

CDC Data Challenge 2025

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From Sweat Equity to Space Equity

Aiding Private-Sector Terrestrial Workers in
Supporting the Prosperity of the U.S. Space
Economy

Background

- Space Economy is the generation of economic value through¹:
 - Commercial activities related to space travel
 - Infrastructure
 - Labor force
 - Telecommunications
 - Military
 - Space tourism
- Real Gross Output: revenue – cost of goods
- Real Value Added: domestic production across industry
- “Real:” Monetary values adjusted for inflation using base year 2017
- Compensation: Total value paid for service



Space-Related Ventures are an Ever-Growing Driver of the U.S. Economy

Human Innovation^{1,2}

- 1960s – 2025: 376 Americans have ventured beyond the 50-mile sky mark
- Advancements in satellite technology broadens intercontinental communications
- Increased weather monitoring and predictive accuracy
- Possibility of Mars colonies

Importance^{1,3}

- Monitoring of weather and meteorological events improves safety measures and early warnings
- Maintain global communication and internet services
- Provide diverse job opportunities in numerous industries
- Involvement of both the private and governmental sectors



KEY FINANCIAL METRICS (2023)³:



Gross Domestic Product (GDP):

\$142.5 billion  6.3% in 2023

Private Compensation:

\$57.924 billion  5.4% in 2023

Private Employment (Full- and Part-Time):

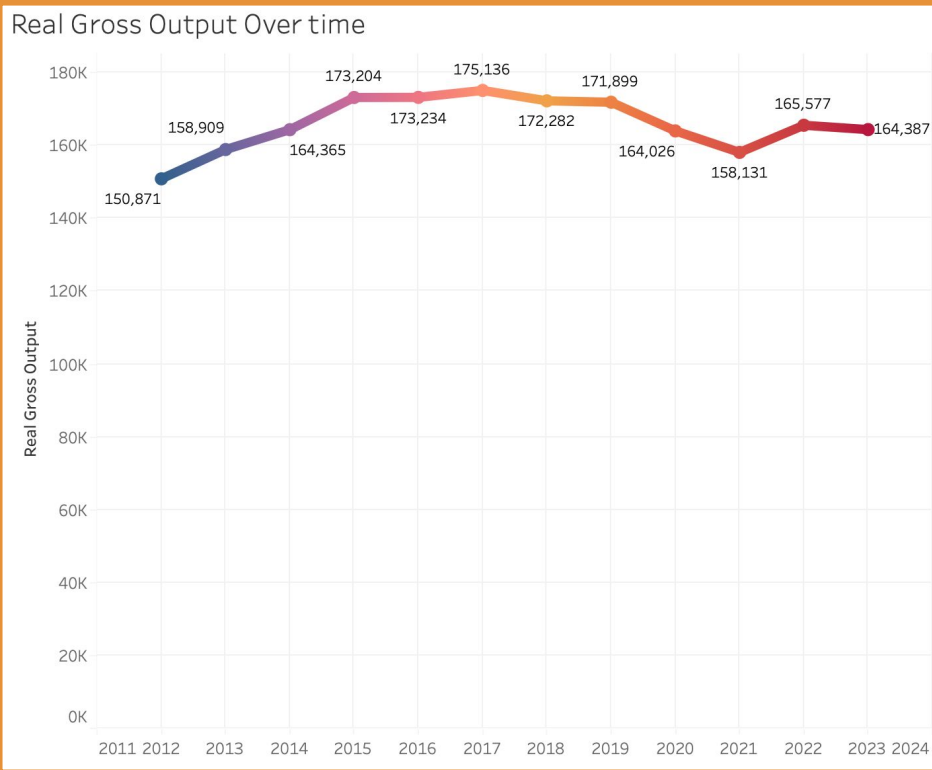
373,000  3.3% in 2023





However...
Recent gains seen do not reflect
prior economic peaks before 2020
And
The U.S. is increasingly relying on
private industries to fund space
ventures

How Has Real Gross Output Changed Over Time?



- Since Covid, real gross output has been having difficulty reaching its prior peaks despite some improvements during 2023 and 2024

How should we address this to support the broader U.S. economy, as well as support the labor force behind the space economy?

