



**Federal Aviation
Administration**

The Economic Impact of Commercial Space Transportation on the U.S. Economy in 2009

SEPTEMBER 2010

About the Office of Commercial Space Transportation

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-federal launch and reentry sites, as authorized by Executive Order 12465 and Title 49 United States Code, Subtitle IX, Chapter 701 (formerly the Commercial Space Launch Act).

FAA/AST's mission is to ensure public health and safety and the safety of property while protecting the national security and foreign policy interests of the United States during commercial launch and reentry operations.

In addition, FAA/AST is directed to encourage, facilitate, and promote commercial space launches and reentries. Additional information concerning commercial space transportation can be found on FAA/AST's web site at <http://ast.faa.gov>.

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EXECUTIVE SUMMARY

The Economic Impact of Commercial Space Transportation on the U.S. Economy in 2009 is the latest study by the Federal Aviation Administration's Office of Commercial Space Transportation (AST) of the commercial launch industry's influence on the nation's economy. It quantifies how commercial space transportation is responsible for supporting space- and non-space- related industries in calendar year 2009.

BACKGROUND

Commercial space transportation and enabled industries (CST&EI) consists of the launch vehicle manufacturing and services industry (LVM&SI), satellite manufacturing, ground equipment manufacturing, satellite services, satellite remote sensing, and distribution industries.¹ Because FAA AST is directly responsible for licensing commercial launch vehicles, LVM&SI is discussed in greater detail later in this report. This report characterizes these industries according to three economic impact metrics: economic activity, earnings, and employment. The objective of this report is to provide an overview of these three metrics for the component industries of CST&EI, with emphasis placed on LVM&SI.

The analysis in this report is based on an industry-standard model using data derived from a model developed by FAA AST. The model contains Regional Input-Output Modeling System (RIMS II) industry multipliers provided by the U.S. Bureau of Economic Analysis (BEA). RIMS II multipliers estimate the impact of final-demand change on total gross output (or economic activity), earnings, and employment.

The data inputs to the model are based on global satellite industry information produced by the Satellite Industry Association (SIA) and FAA AST data concerning U.S. launch activity. The SIA data is adjusted to reflect U.S. industry shares and captures operations related to ground equipment manufacturing within enabled industries. Based on these inputs, the model calculates how industries enabled by commercial space transportation influence *all* U.S. industry sectors according to the three impact metrics mentioned above.

¹ Industry is divided into four sectors: Primary (resource extraction), Secondary (processing and manufacturing), Tertiary (services), and Quaternary (information technologies). CST&EI and LVM&SI have elements in Secondary, Tertiary, and Quaternary sectors (for instance, commercial space transportation is a Tertiary Industrial Sector, whereas Launch Vehicle Manufacturing is a Secondary Industrial Sector). Within each industry are markets, which take on many different forms.

RESULTS

In 2009, CST&EI generated a total of \$208.3 billion in economic activity in the United States. Over one million people throughout the country were employed as a result of this activity, with earnings that exceeded \$53 billion.

In comparison with previous Economic Impact Studies published by FAA AST, these results show that the economic impact of commercial space transportation on the U.S. economy has continued to grow. Table E1 compares these results with four similar studies that measured the economic impact of the same industries in 1999, 2002, 2004, and 2006 respectively. All three impact metrics for CST&EI increased in 2009 relative to 2006.

Total Impact	1999	2002	2004	2006	2009
Economic Activity (\$000)	\$61,313,711	\$95,025,746	\$98,086,960	\$139,262,027	\$208,329,012
Earnings (\$000)	\$16,431,192	\$23,527,745	\$25,045,888	\$35,659,935	\$53,257,346
Jobs	497,350	576,450	551,350	736,130	1,029,440

Table E1: Total impacts on the U.S. economy generated by CST&EI, 1999, 2002, 2004, 2006 and 2009 (in then year dollars).

Overall, CST&EI exhibited an economic impact growth trend from 1999 to 2009, with the exception of a slightly decreased employment impact from 2002 to 2004. The overall trend is a result of consistent growth in satellite services revenue, particularly in direct-to-home television (DTH TV) and ground equipment manufacturing.

During the same year, LVM&SI generated a total of \$828 million in economic activity in the United States. Some 3,820 people throughout the country were employed within this industry, with earnings estimated to be \$219 million.

Results for LVM&SI show that its economic impact activity has fluctuated between a high of \$3.5 billion in 1999 to a low of \$792 million in 2002. There has been a drop in economic activity between the last FAA AST Economic Impact Study in 2006 and the current iteration. Table E2 compares these results with four similar studies that measured the economic impact of the same industries in 1999, 2002, 2004, and 2006 respectively.

Total Impact	1999	2002	2004	2006	2009
Economic Activity (\$000)	\$3,515,978	\$791,759	\$1,658,384	\$1,166,723	\$827,817
Earnings (\$000)	\$1,071,722	\$206,328	\$437,674	\$308,087	\$218,595
Jobs	28,617	4,828	8,870	5,690	3,820

Table E2: Total impacts on the U.S. economy generated by LVM&SI, 1999, 2002, 2004, 2006 and 2009 (in then year dollars).

The data also show a continuing decline in the number of people employed in LVM&SI, with a concurrent decrease in earnings despite a slight increase from 2002 to 2004. The reasons for these trends are a decrease in the number of U.S. commercial orbital launches during the period, combined with greater competition in the worldwide orbital launch services market.

The growth has not been uniform across all CST&EI sectors during this period, as summarized in the comparison of economic activity impacts in Figure E1. Launch vehicle and satellite manufacturing, for example, were the only industry sectors to experience a decrease from 2006 to 2009, while ground equipment manufacturing continues to show strong growth following a dip in 2004. Satellite services sectors showed strong growth because of continued increasing demand for DTH TV and transponder leasing. Satellite digital audio radio service (DARS) experienced strong growth from 2006 to 2009, with very small aperture terminal (VSAT) service, satellite data services, mobile satellite telephony, satellite remote sensing, and distribution industries continuing to show modest growth in 2009, as in previous years. These positive trends are encouraging for the U.S. commercial space transportation industry.

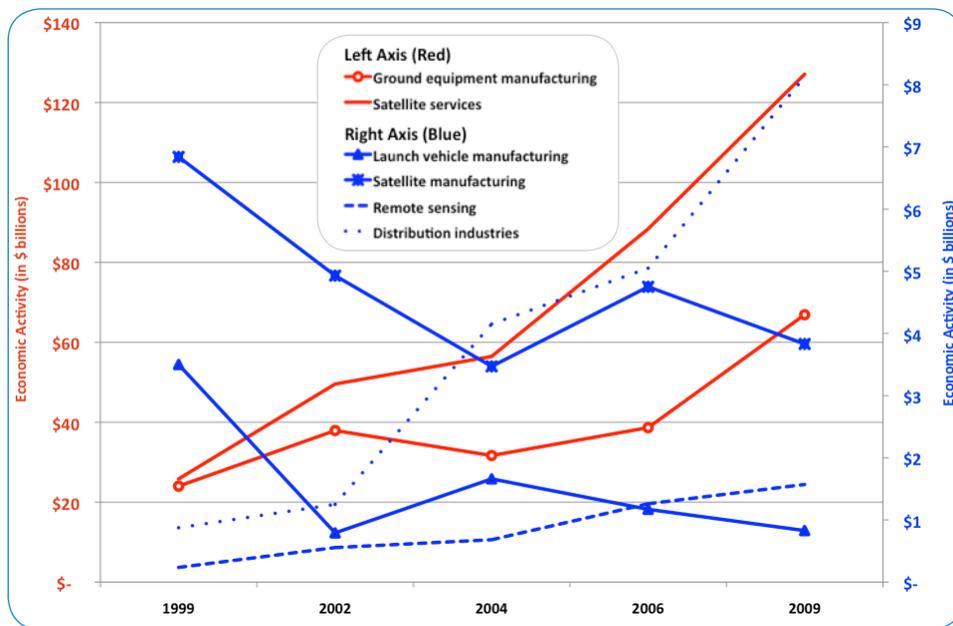


Figure E1: Total economic activity impacts on the U.S. economy of CST&EI, 1999, 2002, 2004, 2006 and 2009.

