The Perryman Group Blast

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February 2022

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Texas Surges Ahead in the New Space Race

Space has captivated the imagination of humankind since history began. Early societies tracked planetary movement and oriented buildings accordingly, navigators relied on the stars to make their way across oceans, and myths were written around constellations.

As space travel became a realistic possibility, a "space race" developed, with the United States pitted against Russia to be the first to achieve milestones such as orbiting the earth and landing on the moon.

Americans were glued to television screens in July

1969 as Neil Armstrong became the first human to step on the moon, and every previous and subsequent milestone has been the subject of intense interest among people in all walks of life. Texas was an integral part of this phenomenon and it left an indelible imprint on the culture and personality of the state.

In the past, activity related to space was largely confined to the public sector, with the federal government supporting all research and development and operations. This basic research enabled development of key knowledge, technologies, and materials, and the industry has reached a point where it is feasible for private firms to be more fully involved in the entire spectrum of spacerelated operations. The race has changed, with public-private partnerships and an expanded

Current Annual Impact of the Space Economy

Economic Indicator	United States	State of Texas
Total Expenditures	+420.0 billion per year	+23.0 billion per year
Gross Product	+\$204.0 billion per year	+\$1 <mark>1.7 billion per year</mark>
Personal Income	+\$123.1 billion per year	+\$7.2 billion per year
Employment	+1,734,515 jobs	+102,267 jobs

Source: US Multi-Regional Impact Assessment System, The Perryman Group Notes: Monetary values in billions of 2021 dollars per year. See page 4 for additional detail on methods and assumptions used.

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range of possibilities generating massive investments and new developments.

THE SPACE ECONOMY

The Space Economy spans elements of many industrial sectors, with major components including the manufacture of space vehicles, propulsion systems, satellites, communication systems, navigation and guidance equipment, and associated parts. It further includes satellite communication, the transportation of people and cargo, and extensive technological supports from scientists and engineers. The Space Economy in the United States currently

supports almost 350,000 direct jobs, with spillover effects permeating the entire spectrum of business activity.

The Perryman Group estimates that when multiplier effects are considered, the current annual impact of the Space Economy on US business activity includes over \$204.0 billion in annual gross product and 1.7 million jobs.

TEXAS

As noted, Texas has long had a presence in spacerelated industries. For more than 60 years, the Lyndon B. Johnson Space Center (JSC) has been engaged in key missions for the National Aeronautics and Space Administration (NASA). JSC is the site of mission control and astronaut training, as well as numerous other initiatives. Some 11,000 people work at the 1,620-acre complex near Houston, and the related museum draws over a million visitors per year (including 33% from other states and 33% from other countries).

Private-sector firms are also expanding space operations, with a significant presence in Texas. These companies are investing not only in the largest metropolitan areas, but also in small communities around the

Projected Annual Impact of the Space Economy

As of 2030	United Sta	ates	State of Texas		
AS 01 2030	Low Case	High Case	Low Case	High Case	
Total Expenditures	+\$613.492 b	+\$709.582 b	+\$46.559 b	+\$53.852 b	
Gross Product	+\$298.003 b	+\$344.679 b	+\$23.612 b	+\$27.310 b	
Personal Income	+\$179.760 b	+\$207.915 b	+\$14.476 b	+\$16.743 b	
Employment	+2,171,531	+2,511,655	+175,274	+202,726	
As of 2040	United Sta	ates	State of	Texas	
As of 2040	United Sta Low Case	ates High Case	State of Low Case	Texas High Case	
As of 2040 Total Expenditures					
	Low Case	High Case	Low Case	High Case	
Total Expenditures	Low Case +\$934.656 b	High Case +\$1,098.670 b	Low Case +\$96.362 b	High Case +\$113.271 b	

Source: US Multi-Regional Impact Assessment System, The Perryman Group

Notes: Monetary values in billions of 2021 dollars per year. See page 4 for additional detail on methods and assumptions used.

state. They are developing capabilities across a spectrum of businesses including cargo, transport, and satellite.

