DATA FOR *PROGRESS*

Economic Impacts of the CHIPS for America Act

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Introduction and Summary of Findings

In January 2021, Congress enacted the Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America Act as part of the National Defense Authorization Act (NDAA) for Fiscal Year 2021, after overriding a veto issued by President Trump in December 2020. The CHIPS for America legislation aims to establish "investments and incentives to support U.S. semiconductor manufacturing, research and development, and supply chain security."[1]

However, while the NDAA authorized a variety of incentive and grant programs to stimulate U.S. manufacturing of microelectronics, it did not actually appropriate any funds for these purposes. The United States Innovation and Competition Act (USICA) and America COMPETES Act, currently the subjects of conference committee negotiations between the Senate and House, would finish the job by allocating more than $50 billion in emergency appropriations for CHIPS Act implementation.

These investments would constitute an important step toward alleviating semiconductor shortages that have developed over the course of the coronavirus pandemic. Given the importance of microelectronics as inputs to the production of everything from smartphones to automobiles, these shortages have had a range of deleterious downstream consequences, including supply chain disruptions and price increases for everyday goods.

In earlier research released this March, we employed the Data for Progress Jobs Model to conduct a macroeconomic analysis of USICA and found that its appropriations provisions, if enacted, would contribute around $287 billion to U.S. GDP and would create or preserve a total of around 2.8 million jobs from 2022 through 2027. In this memo, we now focus on the emergency semiconductor appropriations of the bill and estimate that **this spending would create or preserve just over half a million jobs over the next five years while contributing more than $60 billion to GDP — clearly distinguishing them as among the most impactful elements of this legislation.**

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Background on Semiconductor Industry and Recent Shortages

According to a 2020 report from the Congressional Research Service, domestic production of semiconductors as a share of the global market has substantially declined over the last few decades. Although "[t]he United States remains a leader in semiconductor research and development (R&D), chip design, and some aspects of semiconductor manufacturing," its authors write, many of the facilities actually engaged in fabrication — so-called "fabs" — have been moved offshore. As a result, domestic fabrication capacity as a percentage of global capacity has fallen from around 40 percent in 1990 to just 11 percent in 2019. [2] [3]

From the onset of the pandemic, a sharp increase in demand for semiconductors, in part resulting from the unprecedented shift to remote and offsite work arrangements, has led to ongoing shortages of critical electronic components.[4] Moreover, industrial disruptions caused by the spread of the virus and measures taken to fight it have simultaneously led to volatility in their supply.[5] This is not to suggest that increased semiconductor demand is a transient phenomenon, though: according to one industry analysis, annual growth in chip sales could average 6-8 percent through the year 2030. [6]

In the spring of 2021, one industry analyst reported that the lead time from placement of a typical microchip order to final fulfillment reached 15 weeks — the longest measured duration in four years of data collection.[7] Since semiconductors are used as inputs to the production of a wide array of products, including LED lights and household appliances like refrigerators and washing machines, a supply crunch can have profound ripple effects on many sectors of the economy. A substantial expansion of domestic fabrication capacity has therefore been increasingly recognized as an important national priority.[8]

By boosting domestic capacity to meet this demand, the CHIPS for America Act holds out the promise of alleviating supply chain bottlenecks and shortages, and addressing at least one significant driver of inflation. Indeed, Commerce Secretary Gina Raimondo has highlighted the fact that "car companies can't get their hands on enough chips" as a factor in rising prices for automobiles, insisting in a January 2022 interview that "[w]e need to increase the supply of cars so prices will come down. In order to do that, we need an increase in semiconductor chips." [9]

Semiconductor Provisions in USICA

Section 9902 of the CHIPS for America Act in the 2021 NDAA authorizes the secretary of commerce to administer a grant program to provide financial assistance for building, modernizing, or expanding domestic semiconductor fabs. Private firms, public entities, or consortia of the two are eligible to apply for grants of up to $3 billion for such purposes, and must pledge to abide by a set of stipulations that include Davis-Bacon prevailing wage requirements[10] for fab construction and commitments to invest in worker training and apprenticeship programs.