INTRODUCTION

COMMERCIAL SPACE TRANSPORTATION

Space transportation is the movement of, or means of moving objects, such as satellites and vehicles carrying cargo, scientific payloads, or passengers, to, from, or in space.

Commercial space transportation is carried out using orbital and suborbital vehicles owned and operated by private companies or organizations for profit, procured through a competitive bidding process.

Commercial spaceports have been established to support commercial launch activities, typically in cooperation with federal, state, and local governments.

Before the early 1980s, U.S. national space policy did not officially recognize the commercial space sector.² Only the United States launched commercial satellites (those used to generate revenues) using vehicles owned and operated by the government, including NASA's Space Shuttle. Events of the 1980s, including the birth of a European commercial launch services organization called Arianespace, recognition of commercial space transportation's value by U.S. government officials, and the ban of commercial payloads from flying aboard the Space Shuttle after the 1986 loss of Challenger, promoted the development of the commercial space transportation industry in the United States.

Today, there are several companies around the world that offer orbital commercial launch services. Additionally, some companies are being established to offer suborbital services for paying passengers. In recent years, commercial launches have comprised at least 25 percent of all launches conducted worldwide.

The Federal Aviation Administration (FAA) is the U.S. government agency responsible for issuing licenses to commercial launch providers and commercial spaceports through the Office of Commercial Space Transportation (AST). The office also facilitates critical interaction between government and industry representatives during Commercial Space Transportation Advisory Committee (COMSTAC) meetings held every six months in Washington, DC. FAA AST also analyzes the international competitiveness of the U.S. commercial space transportation industry, and participates in the strategic development of the nation's overall space transportation infrastructure. This report represents a key input to these efforts.

² Frankle, Edward. "Commercial Space: Confidence Built on a Framework of Law and Policy," presented at the 49th International Astronautical Conference, September 28–October 2, 1998.

COMMERCIAL SPACE TRANSPORTATION & ENABLED INDUSTRIES (CST&EI)

The overall category of Commercial Space Transportation and Enabled Industries (CST&EI) includes a large set of markets within the U.S. economy made directly possible because of the commercial launch industry.

For purposes of this report, enabled industries include the following space industry sectors:

- Satellite manufacturing covers the sale of all commercial satellites constructed by U.S. commercial satellite manufacturers.
- Satellite services include direct-to-home television (DTH TV), very small aperture terminal (VSAT) services, satellite data services, transponder leasing, satellite digital audio radio services (DARS), and mobile satellite telephony.
- Ground equipment manufacturing encompasses satellite-related hardware, such as gateways and satellite control stations. It also includes mobile uplink equipment, VSAT terminals, and consumer electronics used with satellite services, such as direct broadcasting satellite antennas and receivers, phone booths, and handheld satellite phones.
- Satellite remote sensing covers the provision of raw satellite imagery, but does not include value added services such as geographic information systems (GIS).
- Distribution industries represent wholesale, retail trade, and transit costs incurred as components are delivered to manufacturing sites. Distribution industries are enabled by the commercial launch industry because truck, air, and rail transportation services are required to move parts to manufacturing sites and to move launch vehicles and satellites to launch sites.

Figure 1, on the following page, summarizes the six enabled industries that compose CST&EI and from which the economic impacts are calculated.

By 2009, U.S. commercial space transportation, and CST&EI accounted for more than \$208.3 billion in economic activity in the United States. That level is likely to grow in the future as markets mature and new applications dependent on commercial space transportation emerge.



Figure 1: CST&EI industries included in analysis.

For more on how these industries relate to the U.S. launch industry, consult FAA AST’s Commercial Space Transportation Advisory Committee (COMSTAC) reports and presentations, which are accessible on the FAA AST website. Further information about satellite-related industries is accessible on the Satellite Industry Association (SIA) website.

LAUNCH VEHICLE MANUFACTURING AND SERVICES INDUSTRY (LVM&SI)

The Launch Vehicle Manufacturing and Service Industry (LVM&SI) is a component of CST&EI. It describes the U.S. industrial infrastructure necessary to manufacture, process, and launch orbital and suborbital vehicles and their payloads into space.³

For this study, launches conducted by the international joint venture, Sea Launch, LLC, through August 2010 are included in the commercial launch industry revenue input because the company (before its emergence from bankruptcy in July 2010) was based in the United States and launches were licensed by FAA

³ This sector is also referred to as the “commercial space transportation industry” or simply “launch industry.”

AST. However, multinational launches are *not* included in the Ten-Year Overview analysis that appears later in this report.

The U.S. launch industry is a critical element of the U.S. transportation infrastructure, for without it the nation is unable to send people and satellites into space. Whereas launch revenues are relatively small, the launch industry nevertheless enables other industries, and it is these industries that generate substantial revenues, profits, and employment.

For more on orbital launch activities and trends, consult FAA AST's many publications and reports on the launch industry including: The Year in Review, Semi-Annual Launch Reports, Quarterly Launch Reports, and reports on various special topics, all accessible on the FAA AST website.

EMERGING COMMERCIAL SPACE MARKETS

In the coming years, commercial space transportation may enable new markets that are currently emerging or have yet to develop (pre-emerging). As with the current enabled markets, these new markets may lead to measurable impacts within the U.S. national economy. Because these markets are, or may soon be emerging, they are not included in this report in measuring the economic impact of the space industry. As these market sectors mature and as their revenues increase, they will likely be included in future reports.

Market studies project that public research, educational, and adventure space transportation sectors will become significant revenue-producing markets in the foreseeable future. For example, market studies have shown that "space tourism," whereby customers pay a fee to experience suborbital spaceflight, could become a billion-dollar market within 20 years.⁴

There are emerging commercial market segments for both short flights into space where the tourists remain in the space vehicle for the entire mission, and extended missions where the spaceflight participants dock with an orbiting destination. From 2001 to the present, seven people have made a flight to the International Space Station (ISS), traveling to the orbital destination aboard the proven Russian Soyuz spacecraft.

The Las Vegas-based company Bigelow Aerospace (BA) is developing inflatable orbital modules that could be used for extended stays by spaceflight participants, with the possibility that these modules could be attached to the ISS. In addition, X Prize Foundation and Google are co-sponsoring a Lunar Prize competition that could help spur innovations in public space travel.

Currently, several private companies in the U.S. are developing vehicles that could serve orbital and suborbital space transportation markets. Suborbital space transportation may provide a boon for research and education missions (REM), possibly serving as a mechanism for some service providers to raise revenue

⁴ Starzyk, Janice. "A Fresh Look at Space Tourism Demand," Futron briefing, June 7, 2006.

necessary to invest in orbital access, which is expected to be more lucrative. Moreover, suborbital vehicles developed to carry humans may provide benefits for other markets like point-to-point passenger travel, microgravity research, and regional remote sensing. These developments have been aided by the passage, in late 2004, of the Commercial Space Launch Amendments Act, which establishes key elements of the regulatory framework needed for the suborbital commercial human spaceflight markets.