SpaceX, founded by Elon Musk, designs, manufactures, tests, and launches satellites and spacecraft for orbit and cargo transport and has been awarded contracts by NASA for development of a lunar lander and other components. For more than a decade, it has been operating a rocket development facility in McGregor, and has recently been expanding that facility to include a \$150 million factory for its Raptor 2 rocket engines. Other SpaceX operations in the state include a commercial rocket launch site in Boca Chica Beach.

Blue Origin, founded by Jeff Bezos, is focused on systems for human spaceflight including space tourism. The company's facility near Van Horn is used for flight testing and launches. Blue Origin is also involved in partnerships with NASA and has begun space tourism flights.

Among other companies operating in Texas, XCOR Aerospace designs and produces reusable launch vehicles, rocket engines and rocket propulsion systems in Midland. Boeing, which has long had operations in the state, is also working on various systems for NASA.

Midland International
Airport became the first
airport in the nation to also
be issued a commercial
spaceport license by the
FAA. Now known as the
Midland International Air
and Space Port, a variety
of related businesses are
developing in the area. The
Houston Spaceport has also
been approved by the FAA
and work is underway, with
a variety of firms planning
locations in the area.

These are only a few of the companies and developments underway in the state. Texas presently is home to about 6.75% of Space Economy jobs, which is less than the state's share of overall jobs in the economy (about 8.5%). The state's importance in the arena has been expanding markedly of late, however, with high profile activities and underlying investments accelerating development. The current impact of the Space Economy on Texas includes an estimated \$11.7 billion in annual gross product and over 102,000 jobs (including multiplier effects).

FUTURE OUTLOOK

Looking ahead, spacerelated industries are expected to see substantial growth, driven by their ability to enhance security, communications, and other aspects of the economy and society. The Space Economy in the United States (as measured by gross product) is projected to expand its output by approximately 120%-200% by 2040, potentially being three times its current size. In Texas, the Space Economy is expected to expand about 120% faster than in the nation, raising its share to almost 15%.

Based on current major industry forecasts, The Perryman Group estimates

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that by 2030, the total impact of the Space Economy on US business activity could rise to between \$298.0 billion and \$344.7 billion in annual gross product and 2.2-2.5 million jobs including multiplier effects (depending on whether the lower bound or median of the forecasts is assumed). For Texas, the Space Economy and related spillover effects generate a projected \$23.6 billion to \$27.3 billion in annual gross product and between about 175,300 and 202,700 jobs as of 2030. By 2040, impacts rise substantially, supporting up to 3.3 million US jobs and nearly 433,500 Texas jobs (including multiplier effects).

CONCLUSION

The Space Economy is a substantial and growing source of business activity. It is also essential to security, communications, and solutions to major problems such as climate change and resource limitation. In addition, the research and development it involves generates new discoveries which enhance daily life and wellbeing.

Texas already plays an important role in space exploration and related industries. With a major public-sector presence, large and growing private-sector initiatives, and aggressive development efforts, the state is likely to significantly increase its share of the Space Economy.

METHODOLOGY

Any economic stimulus leads to dynamic responses across the economy. The Perryman Group has developed complex and comprehensive models over the past four decades to measure these dynamic responses. In this instance, the level of direct activity in space-related business as well as projected future levels of direct activity were used as inputs to the system. The current size and scope of the industry was determined through extensive research related to individual components and is generally consistent with other estimates. Two scenarios for future activity were developed reflecting (1) the lowest and (2) the median of major industry studies and projections of the growth of the Space Economy. Both were examined for plausibility based on patterns in investment, research and

development, and overall demand.