Section 9906, which is devoted to spurring microelectronics R&D, contains a number of other notable provisions. It directs the secretaries of commerce and defense to establish a National Semiconductor Technology Center, which would conduct R&D to improve the security and integrity of the domestic semiconductor supply chain, and a National Advanced Packaging Manufacturing Program within the National Institute of Standards and Technology (NIST) that would improve domestic capabilities around testing, assembly, and packaging of semiconductors.

It also authorizes NIST to pursue R&D into "measurement science, standards, material characterization, instrumentation, testing, and manufacturing capabilities for next-generation microelectronics metrology," and establishes a new institute as part of the Manufacturing USA network of public-private partnerships that would promote R&D into "the virtualization and automation of maintenance and semiconductor machinery; the development of new advanced test, assembly and packaging capabilities; and the development and deployment of educational and skills training curricula needed to support the industry sector."[11]

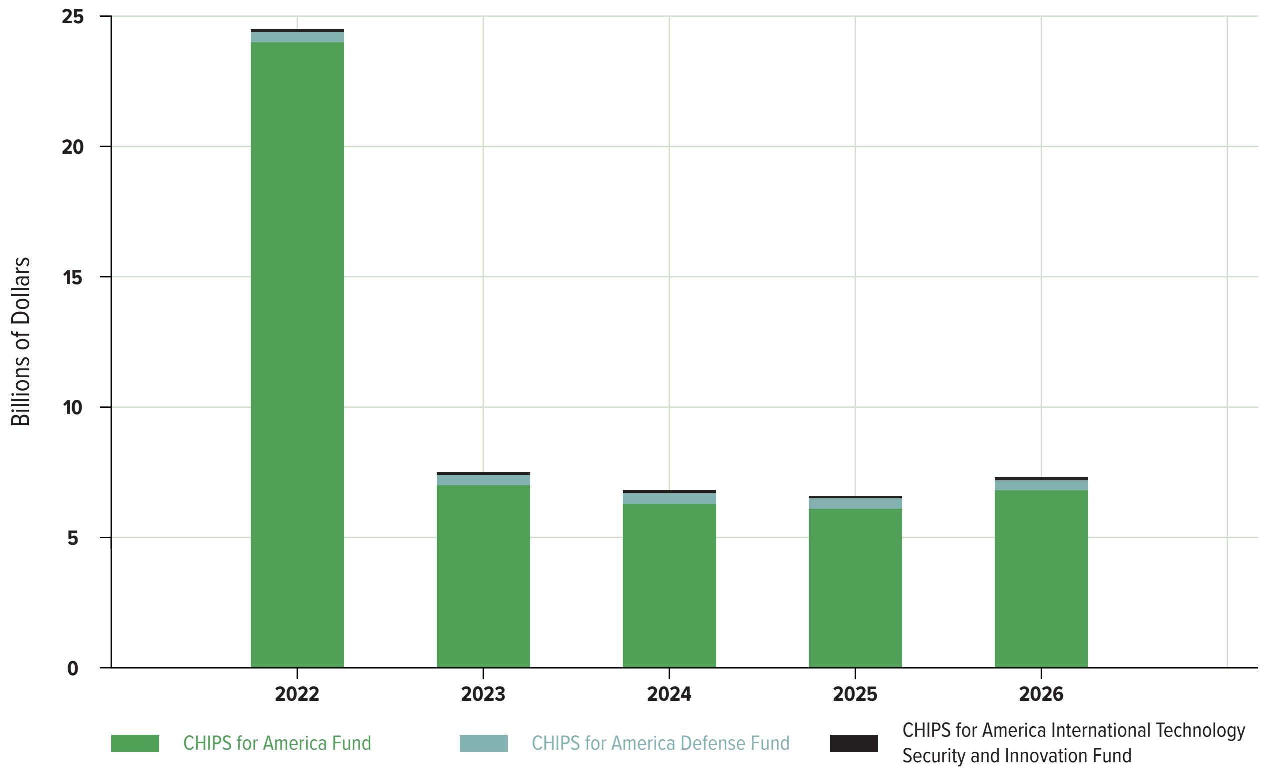
Section 1002 of USICA appropriates money to three funds intended to pay for activities that were authorized by the CHIPS Act/NDAA. These are known as the "CHIPS for America Fund," the "CHIPS for America Defense Fund," and the "CHIPS for America International Technology Security and Innovation Fund." The first would devote funds to the provisions described above, while the Defense Fund would support the semiconductor needs of the defense and intelligence communities. The International Technology Security and Innovation Fund would promote R&D and other measures meant to bolster the security of semiconductor supply chains.