Introduction

Does It Actually Work?

Let's Check!

**Support
Workers**

**Increase
Output**

Increase Compensation



Does It Actually Check Out?

OLS Regression Results

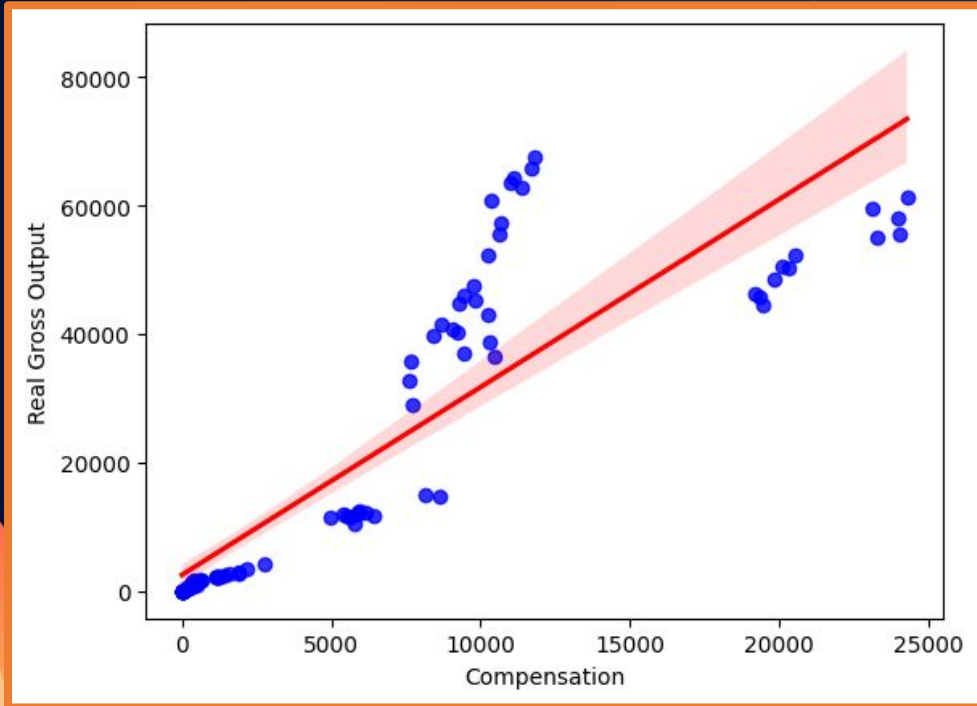
```
=====
Dep. Variable:          output_log    R-squared:                0.970
Model:                  OLS          Adj. R-squared:           0.969
Method:                 Least Squares F-statistic:              2709.
Date:                   Sun, 21 Sep 2025 Prob (F-statistic):      3.00e-66
Time:                   12:22:38      Log-Likelihood:          -40.590
No. Observations:       87           AIC:                      85.18
Df Residuals:           85           BIC:                      90.11
Df Model:               1
Covariance Type:        nonrobust
=====
```

```
=====
              coef    std err          t      P>|t|      [0.025    0.975]
-----
const          0.9708     0.156     6.219     0.000     0.660     1.281
compensation_log 1.0141     0.019    52.049     0.000     0.975     1.053
=====
```

✓ Regression Statistically Significant
→ Prob (F-statistic < 0.05)

✓ Compensation Increases Output
→ $\beta_1 > 0$ ($\uparrow \beta_1$ 1% → $\uparrow y$ 1.01%)

