Global Value Chains and U.S. Economic Activity During COVID-19*

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Abstract

We investigate the role of global value chains on the decline of manufacturing employment and output in the U.S. during COVID-19. We identify the role of global value chains by exploiting heterogeneity across industries in cross-country sourcing patterns, and its interaction with exogenous cross-country variation in the containment policies introduced to combat the virus. We find that global value chains played a significant role on the decline of output and employment across U.S. manufactures. Moreover, we find a modest impact of diversifying or re-nationalizing global value chains at mitigating the economy's exposure to foreign shocks.

Keywords: global value chains, COVID-19, international trade, intermediate inputs

JEL Classification:F13, F14, F44

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1 Introduction

The rapid spread across the world of COVID-19 in early 2020 lead countries to implement drastic policies in an attempt to contain and mitigate the spread of the virus. Vast sectors of the economy were often shut down for significant periods of time, leading to a sizable contraction of world output. While contact-intensive industries were typically hit the hardest, less contact intensive sectors such as manufactures were also affected. For instance, in the United States, manufacturing employment and output declined by about 6 and 11 percent, respectively, between January and June of 2020.

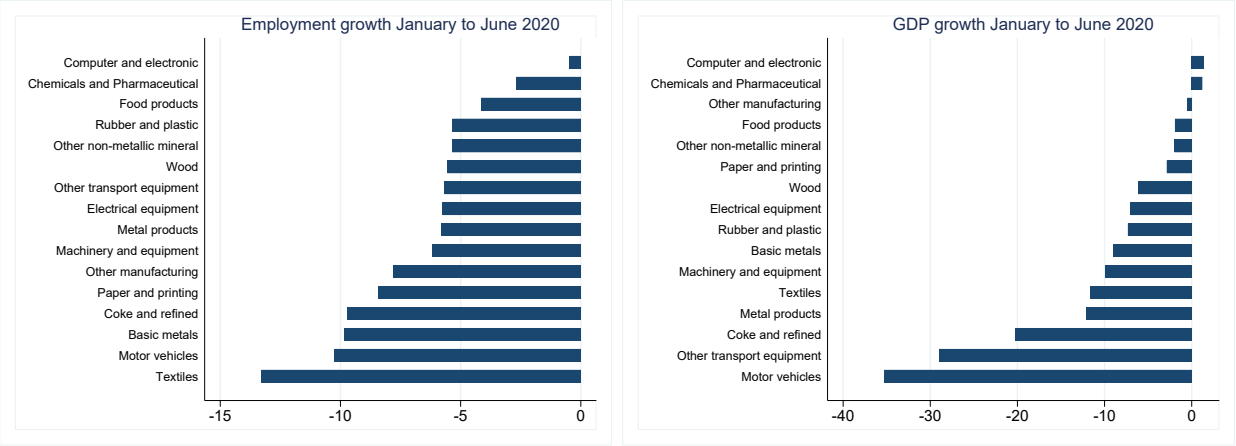
Several channels can account for the decline of economic activity in manufactures. On the one hand, we have domestic factors such as lockdowns and containment policies that depressed demand and curtailed supply across a broad range of industries early in the pandemic. On the other hand, we have foreign factors arising from the dependence of domestic production on inputs produced abroad; that is, the role of *global value chains*. In particular, industries that rely on inputs produced by countries with severe shutdowns might have their production process halted due to a lower availability of intermediate inputs.

In this paper, we investigate the role of global value chains on the decline of manufacturing employment and output in the U.S. during COVID-19. Our empirical approach is motivated by the heterogeneous decline of employment and output across U.S. manufacturing industries (see Figure 1). For instance, textiles and motor vehicles experienced large declines, whereas industries such as computer and electronics and chemicals and pharmaceuticals were hit less severely, having low employment declines or even a small increases of output. In this article, we ask: To what extent have industries that rely more on global value chains experienced a greater decline of economic activity during this period?

A fundamental challenge to addressing this question is the potential relation between an industry's global organization of production and the sensitivity to aggregate shocks of the demand for its goods. For instance, take the case of durable goods like automobiles, which are significantly more volatile than less durable goods like textiles. If durable goods are also more likely to be produced in complex value chains, then a reduced-form correlation between measures of global value chain intensity and changes in economic activity might be spuriously interpreted as capturing the causal effect of differences in global value chains.