Table 1 on the following page presents the annual appropriations proposed for these three funds for the period 2022-2026.

TABLE 1: CHIPS APPROPRIATIONS IN USICA (BILLIONS OF DOLLARS), 2022-2026[12]

	2022	2023	2024	2025	2026	TOTAL
CHIPS for America Fund	24.0	7.0	6.3	6.1	6.8	50.2
CHIPS for America Defense Fund	0.4	0.4	0.4	0.4	0.4	2.0
CHIPS for America International Technology Security and Innovation Fund	0.1	0.1	0.1	0.1	0.1	0.5
Total	24.5	7.5	6.8	6.6	7.3	52.7

Figure 1 — CHIPS Appropriations in USICA (billions of dollars), 2022-2026



Model Results

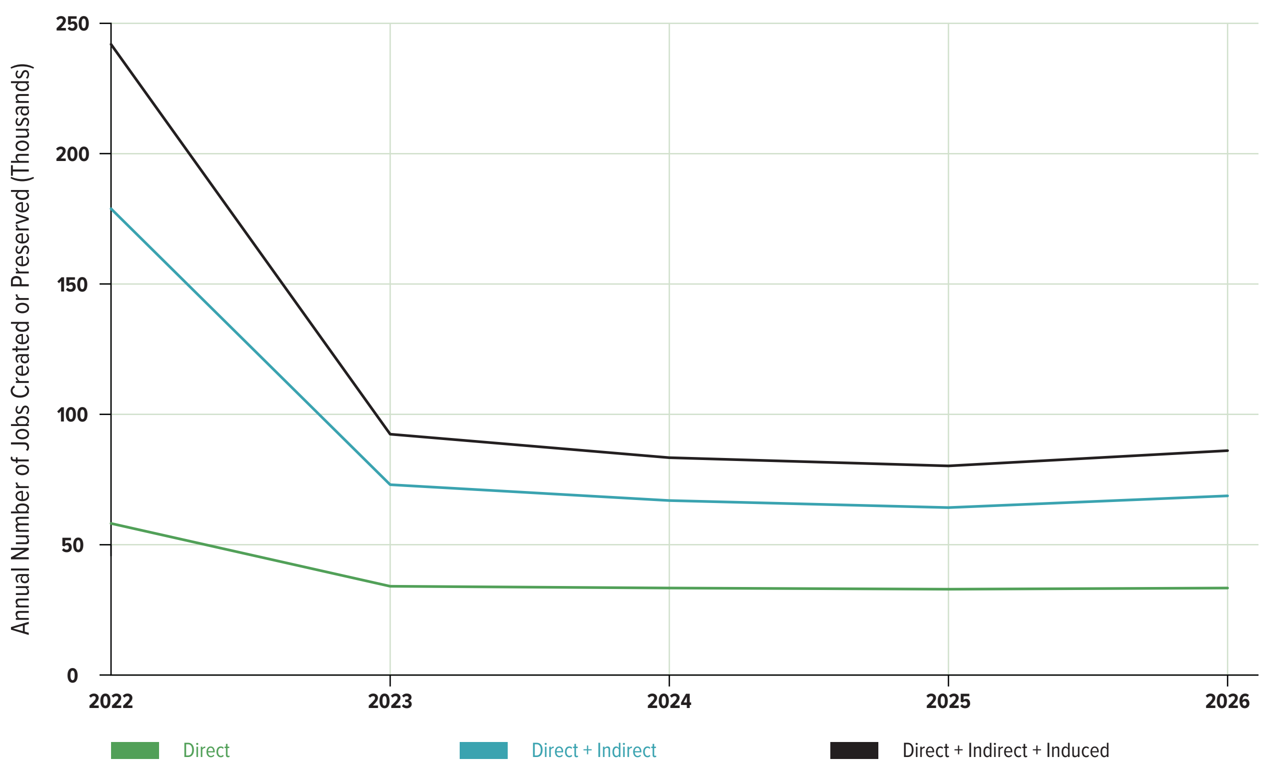
The following table and figure display the results of using our model to estimate the aggregate employment effects of the CHIPS Act funding in USICA.[13] We disaggregate these effects into three categories, termed direct, indirect, and induced jobs.