ECONOMIC IMPACT ANALYSIS REPORT STRUCTURE

The remainder of this report is structured in the following way:

- The Description of Impacts section defines the three economic impact metrics reported in this analysis, and describes the relationship between them.
- The Analysis Description section provides information (with citations) on the analytical model that is the basis of this report (RIMS II), and then provides a description of the source data input into the model.
- The Results section reports and analyzes the outputs of the analytical model.
- The final section in the main report is a comparative overview of the results from the five Economic Impact Models that were conducted since 1999.
- Two final Appendices of this report discuss (1) which industries were most affected by CST&EI and LVM&SI, and (2) how data from this report compares with similar economic impact analyses of other industries.

DESCRIPTION OF IMPACTS

Transactions within CST&EI impact all other industry sectors in term of economic activity, earnings, and employment. The impact results are a factor of the change in final demand for products or services offered by commercial space transportation and enabled industries.

ECONOMIC ACTIVITY

Economic activity is the value of goods and services produced in an economy, measured in revenue generated. In this study, economic activity includes the goods and services produced by CST&EI plus the goods and services produced by all other industry groups to support these industries.

Each measure of economic activity impact contains three components (see Figure 2, on the following page):

- Direct impacts are the expenditures on inputs and labor involved in providing any final good or service relating to the primary industries analyzed in this report.
- Indirect impacts involve the purchases (e.g., metals, composite materials, processors) made by and labor supplied by the industries providing inputs to the launch and enabled industries. This impact quantifies the inter-industry trading and production necessary to provide the final goods and services.
- Induced impacts are the successive rounds of increased household spending resulting from the direct and indirect impacts (e.g., a spacecraft solar array design engineer's spending on food, clothes dry-cleaning, or any other household good and service).

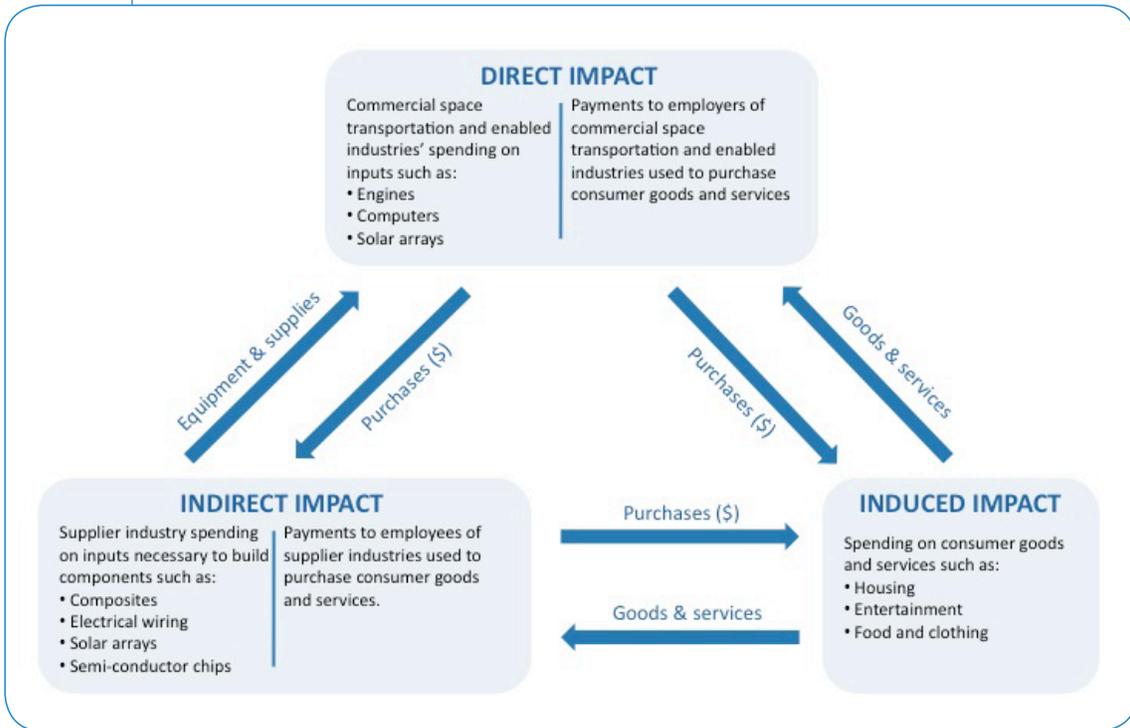


Figure 2: Relationship of impact types.

EARNINGS

Earnings refer to the sum of all the wages and salaries (including employee benefits) paid to employees in an economy. In this study, earnings include wages and salaries paid to all persons employed by CST&EI, plus those employed by all other industry groups to support these industries.

EMPLOYMENT

Employment, or jobs, refers to the total number of workers employed to support the production of goods and services in an economy. In this study, jobs include all workers employed by CST&EI, plus those employed by all other industry groups to support these industries.

ANALYSIS DESCRIPTION

This report uses an analysis based on data derived from a FAA AST-developed model that contains RIMS II industry multipliers provided by BEA. The model's outputs are discussed in this report for CST&EI, with additional detail provided for LVM&SI.

The results of a ten-year overview analysis, performed by FAA AST, are provided in the final section of this report.

RIMS II MODEL AND MULTIPLIERS

RIMS II input-output codes are based on industry groupings gathered within the North American Industry Classification System (NAICS), developed by the United States, Canada, and Mexico in 1997. The NAICS categories used in this report include *Manufacturing, Information, and Professional and Technical Services*. NAICS was revised in 2002, and will be revised again in 2012.

RIMS II multipliers, grouped by industry and organized by final demand for economic activity, earnings, and employment, are used to estimate how much a one-time or sustained increase in economic activity in a particular region is supplied by industries located in the region. Varying levels of granularity are available for the multipliers, with regions grouped by counties, states, or the nation as a whole. For this analysis, multipliers for the nation as a whole were used.⁵ These multipliers are used by industry analysts and by government to measure individual industries' contributions to the economy to support market analysis and policy decision-making.

The model, for this report, was designed using an internally developed database that links source data (described in the next section) with the RIMS II final demand multipliers via Excel formulas. Using the source data, the model automatically calculates endogenous and exogenous impact data across many different industry sectors ranging from agriculture to health care.⁶ In other words, within the model, financial transactions are traced through the economy to measure the benefit of commercial space transportation activity on industry groups.

⁵ In 2009, BEA discontinued developing RIMS II regional multipliers for the nation as a whole, instead only providing multipliers for counties and states. To remain consistent, and to allow for a decadal analysis, this report retained the "United States as region" data used in all previous reports since 1999.

⁶ Endogenous variables are those explained within the model, such as prices for goods and services, annual revenues, and the Consumer Price Index (CPI). Exogenous variables are those outside the model that cannot be anticipated, such as changes in consumer preferences.

SOURCE DATA

Most of the input revenue information used in this analysis is based on the results from the *2010 Satellite Industry Annual Indicators Study* performed by the Satellite Industry Association (SIA), which includes SIA member data from around the world.⁷

For the past ten years, SIA conducted an annual survey of space-related member companies worldwide to determine total revenue amounts for the global space industry. The revenue is segmented into the commercial launch, satellite manufacturing, satellite services, remote sensing, and ground equipment industries.

For this report the data were adjusted to reflect commercial activity within the U.S. national economy. Because each satellite services segment (DTH TV, VSAT services, satellite data services, transponder leasing, mobile satellite telephony, satellite remote sensing, and DARS) is provided by SIA as a global aggregate, the U.S. market share had to be extracted based on information from annual reports from U.S.-based companies (such as DirecTV, DISH Network, and XM-Sirius).

The analysis does not include impacts of activities enabled by Space Shuttle launches or other government expendable vehicle launches, such as revenues from the launch of the military NAVSTAR Global Positioning System (GPS) satellites. Because of this, sales of GPS chipsets or handheld navigation devices are also excluded from this study.

