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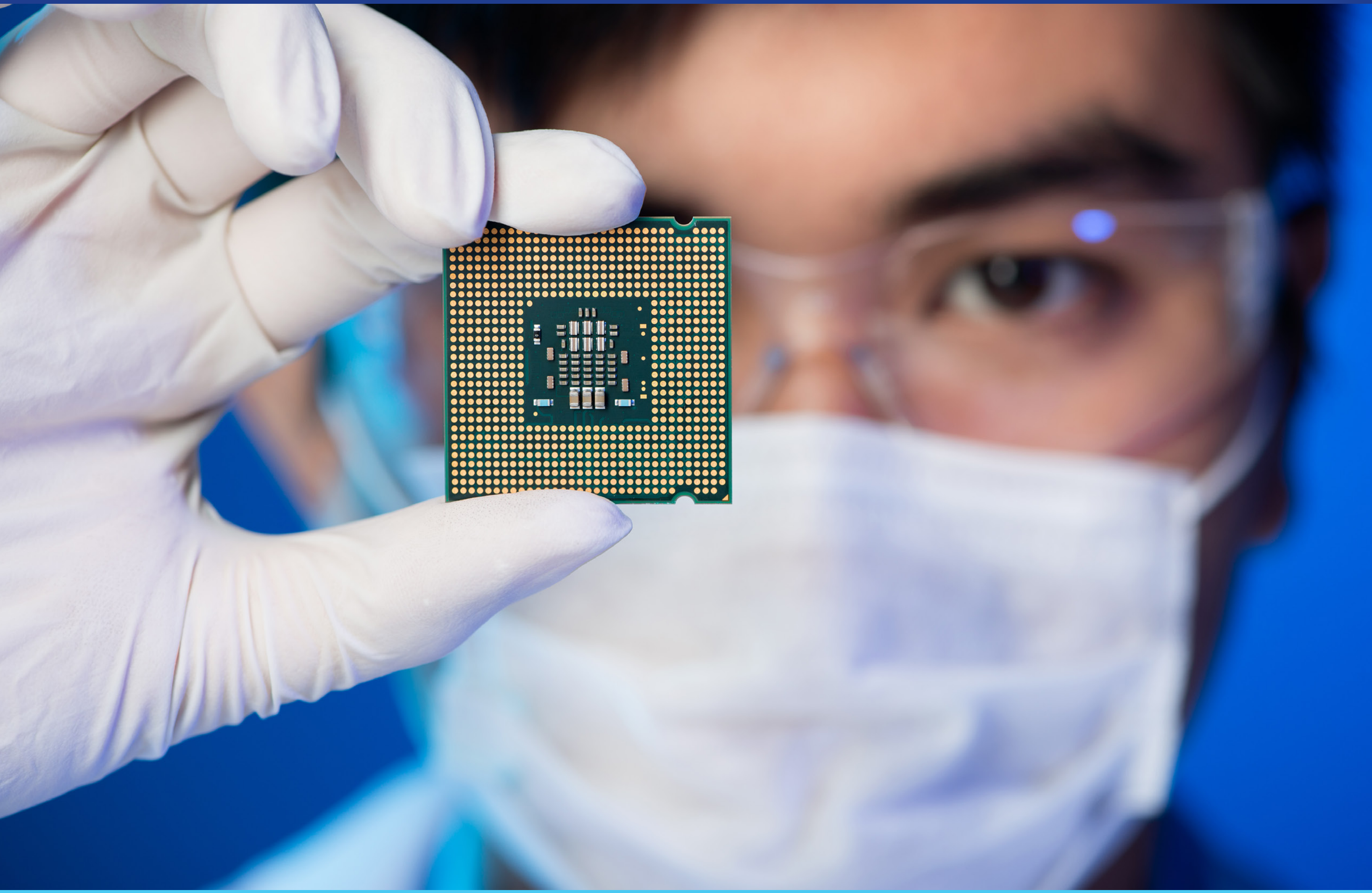
THE POSITIVE IMPACT OF THE SEMICONDUCTOR INDUSTRY ON THE AMERICAN WORKFORCE AND HOW FEDERAL INDUSTRY INCENTIVES WILL INCREASE DOMESTIC JOBS



MAY 2021

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MAY 2021

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EXECUTIVE SUMMARY

With its origin in the latter part of the 20th century, the semiconductor industry has grown to become one of the most important segments of the global economy. Today, semiconductors are found in nearly every electronic device, including phones, cars, and appliances. They enable nearly every industry, reflected by global sales of over $440 billion in 2020.[1] Over 300 downstream economic sectors accounting for over 26 million U.S. workers are consumers of and are therefore enabled by semiconductors as a critical input for their sectors.

Beyond providing inputs to nearly every industry, the U.S. semiconductor industry is essential to the U.S. economy, generating value for the economy, stimulating jobs, and paying income to workers. In total, the U.S. semiconductor industry supported 1.85 million U.S. jobs in 2020. The industry directly employs more than 277,000 domestic workers in R&D, design, and manufacturing activities, among others.

In addition, for each U.S. worker directly employed by the semiconductor industry, an additional 5.7 jobs are supported in the wider U.S. economy, either in the supply chains of the semiconductor industry or through the wage spending of those employed by the firms themselves or their supply chains.

1.85 million U.S. jobs
supported in 2020

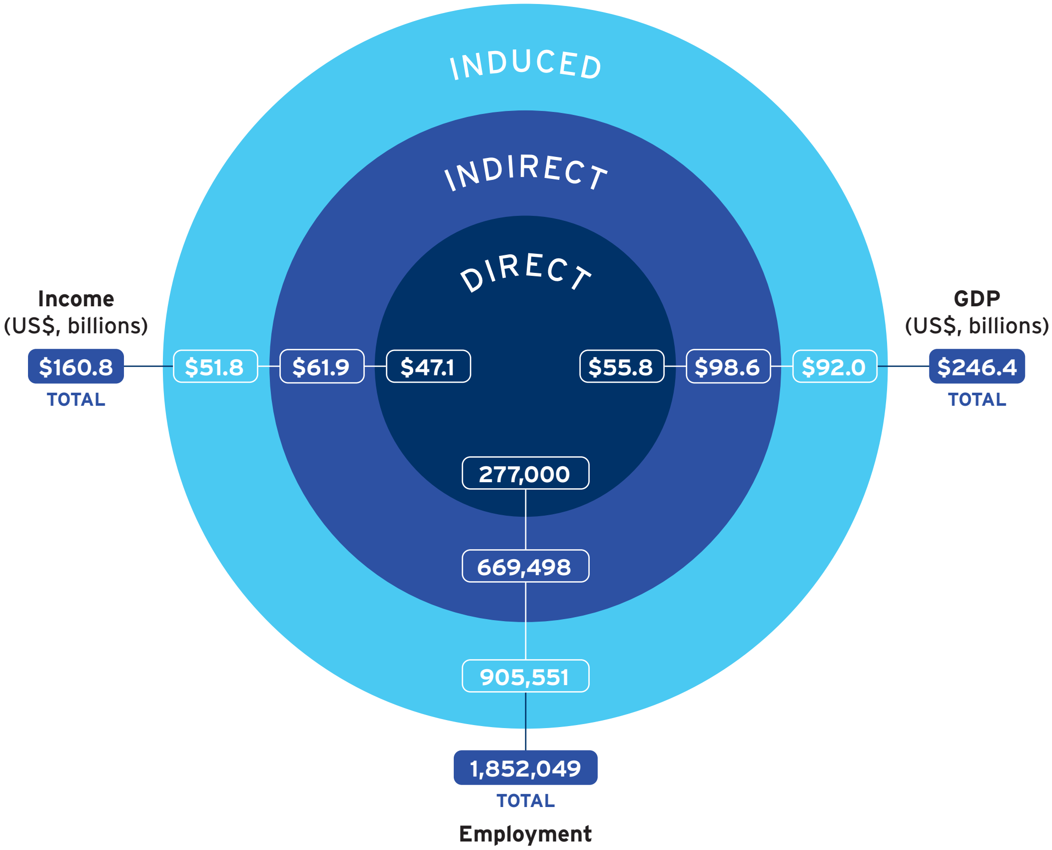


FIG. 1: Economic impact of the semiconductor industry on the U.S., 2020

[1] See https://www.semiconductors.org/global-semiconductor-sales-increase-6-5-to-439-billion-in-2020.

Now, more than ever, there is a need to expand semiconductor R&D, design, and manufacturing in the U.S. through robust federal investments such as those called for in the CHIPS for America (CHIPS) Act, federal legislation enacted in January 2021 but not yet funded. By supporting the expansion of the domestic semiconductor industry, nearly all other sectors of the economy will benefit, beyond the semiconductor industry itself.