The distinctions among these are explained in greater detail in Appendix A, but, in brief, direct jobs are those created through hiring by recipients of appropriated funds, indirect jobs are those created along the supply chains that support the work of the direct hires, and induced jobs are those stemming from the economic stimulus provided by the spending of workers in the first and second categories.

TABLE 2: AGGREGATE EMPLOYMENT EFFECTS, 2022-2026

	2022	2023	2024	2025	2026	TOTAL
Annual Number of Jobs Created or Preserved (Direct)	36,589	10,832	9,722	9,280	9,961	76,384
Annual Number of Jobs Created or Preserved (Indirect)	136,139	42,897	37,224	35,140	39,096	290,496
Annual Number of Jobs Created or Preserved (Induced)	69,091	21,491	18,778	17,768	19,622	146,750
Annual Number of Jobs Created or Preserved (Total)	241,819	75,220	65,724	62,188	68,679	513,630

Figure 2 — Aggregate Employment Effects, 2022-2026



The calculation of induced jobs is based on certain assumptions about the multiplier effect associated with consumer spending,[14] the size of which is likely to fluctuate over the course of the business cycle. For that reason, one could interpret the sum of the direct and indirect jobs as a lower bound on our overall estimates.

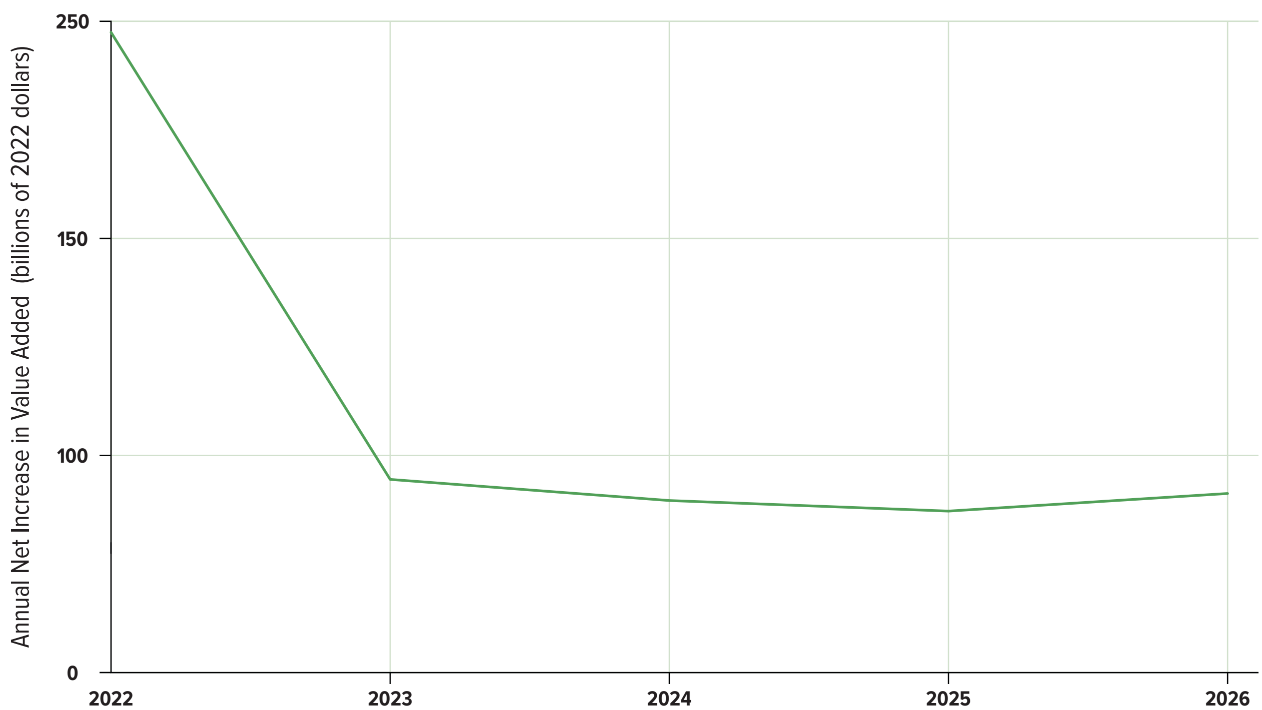
In total, we find that **the CHIPS Act appropriations would create or preserve 366,880 jobs in the direct and indirect categories, and a total of 513,630 jobs in all three, over the period 2022 to 2026.**

