Comments and Discussion

COMMENT BY

GABRIEL CHODOROW-REICH This paper by Erten, Stiglitz, and Verhoogen is a timely and ambitious empirical analysis of the near-term employment effects of the CHIPS Act. The paper is clearly written and makes use of the best available data. It also anticipates follow-up work using additional data and research designs, which I encourage the authors to pursue.

The present paper makes three main claims. First, a meaningful, albeit not primary, objective of the CHIPS Act was to create jobs. Second, the legislative run-up to the CHIPS Act coincided with an increase in national employment in semiconductor production. Third, semiconductor employment in counties with existing semiconductor activity grew faster than semiconductor employment in other counties, suggesting a causal effect of the CHIPS Act on semiconductor employment.

I will start my comment with a detailed discussion of the available data and the paper's research designs. While I will conclude that the cross-county comparison of semiconductor employment may not much improve on examining the national time series directly, I will also discuss other evidence suggesting that there was abnormally fast growth in the sector around the CHIPS Act. Next, I will discuss whether that growth should be attributed to the CHIPS Act or to something else, such as the contemporaneous semiconductor shortage. Finally, I will discuss the possible macroeconomic implications.

DID SEMICONDUCTOR EMPLOYMENT GROW ABNORMALLY FAST AROUND THE CHIPS ACT? Figure 1 shows semiconductor production employment

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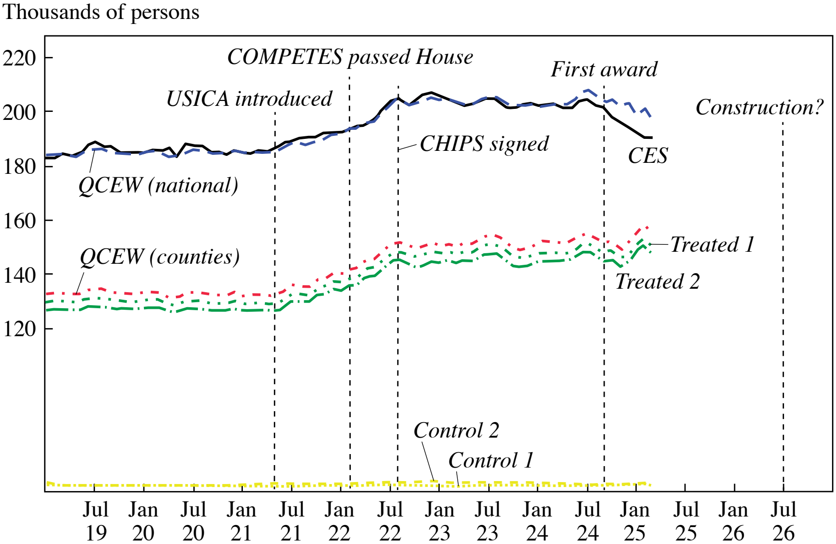
Figure 1. Employment in Semiconductor Production



Source: CES; QCEW; and author's calculations.

Note: The line marked "CES" displays national employment in NAICS 334413 in the BLS CES. The line marked "QCEW (national)" displays national employment in NAICS 334413 in the BLS QCEW. The line marked "QCEW (counties)" displays the sum of employment in NAICS 334413 at the county level in the QCEW. The lines marked "Treated" display the sum of employment in NAICS 334413 in treated counties in the two research designs in the paper. The lines marked "Control" display the sum of employment in NAICS 334413 in control counties in the two research designs in the paper. The *y*-axis is distorted between zero and 120. The control lines never exceed 3,000 persons.

(NAICS 334413) for several different data sources and geographic aggregations. The "CES" line at the top of the figure shows national employment from the Bureau of Labor Statistics (BLS) Current Employment Statistics (CES). According to the authors, the first notable event signaling possible passage of the CHIPS Act occurred in May 2021 with the Senate's consideration of the precursor bill titled United States Innovation and Competition Act (USICA). After remaining quite flat, including through the COVID shutdown period, national semiconductor employment rose by about 20,000 persons, or 10.6 percent, between the consideration of USICA and the end of 2022, after which it again flattened. The "QCEW (national)" line at the top of the figure shows national employment in semiconductor production as reported in the BLS Quarterly Census of Employment and Wages (QCEW). The QCEW aggregates directly from unemployment insurance (UI) tax records and hence contains a near-universe of private sector employment. It also provides the benchmark for the CES program, so not surprisingly the CES and QCEW national employment totals closely track each other.