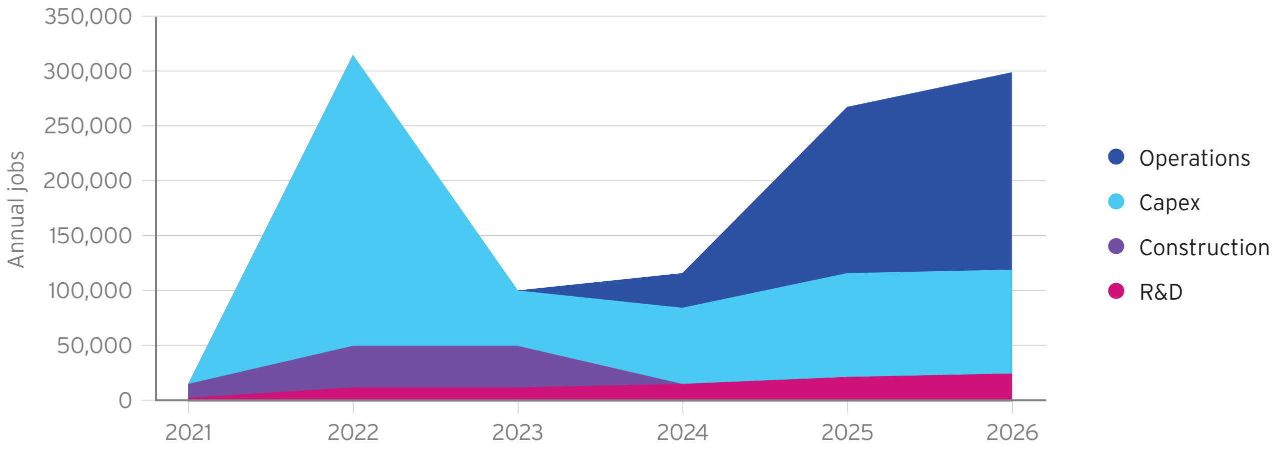
We estimate a $50 billion federal investment program to incentivize domestic semiconductor manufacturing would add $24.6 billion annually to the U.S. economy and would create an average of 185,000 temporary jobs annually throughout the U.S. economy from 2021 to 2026. Over this six-year build-out period, therefore, the cumulative annual impact of such an incentive program on GDP and jobs would be $147.7 billion and 1.1 million, respectively. These economic benefits combine all the channels of impact—direct, indirect (supply chain) and induced (wage spending).[2]

A $50 billion federal investment program to incentivize domestic semiconductor manufacturing can be expected to substantially increase the demand for talent within the semiconductor industry. As more domestic investments in semiconductor R&D, design, and manufacturing come online and increase production, the industry will need to hire more workers in a range of occupations. As a result of these incentives, the enduring positive impact on the U.S. economy is an additional 280,000 new jobs, of which 42,000 would be directly employed in the domestic semiconductor industry. This would boost U.S. semiconductor industry employment to 319,000 and its total jobs impact to 2.13 million in 2027.

$147.7 billion

GDP impact from 2021 to 2026

FIG. 2: The total annual jobs impact of a $50 billion federal semiconductor manufacturing incentive program, 2021–2026



[2] The CHIPS Act also includes semiconductor research provisions, but this analysis does not consider the economic and job gains that would come from federal funding for those research provisions. Because legislation to fund the CHIPS Act has not been finalized as of publication, this report models the domestic jobs and economic impact of a hypothetical $50 billion federal program to incentivize domestic semiconductor manufacturing that was modeled in the recent SIA/BCG joint report, *Turning the Tide for Semiconductor Manufacturing in the U.S.*

1. INTRODUCTION

With its origins in the latter part of the 20th century, the semiconductor industry has grown to become one of the most important segments of the global economy. Today, semiconductors are found in nearly every electronic device, including phones, cars, and appliances. Semiconductors enable nearly every industry, reflected by global sales of over $440 billion in 2020 alone.

Today, semiconductor companies are producing more chips than ever before. The success and growth in computers and software have subsequently helped to drive growth in the semiconductor industry. The U.S. semiconductor industry is substantial, directly contributing $246.4 billion to U.S. GDP and directly employing over 277,000 workers in 2020. However, the economic contribution of the semiconductor industry extends far beyond fabrication facilities (fabs) or research facilities where its products are designed and manufactured. The strong demand for all types of chips facilitates the need for a broader domestic support ecosystem including manufacturing equipment, materials, design services, testing labs, and R&D activity. This ecosystem creates activities that generate additional economic value throughout the U.S. economy.

Now, more than ever, there is a need to expand semiconductor R&D, design, and manufacturing in the U.S. By supporting the expansion of the U.S. semiconductor industry, nearly all other domestic sectors will benefit. Whether it is increased demand for semiconductor equipment, tools, and materials, or a more steady supply of chips for downstream industries, semiconductor R&D, design, and manufacturing is an integral part of the U.S. economy. In fact, we estimate that over 300 different downstream sectors of the economy accounting for a total of 26.5 million American jobs make purchases from and are therefore enabled by the U.S. semiconductor industry. This is done by tracing purchases of semiconductors as inputs into the production of other products. This includes industries such as aircraft manufacturing, automobile manufacturing, and printing.

For this study, Oxford Economics has quantified the economic contribution of the U.S. semiconductor industry by using an economic impact analysis at the national level in the U.S.[3] This technique highlights the importance of the semiconductor industry to the U.S. economy in terms of jobs, wages, and GDP. More detail on our methodology is included in the appendix and footnotes in this report. In the subsequent sections, we will examine the economic impacts of the U.S. semiconductor industry and a federal funding program to incentivize domestic manufacturing in detail.

[3] For the purposes of this report and the domestic employment and GDP figures contained in it, the U.S. semiconductor industry includes all semiconductor companies and their establishments in the United States whether they are U.S. headquartered firms or foreign owned firms with operations in the United States. Similarly, the U.S. semiconductor industry data in this report does not include U.S. firms' activities and establishments outside of the United States.

2. THE ECONOMIC CONTRIBUTION OF THE U.S. SEMICONDUCTOR INDUSTRY

The semiconductor industry has a considerable economic footprint in the U.S. Nearly 277,000 people work in the industry, designing, manufacturing, testing, and conducting R&D on semiconductors throughout 49 states in the U.S. The purchases made by the semiconductor industry from suppliers during the fabrication process (i.e. the indirect effects) enable further activity throughout the U.S., sustaining thousands of more jobs across the country. Finally, wages paid to employees, and those employed in the supply chain, fund consumer spending (i.e. the induced effects), for example in retail and leisure establishments, and deliver additional economic benefit to the country.

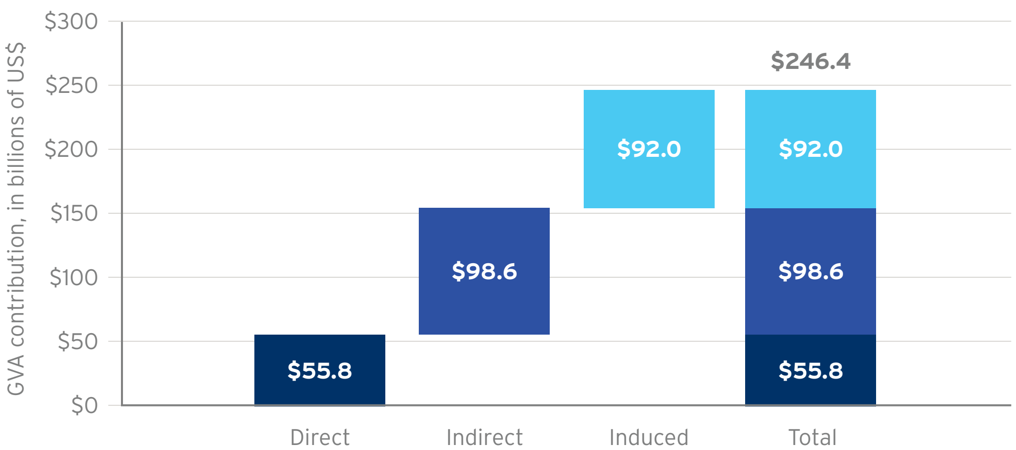
In the following sections, we quantify the industry's economic footprint in terms of its contribution to GDP, and the employment it supports.

2.1 Total contribution to U.S. GDP

Combining all the channels of impact—direct, indirect (supply chain) and induced (wage spending)—the total impact of the semiconductor industry on the U.S. economy amounted to $246.4 billion in 2020. The chart below shows the breakdown of this impact across the three core channels, in terms of gross value added (GVA) contribution to GDP.

$246.4 billion
GDP impact in 2020

FIG. 3: The total GVA contribution of the U.S. semiconductor industry



Source: Oxford Economics

2.1.1 Direct impact

The direct impact of the semiconductor industry's activities comprises the value-added output generated by the industry; those employed directly by the semiconductor industry, the wages these semiconductor firms pay, and their operation expenditures. We estimate that in 2020, this direct impact accounted for $55.8 billion in GDP.

2.1.2 Indirect impact

The indirect impact of the semiconductor industry reflects the employment and GDP contribution made by the suppliers of those establishments (e.g. security providers, IT support, and legal services) and, in turn, within the supply chains of those suppliers. In 2020, the GDP contribution of these suppliers was $98.6 billion. Some of the top inputs (i.e. indirect impacts) for semiconductor industry operations include:

- Electronic devices (part of manufacturing);
- Insurance (part of financial activities); and
- Electricity (part of trade transportation, and utilities).