We address this challenge by exploiting heterogeneity across industries in the nature of

Figure 1: Employment and Output Growth across U.S. Manufactures



their global value chains, as well as heterogeneity in the exposure of such global value chains to containment policies designed to combat COVID-19. First, U.S. manufacturing industries differ in the intensity to which they rely on global value chains as well as on their composition across countries. Second, countries have differed markedly in their exposure to COVID-19 as well as on the policies implemented to combat it, leading to a heterogeneous exposure of global value chains to the virus. Under the assumption that the intensity and composition of an industry's global value chain is unrelated to its exposure to COVID-19, we construct a variable that allows us to identify the role of global value chains on the decline of economic activity.

We begin by measuring global value chains at the industry level using data on trade in value added from the OECD for 2015, the latest year for which these data are available. In a sample of 64 countries and 16 manufacturing industries, we characterize global value chains across U.S. manufactures along two dimensions: (i) their intensity, as measured by the share of foreign value added embodied in an industry's total exports; and (ii) their concentration, measured based on the contribution of each source country to total foreign value added. While the first measure captures an industry's overall dependence on foreign inputs, the second measure captures heterogeneity in the relative contribution of the various country sources.

Then, we measure the role of global value chains on the decline of economic activity across U.S. manufactures during COVID-19 by interacting the share of value added from each source country with a measure of the strictness of the containment policies implemented by each

country to combat COVID-19. We refer to this variable as our *foreign exposure index*; that is, our index of exposure to COVID-19 via global value chains. The idea is to capture that industries dependent on intermediate inputs from countries with severe containment policies might be more exposed to the foreign shock than industries with less exposure to such countries.

Our empirical approach then consists of regressing the change of each industry's employment and output on our foreign exposure index, as well as on a measure of domestic exposure to the effects of COVID-19. We measure the latter using the physical proximity index constructed by Leibovici, Santacreu, and Famiglietti (2020).[1] We focus on the period from January 2020 to June 2020 since it captures the initial period of the pandemic, featuring the sharpest unexpected introduction of policies to contain COVID-19; thereafter, policies have tended to be weakened, particularly in less-contact-intensive industries like manufacturing.

We find that exposure to foreign shocks through global value chains has a negative and significant effect on employment and output. Similarly, industries with a higher physical proximity index have a negative and significant effect on employment and output growth. Both measures jointly account for more than 70% of the variation in employment growth and output growth, respectively. Moreover, we find that the negative relation between exposure to foreign shocks via global value chains and output growth is larger than for employment growth; the reverse is the case for our domestic exposure index.

To quantify the role of global value chains on economic activity, we investigate how much could changes in the structure of global value chains reduce the exposure of the U.S. economy to foreign shocks. We consider three alternative global value chains motivated by ongoing discussions in policy and academic circles. First, we examine the potential of increased diversification as a means to reduce exposure to foreign shocks. We evaluate the impact of perfectly diversifying global value chains across all trade partners, Second, we consider the impact of restricting diversification only across countries that have revealed comparative advantage in the given industry. Finally, we consider the impact of re-nationalizing global value chains away from large countries like China.

Our findings indicate that the impact of global value chains on manufacturing employ-

[1]They combine individual-level data from the 2017 American Community Survey with an index of occupational contact-intensity from O*NET to compute an overall index that measures the extent to which industries require their workers to work in close physical proximity to others. Industries with a higher physical proximity index are assumed to have been more exposed to the domestic shock of COVID-19.

ment and output during COVID-19 is not likely to have significantly depended on the pattern of global value chains across countries. On the one hand, regardless of the extent of diversification, most countries were subject to containment policies that affected economic activity. Thus, the global nature of the shock implies that diversification across countries would not have been an effective strategy to hedge against such risk. On the other hand, we find that even if industries would have re-nationalized to shield against foreign exposure to the virus, industries would have remained exposed to the domestic impact of containment policies. Thus, this mitigates most possible gains from producing inputs domestically. These findings are consistent with those of Bonadio et al. (2020) who observe that re-nationalization would have only slightly changed the output loss from 29.6% to 30.2%.