Because it builds from establishment-level UI reporting, the QCEW also contains information on semiconductor employment at the county level. However, in order to protect the confidentiality of individual establishments, the QCEW suppresses employment in counties with only a few establishments or highly concentrated employment in a sector. The "QCEW (counties)" line in the middle of the figure shows the sum of semiconductor employment as reported at the individual county level. Because semiconductor production tends to concentrate in large factories, the suppression of data is substantial. For example, in May 2021 more than 46,000 employees, or about 25 percent of total semiconductor employment, worked in counties with suppressed records. A county-level research design necessarily excludes these counties, despite several eventual CHIPS awards going to counties with suppressed semiconductor employment.

The authors' cross-county research design, summarized in their figures 5–7, compares semiconductor employment in counties with semiconductor production to semiconductor employment in selected counties without semiconductor production. Their first design designates as treated any county with at least one semiconductor facility prior to 2021 and as control any county labeled as "high-technology" by the Census Bureau and not also treated. Their second design designates as treated any county with at least one semiconductor fabrication facility and as control counties with at least one semiconductor facility but no fabrication facility.

Figure 1 shows the time series of semiconductor employment summed over treated and control counties for both research designs. Two important features stand out. First, essentially all semiconductor employment is in counties designated as treated. This statement holds true using either research design. Second, and a corollary, there is essentially no semiconductor employment in the control counties. (For readability the y-axis on the figure is distorted—total employment in the control counties never exceeds 3,000 for either definition.) This fact should not surprise, since by construction the control counties do not have semiconductor production or fabrication facilities.

A consequence of designating a control group with essentially no employment is that the difference-in-differences estimator in fact just recovers the unweighted average employment change in the treated counties. This result obtains because the authors estimate their main difference-in-differences specification with the level of semiconductor employment as the dependent variable:

$$Y_{it} = \alpha_i + \gamma_t + \beta * \text{Treated}_i * \text{Post}_t + \varepsilon_{it},$$

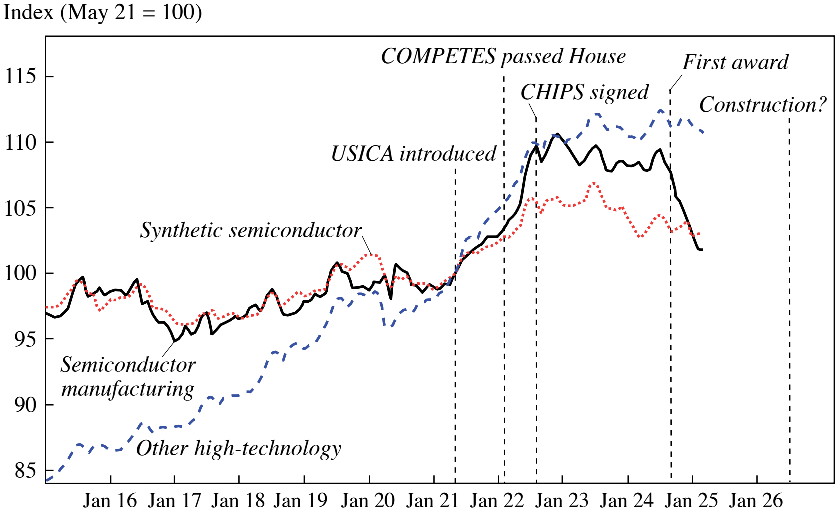
where Y_{it} denotes the level of semiconductor employment in county i at date t. The time fixed effect γ_t equals the average deviation of employment in each control county i from the county's sample mean. If control counties have very low semiconductor employment, then γ_t will be approximately zero in all months, leaving β as the difference in average employment in the treated counties before and after the treatment occurs.

The fact that the control counties do no "work" in the regression opens the question of whether the growth of semiconductor employment in this period actually was abnormal. Indeed, the USICA filing in May 2021 also coincided with the widespread availability of COVID vaccines and the full reopening of much of the US economy, which added 9.3 million jobs between May 2021 and December 2022 according to the CES. Could the increase shown in figure 1 simply reflect overall economic growth?