In Table 3 and the accompanying figure, we show our projection of the impact that USICA would have on U.S. gross domestic product over the same timeframe. The total contribution to GDP over this period is $62.3 billion, or around $12.5 billion per year. For context, this represents about one-fifth of the aggregate GDP effect of about $287 billion that we estimated in our earlier memo for USICA as a whole — suggesting that the CHIPS Act appropriations are a particularly impactful element of the bill.

TABLE 3: AGGREGATE EFFECTS ON VALUE ADDED/GDP, 2022-2026

	2022	2023	2024	2025	2026	TOTAL
Annual Net Increase in Value Added — Baseline Scenario (billions of 2022 dollars)	29.71	8.93	7.92	7.53	8.18	$62.27

Figure 3 — Aggregate Effects on Value Added/GDP, 2022-2026



In addition to modeling the aggregate employment effects, we can also consider the likely distribution of jobs across states. To that end, we take the estimates we obtain from our model and allocate them across states using the following procedure:

- Since many of the direct jobs are likely to be created in the areas where there are already established semiconductor fabs, we allocate all of these jobs in proportion to the observed distribution of employment in this industry as measured in the American Community Survey (ACS);[15]
- Using industry-specific estimates of the indirect and induced jobs from our model, we allocate these in proportion to the observed distribution of employment in each industry from the same dataset.

The table on the following page shows the breakdown by state of cumulative jobs created or preserved due to the CHIPS Act provisions over the period 2022-2026. Since semiconductor manufacturing has a minimal presence in some states at present, these states will have relatively few estimated direct jobs, meaning that comparatively more of the employment effect in those places will consist of indirect and induced jobs.

TABLE 4: TOTAL EMPLOYMENT EFFECTS BY STATE, 2022-2026

State	Cumulative Number of Jobs Created or Preserved, 2022-2026 (Direct)	Cumulative Number of Jobs Created or Preserved, 2022-2026 (Indirect)	Cumulative Number of Jobs Created or Preserved, 2022-2026 (Induced)	Cumulative Number of Jobs Created or Preserved, 2022-2026 (Total)
AL	488	3,562	1,888	5,938
AK	0	564	284	848
AZ	4,038	6,602	3,269	13,909
AR	116	2,012	1,049	3,177
CA	20,586	37,284	18,420	76,290
CO	1,537	6,325	3,104	10,966
CT	1,037	3,422	1,705	6,164
DE	111	776	390	1,277
DC	0	915	446	1,361
FL	2,359	18,088	8,961	29,408
GA	1,057	8,991	4,548	14,596
HI	40	1,117	551	1,708
ID	1,232	1,455	716	3,403
IL	2,432	12,388	6,318	21,138
IN	1,168	5,655	3,084	9,907
IA	172	2,715	1,390	4,277
KS	282	2,394	1,205	3,881
KY	201	3,103	1,647	4,951
LA	24	3,305	1,692	5,021
ME	277	1,189	579	2,045
MD	463	6,132	2,971	9,566
MA	3,117	7,528	3,696	14,341
MI	1,304	8,152	4,247	13,703
MN	1,951	5,530	2,806	10,287
MS	118	1,737	912	2,767
MO	453	4,935	2,539	7,927
MT	58	803	401	1,262
NE	272	1,624	822	2,718
NV	433	2,436	1,221	4,090
NH	968	1,487	741	3,196
NJ	1,668	8,354	4,208	14,230
NM	390	1,644	806	2,840
NY	3,887	16,315	8,154	28,356
NC	1,604	8,690	4,403	14,697
ND	68	652	321	1,041
OH	1,250	10,252	5,484	16,986
OK	190	3,001	1,535	4,726
OR	4,561	4,016	2,012	10,589
PA	2,179	11,086	5,782	19,047
RI	368	1,029	515	1,912
SC	379	4,078	2,097	6,554
SD	363	671	340	1,374
TN	663	5,814	2,998	9,475
TX	7,313	27,049	13,594	47,956
UT	886	2,992	1,499	5,377
VT	534	575	282	1,391
VA	883	7,892	3,890	12,224
WA	1,934	6,866	3,424	12,224
WV	34	1,141	605	1,780
WI	933	5,717	2,983	9,633
WY	0	437	220	657
TOTAL[16]	76,381	290,497	146,754	513,632