The Perryman Group's dynamic input-output assessment system (the US Multi-Regional Impact Assessment System) was then used to estimate the total economic impacts including not only direct activity, but also indirect and induced effects. The impact system uses a variety of data (from surveys, industry information, and other sources) to describe the various goods and services (known as resources or inputs) required to produce another good/ service. This process allows for estimation of the total economic impact. Monetary values were quantified on a constant (2021) basis to eliminate the effects of inflation. Changes in productivity and industry interactions over time were determined using the firm's US Multi-Regional Econometric Model.

Total economic effects are quantified for key measures of business activity including the following. Total expenditures (or total spending) measures the dollars changing hands as a result of the economic stimulus. Gross product (or output) is production of goods and services that will come about in the area as a result of the activity; the measure is parallel to the gross domestic product numbers commonly reported by various media outlets and is a subset of total expenditures. Personal income is dollars that end up in the hands of people in the area; the vast majority of this aggregate derives from the earnings of employees, but payments such as interest and rents are also included. Jobs are expressed on a full-time equivalent basis.

The Annual Impact of the Space Economy on the United States Results by Industry

Current Annual Impact	To		Gro		Perso		Jo	bs
(as of 2021)	Expenditures		Product +\$1.640 b		Income +\$0.061 b		+15,434	
Agriculture	+\$5.723 b				,			
Mining	+\$4.171 b		+\$0.981 b		+\$0.568 b		+3,185	
Utilities	+\$18.885 b +\$5.765 b		+\$4.286 b		+\$1.870 b		+7,474	
Construction			+\$3.095 b		+\$2.550 b		+32,949	
Manufacturing		3.480 b		.138 b		446 b	+583	
Wholesale Trade		.930 b	•	426 b	+\$5.4		+56,	
Retail Trade*		.646 b		.496 b	+\$18.		+537	
Transportation & Warehousing		.117 b		177 b	+\$5.4		+67,	
Information		.740 b		657 b	+\$2.8		+23,	
Financial Activities*		.340 b		.650 b	+\$4.5		+43,	
Business Services	+\$16	.812 b	+\$10.472 b		+\$8.542 b		+95,582	
Health Services	+\$10	.006 b	+\$7.0	001 b	+\$5.9	919 b	+89,	929
Other Services	+\$19	.385 b	+\$9.	996 b	+\$8.0	015 b	+177	',331
Total, All Industries	+\$420	0.001 b	+\$204	l.015 b	+\$123	.065 b	+1,73	4,515
Projected Annual Impact	Low	High	Low	High	Low	High	Low	High
(as of 2030)	Case	Case	Case	Case	Case	Case	Case	Case
Agriculture	+\$8.360 b	+\$9.669 b	+\$2.395 b	+\$2.770 b	+\$0.089 b	+\$0.103 b	+19,323	+22,349
Mining	+\$6.092 b	+\$7.046 b	+\$1.432 b	+\$1.657 b	+\$0.830 b	+\$0.960 b	+3,987	+4,612
Utilities	+\$27.586 b	+\$31.906 b	+\$6.260 b	+\$7.241 b	+\$2.732 b	+\$3.160 b	+9,357	+10,823
Construction	+\$8.421 b	+\$9.740 b	+\$4.521 b	+\$5.229 b	+\$3.725 b	+\$4.309 b	+41,251	+47,712