Figure 2 provides an alternative answer to that question by comparing national semiconductor employment to national employment in other high-technology sectors. The control group thus embodies the same idea as the first research design in the paper, but uses national employment in this group as the counterfactual for semiconductor employment. The solid line displays total semiconductor manufacturing employment and the dashed line total employment in other high-technology industries, both indexed to equal one hundred in May 2021. Immediately visible is much faster pre-2021 growth in the other high-technology sectors. To adjust for this difference, the dotted line displays the synthetic difference-in-differences counterfactual obtained by reweighting the other high-technology sectors using the method of Arkhangelsky and others (2021). A comparison of actual and synthetic semiconductor employment reveals faster growth in actual employment starting in May 2021 and persisting through 2022. If anything, this difference might understate the abnormal growth of semiconductor employment, because the synthetic counterfactual puts about half the weight on two sectors downstream from semiconductors—computer and peripheral equipment (NAICS 3341) and communications equipment (NAICS 3342).

Taking stock, it seems plausible that semiconductor employment after May 2021 grew faster than predicted by either its previous trend or employment growth in similar industries.

Figure 2. Employment in Semiconductor Production and Other High-Technology Sectors



Source: CES; QCEW; and author's calculations.

Note: The line marked "Semiconductor manufacturing" displays national employment in NAICS 334413 in the BLS CES. The line marked "Other high-technology" displays the sum of national employment in NAICS 3341, 3342, 3345, 3364, 5132, 5413, 5415, 5417, and 541713 in the BLS CES and NAICS 5182 in the BLS QCEW. The line marked "Synthetic semiconductor" applies the method of Arkhangelsky and others (2021).

WAS THE ABNORMAL GROWTH DUE TO THE CHIPS ACT? Assigning causality to the CHIPS Act requires additional argument. The timing itself offers prima facie, albeit not dispositive, reason for doubt. As described by the authors and illustrated in the figures in this comment, the timeline from filing of USICA to passage of the CHIPS Act to awarding of grants to construction of new facilities remains incomplete as of this writing. The period of rapid employment growth in semiconductor manufacturing concentrates between the filing of USICA in May 2021 and the signing of the final CHIPS bill in August 2022. Semiconductor employment remained essentially flat for more than a year after the signing of the CHIPS Act before falling starting in the latter part of 2024. Meanwhile, the first CHIPS awards were announced in late 2024, and these awards mostly anticipated construction starting in 2026 or later.[1] Thus, ascribing the employment growth from May 2021 to

1. Information on CHIPS awards can be found at National Institute of Standards and Technology, "CHIPS for America Awards," updated September 19, 2024, https://www.nist.gov/chips/chips-america-awards.

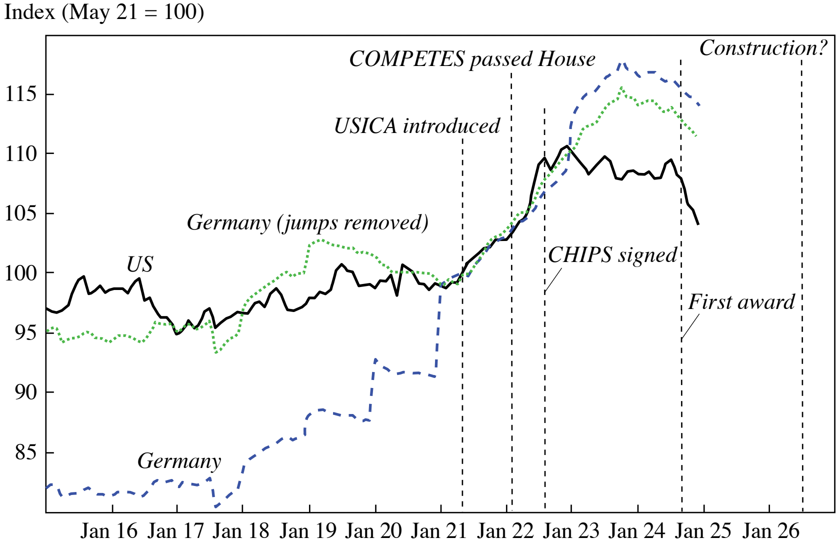
the end of 2022 to the CHIPS Act requires semiconductor firms to have ramped up employment in anticipation of possible passage of the act, with no certainty that they would be chosen as awardees, and years ahead of any new facilities funded by the act.