Conclusion

Our analysis indicates that the CHIPS Act appropriations contained in USICA constitute one of this important bill's most impactful sets of provisions; we find that they would create or preserve over half a million jobs over the next half-decade and would contribute more than $60 billion to U.S. GDP. In light of the worker protections contained in the legislation, we also expect that the jobs directly created by this influx of federal spending would mostly be the sort of well-paid "good" jobs that progressive policies should aim to promote.

These employment and GDP figures correspond to approximately one-fifth of those that we previously estimated when considering the likely impacts of USICA as a whole. Moreover, insofar as supply chain disruptions affecting microelectronics contribute to America's ongoing inflation problem, the investments in this portion of the bill have an important role to play in addressing this issue.[17]

As we described in our earlier research, one limitation of I-O analysis in a setting such as this is that our model of the economy is based on measurements of the current input requirements of various industries and the linkages among sectors. But innovation is an important determinant of productivity and a driver of long-run economic growth, and is likely to reshape the economy in ways that are difficult to forecast.[18]

To the extent that USICA's emergency semiconductor appropriations are routed into R&D in addition to expansion of production capacity — for instance, as part of the provisions contained in Section 9906 of the CHIPS Act/NDAA — there may be additional benefits to be realized in the future that cannot be easily modeled given the data at hand.

Appendix A: Background on Input-Output Modeling

In this section, we describe the basics of the I-O framework used to generate our estimates, as well as some of the assumptions and methodological choices that are specific to our analysis. Appendix B contains even more detail about the mathematics underlying the model.[19]

An I-O model is a simplified representation of an economy that uses data on the inputs that various industries require to produce their final outputs in order to illustrate the linkages among different sectors.[20] Knowing what these linkages look like allows policy analysts to understand how an initial increase or decrease in spending by governments, firms, or consumers — what economists would refer to as a change in autonomous spending — will filter through the economy, and what will be its ultimate effect on certain macroeconomic indicators of interest, such as GDP or aggregate employment.

Input-output modeling assumes that such a change in autonomous spending has three types of effects on output and employment:

- **DIRECT EFFECTS —** the incremental economic activity and jobs created by the production of *final* goods and services brought about by the new spending;
- **INDIRECT EFFECTS —** the incremental economic activity and jobs created by the production of the *intermediate inputs* to those final goods and services; and
- **INDUCED EFFECTS —** the incremental economic activity and jobs created by the expenditures of workers who are paid to produce these final and intermediate goods and services.

To model direct and indirect effects, we can make use of data on industry-level input requirements made available by the Bureau of Economic Analysis (BEA), which publishes a variety of different tables that can be used to construct an I-O model.[22] One of these tables is known as the direct requirements matrix, which shows, for each of a specified set of industries, how many dollars of inputs are required to be purchased from each of the other industries in order to produce one dollar of its output.

Another is known as the *total requirements matrix* or the *Leontief inverse matrix*, after the economist Wassily Leontief, a pioneer of I-O analysis. This shows, for each industry, how many dollars of goods each of the other industries must ultimately produce in order for the initial industry to produce one dollar of its output, taking into account the production of intermediate inputs. Thus, the total requirements matrix allows one to isolate indirect effects by comparing to estimates that would be obtained from calculations based on the direct requirements matrix alone.