Manufacturing	+\$311.828 b	+\$360.669 b	+\$143.350 b	+\$165.803 b	+\$85.372 b	+\$98.743 b	+730,462	+844,874
Wholesale Trade	+\$20.347 b	+\$23.534 b	+\$13.768 b	+\$15.925 b	+\$7.939 b	+\$9.182 b	+71,071	+82,203
Retail Trade*	+\$63.753 b	+\$73.739 b	+\$47.466 b	+\$54.901 b	+\$27.532 b	+\$31.844 b	+673,232	+778,680
Transportation & Warehousing	+\$19.161 b	+\$22.162 b	+\$11.945 b	+\$13.816 b	+\$7.900 b	+\$9.137 b	+84,868	+98,161
Information	+\$15.688 b	+\$18.145 b	+\$9.724 b	+\$11.247 b	+\$4.152 b	+\$4.802 b	+29,316	+33,908
Financial Activities*	+\$64.767 b	+\$74.912 b	+\$17.017 b	+\$19.683 b	+\$6.657 b	+\$7.700 b	+54,402	+62,923
Business Services	+\$24.558 b	+\$28.404 b	+\$15.296 b	+\$17.691 b	+\$12.477 b	+\$14.432 b	+119,664	+138,406
Health Services	+\$14.616 b	+\$16.905 b	+\$10.226 b	+\$11.828 b	+\$8.647 b	+\$10.001 b	+112,586	+130,220
Other Services	+\$28.316 b	+\$32.751 b	+\$14.602 b	+\$16.889 b	+\$11.708 b	+\$13.542 b	+222,010	+256,784
Total, All Industries	+\$613.492 b	+\$709.582 b	+\$298.003 b	+\$344.679 b	+\$179.760 b	+\$207.915 b		
Projected Annual Impact	Low	High	Low	High	Low	High	Low	High
(as of 2040)	Case	Case	Case	Case	Case	Case	Case	Case
Agriculture	+\$12.736 b	+\$14.971 b	+\$3.649 b	+\$4.290 b	+\$0.135 b	+\$0.159 b	+25,359	+29,809
Mining	+\$9.281 b	+\$10.910 b	+\$2.182 b	+\$2.565 b	+\$1.265 b	+\$1.487 b	+5,233	+6,151
Utilities	+\$42.027 b	+\$49.402 b	+\$9.537 b	+\$11.211 b	+\$4.162 b	+\$4.892 b	+12,280	+14,435
Construction	+\$12.829 b	+\$15.080 b	+\$6.887 b	+\$8.096 b	+\$5.676 b	+\$6.672 b	+54,136	+63,636
Manufacturing	+\$475.071 b	+\$558.437 b	+\$218.394 b	+\$256.718 b		+\$152.888 b		+1,126,860
Wholesale Trade	+\$30.998 b	+\$36.438 b	+\$20.976 b	+\$24.657 b	+\$12.095 b	+\$14.217 b	+93,271	
Retail Trade*	+\$97.128 b	+\$114.172 b	+\$72.315 b	+\$85.005 b		+\$49.305 b		+1,038,574
Transportation & Warehousing	+\$29.191 b	+\$34.314 b	+\$18.198 b	+\$21.391 b		+\$14.147 b		
Information	+\$23.900 b	+\$28.094 b	+\$14.815 b	+\$17.414 b		+\$7.435 b	+38,474	+45,226
Financial Activities*	+\$98.673 b	+\$115.988 b	+\$25.926 b	+\$30.475 b		+\$11.923 b	+71,395	+83,924
Business Services	+\$37.414 b	+\$43.979 b	+\$23.303 b	+\$27.392 b		+\$22.345 b		+184,601
Health Services	+\$22.267 b	+\$26.175 b	+\$15.580 b	+\$18.314 b	+\$13.173 b	+\$15.485 b		+173,683
Other Services	+\$43.140 b	+\$50.710 b	+\$22.246 b	+\$26.150 b	+\$17.837 b	+\$20.967 b		+342,488
Total, All Industries	+\$934.656 b	+\$1,098.670 b	+\$454.009 b	+\$533.679 b		+\$321.922 b		
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Source: US Multi-Regional Impact Assessment System, The Perryman Group

Notes: Monetary values given in billions of 2021 US dollars per year. Components may not sum due to rounding. Retail Trade includes Restaurants, Financial Activities includes Real Estate. The Low Case and High Case reflect the lower bound and median of current major industry forecasts and analysis of individual segments by The Perryman Group. Results are fully adjusted for anticipated gains in labor productivity.

