

## Methodology and Sources

### Robotics – GMF/Fanuc

Conservative analysis estimates the cumulative productivity impact of GMF/Fanuc industrial robots from 1981 to 2025 to be roughly \$1.16 trillion. The methodology used was to consider the incremental impact of robot densification on national GDP for the 17 most industrialized nations during this time period, and then assign a share of this impact to GMF/Fanuc based on a conservative estimate of market share.

- The 2018 report published by Graetz & Michaels titled *Robots at Work, Review of Economics & Statistics Robots*. <https://cep.lse.ac.uk/pubs/download/dp1335.pdf>, finds that robot densification from 1993-2007 across 17 industrialized nations raised annual growth of GDP and labor productivity by an average of 0.37 and 0.36 percentage points, respectively.
- According to figures from The World Bank, published at [https://www.theglobaleconomy.com/rankings/gdp\\_share/](https://www.theglobaleconomy.com/rankings/gdp_share/) the combined GDP of the top 17 industrialized nations amounts to roughly 79% of total global GDP.
- In November 2017, FANUC reported that it produced its [500,000th](#) industrial robot, and in September 18, 2023, the company reported that it produced its [one-millionth](#) industrial robot. These figures, compared with International Federation of Robotics (IFR) figures for Annual Installations of Industrial Robots [Our World in Data Report](#) indicate that 19% is a reasonable, conservative estimate for GMF/Fanuc market share, by unit for the time period.

To calculate:

Total incremental GDP growth of .37% per year for the 15 years from 1993 to 2007 across the 17 most industrialized nations totals \$2.33 trillion. GMF/Fanuc's share of this incremental growth is 19%, or \$442 billion. To estimate the impact from 1981 to 1993 and from 2007 to 2025, our analysts assumed a gradual ramp up to the incremental growth rate of .37% in 1993, as industrial robotics gained influence in manufacturing,

and a gradual decline in this growth rate between 2007 and 2025 as the initial wave of robot densification ran its course.

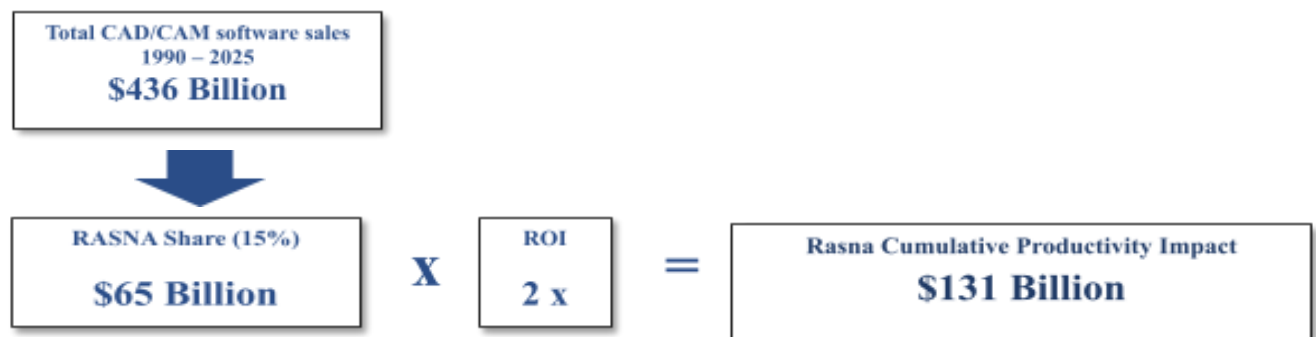
Year	GDP for 17 industrialized nations (trillions)	Incremental Growth Rate	Incremental GDP from Robotics (billions)
1993	29.92	0.0037	111
1994	30.70	0.0037	114
1995	31.49	0.0037	117
1996	33.85	0.0037	125
1997	36.22	0.0037	134
1998	38.58	0.0037	143
1999	40.94	0.0037	151
2000	43.30	0.0037	160
2001	44.88	0.0037	166
2002	46.45	0.0037	172
2003	48.03	0.0037	178
2004	49.60	0.0037	184
2005	51.17	0.0037	189
2006	51.96	0.0037	192
2007	52.75	0.0037	195
Cumulative Incremental GDP from robotics			\$ 2,330
GMF/Fanuc Share (19%)			\$ 442

### CAD/CAM – Rasna

Analysts estimate Rasna enabled over \$130 billion in productivity gains by accelerating development, cutting prototyping costs, and improving design reliability.