Induced effects result from the fact that a portion of the income earned by firms in a given industry when selling their outputs will be paid out as labor income for workers, who will then spend some of that income on purchases of consumer goods. The question of how best to model induced effects is itself a potentially complicated one, but for the sake of simplicity, in our baseline model run we choose to follow the approach of Pollin, Garrett-Peltier, Heintz, and Hendricks (2014),[21] who assume on the basis of relevant macroeconomic research that consumer spending has a multiplier of approximately 1.4. That is, each dollar of economic activity associated with the direct and indirect effects of a change in autonomous spending by governments or firms will ultimately generate total economic activity of $1.40.

The requirements matrices allow us to assess the impact of a change in autonomous spending on the *gross output* of every industry, including both intermediate goods sold to other producers and final goods sold to consumers. If we are interested in computing the total impact of an initial stimulus on GDP, we need estimates of *value added* in each industry, which subtract off the costs of intermediate outputs.

To that end, we obtain measures of both gross output and value added by industry from the BEA for each year, and use these to calculate industry-specific ratios of value added to output. Thus, we can take the gross output figures derived from our model and convert them into estimates of value added, which we can then sum across industries in order to obtain an estimate of the total impact on GDP in that year.

Appendix B: Matrix Algebra of I-O Modeling

In algebraic terms, we let the direct requirements matrix be denoted by A, the dimension of which is 71-by-71. The entry in the ith row and the jth column of A indicates how many dollars of industry i's output need to be purchased by industry j in order to produce one dollar of j's output.

Suppose we want to consider the direct economic effect of spending a certain amount of money on purchasing the product of industry j. We can model this spending with a vector X consisting of a single column and 71 rows, where the entry in the jth row, which we denote by x_j, is the amount that we want to spend on product j (and the entries in every other row are zero, if we are not purchasing anything else).

Premultiplying X by the matrix A gives us the product vector AX, which shows how much input we require (in dollars) from each of the industries in order to produce x_j dollars of industry j's output. (Simple matrix algebra shows that the entries of AX will be equal to the entries in the jth column of A multiplied by the scalar x_j.)

However, this calculation only provides us with a partial picture of the total impact that the initial influx of autonomous spending represented by vector X will have on the economy. This is because each of the industries that provide the inputs to allow industry j to produce its output will itself have to purchase inputs from other industries, and each of *those* industries will have to purchase *its* own inputs, and so on. The *direct* effect of the spending represented by vector X will be AX, but the inputs needed to produce AX will be given by A^2X, the inputs needed to produce A^2X by A^3X, and so on.

Therefore, the total effect on the economy, *direct* effects plus *indirect* effects, will be given by the infinite sum:

$$AX + A^2X + A^3X + A^4X + \dots$$

Through algebraic manipulation, it can be shown that this sum is equal to

$$(I\text{-}A)^{-1}X$$

where the matrix $(I\text{-}A)^{-1}$ is known as the *total requirements matrix* or the *Leontief inverse matrix*.

The entry in the ith row and jth column of the total requirements matrix gives the total amount of production (in dollars) by industry i that is brought about when industry j produces one dollar of final output. Thus, multiplying this matrix by the spending vector X gives the total economic impact of that initial stimulus.

Endnotes

[1] H.R. 7178 – CHIPS for America Act. Available at https://www.congress.gov/bill/116th-congress/house-bill/7178.

[2] Congressional Research Service Report R46581; October 26, 2020; "Semiconductors: U.S. Industry, Global Competition, and Federal Policy." Available at https://crsreports.congress.gov/product/pdf/R/R46581.

[3] For further history of the US semiconductor industry and production trends over time, see Alex Williams and Hassan Khan (Employ America); March 21, 2021; "A Brief History of Semiconductors: How The US Cut Costs and Lost the Leading Edge." Available at https://employamerica.medium.com/a-brief-history-of-semiconductors-how-the-us-cut-costs-and-lost-the-leading-edge-c21b96707cd2.

[4] Heekyong Yang and Makiko Yamazaki (Reuters); March 23, 2020; "Home work triggers demand jump for chips, laptops and network goods." Available at https://www.reuters.com/article/us-health-coronavirus-tech-demand-idCAKBN21A0Y9.

[5] Bloomberg News; April 18, 2022; "China's Chip Output Shrinks as Lockdowns Hurt Production." Available at https://www.bloomberg.com/news/articles/2022-04-18/china-s-chip-output-shrinks-as-lockdowns-hurt-production.