Our article complements recent work that exposes the vulnerabilities of global value chains to a global pandemic like COVID-19.[2] Javorcik (2020) argues that changes in trade policy and the COVID-19 pandemic has lead to a rethinking of global value chains, with some governments pushing for re-shoring of foreign production. Miroudot (2020) emphasizes that renationalization of global value chains may go against the benefits of outsourcing production based on comparative advantage. Similarly, Goldberg (2020) emphasizes the advantages of having more diversified global value chains.

Bonadio et al. (2020) study the cross-country impact of global value chains during COVID-19 though the lens of a quantitative model of international trade and input-output linkages. Méjean, Martinez, and Gerschel (2020) focuses on its impact on Europe, calculating the effect that a productivity drop in China has on European GDP growth and the role of Europe's integration with China though global value chains. In contrast to these studies, in this paper we study the role of global value chains in the transmission of foreign shocks during the COVID-19 pandemic to the U.S. economy.

2 Characterizing Global Value Chains

In this section, we characterize the role of global value chains (GVC) for the U.S. manufacturing sector. Our focus is on two key dimensions of the global linkages of U.S. manufactures. First, to what extent do they rely on global vs. domestic value chains? Second, how diver-

[2]Other studies such as Leibovici and Santacreu (2020) and Gereffi (2020) have instead focused on the role of trade in allowing countries to access goods that have been critical to combat the COVID-19 pandemic.

sified across countries are the global value chains used by U.S. manufactures?

To answer these questions, we collect data from the OECD Trade in Value Added (TIVA) dataset for 2015, the latest year available. This dataset allows to decompose the value added of U.S. manufacturing exports into 65 sources: (*i*) the U.S., (*ii*) 63 other source countries, and (*iii*) a "rest of the world" aggregate that encompasses the remaining countries. Values are expressed in millions of 2015 U.S. dollars across 16 manufacturing industries (classified according to ISIC rev. 4).

On the one hand, U.S. industries rely on domestic labor and capital to produce its goods; these factors of production are the source of domestic value added. On the other hand, they rely on intermediate inputs imported from various countries; insofar these inputs are fully produced abroad, these factors of production are the source of foreign value added. However, tracking down the ultimate source of foreign value added is a complex problem, since imported intermediate may themselves be produced using imported intermediates from other countries (including the U.S., in which case it should count as domestic value added). The OECD's TIVA dataset relies on the OECD's World Input-Output tables to resolve this problem and provide the decomposition that we need.

First, we characterize the extent to which U.S. manufactures rely on global value chains by computing:

$$GVCI_j \equiv \frac{\text{Foreign VA Content of Exports}_j}{\text{Exports}_j},$$

for each industry j, where Foreign VA Content of Exports_j denotes the foreign value added content in the production of exports and Exports_j denotes total exports. Note that $GVCI_j \in [0, 1]$. We refer to this statistic as *GVC intensity*.

This statistic allows us to identify the share of gross exports produced using foreign factors of production and, thus, allows us to measure each industry's exposure to foreign supply shocks.

This measure of exposure is informative about each industry's overall exposure to foreign supply shocks insofar (*i*) exports are positive, and (*ii*) the production of goods sold domestically is as intensive in imported intermediates as the production of exports. Condition (*i*) holds in our empirical implementation. To the extent that exporters are typically more productive and thus more likely to rely on imported intermediates, then the degree of exposure

under (ii) is likely to be an upper bound of the overall industry-level exposure.

Second, we characterize the extent to which the global value chains of U.S. manufactures are diversified across foreign countries. To do so, we compute the Herfindahl index for each industry j:

$$GVCC_j \equiv 10,000 \times \sum_{i \neq US}^{N} \left(\frac{\text{Foreign VA Content of Exports}_j^i}{\text{Foreign VA Content of Exports}_j} \right)^2,$$

where N denotes the number of possible foreign suppliers and $\text{Foreign VA Content of Exports}_j^i$ is the contribution of country i to the value added of U.S. exports in industry j. The index ranges between $10,000/N$ if there is perfect diversification (i.e., equal shares across countries) to $10,000$ if all foreign value added is sourced from a single country. With a sample of $N = 64$ countries, $GVCC_j \in [156, 10,000]$. We refer to this statistic as *GVC concentration*.