The authors discuss and dismiss a leading alternative explanation, the shortages of chips in early 2021. The case for this alternative emerges from news reports at the time. For example, a June 2021 *Wall Street Journal* article with the headline "Chip Shortages Are Starting to Hit Consumers. Higher Prices are Likely" describes the intersection of surging demand and strained supply (Fitch 2021). Or consider a January 2022 headline: "Chip Shortage Leaves U.S. Companies Dangerously Low on Semiconductors, Report Says" (Zumbrun and Leary 2022). The authors dismiss this alternative on two grounds: (1) The shortage already appeared before May 2021, but the employment growth coincided with the filing of USICA; and (2) semiconductor employment in Canada and Germany did not accelerate at the same time.

I find the international comparisons especially informative; however, to my eye, they do not clearly rule out a common cross-country factor. The sector in Canada employs less than 20,000 workers, or only about 10 percent of the US workforce (see figure 4 in the paper). The sector in Germany employs about 70,000 workers (see figure A2 in the paper's online appendix). However, interpretation of the German case is complicated by periodic reclassifications of establishments. Figure 3 shows US semiconductor employment along with the German series without (as in the paper's figure A2) and with the reclassification jumps removed. With the reclassification jumps removed, the employment trend in Germany looks very similar to the United States, with flat employment in 2019 and 2020, rising employment starting around the same time in the spring of 2021 and lasting through 2022, and a decline again in 2024. The German data therefore seem consistent with global demand for semiconductors affecting semiconductor employment during this period.[2]

2. Neither the authors nor I were able to fully discern whether the jumps should be removed. They arise due to the reclassification of activity at individual establishments. Typically, employment changes due to industry reclassification are removed from time series, as is done in the line labeled "Germany (jumps removed)." If one instead thinks the jumps should be "wedged" back into the preceding months, then the line labeled "Germany" appropriately characterizes the medium-term behavior of the series and the pre-May 2021 period looks very different from the United States. The case for wedging would appear to be that the reclassification of establishments captures the extensive margin of plant-level growth in semiconductor employment. However, it would seem economically surprising for the extensive margin to contribute positively to employment growth as in 2019 and 2020 at the same time that the intensive margin of employment changes at existing semiconductor plants was negative.

Figure 3. Semiconductor Employment in the United States and Germany



Source: CES and Statistisches Bundesamt (2021).
Note: The line marked "US" displays national US employment in NAICS 334413 in the BLS CES. The line marked "Germany" displays employment in 26.11 and 26.12 in the German monthly report for companies in the manufacturing sector. The line marked "Germany (jumps removed)" removes the January reclassification jumps in 2020, 2021, and 2023.

Global demand for semiconductors may also have spurred passage of the CHIPS Act. Indeed, concerns about fractured supply chains and shortages directly motivated the policy concern of increasing domestic manufacturing capacity. In this vein, the *Wall Street Journal* article reporting on the Commerce Department's survey of chip inventories noted: "Commerce Secretary Gina Raimondo said the survey results show the urgency for Congress to approve the U.S. Innovation and Competition Act" (Zumbrun and Leary 2022). In this interpretation, semiconductor shortages caused both employment growth in semiconductor manufacturing and the passage of the CHIPS Act.

A third possibility is that a chips shortage and the promise of the CHIPS subsidies were both necessary conditions for semiconductor employment growth in 2021 and 2022. In this version, the shortage required additional investment and capacity expansion somewhere around the world, and the promise of CHIPS ensured that the expansion occurred in the United States. The quote from the CEO of SkyWater Technology in the paper supports this interpretation, as it mentions both the near-term supply constraints and the long-term strategy tied to the CHIPS Act.

Taking stock, it is possible that the CHIPS Act mattered to employment in 2021 and 2022, prior to the actual passage. But the fact that the growth occurred prior to passage and years prior to construction, the coincidence with the global chips shortage, and the similarity of employment growth in Germany all suggest that at least some of the employment growth might have occurred without the act.

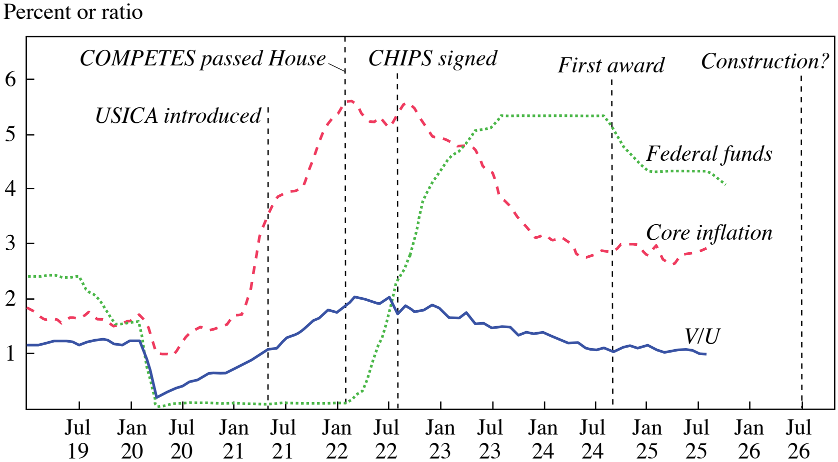
WHAT ABOUT AGGREGATE EMPLOYMENT? Suppose the additional semiconductor employment occurred due to the CHIPS Act. What were the macroeconomic consequences?