2.1.3 Induced impact

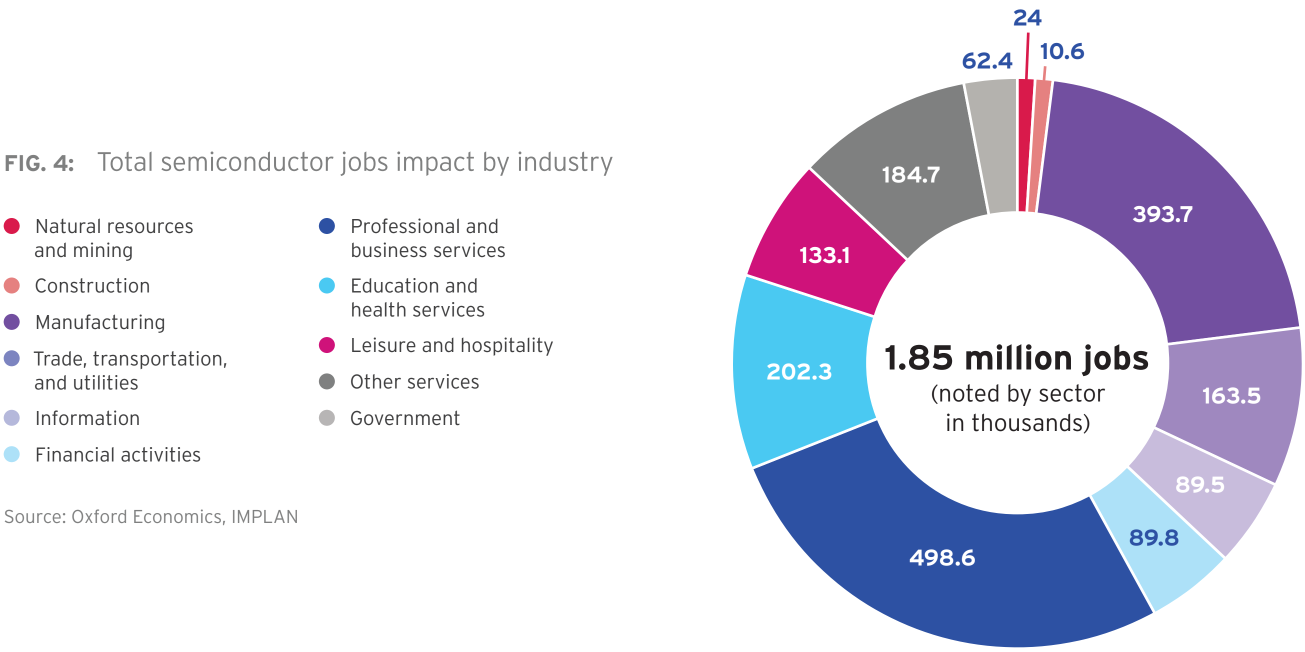
The induced impact of the semiconductor industry represents the economic activity supported by the consumer spending of wages by those employed directly by the semiconductor industry or in its supply chains. As a result of this consumer spending, we estimate that the induced impact attributable to the semiconductor industry operations to be a $92.0 billion contribution to GDP in 2020. Some of the top expenditures for consumers (i.e. induced impacts) include:

- Housing (part of financial activities);
- Transportation (part of trade transportation, and utilities); and
- Healthcare (part of education and health services).

2.2 Jobs impact of the semiconductor industry

The total 1.85 million jobs impact (direct + indirect + induced) of the semiconductor industry is displayed in the following chart. The industry's employment impact is concentrated in the manufacturing industry, which accounts for 21 percent of the total employment impact. Still, other sectors are supported by the industry's activities including professional and business services (27 percent); education (11 percent); and other services (10 percent).

FIG. 4: Total semiconductor jobs impact by industry



Source: Oxford Economics, IMPLAN

CASE STUDY:

COMMUNITY IMPACTS

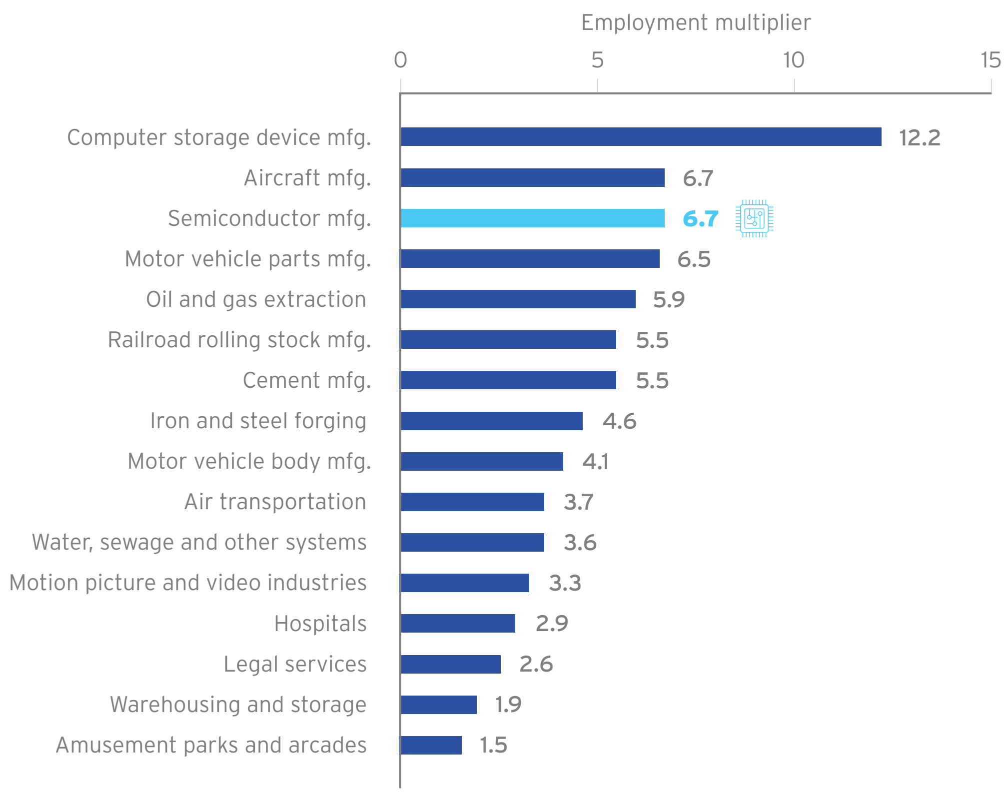
Beyond the direct, indirect, and induced domestic jobs impacts of their operations, semiconductor companies have a strong record of charitable support and involvement in the local communities where they have a presence. For example, one major U.S. semiconductor firm runs a $4.5 million multi-year program with 6 historically black colleges and universities (HBCUs) to increase the pipeline of African Americans in engineering fields. This program has increased black enrollment in these fields by as much as 55 percent in some partner universities. The same firm also runs a $5 million partnership with a local public school district to encourage underrepresented youth to pursue further education in STEM fields. Over four years, underrepresented minority students enrolled in computer science classes in the district increased by 17 times, and girls enrolled in computer science increased by 33 times.

2.2.1 **Jobs multiplier**

Beyond its GDP impact, the U.S. semiconductor industry supported 1.85 million jobs throughout the economy in 2020. While different industries affect the U.S. economy in different ways, a useful metric to compare those industries is by evaluating the jobs multiplier. Employment multipliers represent the total jobs generated as a result of 1 job in the specified industry. For example, the semiconductor jobs multiplier is 6.7, which means that for every direct job in the semiconductor industry, an additional 5.7 jobs are supported in other industries.

The number itself reflects 1) what the industry needs to purchase in order to make its product—the indirect, or supply-chain effect, and 2) the value of the industry's labor income, profits and what each household consumes as a result of earning income—the induced effect. The multiplier of 6.7 ranks in the 85th percentile for all detailed industry jobs multipliers. By comparison, the median value of all 534 detailed industries was 3.7. The following chart highlights semiconductor manufacturing along with other industries and their respective jobs multipliers.

FIG. 5: Multipliers of U.S. semiconductor industry compared to other U.S. industries



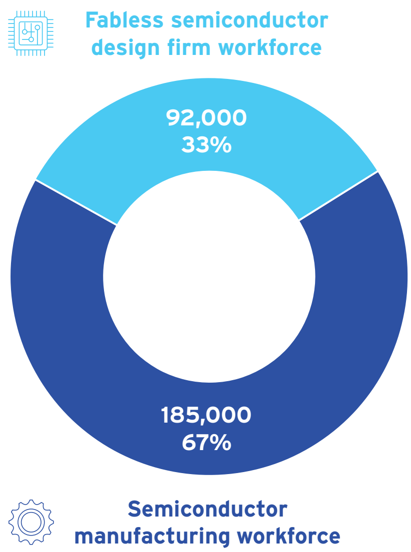
Source: IMPLAN

3. THE SEMICONDUCTOR WORKFORCE

The semiconductor industry is a significant employer in the U.S. In 2020, we estimate the size of the workforce at 277,000 inclusive of workers in research and fabrication facilities where semiconductors are designed and manufactured. Semiconductor integrated device manufacturers, pure-play foundries, and other establishments involved in semiconductor manufacturing directly employed nearly 185,000 U.S. workers. In addition, we estimate the employment by fabless semiconductor design firms accounts for an additional 92,000 workers in the U.S.

Workers in the semiconductor industry are highly productive, and wages reflect this at $170,000 annual income on average in 2020, placing them well above the average income earners in the U.S. In this section, we examine the occupation profile of the industry to get an enhanced sense of the types of skills and education that workers need to be employed in the industry. Additionally, we explore the workforce characteristics to better understand who the people are that support the industry. But first, we explore the geographic distribution of the workforce across the U.S.

FIG. 6: Composition of the semiconductor workforce



3.1 Semiconductor workforce by state

The semiconductor industry directly employed an estimated 277,000 workers in the U.S. in 2020. The semiconductor workforce is represented in 49 states and Washington, D.C. The total state workforce is largest in a handful of Western and Southwestern states including California, Oregon, and Arizona with Texas accounting for a large workforce presence, as well.

