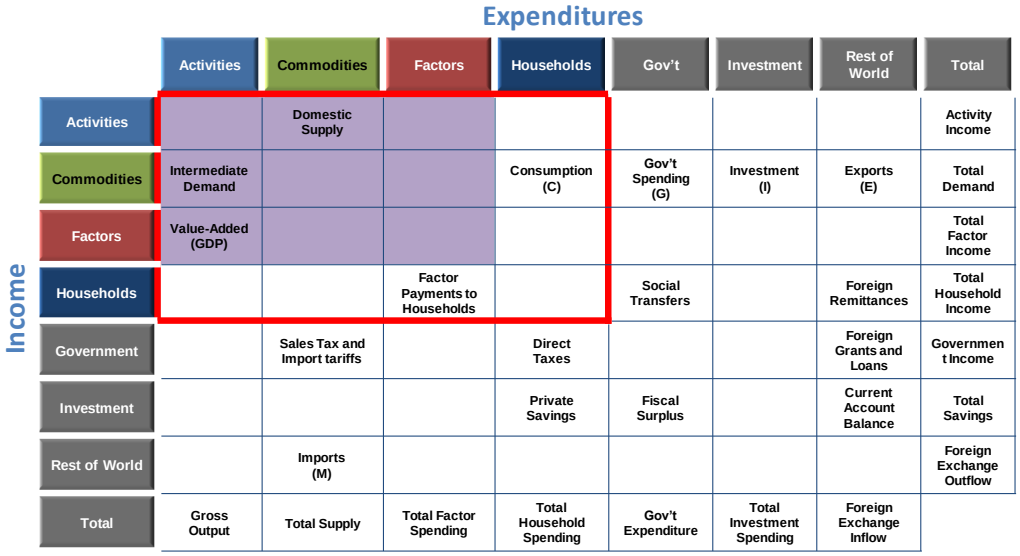
The following graphic populates the SAM framework with the classes of transactions that link expenditures (columns) to income (rows). A SAM is similar to double entry bookkeeping where each entry is a transaction that has both a price and a quantity dimension, and that identifies both its source and destination. Therefore, the total expenditures by each account must be exactly equal to the total receipts for the account, i.e. the respective row and column totals must equate. This means, for example, that total domestic demand (the commodity row) equals total domestic supply (the commodities column). It is this characteristic that makes a SAM a tool that can be used for modeling purposes.

Social Accounting Matrix Structure Transaction Classes

Income \ Expenditures	Activities	Commodities	Factors	Households	Gov't	Investment	Rest of World	Total
Activities		Domestic Supply						Activity Income
Commodities	Intermediate Demand			Consumption (C)	Gov't Spending (G)	Investment (I)	Exports (E)	Total Demand
Factors	Value-Added (GDP)							Total Factor Income
Households			Factor Payments to Households		Social Transfers		Foreign Remittances	Total Household Income
Government		Sales Tax and Import tariffs		Direct Taxes			Foreign Grants and Loans	Government Income
Investment				Private Savings	Fiscal Surplus		Current Account Balance	Total Savings
Rest of World		Imports (M)						Foreign Exchange Outflow
Total	Gross Output	Total Supply	Total Factor Spending	Total Household Spending	Gov't Expenditure	Total Investment Spending	Foreign Exchange Inflow	

Economic impact analyses focus on inter-industry interactions (Activity-Commodity-Factors) and consumer transactions (Activity-Commodity-Factors-Households). The inter-industry interactions, which encompass direct and indirect effects, are highlighted in the purple region of the following figure. Similarly, the consumer transactions are enclosed by the red box. Ultimately, these two regions of the SAM are transformed into the core of an economic impact model such as IMPLAN.

Portions of a SAM Needed for the Economic Impact Assessment



IMPLAN multipliers

The notion of a multiplier rests upon the difference between the initial effect of a change in final demand and the total effects of that change. Total effects can be calculated either as direct and indirect effects or as direct, indirect, and induced effects. Direct effects are production changes associated with the immediate effects or final-demand changes. Indirect effects are production changes in backward-linked industries caused by the changing input needs of directly affected industries (for example, additional purchases to produce additional output). Induced effects are the changes in regional household spending patterns caused by changes in household income generated from the direct and indirect effects.

Type I multipliers

A Type I multiplier is the direct effect produced by a change in final demand plus the indirect effect, divided by the direct effect. Increased demands are assumed to lead to increased employment and population, with the average income level remaining constant. The Leontief inverse (Type I multipliers matrix) is derived by inverting the direct coefficients matrix. The result is a matrix of total requirement coefficients, the amount each industry must produce for the purchasing industry to deliver one dollar's worth of output to final demand.

Type SAM multipliers

Type SAM multipliers incorporate "induced" effects resulting from household expenditures from new labor income. The linear relationship between labor income and household expenditure can be customized in the IMPLAN software. The default relationship is Personal Consumption Expenditure (PCE) and total household expenditure. Each dollar of workplace-based income is spent based on the SAM relationship generated by IMPLAN.