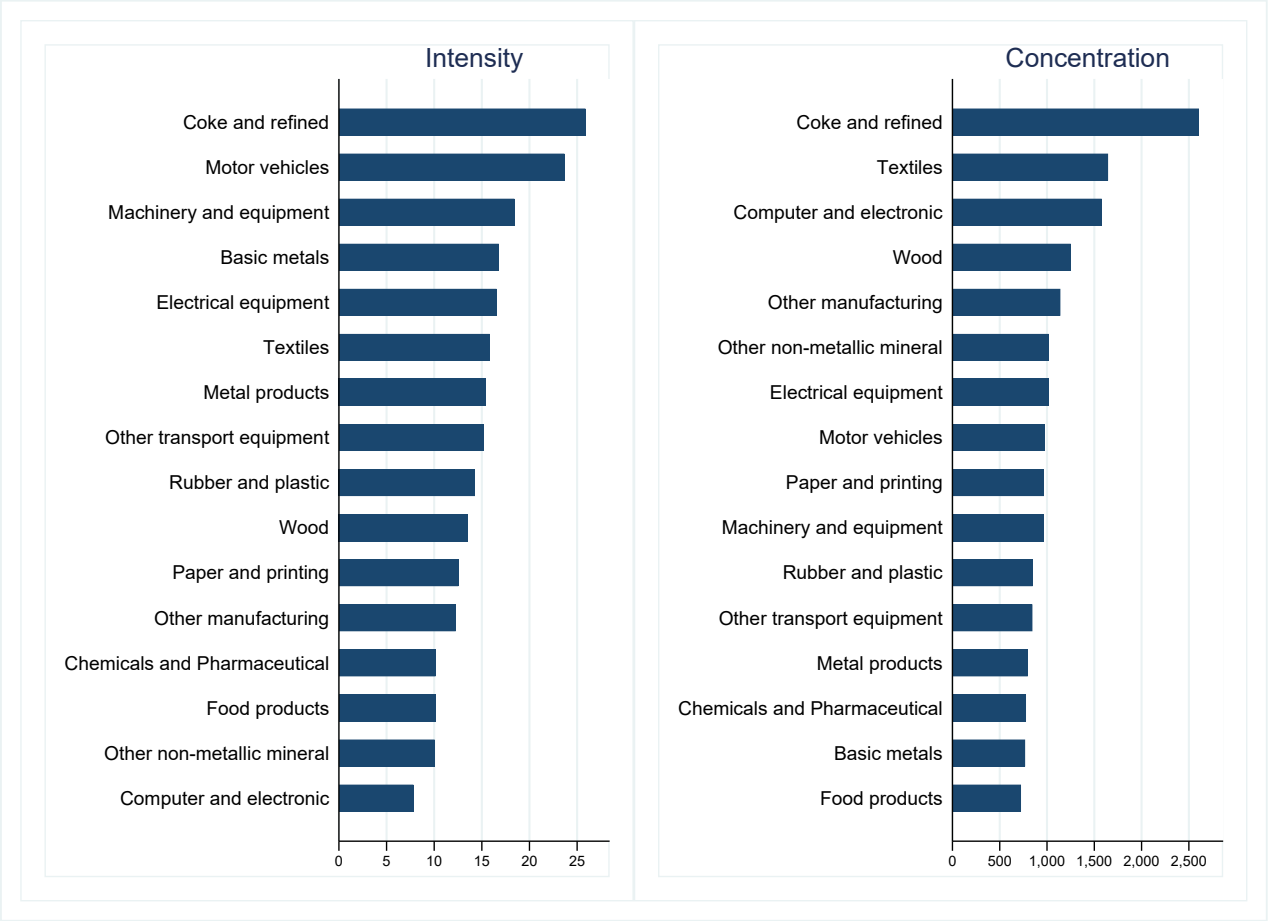
Figure 2 summarizes the GVC intensity (left panel) and concentration (right panel) of the 16 industries that span the U.S. manufacturing sector. The left panel shows that Coke and Refined Petroleum and Motor Vehicles have the highest GVC intensity, with 25.9% and 23.7%, respectively. In contrast, Computer, Electronics, and Optical Equipment and Other non-metallic mineral products have the lowest GVC intensity, with 7.8% and 10%, respectively. The average GVC intensity is approximately 15%: that is, on average, 15% of the value added of U.S. manufacturing exports is sources from abroad.