The semiconductor workforce is represented in **49 states and Washington, D.C.**

FIG. 7: Rank of top 15 semiconductor workforces by state

Rank	State	Semiconductor employment	Share of U.S. semiconductor employment	Rank	State	Semiconductor employment	Share of U.S. semiconductor employment
1	California	63,300	23%	9	North Carolina	7,900	3%
2	Texas	43,800	16%	10	Washington	5,000	2%
3	Oregon	40,300	15%	11	Virginia	4,100	1%
4	Arizona	28,900	10%	12	Ohio	4,000	1%
5	Florida	12,900	5%	13	New Mexico	4,000	1%
6	Idaho	12,300	4%	14	Utah	3,700	1%
7	Massachusetts	12,200	4%	15	Pennsylvania	3,300	1%
8	New York	10,200	4%				

Source: Oxford Economics

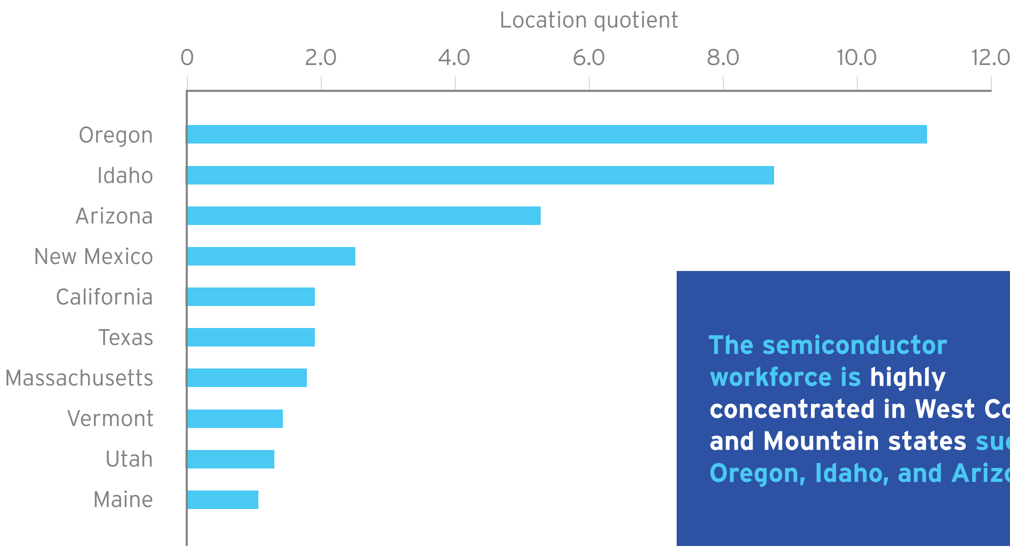
3.1.1 Location quotients

A location quotient (LQ) for an industry helps to illustrate how concentrated it is in one state by comparison to others. A location quotient that is equal to one indicates that the state's industry concentration is equal to the national concentration of the same industry. Industries with above-average location quotients (greater than 1.0) indicate that a region has a higher concentration in the production of that good or service, relative to the rest of the nation. A value of 1.5 indicates that industry output within the region is 1.5 times more concentrated than the U.S. average. A location quotient below 1.0 indicates that industry output within the region is less concentrated compared to the U.S. average.

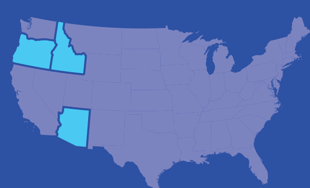
Note, high employment states do not necessarily result in high location quotients, as this statistic is relative to national employment. For example, if the semiconductor industry makes up 0.50 percent of New Mexico's workforce and only 0.20 percent of output in the U.S., then New Mexico's LQ for the semiconductor workforce would be 2.5 (0.50%/0.20%).

As noted above, the semiconductor workforce is largest in California, Texas, and Oregon. However, the states with high LQ values include Idaho, Arizona, and New Mexico. This indicates, for example, that the workforce of Idaho is more reliant on the semiconductor industry compared to California, even though California has a larger semiconductor workforce by volume.

FIG. 8: Top states by workforce location quotients (LQ)



The semiconductor workforce is highly concentrated in West Coast and Mountain states such as Oregon, Idaho, and Arizona.



Source: Oxford Economics

3.2 Occupational profile

The occupation profile of the semiconductor industry describes the types of jobs that are employed in the industry. The roles and responsibilities of employees are many and varied. They are assemblers and fabricators, maintenance and repair workers, logisticians, management analysts, software developers, engineers, electricians, and procurement clerks among others. The major occupation group that has the largest share of employment within the industry is production occupations, which account for about 39 percent of workers in the industry. Together, these job functions make up more than half of the semiconductor workforce.

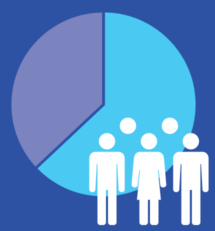
Beyond the production capacity the semiconductor industry provides, several other functions are essential to the operations of the industry, including engineering occupations that comprise about 24 percent of workers, management occupations that make up about 9 percent, as well as computer and mathematical roles, which account for around 7 percent of workers in the industry.

FIG. 9: Occupation profile of semiconductor industry

Occupation group	Share of total	Average wage
Management	8.6%	$375,124
Business and Financial Operations	6.3%	$204,223
Computer and Mathematical	6.9%	$265,582
Architecture and Engineering	**23.9%**	**$226,145**
Life, Physical, and Social Science	0.6%	$207,991
Legal	0.2%	$213,996
Arts, Design, Entertainment, Sports, and Media	0.5%	$195,762
Healthcare Practitioners and Technical	<0.1%	$63,432
Protective Service	0.1%	$61,116
Building and Grounds Cleaning and Maintenance	0.2%	$40,164
Sales and Related	2.4%	$116,664
Office and Administrative Support	6.3%	$57,864
Construction and Extraction	0.1%	$75,108
Installation, Maintenance, and Repair	3.3%	$70,320
Production	**38.6%**	**$94,824**
Transportation and Material Moving	2.0%	$43,836
Total	**100%**	**$170,000**

Source: BLS OES May 2019, Oxford Economics tabulations

Production and engineering jobs make up over half of the domestic semiconductor workforce.



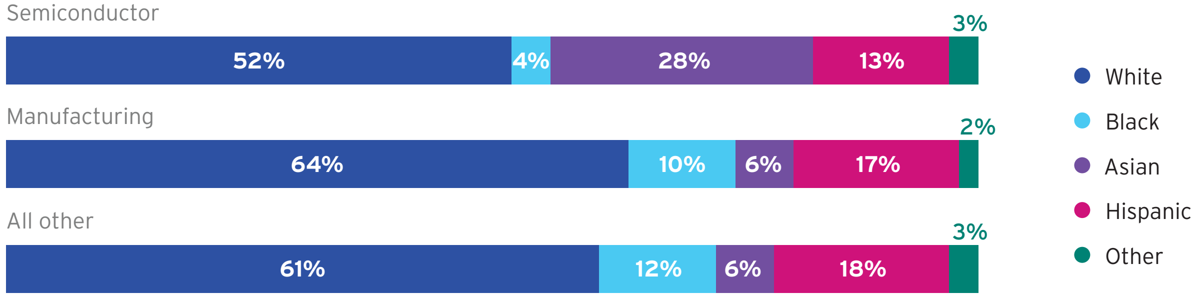
3.3 People who work in the semiconductor industry

This section considers the socioeconomic characteristics of the semiconductor industry in the U.S. The data come from the 2019 American Community Survey (ACS), the most recently available data. It includes all workers currently employed in the semiconductor industry as well as a comparison to the broader manufacturing industry as well as all other[4] employed workers in the U.S.

3.3.1 Race and ethnicity

The U.S. semiconductor workforce is racially and ethnically diverse. In fact, the semiconductor industry employs a greater share of non-white workers when compared to the manufacturing sector and all other industries in the U.S.

FIG. 10: Race and ethnicity profile



Source: ACS 2019, Oxford Economics tabulations

[4] All other excludes workers in the manufacturing sector.

CASE STUDY:

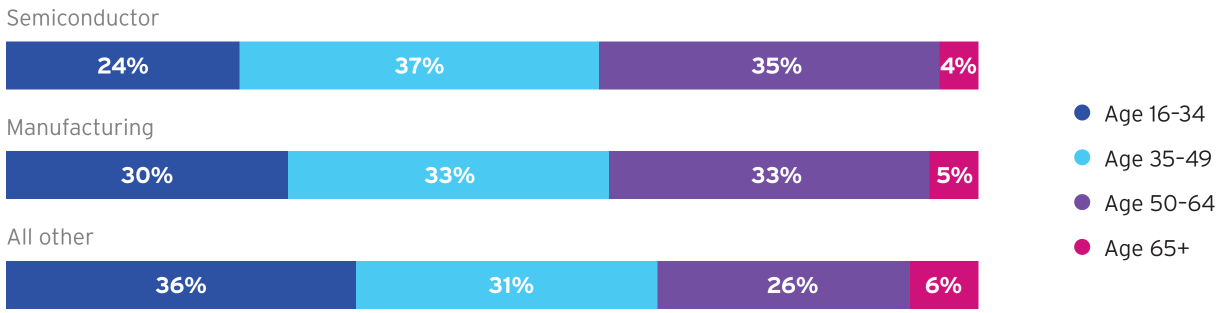
DIVERSITY AND INCLUSION

The U.S. semiconductor industry is constantly working to diversify its workforce, leveraging support for both underrepresented professionals and students, including women and people of color, pursuing STEM degrees. One large U.S. semiconductor firm has supported external students through annual contributions of over $500,000 to underrepresented minorities pursuing electrical engineering through scholarship awards and program sponsorships. Another U.S. semiconductor company runs a workforce diversity recruitment program, including support to national affinity engineering associations and minority serving institutions (MSIs) of higher education, as well as internal financing for employee affinity groups. In addition, another semiconductor firm created an endowment fund that provides financial support for students from underrepresented minority populations in their graduate STEM pursuits.

3.3.2 **Age distribution**

Workers in the semiconductor industry are more likely to be between 35 and 49 years old compared to the rest of the U.S. workforce. Indeed, only 24 percent of the semiconductor workforce was under the age of 35, reflecting the length of tenure within the industry as well as industry knowledge. But as workers aged 50 years old and above approach retirement age, employers in the industry will need to prepare to recruit for the future workforce.