FAA AST data concerning U.S. launch activity in 2009, found in the office's *2009 Year in Review* (available on the FAA AST website), was used to estimate the commercial launch vehicle manufacturing and services input. There were five FAA AST-licensed launches in 2009, and four of these are included in this report, with estimated revenues totaling \$298 million. One licensed launch is not included because the satellite is operated by the federal government (National Oceanic and Atmospheric Administration).

⁷ The report is available on the SIA website at www.sia.org.

RESULTS

ECONOMIC ACTIVITY

In 2009, CST&EI generated a total of \$208.3 billion in economic activity. This includes \$127.1 billion generated by satellite services and \$66.9 billion from the manufacture of ground equipment; the top two revenue contributors. LVM&SI generated \$828 million.

Table 1 illustrates the total economic impacts generated by CST&EI and LVM&SI, with CST&EI divided among the five enabled industries. The table details the direct, indirect, and induced impacts of economic activity, which, when combined, yield the total impact on the U.S. economy.

Industry	Direct	Indirect	Induced	Total Impacts
LVM&SI (\$000)	\$141,334	\$373,939	\$312,545	\$827,817
CST&EI (\$000)				
Satellite manufacturing	\$683,530	\$1,805,935	\$1,340,032	\$3,829,498
Ground equipment manufacturing	\$11,940,379	\$31,547,321	\$23,408,610	\$66,896,310
Satellite Services	\$20,897,418	\$59,335,354	\$46,846,180	\$127,078,951
Remote sensing	\$157,580	\$632,770	\$780,949	\$1,571,300
Distribution industries	\$1,025,177	\$3,635,693	\$3,464,265	\$8,125,135
TOTAL (\$000)	\$34,845,418	\$97,331,013	\$76,152,583	\$208,329,012

Table 1: Economic activity impacts of CST&EI, 2009. The satellite services industry includes the six separate sectors: DARS, DTH TV, mobile satellite telephony, satellite data services, transponder leasing, and VSAT services (sum of total impact varies due to rounding).

Due to expenditures and labor required, the sector of satellite services was responsible for the majority of CST&EI direct impacts, with DTH TV being the dominant contributor (see Table 2, on the following page). Overall, direct impacts in 2009 showed an increase of 44 percent from 2006. Direct impacts related to LVM&SI showed a decline of about 30 percent from 2006, due to a decline in the number of U.S. commercial launches.

Indirect impacts of CST&EI, strongly propelled by inter-industry trading and production among companies providing satellite services, also showed an increase of 44 percent from 2006. The LVM&SI indirect impacts showed a decline during this timeframe.

Finally, induced impacts followed the other two metrics with a substantial increase between 2006 to 2009 for CST&EI, though a decline took place for LVM&SI. Over one million people employed within CST&EI produced \$76 billion in induced economic activity in the form of housing, entertainment, food, clothing and other purchases.

Table 2 summarizes the three economic impacts of CST&EI in 2009.

Industry	Economic Activity (\$000)	Earnings (\$000)	Employment (Jobs)
LVM&SI (\$000)	\$827,817	\$218,595	3,820
CST&EI (\$000)			
Satellite manufacturing	\$3,829,498	\$936,842	17,030
Ground equipment manufacturing	\$66,896,310	\$16,365,395	297,560
Satellite Services			
Direct-to-home (DTH) TV services	\$101,473,026	\$26,180,928	519,320
VSAT services	\$5,973,790	\$1,534,790	30,120
Satellite data services	\$966,196	\$248,236	4,870
Transponder leasing	\$10,389,200	\$2,669,200	52,380
Mobile satellite telephony	\$697,115	\$179,103	3,510
Remote sensing	\$1,571,300	\$546,255	11,840
Satellite Digital Audio Radio Service	\$7,579,625	\$1,955,609	38,790
Distribution industries	\$8,125,135	\$2,422,393	50,200
TOTAL (\$000)	\$208,329,012	\$53,257,346	1,029,440

Table 2: Total impacts on the U.S. economy generated by CST&EI, 2009 (total varies due to rounding).

The relative proportion that each of the six primary industries contributed to total economic activity impacts in 2009 is shown in Figure 3, on the following page. Satellite services and ground equipment manufacturing contributed the largest portions of this activity, comprising 61 percent and 32 percent, respectively, of the total impact. Almost 95 percent of the total economic activity impact on the U.S. economy from CST&EI came from the Satellite Services and Ground Equipment Manufacturing sectors. LVM&SI, in contrast, accounts for less than 0.4 percent of the overall CST&EI activity in the U.S. economy. Put another way, for every \$1000 of economic impact attributable to CST&EI, LVM&SI is responsible for under \$4. See the next section entitled “Ten Year Overview” for further discussion on the economic impact of LVM&SI.

These results show that the launch vehicle manufacturing industry functions as an enabler of other industries rather than a significant economic activity generator. Over time, commercial launches have placed many satellites in orbit allowing operators to offer a range of satellite services and spurring the growth of ground equipment production to support these satellite services. Commercial launch is essential for maintaining existing satellite services markets and is invaluable for future emerging space markets.

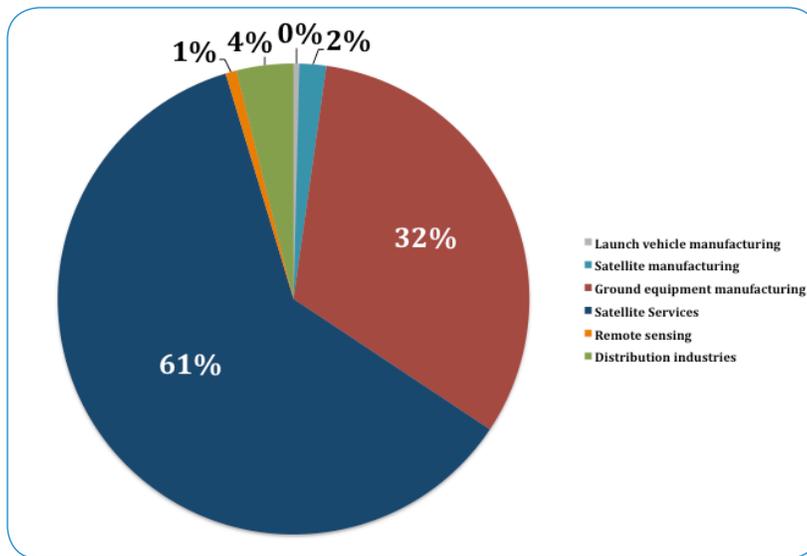


Figure 3: Distribution of total economic activity impacts resulting from CST&EI, 2009.

Figure 4 shows a further breakout of the Satellite Services portion of economic activity impact. DTH TV dominated the Satellite Service sector, accounting for 80 percent of the economic activity generated within the sector. Transponder leasing was the next largest contributor, with eight percent of the total Satellite Services impact. DARS created about six percent of the impact, while VSAT services created slightly less than five percent. Data Services and Mobile Satellite Telephony comprise the remaining one percent of the total economic activity impact due to Satellite Services.