The right panel shows that Coke and Refined Petroleum not only has the highest GVC intensity but is also the most concentrated across foreign sources of value added. In particular, the Herfindahl index in that industry is 2,607 vs. 1,120 in the average industry.[3] The second most concentrated industry is Textiles, with a Herfindahl index of 1,646; China contributes almost 40% of the total foreign value added of this sector's exports. The industries that have more evenly distributed global value chains are Food Products, Beverages and Tobacco, and Basic Metals.

While our characterization of the global value chains of U.S. manufactures is based on a decomposition of the total value added of exports, we interpret our findings as informative about the importance of global value chains for the production of U.S. manufactures more generally. Thus, in the next section we investigate the role of global value chains in

[3]Canada accounts for 45% of the total foreign value added of U.S. exports of Coke and Refined Petroleum, while Saudi Arabia is the second largest supplier contributing just over 15%.

Figure 2: Intensity and Concentration of Global Value Chains Across U.S. Manufactures



transmitting foreign shocks to the U.S. economy.

3 Global Value Chains and Economic Activity

We now investigate the role of global value chains on U.S. economic activity. We ask two questions. First, to what extent are industries with heavier dependence on global value chains more vulnerable to shocks than industries with lower foreign exposure? Second, what is the relative importance of domestic vs. foreign shocks in accounting for changes in economic activity across the U.S. manufacturing sector? Answering these questions is no easy task since, in principle, industries with heavier dependence on global value chains might be systematically different along various other dimensions (e.g., durability of the goods produced, etc.).

In this paper we exploit the heterogeneous exposure to foreign lockdown policies in re-

sponse to COVID-19 across the global value chains of U.S. manufactures as a source of exogenous variation that allows us to identify the role of global value chains in transmitting shocks to the U.S. economy.

During COVID-19, countries have been differentially exposed to the virus and, moreover, have exhibited very heterogeneous policy responses to curb the spread of the pandemic. Some countries introduced severe lockdown policies that reduced economic activity and, thus, limited access to imports from those countries to U.S. manufactures. While the exposure of U.S. manufactures to such sources of foreign shocks is a function of the industries' GVC intensity and concentration, we assume that exposure to foreign containment policies is orthogonal to other industry characteristics.

Therefore, we evaluate the role of global value chains in transmitting foreign shocks during the lockdown by constructing a measure of exposure to foreign shocks for each industry. Industries with a higher share of value added sourced from a country with stricter lockdown policies are assumed to be more exposed to foreign shocks due to COVID-19. We thus compute our measure of exposure to the lockdown, E_j, as:

$$E_j = \sum_{i=1}^{N} \left(\frac{\text{Foreign VA Content of Exports}_j^i}{\text{Foreign VA Content of Exports}_j} \times S_i \right) \tag{1}$$

where S_i is a policy stringency index (between 1 and 100) that measures the strictness of lockdown policies implemented across countries in response to COVID-19. The index is reported by the Oxford COVID-19 Government Response Tracker (OxCGRT), which collects information on common policy responses that governments have taken to respond to the pandemic.[4] For each country, we compute the maximum Stringency index as of April 30th 2020 (as in Bonadio et al., 2020). In our sample of 64 countries, the stringency index ranges between 30.56 and 100, with a mean of 80.59 and a standard deviation of 13.5. Figure 3 plots the histogram for the stringency index in our sample.[5]

Our starting point to examining the role of global value chains in transmitting foreign shocks during COVID-19 is to plot the unconditional relation between changes in economic activity and our measure of exposure to foreign shocks E_j across U.S. manufactures. The

[4]These data can be found in https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker.

[5]The countries with the strictest lockdowns have indices equal to 100: Argentina, Philippines, and India; in contrast, Taipei, Sweden and Japan had more lax policies and thus values of the index lower than 50.