FIG. 11: Age profile of the semiconductor industry

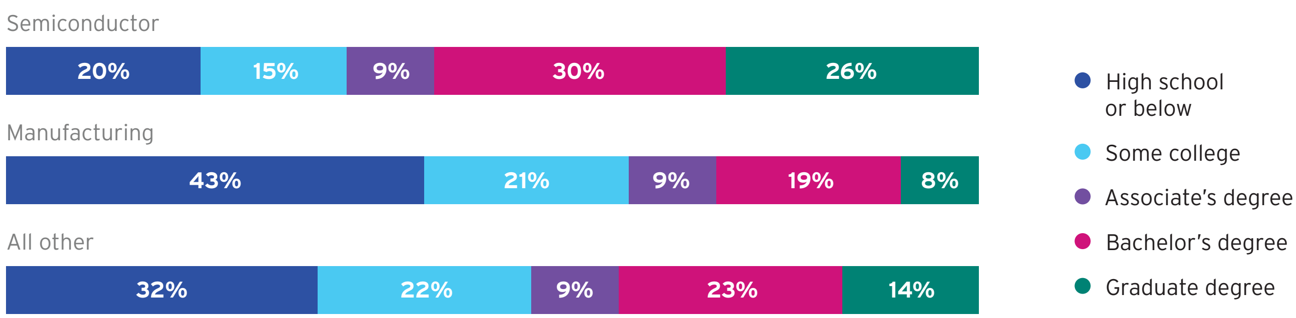


Source: ACS 2019, Oxford Economics tabulations

3.3.3 **Educational attainment**

The semiconductor industry employs a higher share of workers with college degrees compared to manufacturing and all other industries. Still, one in five workers in the semiconductor industry has not attended university. This highlights how the semiconductor industry is an increasingly rare example of an industry that provides opportunities across the education and skills spectrum in which jobs exist for workers to earn family-sustaining wages.

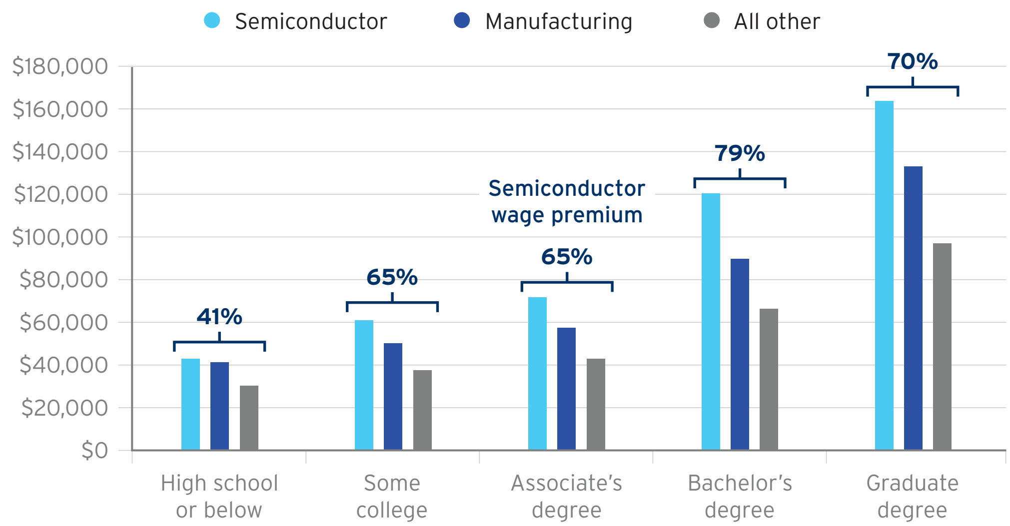
FIG. 12: Educational attainment in the semiconductor industry



Source: ACS 2019, Oxford Economics tabulations

The average pay across the education spectrum within the semiconductor industry is an order of magnitude higher when compared to the average of all other industries. While average wages vary based on educational attainment, semiconductor industry workers consistently earn more than the U.S. average at all education attainment levels. The figure below highlights the pay premium that semiconductor workers can expect to see when compared to workers with similar educational backgrounds who are employed elsewhere in the economy.

FIG. 13: Educational wage premium in the semiconductor industry



Source: ACS 2019, Oxford Economics tabulations

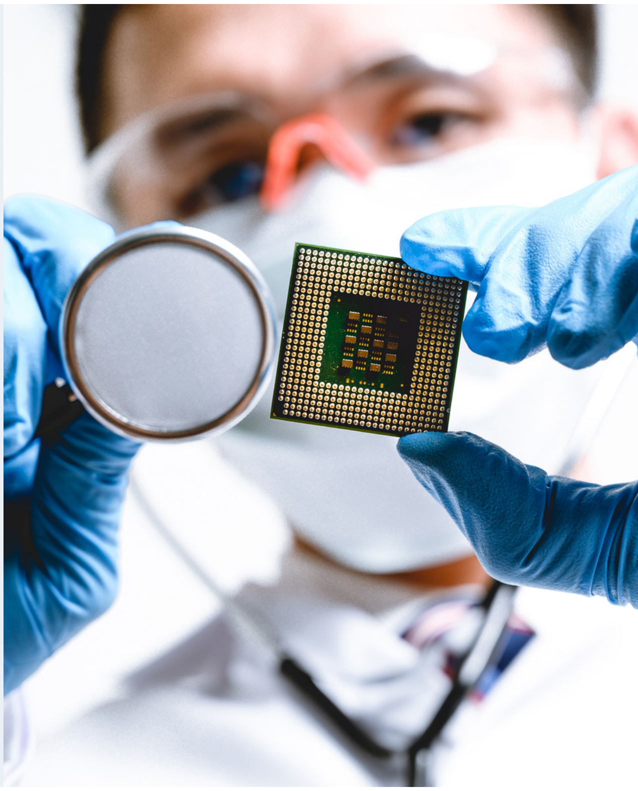
65% degree educated

35% of semiconductor workers do not have a college degree.

CASE STUDY:

THE UPSKILLING OF THE SEMICONDUCTOR WORKFORCE

Because the demand for highly skilled talent regularly outstrips the supply of U.S. STEM graduates, the U.S. semiconductor industry reinvests significantly in their current workforce to maintain and up-level their skills. For example, one major U.S. semiconductor firm runs a robust $1.4 million annual educational assistance program where hundreds of employees are supported each year to pursue master's degrees, bachelors, associates, and certificate programs in job-related fields. Similarly, another firm supports its own employees' up-skilling with a $30,000 annual tuition reimbursement program. Beyond tuition assistance, another U.S. firm hires over 170 Co-Op/Intern students each year, while another firm spends over $1.5 million annually to support approximately 70 interns across the U.S. The vocational training programs offered by another firm is especially effective at developing the technology workforce, as its training program does not require participants to have a bachelor's degree.



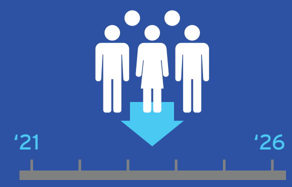
4. THE ECONOMIC IMPACT OF FEDERAL CHIP INCENTIVES

Now, more than ever, there is a need to expand semiconductor research, design, and fabrication in the U.S. By supporting the expansion of the semiconductor industry, nearly all other sectors will benefit, beyond the semiconductor industry itself, either through supply chain spending and increased consumer spending or through the increased availability of chips for downstream industries to secure for their production processes.

In this section, we estimate the economic impacts of federal incentives for semiconductor manufacturing to understand how they could benefit both the semiconductor industry and the broader U.S. economy.[5] We do this over a 6-year period to reflect the duration of construction, equipment installation, and the ramp-up period of potential new fabs to reach full capacity. These jobs are reflective of the build-out period, and their impacts should be considered temporary, in that they are attributable to this investment activity between 2021 and 2026. All impacts are reported in constant, 2020 U.S. dollars unless otherwise stated. The sections below examine in more detail what this means for domestic jobs and wages.

We expect this investment will expand semiconductor manufacturing capacity by adding new manufacturing facilities in the U.S. that would otherwise not be built and create 42,000 new permanent semiconductor jobs in the U.S., growing from 277,000 direct jobs in 2020 to 319,000 direct jobs by 2027. In addition, the total number of jobs supported throughout the U.S. economy would grow by 280,000 from 1.85 million in 2020 to 2.13 million by 2027. These new fabs and jobs would represent a permanent expansion to the U.S. semiconductor industry footprint and its impact, which we explore in Section 4.7. The sections below examine in more detail what this means for domestic jobs and wages.

1.1 million temporary jobs
created from 2021 to 2026*



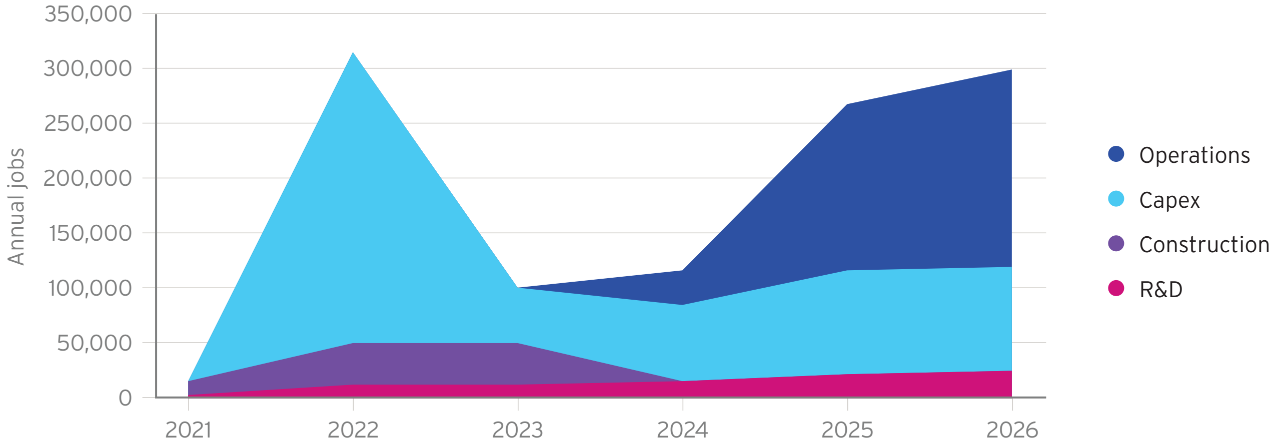
*Inclusive of the direct, indirect, and induced job impacts

4.1 Total impact on the U.S. economy during the build-out phase, 2021 to 2026

We estimate a $50 billion federal investment program to incentivize domestic semiconductor manufacturing would add $24.6 billion annually to the U.S. economy and would create an average of 185,000 temporary jobs annually throughout the U.S. economy from 2021 to 2026. Over this six-year build-out period, therefore, the cumulative annual impact of such an incentive program on GDP and jobs would be $147.7 billion and 1.1 million, respectively. These economic benefits combine all the channels of impact—direct, indirect (supply chain) and induced (wage spending).