[6] Ondrej Burkacky, Julia Dragon, and Nikolaus Lehmann (McKinsey); April 1, 2022; "The semiconductor decade: A trillion dollar industry." Available at https://www.mckinsey.com/industries/semiconductors/our-insights/the-semiconductor-decade-a-trillion-dollar-industry#:~:text=The%20global%20semiconductor%20industry%20is,trillion%2Ddollar%20industry%20by%202030.

[7] Ian King, Debby Wu, and Demetrios Pogkas (Bloomberg); March 29, 2021; "How a Chip Shortage Snarled Everything from Phones to Cars." Available at https://www.bloomberg.com/graphics/2021-semiconductors-chips-shortage/.

[8] Gregory Arcuri (Center for Strategic and International Studies); January 31, 2022; "The CHIPS for America Act: Why It is Necessary and What It Does." Available at https://www.csis.org/blogs/perspectives-innovation/chips-america-act-why-it-necessary-and-what-it-does

[9] Ben Werschkul (Yahoo Finance); January 15, 2022; "Inflation has 'direct correlation' with America's chip shortage: Commerce Secretary." Available at https://news.yahoo.com/inflation-chip-shortage-commerce-secretary-122005269.html

[10] The Davis-Bacon Act of 1931 is a federal law that requires contractors and subcontractors performing public works projects that receive federal funding to ensure that all workers are paid the "prevailing wage" (and prevailing fringe benefits) for their occupations in the local area where the work is being performed. Determinations of what constitutes the prevailing wage for a given place, occupation, and year are issued by the Department of Labor. For more details see https://www.dol.gov/agencies/whd/government-contracts/construction/faq#23.

[11] Congressional Research Service; January 13, 2022; "Semiconductors, CHIPS for America, and Appropriations in the U.S. Innovation and Competition Act (S. 1260)." Available at https://crsreports.congress.gov/product/pdf/IF/IF12016.

[12] Author calculations. We assign to 2022 spending stipulated in the bill as being for Fiscal Year 2021.

[13] Estimates of employment increases are obtained by using data from the Bureau of Economic Analysis (BEA) to calculate the ratio of gross output to employment in each industry in 2020 (the most recent year for which data are available), and then multiplying the output effects from our model by these ratios.

[14] See Appendix A for more detail on the assumptions underlying the estimation.

[15] Although ACS data are available through 2020, we make use of the 2019 data to avoid potential issues with the reliability of survey results and the resulting sampling weights from the early phase of the pandemic. We proxy for semiconductor industry employment by identifying individual respondents whose industry is reported as "electronic component and product manufacturing."

[16] Note that state figures may not exactly sum to national totals due to rounding.

[17] Matt Mazewski, January 10, 2022, "How Build Back Better and USICA Can Strengthen Supply Chains and Fight Inflation," available at https://www.dataforprogress.org/blog/2022/1/10/how-build-back-better-and-usica-can-strengthen-supply-chains-and-fight-inflation.

[18] See, for instance, Joseph Stiglitz and Bruce Greenwald (2014), Creating a Learning Society: A New Approach to Growth, Development, and Social Progress, New York: Columbia University Press.

[19] Even more background and a case study can be found in "Introduction to the Data for Progress Jobs Model," available at https://www.dataforprogress.org/memos/2022/2/28/introduction-to-the-data-for-progress-jobs-model.

[20] For further background on I-O modeling, see Ronald E. Miller and Peter D. Blair (2009), Input-Output Analysis: Foundations and Extensions, 2nd Ed. Cambridge, U.K.: Cambridge University Press.

[21] For our purposes here, all of the BEA tables that we use rely on an industry classification scheme involving 71 industries based on the North American Industry Classification System (NAICS). To access these tables, see the Bureau of Economic Analysis webpage on "Input-Output Accounts Data," available at https://www.bea.gov/industry/input-output-accounts-data.

[22] Robert Pollin, Heidi Garrett-Peltier, James Heintz, and Bracken Hendricks (2014), "Green Growth: A U.S. Program for Controlling Climate Change and Expanding Job Opportunities," available at https://peri.umass.edu/fileadmin/pdf/Green_Growth_2014/GreenGrowthReport-PERI-Sept2014.pdf.