Figure 3: Distribution of the Policy Stringency Index

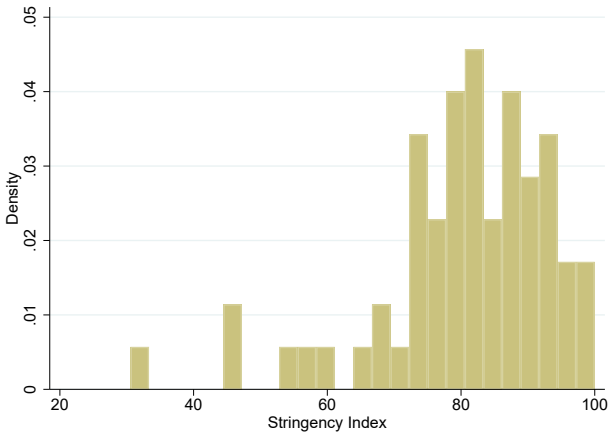
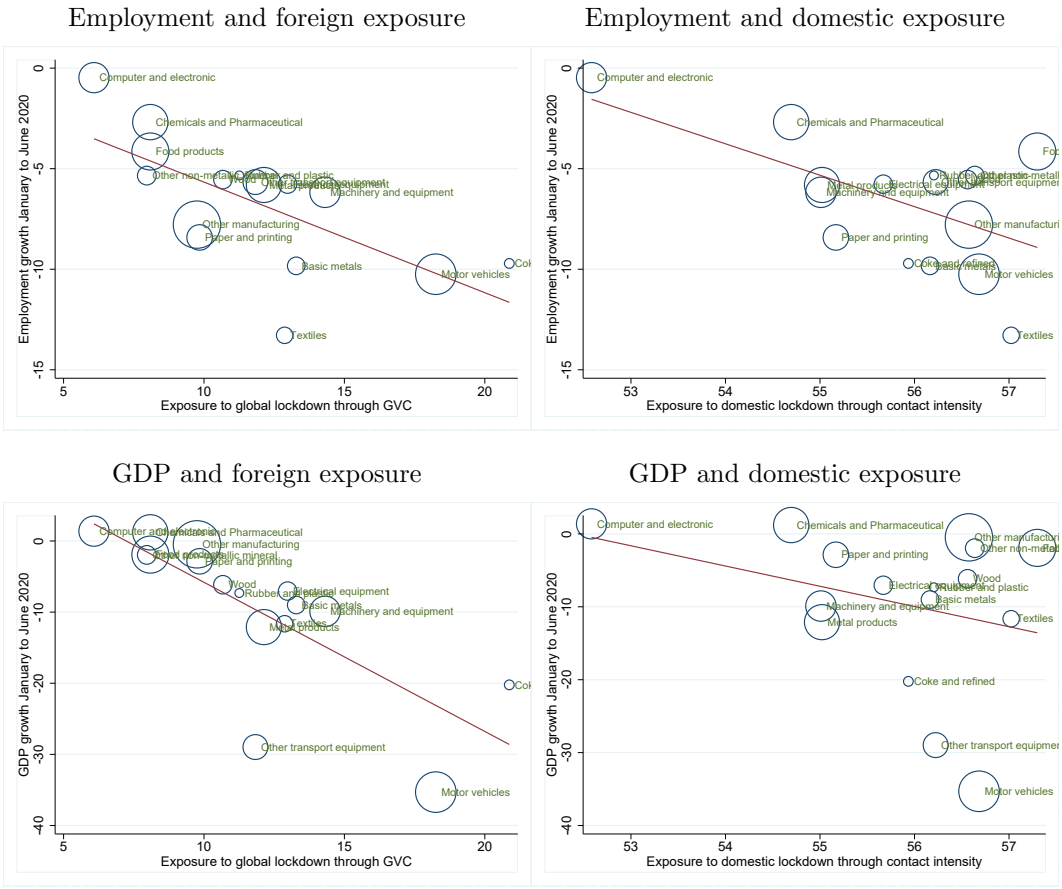


Figure 4: The Role of Domestic and Foreign Shocks on Economic Activity



Note: Each bubble represents an industry and the size is proportional to industry employment.

top-left panel of Figure 4 plots this relation for employment growth between January 2020 and June 2020, while the bottom-left panel plots the analogous relation for output growth

over the same period. We observe that industries with higher exposure to foreign shocks through global value chains experienced larger decreases of employment and output between January and June of 2020.