- By the early 1990s Parametric was controlling about ten percent of the entire CAD-CAM market and was aggressively boosting that share every quarter. By 1993 Parametric's share of the CAD-CAM market was approaching 20 percent.  
<https://www.fundinguniverse.com/company-histories/parametric-technology-corp-history/>
- Literature published at the time suggests as much as a 10-20x return on investment for CAD/CAM software that incorporated Mechanical Design Synthesis.
  - o One report cites a \$60,000 return in the first year on a \$10,000 investment in MDS style software, and a 3-year ROI of over \$205,000  
[https://www.solidworks.com/sw/images/content/other/roi\\_report\\_solidworks\\_2006.pdf](https://www.solidworks.com/sw/images/content/other/roi_report_solidworks_2006.pdf)
  - o Customer testimonials from Autodesk claim, “Adding parametric modeling to your engineering process leads to a significant reduction in time spent incorporating design changes... The additional investment made up front pays off tenfold when making changes to that design later.”  
<https://damassets.autodesk.net/content/dam/autodesk/docs/pdfs/fy21-dm-pdmc-why-engineers-design-parametric-3D-en-asean.pdf>
- For this analysis, analysts used a modest estimate of a 2x return on investment. Today, CAD/CAM is a \$30+ billion annual industry, powering design-driven manufacturing worldwide.

To calculate:



## E-Commerce – Ariba

The number of businesses connected and volume of transactions on the Ariba network have grown dramatically since the company was founded.

- SAP/Ariba does not publish annual transaction volumes every year, but the company does occasionally update its figures.
  - o In 2012 the company reported \$319 billion.  
<https://anibalgoicochea.com/wp-content/uploads/2012/05/sap-2012-ariba-acquisition-presentation.pdf>
  - o In 2019 the figure was updated to \$1.5 trillion.  
[https://www.nttdata.com/global/ja/-/media/nttdataglobal-ja/files/about-us/proc/purchasing/en/purchasing\\_02.pdf](https://www.nttdata.com/global/ja/-/media/nttdataglobal-ja/files/about-us/proc/purchasing/en/purchasing_02.pdf)
  - o In 2022 transaction volume had grown to \$3.75 trillion  
<https://news.sap.com/africa/2022/06/sap-closes-gap-between-sustainability-and-profitability-with-solutions-for-africa/>

- o And today SAP claims that \$6 trillion is transacted on the network annually.  
<https://cloudwars.com/cloud/sap-business-network-enhances-supply-chain-resilience-with-ai-massive-data-sets/>
- Taking a conservative approach to filling in the gaps yields a total transaction volume from 2005 to 2025 of \$27.9 trillion.
- “Contracting authorities and entities that have already made the transition to e-procurement commonly report savings between **5 and 20%**” <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/>
- According to a Capgemini Consulting poll of over 1,000 CPOs, 39% of respondents anticipate procurement to save their company’s cost, with 35 percent expecting savings of more than 6% and 5 percent expecting savings of more than 10%. <https://procurementpartners.com/procurement-profitability/>
- Based on the studies above our analysis uses the conservative figure of 5% savings, or productivity gain on transactions conducted on the e-procurement network. Multiplying that by the \$27.9 trillion total transaction volume from 2005 to 2025 yields \$1.396 trillion – nearly \$1.4 trillion in Cumulative Productivity Impact for the commerce platform.

## Digital Transactions – DocuSign

Analysts approached the estimate of DocuSign’s productivity impact by assigning a conservative value to the productivity savings per agreement processed through the platform, and then estimating agreements processed annually.