[5] Because legislation to fund the CHIPS Act has not been finalized as of publication, this report models the domestic jobs and economic impact of a hypothetical $50 billion federal program to incentivize domestic semiconductor manufacturing that was modeled in the recent SIA/BCG joint report, *Turning the Tide for Semiconductor Manufacturing in the U.S.*

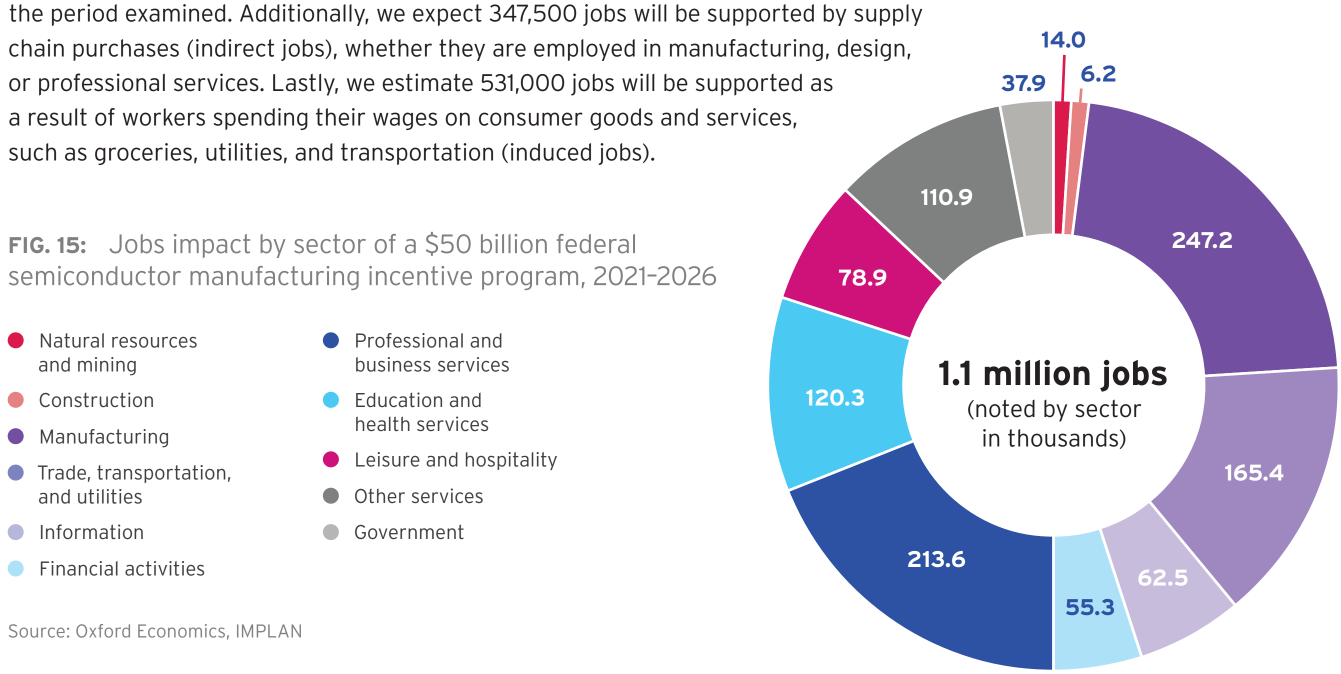
FIG. 14: The total annual jobs impact of a $50 billion federal semiconductor manufacturing incentive program, 2021–2026



4.2 Total temporary jobs created during the build-out phase, 2021 to 2026

In addition to its GDP impact, such a federal incentive program would create an average of 185,000 temporary jobs annually throughout the U.S. economy from 2021 to 2026. In total therefore, if you were to sum the number of jobs created per year due to the incentive program over the six-year build-out phase, the total would be 1.1 million temporary jobs. Of these 1.1 million jobs, we estimate that approximately 235,500 jobs will directly support the design, construction, and equipment installation phase, and operations of the new fab facilities during the period examined. Additionally, we expect 347,500 jobs will be supported by supply chain purchases (indirect jobs), whether they are employed in manufacturing, design, or professional services. Lastly, we estimate 531,000 jobs will be supported as a result of workers spending their wages on consumer goods and services, such as groceries, utilities, and transportation (induced jobs).

FIG. 15: Jobs impact by sector of a $50 billion federal semiconductor manufacturing incentive program, 2021–2026



Source: Oxford Economics, IMPLAN

In the following sections, we provide detail on the impacts of each activity considered, including construction, capex, fab operations, and R&D activity over the period 2021 to 2026.

4.3 Fab operational impacts

These are estimates of expanded semiconductor manufacturing activity economic impacts on the U.S. economy. Excluded from the calculations in this section are the economic impact associated with regular and significant investments in the construction of new facilities, which is explored in subsequent sections. Also excluded are impacts associated with the research and development activities, which we estimate separately. These impacts represent the ramp up period to full capacity in the initial years of operations and would help to create over 523,000 jobs and add $76.3 billion to GDP between 2021 and 2026.

FIG. 16: Semiconductor incentive program operational impacts, 2021–2026

	Direct	Indirect	Induced	Total
Income and GVA in billions of US$				
Employment	89,250	176,566	257,264	523,080
Income	$15.1	$15.7	$14.7	$45.5
GVA	$26.9	$23.4	$26.0	$76.3

Source: Oxford Economics, IMPLAN

4.4 R&D impacts

These are estimates of expanded semiconductor R&D activity economic impacts on the U.S. economy. Although we do not consider the economic and job gains that would come from federal funding for those research provisions, R&D activity is a critical function that begins even before a modern semiconductor fab is complete. Such activity typically can begin even before the start of fab construction, continue and ramp up while the fab is being built, and then continue in earnest once the fab is completed. Fabricating semiconductors is one of the most R&D intensive manufacturing processes of any industry, and that R&D activity occurs across production stages and throughout front-end fabrication, including during preproduction when a fab is still being built. These impacts are substantial and help to create over 66,000 jobs and add $7.7 billion to GDP between 2021 and 2026.[6]

[6] In addition to the direct, indirect, and induced employment impacts of R&D activity in the U.S., the academic literature suggests R&D activity to have additional broader economic spillover effects that positively impact total factor productivity (TFP) and GDP by increasing output per worker. See, for example: Blanco, Luisa; Prieger, James; and Gu, Ji, "The Impact of Research and Development on Economic Growth and Productivity in the US States" (2013). Pepperdine University, School of Public Policy Working Papers. Paper 48.

FIG. 17: Semiconductor incentive program R&D impacts, 2021–2026

	Direct	Indirect	Induced	Total
	Income and GVA in billions of US$			
Employment	19,830	18,027	28,221	66,079
Income	$2.1	$1.3	$1.6	$5.0
GVA	$2.8	$2.0	$2.9	$7.7

Source: Oxford Economics, IMPLAN

4.5 Construction impacts

These are estimates of construction activity economic impacts on the U.S. economy as the result of building new semiconductor fabrication facilities incentivized by a $50 billion federal incentive program. These impacts, while temporary, are substantial and help to create nearly 120,000 jobs and add $10.7 billion to GDP between 2021 and 2026.

FIG. 18: Semiconductor incentive program construction impacts, 2021–2026

	Direct	Indirect	Induced	Total
	Income and GVA in billions of US$			
Employment	56,427	19,904	43,669	119,999
Income	$3.8	$1.5	$2.5	$7.8
GVA	$3.8	$2.5	$4.4	$10.7

Source: Oxford Economics, IMPLAN

4.6 Capex and equipment outfitting impacts

These are estimates of capital expenditure investment economic impacts on the U.S. economy as the result of outfitting new semiconductor fabrication facilities with manufacturing equipment, tools, computers, and other necessary investments to enable operations. Indeed, the manufacturing equipment itself represents the largest investment when building a new fab. As a result of new equipment, we expect the semiconductor manufacturing equipment sector would benefit and grow substantially.

The capex impacts, while also temporary, are indeed substantial and help to create nearly 405,000 jobs and add $53.0 billion to GDP between 2021 and 2026.