First, Checking Conditions Of Our ML Regression Model



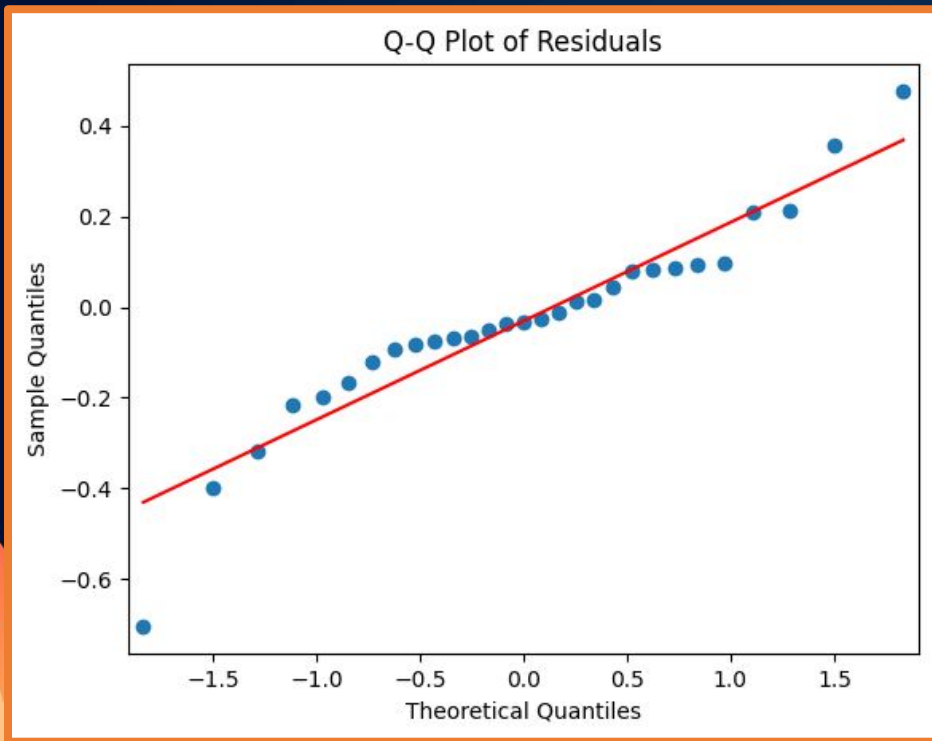
✓ Is our X and Y not better explained by a non-linear relationship?

→ Based off of this graph, took Log of Real Gross Output for the regression model to stabilize variance, reduce skew, and linearize the relationship

✓ Are our VIF scores < 10 ?

→ Eliminates multicollinearity

First, Checking Conditions Of Our ML Regression Model



✓ Are the residuals relatively normally distributed?

→ Mean zero residuals

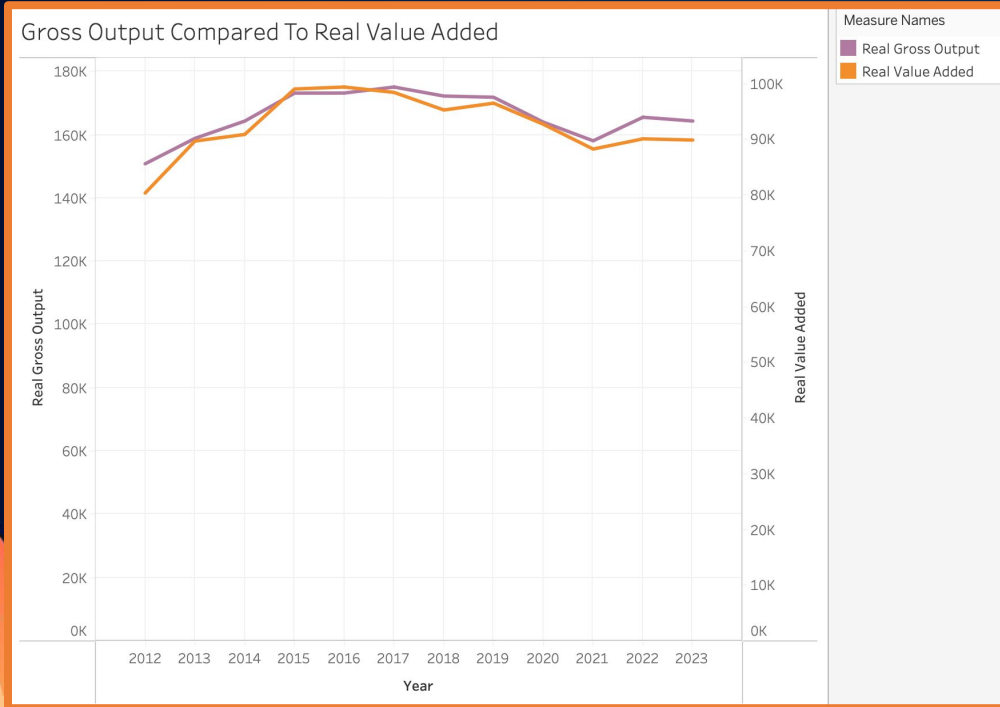
✓ Are residuals randomly scattered on residuals vs. fitted value plot?