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The Annual Impact of the Space Economy on the State of Texas Results by Industry

Current Annual Impact	Tot		Gro		Perso	nal	lol	ne
(as of 2021)	Expenditures		Product		Income		Jobs	
Agriculture	+\$0.314 b		+\$0.088 b		+\$0.058 b		+841	
Mining	+\$0.259 b		+\$0.060 b		+\$0.033 b		+183	
Utilities	+\$0.906 b		+\$0.206 b		+\$0.090 b		+358	
Construction	+\$0.348 b		+\$0.188 b		+\$0.155 b		+2,004	
Manufacturing	+\$10.	164 b	+\$5.010 b		+\$3.039 b		+29,988	
Wholesale Trade	+\$0.8	314 b	+\$0.5	551 b	+\$0.3	18 b	+3,3	318
Retail Trade*	+\$2.0	667 b	+\$1.9	986 b	+\$1.1	.52 b	+32,	855
Transportation & Warehousing	+\$0.9	930 b	+\$0.5	554 b	+\$0.3	66 b	+4,5	590
Information	+\$0.7	784 b	+\$0.4	186 b	+\$0.2	07 b	+1,7	709
Financial Activities*	+\$2.7	721 b	+\$0.6	597 b	+\$0.2	71 b	+2,5	83
Business Services	+\$1.326 b		+\$0.842 b		+\$0.687 b		+7,688	
Health Services	+\$0.0	620 b	+\$0.4	134 b	+\$0.3	67 b	+5,5	571
Other Services	+\$1.:	158 b	+\$0.6	600 b	+\$0.4	79 b	+10,	577
Total, All Industries	+\$23.	009 b	+\$11.	701 b	+\$7.2	22 b	+102	,267
Projected Annual Impact	Low	High	Low	High	Low	High	Low	High
(as of 2030)	Case	Case	Case	Case	Case	Case	Case	Case
Agriculture	+\$0.630 b	+\$0.728 b	+\$0.177 b	+\$0.204 b	+\$0.116 b	+\$0.135 b	+1,448	+1,675
Mining	+\$0.524 b	+\$0.606 b	+\$0.122 b	+\$0.141 b	+\$0.068 b	+\$0.078 b	+318	+368
Utilities	+\$1.824 b	+\$2.110 b	+\$0.414 b	+\$0.479 b	+\$0.181 b	+\$0.209 b	+619	+716
Construction	+\$0.704 b	+\$0.814 b	+\$0.383 b	+\$0.443 b	+\$0.316 b	+\$0.365 b	+3,495	+4,042
Manufacturing	+\$21.176 b	+\$24.493 b	+\$10.468 b	+\$12.108 b	+\$6.358 b	+\$7.354 b	+53,742	+62,160
Wholesale Trade	+\$1.656 b	+\$1.915 b	+\$1.121 b	+\$1.296 b	+\$0.646 b	+\$0.747 b	+5,785	+6,691
Retail Trade*	+\$5.351 b	+\$6.189 b	+\$3.984 b	+\$4.608 b	+\$2.311 b	+\$2.673 b	+56,505	+65,356
Transportation & Warehousing	+\$1.947 b	+\$2.252 b	+\$1.150 b	+\$1.330 b	+\$0.760 b	+\$0.880 b	+8,169	+9,449
Information	+\$1.720 b	+\$1.989 b	+\$1.067 b	+\$1.234 b	+\$0.456 b	+\$0.527 b	+3,217	+3,721
Financial Activities*	+\$5.453 b	+\$6.307 b	+\$1.397 b	+\$1.616 b	+\$0.543 b	+\$0.628 b	+4,438	+5,133
Business Services	+\$2.026 b	+\$2.343 b	+\$1.264 b	+\$1.462 b	+\$1.031 b	+\$1.192 b	+9,887	+11,436
Health Services	+\$1.243 b	+\$1.437 b	+\$0.869 b	+\$1.006 b	+\$0.735 b	+\$0.850 b	+9,572	+11,071
Other Services	+\$2.306 b	+\$2.667 b	+\$1.196 b	+\$1.383 b	+\$0.955 b	+\$1.105 b	+18,078	+20,909
Total, All Industries	+\$46.559 b	+\$53.852 b	+\$23.612 b	+\$27.310 b	+\$14.476 b	+\$16.743 b	+175,274	+202,726
Projected Annual Impact	Low	High	Low	High	Low	High	Low	High
(as of 2040)	Case	Case	Case	Case	Case	Case	Case	Case
Agriculture	+\$1.313 b	+\$1.543 b	+\$0.368 b	+\$0.433 b	+\$0.243 b	+\$0.285 b	+3,035	+3,568