FIG. 19: Semiconductor incentive program capex impacts, 2021–2026

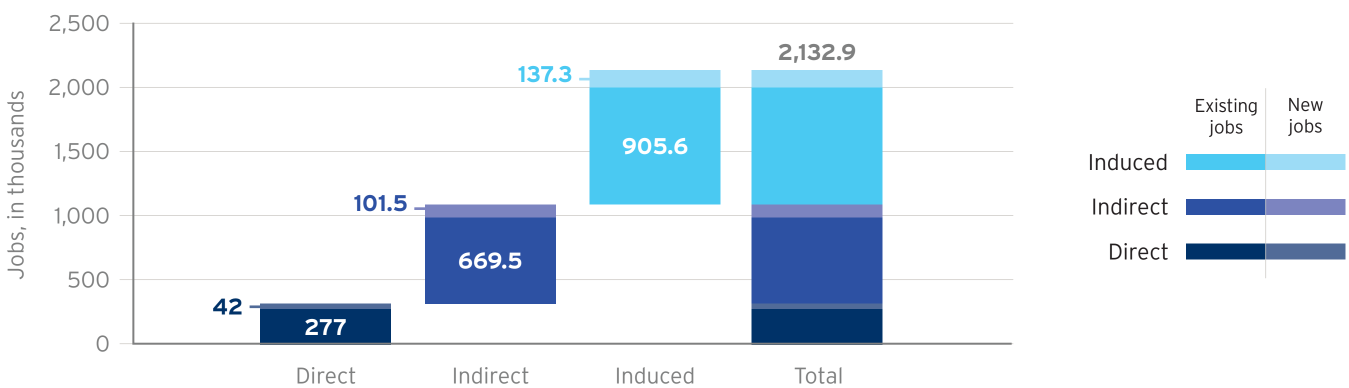
	Direct	Indirect	Induced	Total
	Income and GVA in billions of US$			
Employment	69,973	133,055	201,641	404,669
Income	$12.9	$11.4	$11.6	$36.0
GVA	$15.5	$16.8	$20.7	$53.0

Source: Oxford Economics, IMPLAN

4.7 Long-term, positive incentive program impacts

While the $50 billion federal incentive program would be a one-time investment, the end result of building up this domestic semiconductor industrial infrastructure will have an enduring positive impact on the U.S. economy and jobs. An investment of this magnitude would help create an estimated 10 additional fabs in the U.S. that would otherwise not be built and add 42,000 new semiconductor jobs to the U.S. economy.[7] This uplift would translate into additional ripple effects that the domestic semiconductor industry contributes to the U.S. economy. For example, we would expect the U.S. semiconductor workforce to reach 319,000 by 2027, an increase of 42,000 from the 2020 total of 277,000.[8] Assuming a similar magnitude of jobs multipliers identified in our 2020 findings, (6.7 jobs multiplier for the semiconductor industry), we anticipate the U.S. semiconductor industry would support roughly 2.13 million jobs in the U.S. economy in 2027, an increase of 280,000 from the 2020 total of 1.85 million.

FIG. 20: The estimated long-term job impacts of the U.S. semiconductor industry in 2027 as a result of a $50 billion federal incentive program



Source: Oxford Economics

[7] According to the SIA/BCG joint report, *Turning the Tide For Semiconductor Manufacturing in the U.S.*, a $50 billion incentive program would enable the constructions of 19 advanced fabs in the U.S. over the next 10 years, 10 more than what would be built without the incentive program. In addition, of the estimated 70,000 direct jobs created by the 19 total fabs, 42,000 would be the direct result of the 10 additional fabs built because of the incentive program.

[8] We consider this estimate to be conservative in terms of job growth. While the 42,000 new jobs would be a result of the $50 billion dollar investment, we do expect some amount of organic growth in the U.S. semiconductor industry without the investment. However, for modeling purposes, we do not include that in our impact estimates.

5. THE MANY USES OF SEMICONDUCTORS

26.5 million
downstream jobs supported in 2019

Semiconductors are an integral part of the U.S. economy. Over 300 different industries out of 546 in the U.S. economy made $86.1 billion in purchases from the semiconductor industry in 2020. This is identified by tracing purchases of semiconductors as inputs into the production of other products, such as aircraft, appliances, and automobiles. The uses of semiconductors vary by purpose and industry. Automobile manufacturers use them to provide safety and performance indicators; cell phone makers design them to fit perfectly in a pocket-sized computer, and appliance manufacturers are increasingly using them to improve performance and reduce energy consumption. Indeed, semiconductors can be found as an input for or used by nearly every industry of the economy.

It should also be noted that these 300 sectors are only the ones that directly purchase semiconductors as inputs for the products they produce in their sectors. It does not account for those sectors that purchase electronic products and subsystems enabled by semiconductors. If you were to account for all downstream sectors of the economy that either purchase semiconductors directly as well as those that purchase semiconductors indirectly through the purchase of electronic products and subsystems enabled by semiconductors, it is not a stretch that total would likely be close to if not all 546 industries in the U.S. economy.[9]

FIG. 21: The top consumers of semiconductors by industry and their 2019 U.S. workforce size

Source: IMPLAN, BLS QCEW 2019

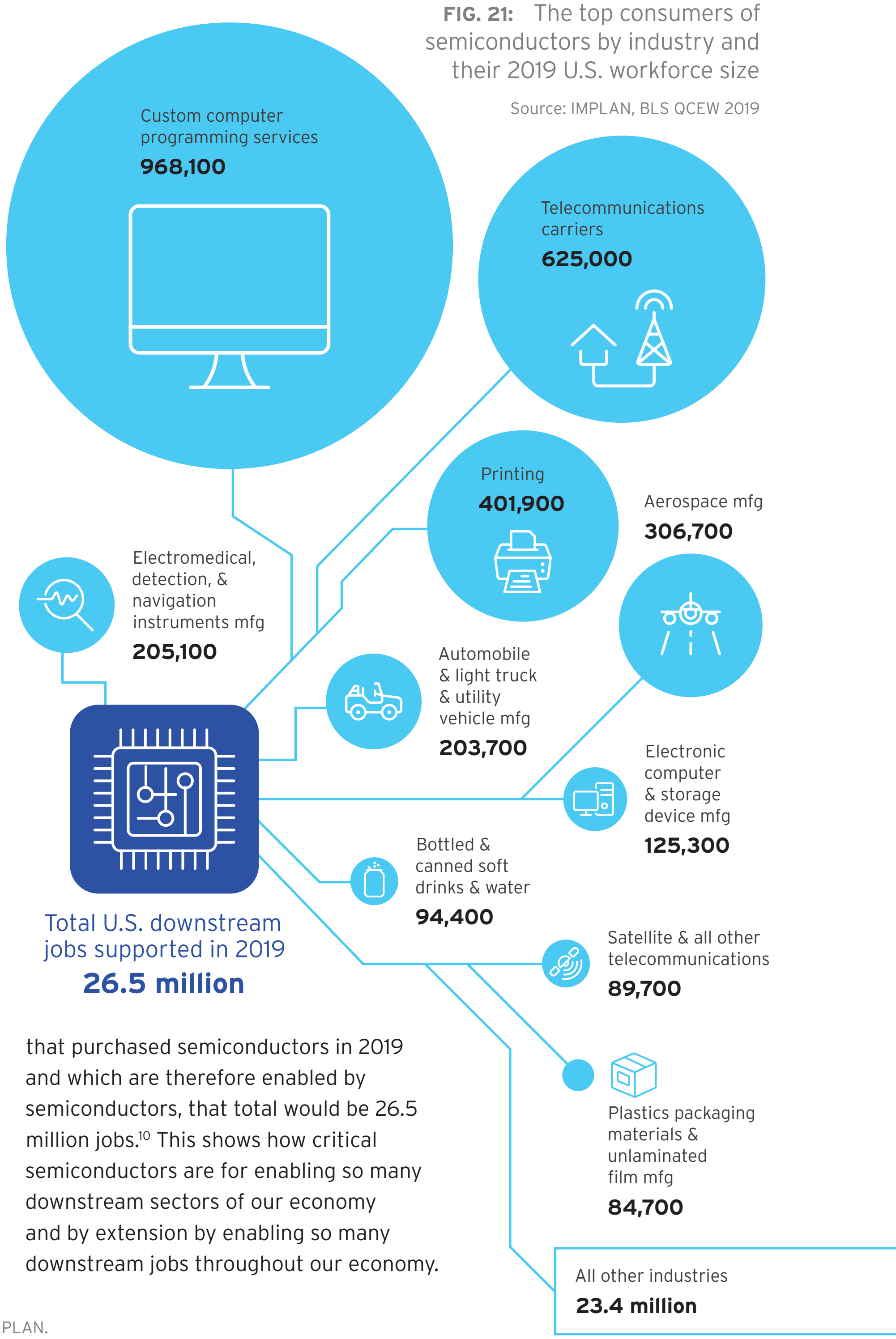


Fig. 21 shows the top 10 purchasers of semiconductors and their respective U.S. workforce in 2019. If you were to total all the workers in the 300 plus sectors that purchased semiconductors in 2019 and which are therefore enabled by semiconductors, that total would be 26.5 million jobs.[10] This shows how critical semiconductors are for enabling so many downstream sectors of our economy and by extension by enabling so many downstream jobs throughout our economy.

[9] Industry classifications as defined and classified by IMPLAN.

[10] 2019 data from QCEW is used, as 2020 annual data was not complete as of the date of report release.

6. CONCLUSION

The U.S. semiconductor industry is a vital and growing part of the U.S. economy. The industry's ability to provide key inputs into a variety of products throughout the broader economy is evidenced by its significant contribution to U.S. GDP and the number of domestic jobs it supports. In 2020, we estimate that the semiconductor industry directly employed over 277,000 workers across 49 states and DC. The industry's overall contribution to the U.S. economy is substantial and it spreads the benefits of the industry to other parts of the U.S. economy. Of the $246.6 billion total contribution to GDP in 2020, some $189 billion came from supply chain and consumer spending activities.