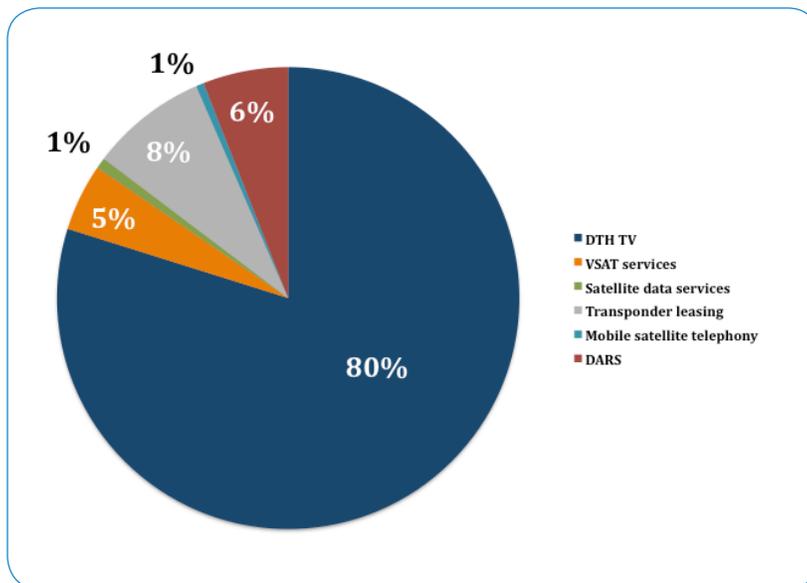


Figure 4: Distribution of economic activity impacts resulting from satellite services industry sectors, 2009.

EARNINGS

Commercial space transportation and enabled industries supported about \$53.3 billion in salaries and wages throughout the United States.

Earnings showed an increase of 34 percent from 2006 to 2009, with an average growth rate of 14 percent a year, the second fastest growth rate since FAA AST started measuring this metric in 2001. The growth in earnings from 2004 to 2006 was the fastest growing at an average annual rate of 19 percent. The growth rate was slowest in the 2002 to 2004 period with an average annual rate of only three percent. The 1999 to 2002 period grew almost as fast as the current period, 13 percent on average annually.

EMPLOYMENT

The \$208.3 billion in economic activity generated by CST&EI supported over one million jobs throughout the economy.

The number of jobs supported by CST&EI increased significantly between 2006 and 2009, from 736,130 to 1,029,440 jobs. This increase correlates with the increases in economic activity and earnings.

TEN-YEAR OVERVIEW (1999-2009)

CHANGES TO ECONOMIC IMPACTS OVER TIME

This section describes the economic performance data for CST&EI and LVM&SI for the past decade (in then-year dollars). Tables 3 and 4 represent economic impacts of both industry groups as described in previous sections.

	1999	2002	2004	2006	2009
Economic Activity (\$000)	\$61,313,711	\$95,025,746	\$98,086,960	\$139,262,027	\$208,329,012
Direct (\$000)	\$9,644,429	\$16,959,859	\$16,666,148	\$23,240,911	\$34,845,418
Indirect (\$000)	\$29,510,733	\$46,715,917	\$46,382,890	\$65,031,780	\$97,331,013
Induced (\$000)	\$22,158,549	\$31,349,971	\$35,037,924	\$50,989,338	\$76,152,583
Earnings (\$000)	\$16,431,192	\$23,527,745	\$25,045,888	\$35,659,935	\$53,257,346
Employment	497,346	576,448	551,350	729,240	1,029,440

Table 3: CST&EI economic impact totals (in then year dollars).

	1999	2002	2004	2006	2009
Economic Activity (\$000)	\$3,515,978	\$791,759	\$1,658,384	\$1,166,723	\$827,817
Direct (\$000)	\$499,027	\$149,273	\$286,936	\$199,195	\$141,334
Indirect (\$000)	\$1,580,890	\$367,530	\$759,171	\$527,028	\$373,939
Induced (\$000)	\$1,446,061	\$274,956	\$612,277	\$440,500	\$312,545
Earnings (\$000)	\$1,071,722	\$206,328	\$437,674	\$308,087	\$218,595
Employment	28,617	4,828	8,870	5,690	3,820

Table 4: LVM&SI economic impact totals (in then year dollars).

To perform a ten-year analysis of economic activity impacts, it is necessary to normalize the then-year dollars to a specified standard. The numbers in the tables above (Tables 3 and 4) are adjusted using a Consumer Price Index (CPI) multiplier. The results are displayed in the following tables (Tables 5 and 6).

	1999	2002	2004	2006	2009
Economic Activity (\$000)	\$79,094,687	\$113,080,638	\$111,819,134	\$147,617,749	\$208,329,012
Direct (\$000)	\$12,441,313	\$20,182,232	\$18,999,409	\$24,635,366	\$34,845,418
Indirect (\$000)	\$38,068,846	\$55,591,941	\$52,876,495	\$68,933,687	\$97,331,013
Induced (\$000)	\$28,584,528	\$37,306,465	\$39,943,233	\$54,048,698	\$76,152,583
Earnings (\$000)	\$21,196,238	\$27,998,017	\$28,552,312	\$37,799,531	\$53,257,346
Employment	497,346	576,448	551,350	729,240	1,029,440

Table 5: CST&EI economic impact totals (in 2009 dollars).

	1999	2002	2004	2006	2009
Economic Activity (\$000)	\$4,535,612	\$942,193	\$1,890,558	\$1,236,726	\$827,817
Direct (\$000)	\$643,745	\$177,635	\$327,107	\$211,147	\$141,334
Indirect (\$000)	\$2,039,348	\$437,361	\$865,455	\$558,650	\$373,939
Induced (\$000)	\$1,865,419	\$327,198	\$697,996	\$466,930	\$312,545
Earnings (\$000)	\$1,382,521	\$245,530	\$498,948	\$326,572	\$218,595
Employment	28,617	4,828	8,870	5,690	3,820

Table 6: LVM&SI economic impact totals (in 2009 dollars).

Figures 5 and 6 show graphs of the resulting data. Figure 7 and 8 show earnings data and employment data from the preceding tables (Tables 5 and 6).

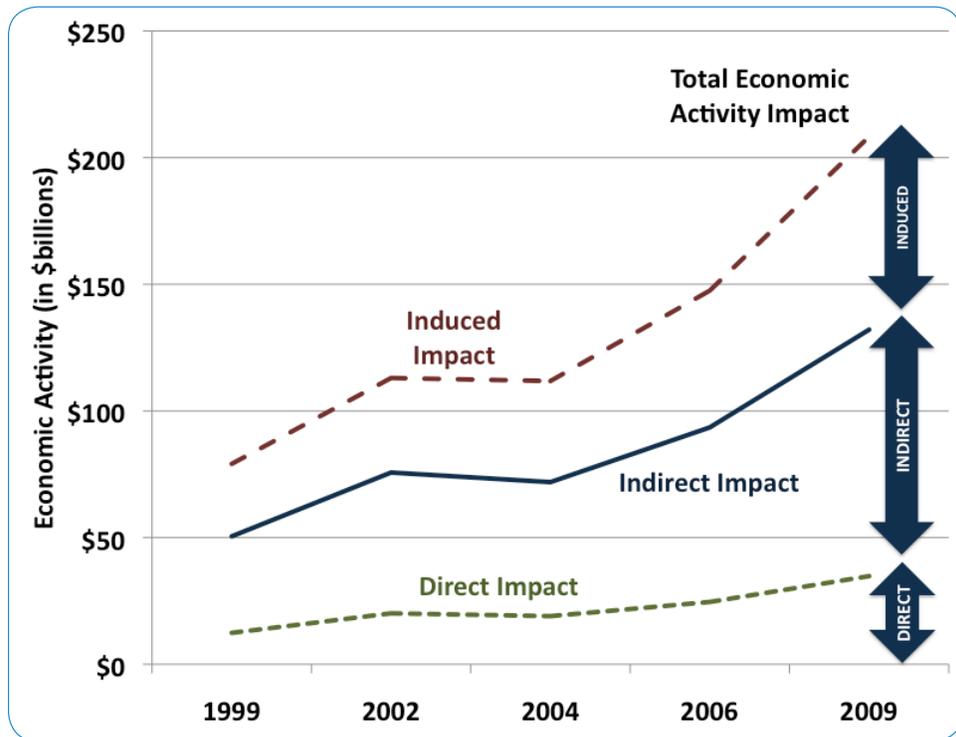


Figure 5: CST&EI economic impact totals (in 2009 dollars), showing direct, indirect, and induced impacts.