We contrast these findings with the relation between economic activity and a measure of the industries' exposure to domestic shocks. To do so we use the physical proximity index constructed by Leibovici, Santacreu, and Famiglietti (2020) that ranks industries as a function of two dimensions: (1) the extent to which industries require high physical proximity across individuals to carry out their operations and (2) their reliance on intermediate inputs from industries that do require this type of physical proximity.[6,7] The idea is that industries with a higher physical proximity index are more likely to have been affected by the domestic spread of COVID-19 in the U.S.

The right panels of Figure 4 plot the relation between changes in economic activity and our measure of exposure to domestic sources of shocks. We find that industries with higher exposure to the domestic shock (i.e., a higher degree of physical proximity) also experienced larger declines in employment and output. Foreign exposure through global value chains appears to have a stronger negative correlation with output growth than with employment growth; the reverse occurs with domestic exposure to shocks.

The strong relation between exposure and output is consistent with a short-run disruption of global value chains that temporarily limits access to imported intermediates and, thus, disrupts production with proportionally smaller employment losses.[8] A more persistent disruption of global value chains is likely to have led to a stronger employment adjustment.

The findings above suggest that both foreign and domestic sources of shocks appear to be significantly related to changes in economic activity observed during COVID-19. We now investigate the relative importance of these sources of shocks by estimating the following specification:

$$\Delta \log X_j = \alpha + \beta E_j + \gamma \text{Physical Proximity}_j + u_j \tag{2}$$

where $\Delta \log X_j$ represents the growth rate of either employment or output in industry j between January 2020 and June 2020, $\text{Physical Proximity}_j$ denotes industry j's physical

[6]According to this index, Computer and Electronic products has the lowest physical proximity index (52.6), while Food Products, Beverages and Tobacco has the highest index (57.3).

[7]Our results are robust to additionally controlling for cross-industry differences in the labor share.

[8]We conjecture that using data on hours worked instead of employment are likely to lead to a stronger relation between foreign exposure and labor, potentially closer to the relation between foreign exposure and output.

Table 1: The Role of Domestic and Foreign Shocks on Economic Activity

	Employment Growth	GDP Growth
Domestic shocks: Physical proximity$_j$	-0.98***	-0.11**
	(0.011)	(0.041)
Foreign shocks via GVC: E_j	-0.49***	-2.99***
	(0.0037)	(0.014)
Constant	53.98***	30.41***
	(0.59)	(2.26)
Observations	16	16
Adjusted R^2	0.71	0.77

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Employment and output growth measured between January and June 2020.

proximity index, and u_j is the error term.[9] We estimate the regression via OLS weighting industries using industry-level employment in order to capture the relative importance of foreign vs. domestic shocks for economic activity in the aggregate manufacturing sector.

Table 1 reports the estimation results. The first column reports the results using employment growth as the dependent variable, while the second column reports the analogous estimates for output growth. We find that exposure to both foreign and domestic shocks has a negative and statistically significant relation with both industry-level employment and output growth. The two variables can jointly explain 71% and 77% of the variation of employment and output growth across industries, respectively.