FIG. 22: Summary of the U.S. semiconductor industry's economic impact, 2020

	Direct	Indirect	Induced	Total
	Income and GVA in billions of US$			
Employment	277,000	669,498	905,551	1,852,049
Income	$47.1	$61.9	$51.8	$160.8
GVA	$55.8	$98.6	$92.0	$246.4

Source: Oxford Economics, IMPLAN

The use of semiconductors is essential to virtually all supply chains in every industry, making them indispensable to the economy. Not only does the semiconductor industry produce a vital product to support that economic activity, it also provides additional support services such as design, testing, and R&D services that generate additional economic value throughout the economy.

Now, more than ever, there is a vital need to expand semiconductor R&D, design and manufacturing in the U.S. By supporting the expansion of the semiconductor industry, nearly all other sectors will benefit, either through supply chain spending and increased consumer spending or through the increased availability of downstream industries to secure semiconductor chips for their production processes.

FIG. 23: Estimated impact of a $50 billion federal U.S. semiconductor manufacturing incentive program, 2021–2026

	Direct	Indirect	Induced	Total
	Income and GVA in billions of US$			
Employment	235,480	347,551	530,796	1,113,827
Income	$34.0	$29.9	$30.4	$94.4
GVA	$49.0	$44.8	$53.9	$147.7

Source: Oxford Economics, IMPLAN

7. APPENDIX

Creating the database

To conduct the impact assessment and analysis, Oxford Economics constructed a state-level database using information gathered from various sources. Use of multiple data sources increases accuracy in the database and mitigates chances of error and outliers in estimation process. The sources of data include:

- BLS Quarterly Census of Employment and Wages (QCEW): 2019 annual data.
- BLS Occupational Employment Statistics (OES): May 2019 data.
- Census American Community Survey (ACS): 2019 annual data.
- IMPLAN (IMpact analysis for PLANning): 2020 annual data.
- Census County Business Patterns (CBP): 2018 annual data.
- Proprietary databases: Including data provided by a member survey.

Oxford Economics would like to thank the members of SIA for their support in completing detailed surveys that allowed U.S. to complete this analysis. Without this input, the analysis would not have been possible.

An introduction to economic impact analysis

A standard economic impact assessment identifies three channels of impact that stem from an activity:

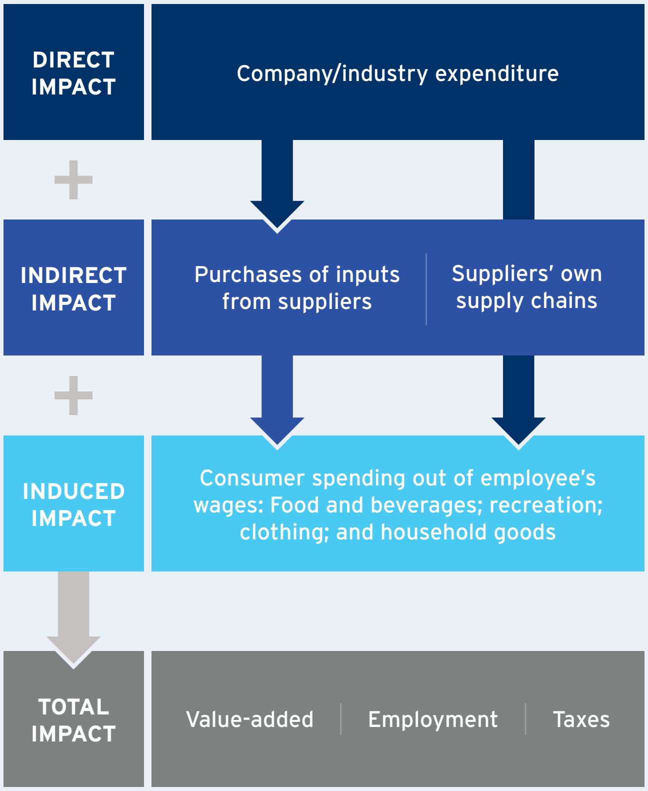
- **Direct effect**, which measures the economic benefit of semiconductor operations and activities in the U.S.
- **Indirect effect**, which encapsulates the activity driven by the supply chain as a result of the procurement of goods and services from other businesses.
- **Induced effect**, which captures the impact of workers spending their wages on locally produced goods and services. This supports activity across the spectrum of consumer goods and services, and their supply chains. An example of this is the purchases a worker makes spending his wages on groceries, clothing, transportation, and utilities.

In accordance with standard economic impact assessments, the scale of the semiconductor industry is measured using three key metrics:

- **GVA:** the gross value added (GVA) contribution to GDP.
- **Employment:** employment is measured in terms of headcount of workers.
- **Wages:** the compensation paid to workers within the industry, the industry's supply chain and induced wages paid to workers in consumer industries.

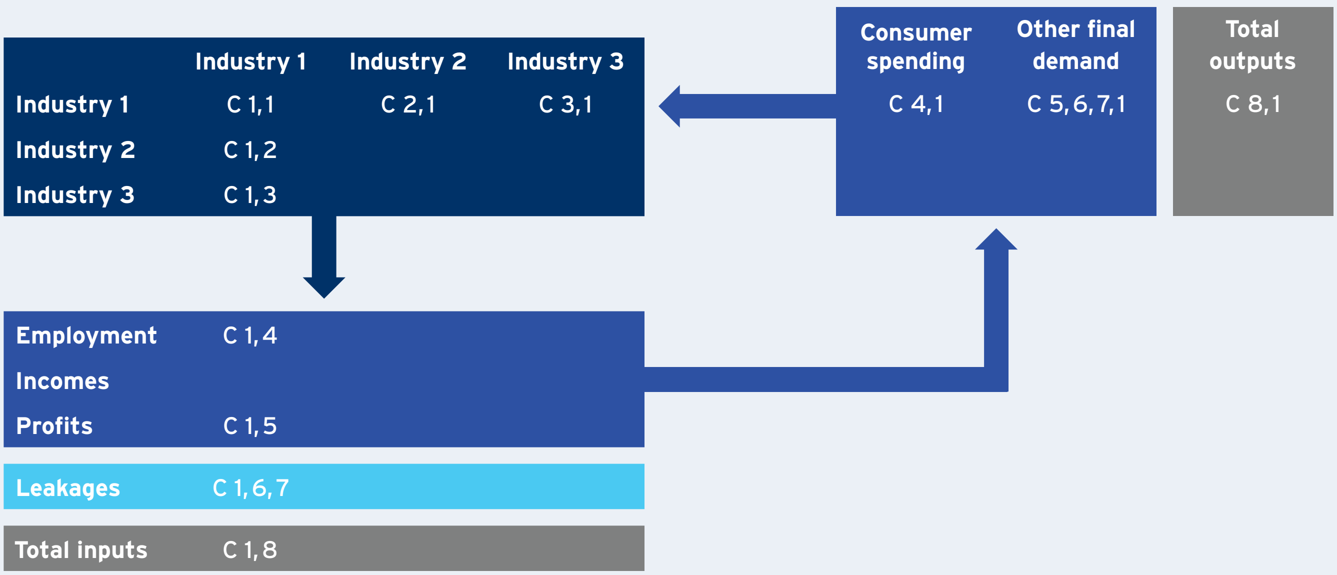
All monetary impacts in this report are presented in current 2020 (i.e. non-inflation adjusted) U.S.$.

FIG. 24: The channels of economic impact



Impact model structure

The model is designed to capture the inter-industry relationships, consumer spending, and ripple effects that result from direct economic activity generated by the U.S. semiconductor industry Input-output modeling characterizes and follows the flow of spending through an economy, thereby capturing and quantifying effects on supply chains, consumer/payroll spending, economic leakages and even taxes paid to governments. The following figure depicts the overarching structure of the model.



About IMPLAN

This analysis utilized IMPLAN economic impact software. IMPLAN is an input-output modeling system used to build models at various levels of geography, including national, state, county, and congressional district. It allows for adjustable assumptions of supply-chain connections and leakages from survey input data and improved accuracy of assumptions. IMPLAN is widely used and recognized by government organizations, non-profits, economic development organizations, workforce planners, education institutions, and consultants across the U.S. and Canada.

Glossary of terms

American Community Survey (ACS): An annual household survey conducted by the U.S. Census Bureau that samples about 3.5 million addresses across the U.S. It provides information on individual socioeconomic and demographic characteristics.

County Business Patterns (CBP): A U.S. Census program that measures subnational economic data by industry. This series includes the number of establishments, employment during the week of March 12, first quarter payroll, and annual payroll.

Gross Domestic Product (GDP): Produced by the Bureau of Economic Analysis (BEA), GDP is the official economic measure of output in the U.S. economy.

Gross Value Added (GVA): A measure of output less intermediate consumption (contribution to GDP), it is the measure of the value of goods and services produced in a specified region.

IMPLAN: Economic impact software that uses Input-Output tables showing the relationships between industries to evaluate the full economic contribution of one industry throughout the economy.

Location Quotient: A location quotient (LQ) for an industry helps to illustrate how concentrated it is in a state by comparing it to the U.S. An LQ equal to 1.0 indicates that the state's industry concentration is equal to the U.S. concentration of the same industry. Industries with LQs greater than 1.0 indicate that a state has a higher concentration of the industry, relative to the U.S. For example, a value of 1.5 indicates that industry employment within the state is 1.5 times more concentrated than the U.S. overall. A location quotient below 1.0 indicates that industry employment within the state is less concentrated compared to the U.S.

NAICS: The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

Occupational Employment Statistics (OES): A Bureau of Labor Statistics (BLS) program that produces employment and wage estimates annually for over 840 occupations.

Quarterly Census of Employment and Wages (QCEW): A Bureau of Labor Statistics (BLS) program that publishes a quarterly count of employment and wages reported by employers covering 98 percent of U.S. jobs.

Standard Occupational Classification (SOC): A system used by Federal statistical agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data. All workers are classified into one of 840 detailed occupations according to their occupational definition.

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