- In 2010 DocuSign announced that it had processed 80 million agreements that year.  
<https://www.pcmag.com/archive/docusign-releases-updated-version-of-e-signature-software-252387>
- The company does not release the number of agreements processed on an annual basis, so analysts used publicly released revenue figures from the company and determined that the number of agreements processed per year could be reasonably be assumed to parallel annual revenue growth.
- Assuming transaction growth ran parallel to revenue growth yielded a cumulative total of envelopes processed from 2010 to 2025 of 69.6 billion agreements signed over the 16-year period. Reasonable, considering the company has more than 1 million business clients and more than 1 billion users.
- Analysis by Forrester has shown that companies see a productivity boost of \$13.50 for each agreement processed via DocuSign.  
[https://www.docusign.com/en-gb/sites/default/files/resource\\_event\\_files/Forrester%20Study%20-%20The%20Total%20Economic%20Impact%20of%20DocuSign%20within%20USEL%20.pdf](https://www.docusign.com/en-gb/sites/default/files/resource_event_files/Forrester%20Study%20-%20The%20Total%20Economic%20Impact%20of%20DocuSign%20within%20USEL%20.pdf)
- Taking a conservative approach, and assuming some possible inaccuracies in the estimation of total agreements processed, our analysts calculated the cumulative productivity impact of DocuSign based on only half of this amount, or \$6.75 per transaction.
- This yielded a cumulative productivity impact of \$471 billion from 2005 to 2025.

To calculate:

69.6 billion agreements processed x \$6.75 productivity increase per agreement = \$471 billion Cumulative Productivity Impact.

## Semiconductor Manufacturing -- TSMC + CHIPS

Cumulative productivity impact of the TSMC deal and the CHIPS Act was calculated by totaling up the direct investment in the semiconductor industry by the government with a string of publicly announced investments by private industry.

- A summary table of public and private investments in the semiconductor industry is presented below. These investments include both the TSMC deal and the CHIPS act, all are available in public news reports.

Entity	Location	Investment (billions)	Purpose
TSMC	Phoenix, AZ	165	Six fabs, packaging, R&D
40+ ecosystem partners (Applied Materials, KLA, ASML, more)	Phoenix, AZ	100	Local Ecosystem expansion
Samsung	Taylor, TX	40	Tesla AI6 chip deal
Intel	New Albany, OH	90	First phase of large megasite
Texas Instruments	Sherman, TX & Lehi, UT	60	Seven fabs across two states
Micron	Boise, ID & Clay, NY	35	Multiple high-tech fabs
Global Foundries	New York & Vermont	16	Fab expansion, photonics
GlobalWafers	Sherman, TX	7.5	300 mm wafer manufacturing
CHIPS direct investment	Various	52	Various
<b>Total:</b>		<b>565.5</b>	

- The estimation of Cumulative Productivity Impact all comes down to the 2.5x multiplier. Research indicates this most likely underestimates total productivity impact by a significant margin.
  - o The National Association of Manufacturers estimates that **“Including indirect and induced impacts, for every \$1.00 spent in manufacturing, there is a total impact of \$2.64 to the overall U.S. economy.** This figure represents one of the largest sectoral multipliers in the economy. In addition, for every one worker in manufacturing, 4.8 workers are added in the overall U.S. economy, including indirect and induced impacts, and for every \$1.00 earned in direct labor income in the manufacturing sector, \$3.92 in labor income earned is added to the overall U.S. economy. (Source: NAM calculations using 2023 IMPLAN data) <https://nam.org/mfgdata/facts-about-manufacturing-expanded/> Semiconductors can be expected to perform at or above that level due to high-skilled labor and far-reaching ecosystem effects.
  - o According to a McKinsey report on the semiconductor industry, “The semiconductor industry also has strong economic multipliers, with investments estimated to increase its current value to GDP by **threefold** within six years. Employment multipliers are also strong, with every new job within the semiconductor industry expected to sustain over five new jobs in other industries.” <https://www.mckinsey.com/industries/semiconductors/our-insights/exploring-new-regions-the-greenfield-opportunity-in-semiconductors>
  - o A report by The Semiconductor Industry Association (SIA), in partnership with Oxford Economics, estimates that the \$50 billion invested in the Semiconductor industry by the CHIPS Act will “Create an average of nearly 200,000 American jobs annually as fabs are built and add nearly \$25 billion annually to U.S. economy.” <https://www.semiconductors.org/chipping-in-sia-jobs-report/> -- A long-term economic/productivity impact well beyond the modest 2.5x multiplier used in our model.

To calculate:

\$597 billion public and private investment in the semiconductor industry x 2.5 multiplier = \$1.414 trillion in Cumulative Productivity Impact.