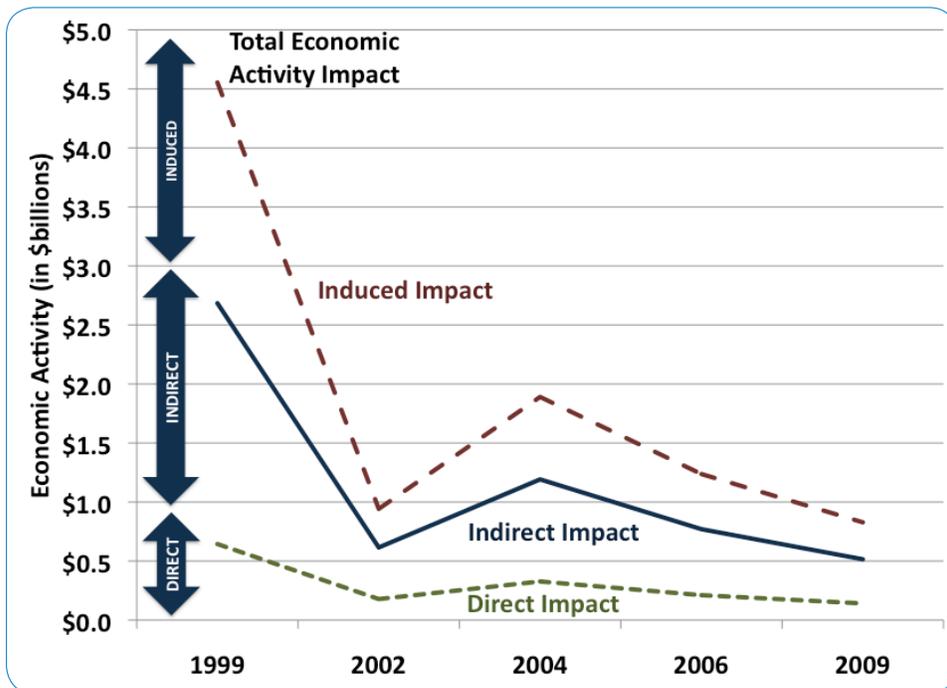


Figure 6: LVM&SI economic impact totals (in 2009 dollars), showing direct, indirect, and induced impacts.

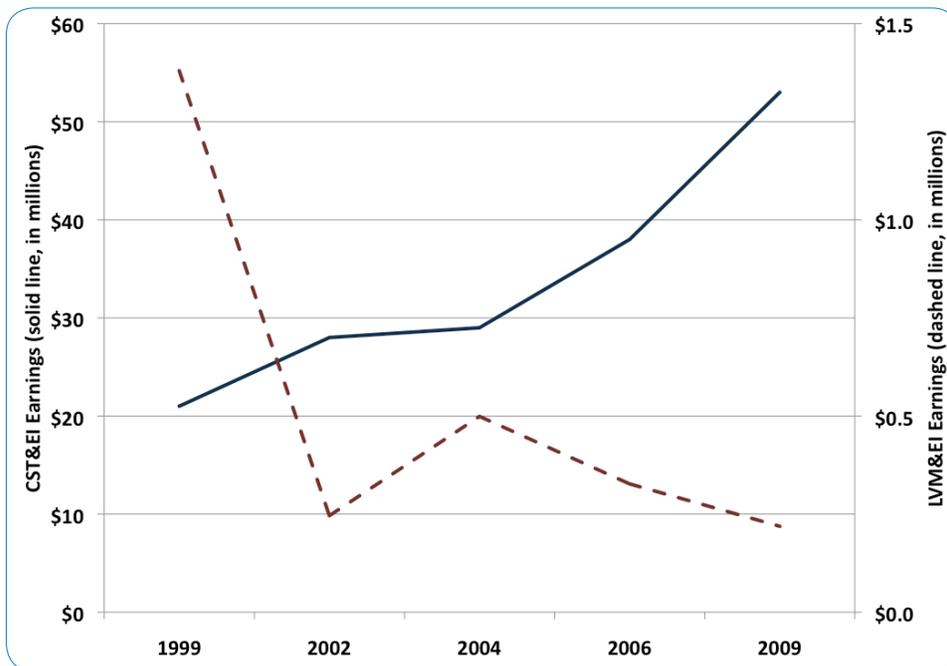


Figure 7: CST&EI and LVM&SI earnings totals (in 2009 dollars).

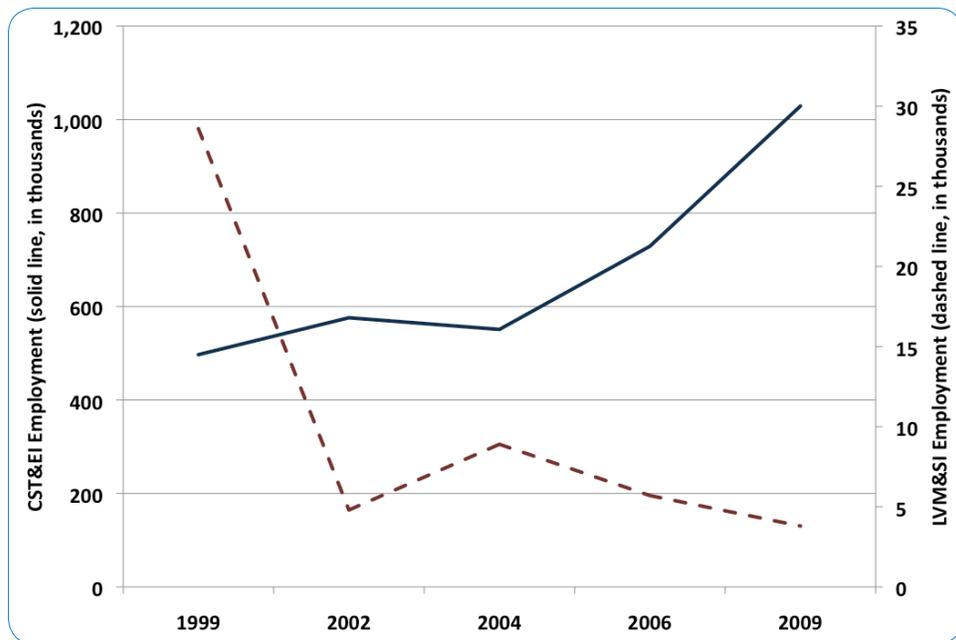


Figure 8: CST&EI and LVM&SI employment totals (in 2009 dollars).

ANALYSIS

Analysis of this data includes questioning the following trends:

- What is the cause of the dramatic decrease from 1999 to 2002 in LVM&SI economic activity impact (shown in Figure 6)?
- How is it that the economic activity impact of LVM&SI is steadily decreasing at the same time that the economic activity impact of LVM&SI enabled industries is steadily increasing?
- What is the leverage value of every U.S. LVM&SI Economic Activity Impact dollar on the rest of the U.S. LVM&SI and CST&EI?

Dramatic Decrease in 2002 LVM&SI Data

The first point of analysis is to investigate the steep decline reported from 1999 to 2002, explained in the 2002 Economic Impact report as being “primarily due to a sharp decrease in the manufacture and launch of commercial spacecraft.”⁸ An increase was seen in all three Economic Activity components with the 2004 data, explained in that report as follows: “Launch vehicle manufacturing rebounded from 2002 because of an increase in commercial launches conducted in 2004.”⁹

These explanations posit a direct relationship between the number of U.S. commercial launches and the three components of Economic Activity Impact. Table 7 lists the number of FAA-licensed orbital launch events that occurred from 1999 through 2009 (the years for which FAA AST has tracked Economic Impact). Note that these are U.S. launches only and do not include multi-national launch vehicles, such as the Sea Launch Zenit.¹⁰

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of U.S. Commercial launches	15	7	3	5	5	6	1	2	3	6	4

Table 7: U.S. Orbital Commercial Launches, 1999-2009 (includes all orbital launches licensed by AST, except those conducted by Sea Launch).