→ Ensures homoscedasticity

✓ $RMSE_{test} \approx RMSE_{train}$

→ Checks against overfitting

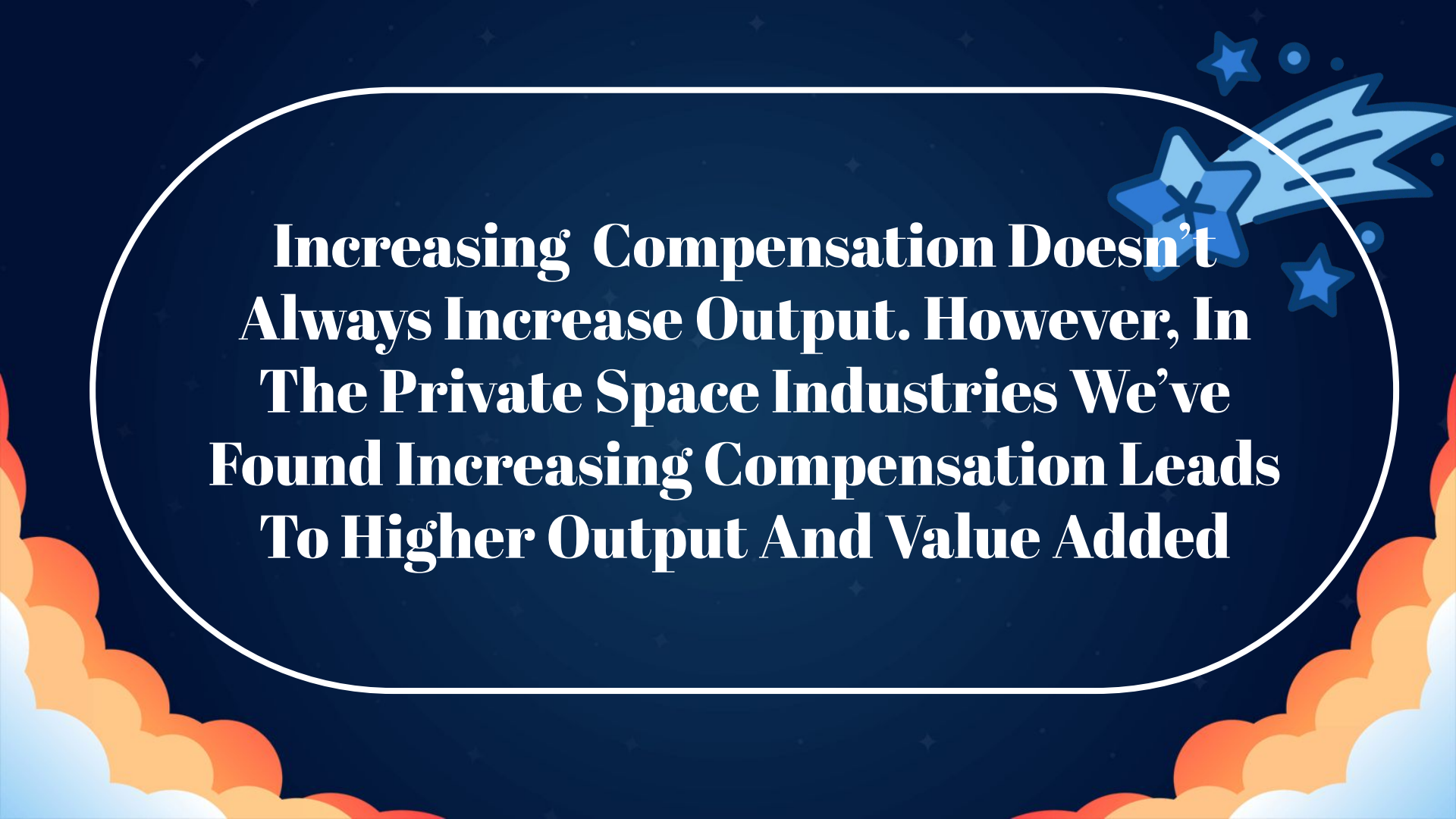
Increases In Compensation = Increases in Total Output