A first step in this analysis involves looking for local spillovers around semiconductor production. Figure 8 in the paper shows the difference-in-differences of nonresidential construction employment in counties with and without semiconductor production. Importantly, here the control counties do some "work," since they also have substantial employment in nonresidential construction (although I would still prefer the estimation in logs than levels). The evidence suggests some spillovers to construction employment. On the other hand, total employment in treated and control counties does not evolve statistically differently after May 2021 and also reveals some pretreatment differences during the COVID shutdown period.

Determining the effect on aggregate employment requires also examining overall macroeconomic conditions. Figure 4 of this comment provides this context. The period of semiconductor employment growth after May 2021 coincided with the tightest labor market and highest inflation rate of the past forty years. By early 2022 the Federal Reserve had embarked on a historically rapid rate tightening cycle, with the express goal of cooling the labor market. In this context, no fiscal program could generate a large employment effect, both because of the limit of total workers and because any further tightening of the labor market would only lead to additional monetary policy action. The authors sidestep these considerations by pointing out that the employment effects were not large enough to arrive on the Federal Reserve's radar. I am sympathetic to their argument and their framework, which closely follow Chodorow-Reich (2020). But it leaves the result that the macroeconomic employment consequences cannot have made much difference to the overall cost-benefit calculus of the CHIPS Act.

FINAL COMMENTS Outside of recessionary periods, "jobs created" provides an odd measure of macroeconomic success. An alternative focus of "good jobs" might emphasize the high wages directly associated with the project, the location of jobs in economically depressed areas, or the downstream

Figure 4. Semiconductor Employment Growth and the US Macroeconomic Conditions



Source: BLS Job Openings and Labor Turnover Survey and Employment Situation; Bureau of Economic Analysis; and the Federal Reserve.

Note: The line marked "V/U" displays the ratio of job openings to unemployed persons in the US economy. The line marked "Core inflation" displays core personal consumption expenditures (PCE) inflation. The line marked "Federal funds" displays the federal funds rate.

benefits to workers in other sectors from a lower cost and more stable semiconductor supply chain. Put more simply, more capital may benefit workers, even if the number of workers does not change.

Of course, this alternative framing requires the additional capital to actually materialize. Here, the crowding out of other investment through higher interest rates matters, as does the substantial lag between the passage of the act and the award announcements and the ongoing lag between the announcements and the breaking of ground on new facilities. Design issues, including workforce requirements such as recruiting demographically diverse workers and providing worksite childcare, likely contributed to these lags. These considerations should also enter into the lessons learned from the CHIPS Act.

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COMMENT BY

PINELOPI K. GOLDBERG This paper by Erten, Stiglitz, and Verhoogen represents one of the first rigorous empirical attempts to assess the labor market effects of the CHIPS and Science Act of 2022—arguably the centerpiece of the recent revival of US industrial policy. Using county-level data from the Quarterly Census of Employment and Wages, the authors implement two difference-in-differences designs comparing counties with existing semiconductor facilities to otherwise similar high-tech counties without such facilities. The study yields three main sets of results:

1. There were large anticipation effects.
2. The policy had significant, positive short-run effects on employment in the semiconductor industry at the county level. There is some evidence of wage effects as well, but these are not robust. Given that these effects were obtained based on difference-in-differences designs, they are only relative effects, as the authors emphasize. Nevertheless, given the research design and the focus on the semiconductor industry, which is present only in a small set of counties, the authors make a convincing case that the results can be easily scaled up to the national level to yield the number of jobs added in the US semiconductor industry.
3. There are robust positive spillovers to employment in the local construction industry. The evidence on spillovers to upstream input sectors is mixed. There are no significant aggregate employment or wage gains at the county level.