When Economic Activity Impact is plotted together with the number of U.S. launches (as shown in Figure 9, on the following page), the results reveal two trends:

- The dramatic decrease in the 2002 LVM&SI economic activity impact data, including all three components, does seem to reflect a dramatic decrease in the number of U.S. commercial launches immediately before 2002. Notably, the number of launches dropped from 15 to 7 to 3 (from 1999 to 2001) before increasing (briefly) again. The relative level and time scale of volatility of both data sets for this brief period seem to be similar.
- The implication (inferred by the data before and including 2004) of a strong direct relationship between the number of U.S. commercial launches and the value of LVM&SI economic activity impact seems to be counter-indicated by the same data for the rest of the reporting period (from 2004 to 2009). At first glance, the relative volatility level and time scale in this portion of the graph seem to be very different than during the earlier time period. In fact, it is plausible that the economic activity impact metric reacts sluggishly as compared to the number of launches. However, the inconsistencies of volatility and time scale are over-emphasized by showing more annual launch data points (five) as compared to bi-annual data points for Economic Activity (only three). When the same number of data points are plotted for similar years, the apparent level of volatility and time-lag is less pronounced.

⁸ “The Economic Impact of Commercial Space Transportation on the U.S. Economy: 2002 Results and Outlook for 2010”, March 2004, page 1.

⁹ “The Economic Impact of Commercial Space Transportation on the U.S. Economy: 2004”, February 2006, page 1.

¹⁰ Launch data taken from multiple FAA AST Year In Review and Quarterly/Semi-Annual Launch Reports.

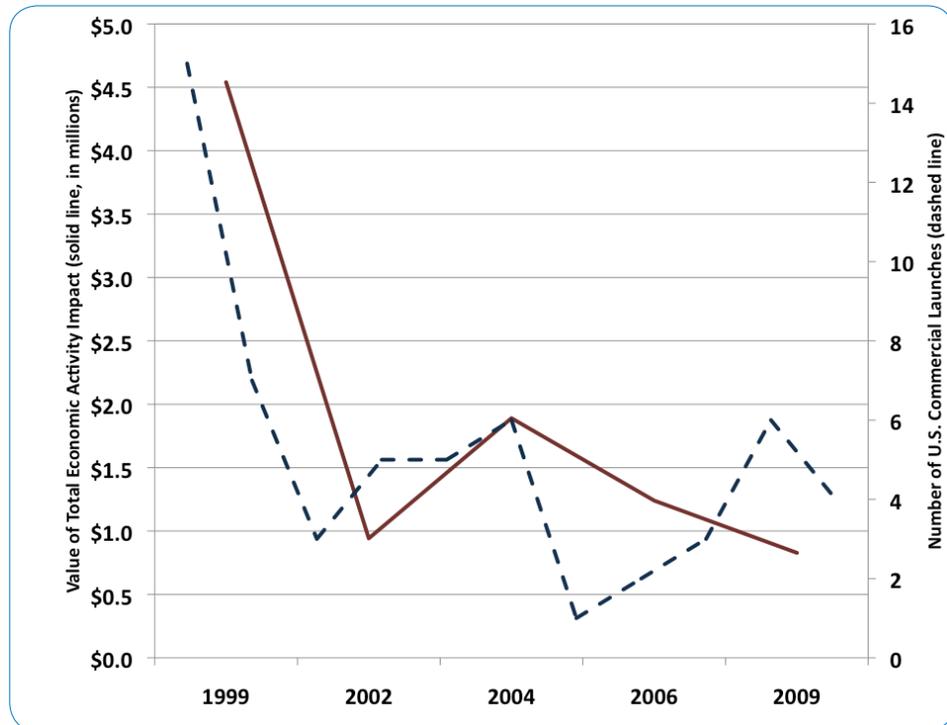


Figure 9: LVM&SI total economic activity plotted with U.S. commercial launches, 1999-2009.

Decrease of LVM&SI Economic Impact Values

The second analysis centers on the dramatic difference in economic activity data of both CST&EI as well as LVM&SI.

The CST&EI Total Economic Activity chart (Figure 5) shows a generally increasing trend of all three components (Direct, Indirect, and Induced impacts) as a function of time. A brief period of stagnation (or slight decline) was seen from 2002 to 2004. Inversely, LVM&SI Total Economic Activity chart (Figure 6) shows a generally decreasing trend of all three components as a function of time (except for the dramatic decrease from 1999 to 2002 discussed in the previous section).

The U.S. LVM&SI economic activity impact data (Table 6) shows a decrease of 71.7 percent from 1999 to 2009 in economic impact values. This trend is reflected by the decreasing number of U.S. commercial launches (Table 7 and Figure 9) that denotes a direct relationship with employment levels, orders of raw materials, etc., all of which are factored into the total economic activity impact value.

Another contribution to the decrease of LVM&SI economic activity impact values, and one which contributes to the declining number of U.S. commercial launches, includes fierce market competition from non-U.S. LVM&SI companies and this has resulted in a diminished market share for U.S. launch providers.

However, if the 2002 data point is not seen as an anomaly (as proposed in the first analysis discussion) but rather as the beginning of a new “normal” in the launch rate (and the resulting economic activity impact), a new conclusion results. From this perspective, the 1999 data point is the end of the launch market based on a large

number of communication satellites that, in fact, did not materialize.

The new conclusion would be that the launch rate, and resulting economic activity impact is not generally decreasing, but has been at a constant (albeit lower) level ever since 2002.

Leverage of LVM&SI Direct Benefits

Finally, the calculation of how much impact each dollar of LVM&SI Direct impact dollar spent has on the rest of the U.S. LVM&SI as well its impact on the overall CST&EI might be of interest.

The LVM&SI leverage ratio is calculated by dividing the sum of the indirect and induced impact values by the LVM&SI direct impact value. The values of this leverage ratio are tabulated below in Table 8.

	1999	2002	2004	2006	2009
LVM&SI	6.1	4.3	4.8	4.9	4.9
CST&EI	121.9	645.6	340.8	698.1	1473

Table 8: CST&EI and LVM&SI direct impact leveraging ratios, 1999-2009.

The calculations show that the LVM&SI Direct Impact Leverage on the LVM&SI ratio is relatively stable, retaining a value just under 5.0 since the 2002 report (after the launch market experienced its dramatic readjustment). This indicates that for every dollar spent in the direct purchase of a launch vehicle and service results in almost \$5 of indirect and induced economic impact within that same industry segment.

CONCLUSIONS

The variation of LVM&SI Economic Activity Impact data between 1999 and 2009 is satisfactorily explained by the seemingly strong relationship between the economic activity impact values and the number of U.S. commercial launches. The number of commercial launches resulted from a dramatic adjustment in the launch market that occurred after 1999. Other factors, such as the competitive launch services market environment, also contribute to this relationship.

The total LVM&SI Economic Activity Impact data shows a consistent trend of decline, especially when viewing the data from 1999 onward. (It is more constant when viewed starting with the 2004 data.) The explanation for this trend is attributable toward a consistently lower number of U.S. commercial orbital launches, due to intense market competition for candidate launches from foreign providers (as mentioned above).

Finally, every dollar of LVM&SI direct impact ripples through the economy with indirect and induced impacts. The leveraging ratio of the direct impact has remained fairly constant since 2002 with a value just less than 5:1. Plainly stated, for every dollar spent purchasing a U.S. commercial space launch, almost \$5 is subsequently spent in indirect or induced ways.