Mining	+\$1.089 b	+\$1.280 b	+\$0.253 b	+\$0.297 b	+\$0.141 b	+\$0.165 b	+662	+778
Utilities	+\$3.789 b	+\$4.454 b	+\$0.860 b	+\$1.011 b	+\$0.375 b	+\$0.441 b	+1,292	+1,518
Construction	+\$1.471 b	+\$1.729 b	+\$0.803 b	+\$0.944 b	+\$0.662 b	+\$0.778 b	+7,365	+8,657
Manufacturing	+\$42.124 b	+\$49.515 b	+\$20.696 b	+\$24.328 b	+\$12.573 b	+\$14.779 b	+107,545	+126,417
Wholesale Trade	+\$3.385 b	+\$3.979 b	+\$2.291 b	+\$2.693 b	+\$1.321 b	+\$1.553 b	+11,885	+13,971
Retail Trade*	+\$11.159 b	+\$13.117 b	+\$8.310 b	+\$9.768 b	+\$4.820 b	+\$5.666 b	+118,424	+139,205
Transportation & Warehousing	+\$4.066 b	+\$4.779 b	+\$2.400 b	+\$2.822 b	+\$1.588 b	+\$1.866 b	+17,142	+20,150
Information	+\$3.800 b	+\$4.467 b	+\$2.358 b	+\$2.772 b	+\$1.007 b	+\$1.183 b	+7,145	+8,399
Financial Activities*	+\$11.366 b	+\$13.361 b	+\$2.911 b	+\$3.422 b	+\$1.133 b	+\$1.332 b		+10,942
Business Services	+\$5.365 b	+\$6.306 b	+\$3.407 b	+\$4.005 b	+\$2.779 b	+\$3.267 b		+31,489
Health Services	+\$2.592 b	+\$3.047 b	+\$1.814 b	+\$2.132 b	+\$1.534 b	+\$1.803 b		+23,590
Other Services	+\$4.843 b	+\$5.693 b	+\$2.509 b	+\$2.949 b	+\$2.003 b	+\$2.355 b	+38,098	+44,784
Total, All Industries	+\$96.362 b	+\$113.271 b	+\$48.979 b	+\$57.574 b	+\$30.178 b	+\$35.473 b		+433,469

Source: US Multi-Regional Impact Assessment System, The Perryman Group

Notes: Monetary values given in billions of 2021 US dollars per year. Components may not sum due to rounding. Retail Trade includes Restaurants, Financial Activities includes Real Estate. The Low Case and High Case reflect the lower bound and median of current major industry forecasts and analysis of individual segments by The Perryman Group. Results are fully adjusted for anticipated gains in labor productivity.

THE PERRYMAN GROUP



The Perryman Group is a focused team of analysts who know how to address complex economic information tasks and present our findings effectively.

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Dr. Perryman is the President and CEO of the Perryman Group and Distinguished Professor of Economic Theory and Method at the International Institute for Advanced Studies. Over the past 40 years, Dr. Perryman has helped recruit corporations providing tens of thousands of jobs through economic development work, resolved billion-dollar legal issues, and revamped public policy through impact assessments and other studies. His firm has measured economic impacts for corporate locations and expansions involving billions in investments, and his economic forecasts are used by corporations and government agencies alike.

He has provided economic analysis and expert testimony for civil litigation across a wide range of

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