RMSE: **.22** vs. Baseline RMSE: 3.55
R²: **.99** vs. Baseline RMSE: -0.019
 β_1 : $3.45 \times e^{-5}$

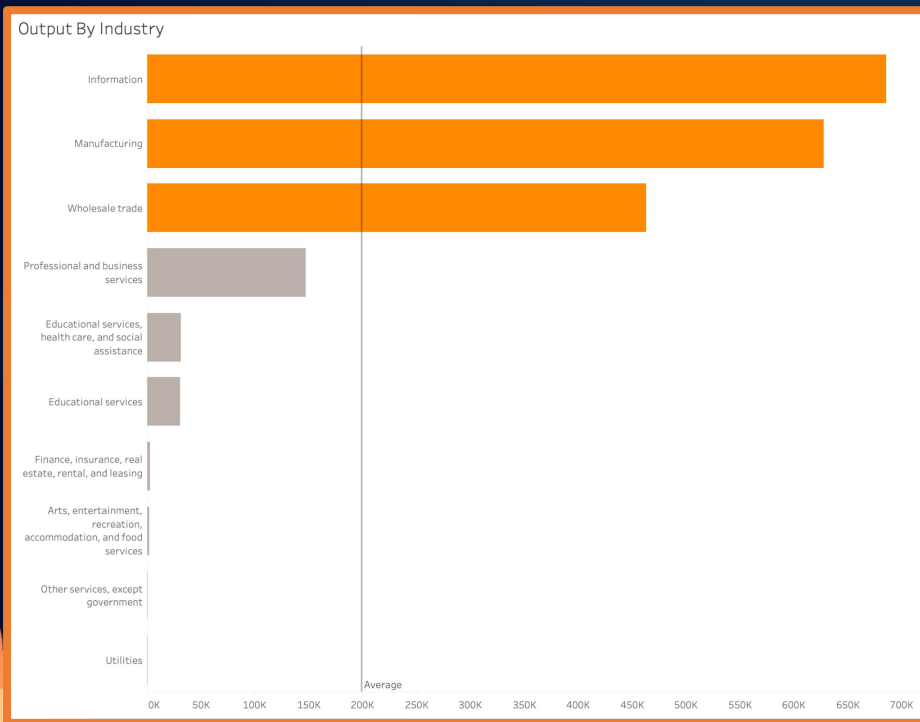
- For every 1 unit increase in compensation (in 100s of thousands of dollars), real gross output increases by .0035% (in millions of dollars)

Output matches relative to Value Added (which sums to GDP):
→ ↑ Output = ↑ GDP



**Increasing Compensation Doesn't
Always Increase Output. However, In
The Private Space Industries We've
Found Increasing Compensation Leads
To Higher Output And Value Added**

Limitations and What's Next



- **Limitations**
 - Small # of data points when examining by industries
 - Broad economic measurements
 - Not a causal relationship
- **What's Next**
 - Merging another dataset to make it larger
 - Looking at demographic data for worker specific knowledge

References

- (1) Mathieu, E.; Roser, M. Space Exploration and Satellites. Our World in Data 2022.
- (2) Moskowitz, C.; Wolf, Z. Everyone Who Has Ever Been to Space, Charted. Scientific American. <https://www.scientificamerican.com/article/everyone-who-has-ever-been-to-space-charted/> (accessed 2025-09-21).
- (3) Georgi, P. SCB, New and Revised Statistics for the U.S. Space Economy, 2012–2023, March 2025. Bea.gov. <https://apps.bea.gov/scb/issues/2025/03-march/0325-space-economy.htm>.

Thank You!