APPENDIX I: MOST AFFECTED INDUSTRIES

All RIMS II-designated industry groups are impacted by the activities of the commercial space transportation and enabled industries. Table A1 shows how each of the industry groups was impacted in terms of revenues, earnings, and jobs as a result of commercial space transportation and enabled industries in 2009. The industry groups are ranked by the amount of impact on economic activity. Although some of these industry types may appear unrelated to commercial space transportation, they are impacted because they provide goods and services, directly or indirectly, to the commercial space industry. The industry groups also benefit when employees of the commercial space industry spend earnings on consumer goods and services, such as household items and leisure activities.

Industry	Annual Economic Activity (\$000)	Annual Earnings (\$000)	Jobs (actual)
Information	\$65,439,541	\$15,300,588	213,230
Manufacturing	\$55,057,996	\$10,344,418	139,330
Real Estate and Rental and Leasing	\$14,117,305	\$1,045,577	26,460
Finance and Insurance	\$10,293,180	\$2,837,099	41,270
Wholesale Trade	\$9,604,696	\$3,086,597	49,520
Professional, Scientific, and Technical Services	\$8,924,227	\$3,907,575	67,580
Health Care and Social Assistance	\$7,573,426	\$3,686,542	86,910
Retail Trade	\$6,433,283	\$2,186,157	83,970
Transportation and Warehousing	\$4,953,733	\$1,721,070	37,490
Other Services	\$4,488,631	\$1,487,338	49,580
Accommodation and Food Services	\$3,838,417	\$1,468,241	78,590
Management of Companies	\$3,642,211	\$1,798,479	19,860
Administrative and Waste Management Services	\$3,433,803	\$1,444,426	53,400
Arts, Entertainment, and Recreation	\$2,943,346	\$1,134,515	39,430
Utilities	\$2,770,861	\$513,427	4,950
Agriculture, Forestry, Fishing, and Hunting	\$1,906,597	\$279,481	11,170
Educational Services	\$1,209,871	\$548,406	18,630
Mining	\$976,568	\$191,344	2,130
Construction	\$721,322	\$276,068	5,960
TOTAL	\$208,329,012	\$53,257,346	1,029,460

Table A1: Distribution of economic activity, earnings, and jobs throughout major U.S. industry groups, generated by commercial space transportation and enabled industries, 2009.

In 2009, the *Information Services* industry was the most affected group in terms of additional economic activity, earnings, and jobs, generating over \$65.4 billion of revenues, over \$15.3 billion in earnings, and creating 213,230 jobs. *Information Services* include data processing, Web and application hosting, and related services; Internet service providers; Internet publishing and broadcasting; newspaper, magazine, and book publishing; software publishing; and film, television, and video production and distribution.

The *Manufacturing Industry* group ranked second in 2009, with an impact of \$55.1 billion in economic activity, \$10.3 billion in earnings, and 139,330 jobs. This group includes manufacturing of a wide range of products such as machinery, computer and electronic devices and components (e.g., semiconductor microprocessors and integrated circuits), electrical equipment and appliances (e.g., motors and generators), motor vehicles, textiles and apparel, food and beverages, and paper and plastics.

In 2009, the *Professional, Scientific, and Technical Services* industry group experienced an economic impact of approximately \$8.9 billion in revenues, \$3.9 billion in employee earnings, and 67,580 jobs. As was the case in 2006, this industry group ranks sixth in economic activity and jobs and ranks third in earnings. The group is composed of legal, accounting, architecture and engineering, advertising, computer system design, technical and management consulting, scientific research and design, specialized design, photographic, and veterinarian services.

Transportation and Warehousing experienced about \$5 billion in economic activity in 2009 as a result of the commercial space transportation and enabled industries, ranking ninth out of 19 industry groups. About \$1.7 billion in earnings and 37,490 jobs were supported. *Transportation and Warehousing* industries have a clear role supporting the commercial space transportation and enabled industries. Launch vehicle and spacecraft components must be transported to launch locations and employees need food brought to the grocery stores in which they shop, among numerous other examples. Air, sea, and ground transportation for goods and people, as well as the movement of goods through pipelines, the storage of goods, couriers and messengers (excluding postal service), including support services, are all included in *Transportation and Warehousing*.

The far-reaching economic impacts of the commercial space transportation industry are seen also in the *Agriculture, Forestry, Fishing, and Hunting* industry group. This sector, which ranks 16th out of the 19 industry groups, experienced \$1.9 billion of economic activity impact as a result of the commercial space transportation and enabled industries. Earnings of approximately \$279 million and over 11,170 jobs were supported in 2009. The activities in this industry group—none of which have a direct relationship with commercial space transportation—include crop and animal farming, greenhouse and nursery production, forestry and logging, fishing, hunting, trapping, and support services for these activities. Although these activities are linked to commercial space transportation and enabled industries only through indirect and induced relationships, there is still a measurable economic impact on this industry group within the U.S. economy.

APPENDIX II: ECONOMIC IMPACT COMPARISON TO OTHER INDUSTRIES

The type of analysis presented in this report is not unique to the commercial space transportation industry. Several other industries have similar studies calculating their respective economic impacts on U.S. economic activity. This section compares other national economic impact studies from 2004 to 2009 with the contributions of commercial space transportation in 1999, 2002, 2004, 2006, and 2009. Table A2 compares the economic impacts of commercial space transportation alongside other studied industries.

Industry	Economic Activity (in \$billions)	Earnings (in \$billions)	Employment
Commercial Aviation (2006)	\$1,247	\$380	11,393,000
Travel and Tourism (2006)	\$700	\$177	7,500,000
Commercial Space Transportation and Enabled Industries (2009)	\$208	\$53	1,029,440
Wine, Grape, and Grape Products (2005)	\$162	\$33	1,100,000
Commercial Space Transportation and Enabled Industries (2006)	\$139	\$36	729,280
General Aviation (2004)	\$118	\$38	956,000
Commercial Space Transportation and Enabled Industries (2004)	\$98	\$25	551,000
Commercial Space Transportation and Enabled Industries (2002)	\$95	\$24	576,000
Time Share (2005)	\$62	\$22	565,300
Ethanol (2006)	\$42	\$7	163,000

Table A2: Comparison of economic impacts of commercial space transportation and enabled industries and economic impacts of other industries.

The majority of studies selected for comparison use the RIMS II model, however the wine and grape industry and timeshare studies use the IMPLAN model. Similar to the RIMS II model, IMPLAN is a regional input-output economic modeling system that is maintained and sold by a private company. There are differences between the two models, as well as with other available economic impact models, but neither model has distinct advantages over the other for the economic impacts calculated for this report. Empirical evaluations of estimates produced by IMPLAN, REMI, and RIMS II show a similarity in magnitude.¹¹

Two of the industries in Table A2 are transportation-related: commercial aviation and general aviation. These industries show the impact of commercial space transportation in relation to that of other FAA-regulated aviation activity. Commercial space transportation and enabled industries' economic activity impacts fall between those two aviation types, with commercial aviation significantly higher than all other compared industries. General aviation has slightly lower impacts in terms of economic activity, but higher impacts in terms of jobs and earnings, compared to the impacts of this study.

¹¹ Lynch, Tim. "Analyzing the Economic Impact of Transportation Projects Using RIMS II, IMPLAN and REMI," Center for Economic Forecasting and Analysis, October 2000.

There are also non-transportation industries included in this comparison. Commercial space transportation and enabled industries has a greater impact on the U.S. economy than the timeshare and ethanol industries combined, while the travel and tourism industry economic impact dwarfs that of commercial space transportation.