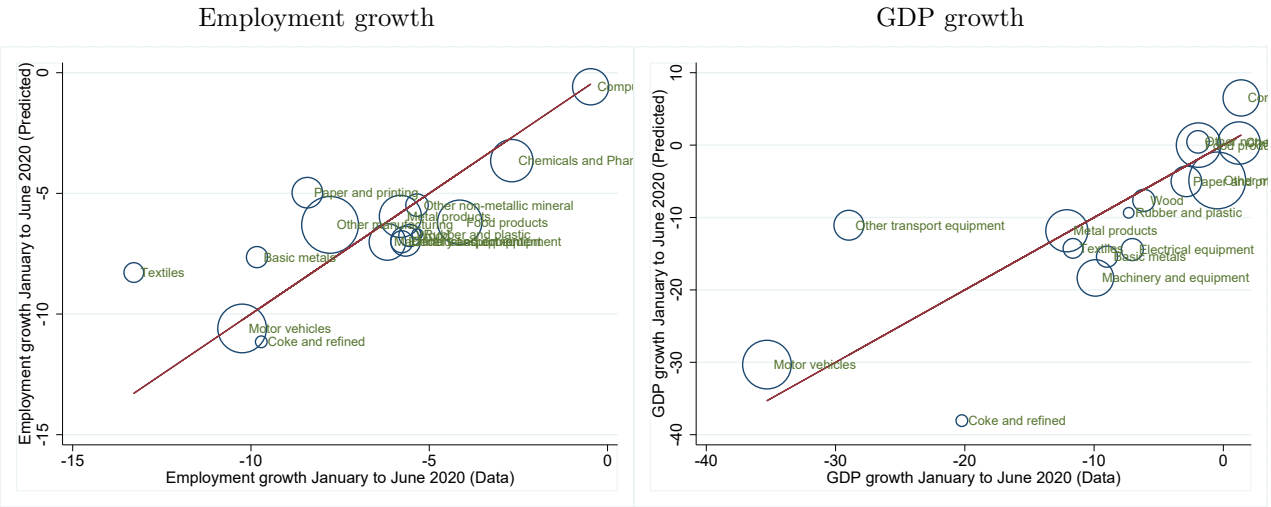
Our regression results imply that doubling the physical proximity index would lead to a decrease in employment growth of 2 percentage points between January and June of 2020. Similarly, doubling the exposure to foreign supply shocks would lead to a decrease of employment growth of 1 percentage points during the same period.

Moreover, we find that the negative relation between exposure to foreign shocks via global value chains and output growth is larger than its counterpart for employment growth. In contrast, the physical proximity index is estimated to have a stronger relation with employment than output growth.

We conclude this analysis by examining the fit of our empirical model. To do so, Figure

[9]Our focus on this six-month period allows us to construct our exposure measure while abstracting from exploiting cross-country variation in the timing of COVID-19 spread.

Figure 5: Employment and Output Growth: Data vs. Predicted Values



5 plots the correlation between the data (X-axis) and the predicted values (Y-axis) of both employment growth (left panel) and output growth (right panel) based on the estimated specification described above.

4 How Much Could Changes to Global Value Chains Reduce the Economy's Exposure to Foreign Shocks?

To quantify the role of global value chains on economic activity, we investigate the extent to which changes in the current structure of global value chains could reduce the economy's exposure to foreign shocks. We use the estimated specification from the previous section to evaluate how economic activity in the U.S. would have been impacted under alternative global value chain patterns. We consider three scenarios that are motivated by recent discussions in policy and academic circles during the COVID-19 pandemic.

The analysis assumes that the parameter estimates from the previous section are invariant to the policy changes under consideration. This implies that an industry's output and employment are invariant to changes in the underlying structure of global value chains that do not impact the degree of foreign exposure E^j. This allows us to focus on the relation between alternative patterns of foreign exposure and economic activity, while keeping other variables unchanged.

4.1 Perfectly Diversified Global Value Chains

One concern with global value chains is that they might not be sufficiently diversified across foreign suppliers. The idea is that some industries in the U.S. might be heavily exposed to foreign shocks from countries which might have implemented particularly strict lockdowns, leading to a significant impact of foreign shocks on the U.S. economy. A natural implication is that increasing the diversification of global value chains across foreign suppliers could help mitigate this exposure by reducing the overall foreign risk faced.[10]

We evaluate the potential of diversification as a means to reduce exposure to foreign shocks by using the empirical estimates from the previous section. We compute the implied changes in output and employment if each industry's global value chain was perfectly diversified across all source countries.

To implement this experiment, we construct an alternative measure of exposure to foreign shocks under which global value chains are perfectly diversified across all countries in the sample. That is, we set the share of foreign value added content in exports for each country to equal $1/N$ in equation 1, while leaving the stringency index unchanged.[11] The alternative exposure index is given by:

$$\widetilde{E}_j = \sum_{i=1}^{N} \left(\frac{1}{N} \times S_i \right) \tag{3}$$

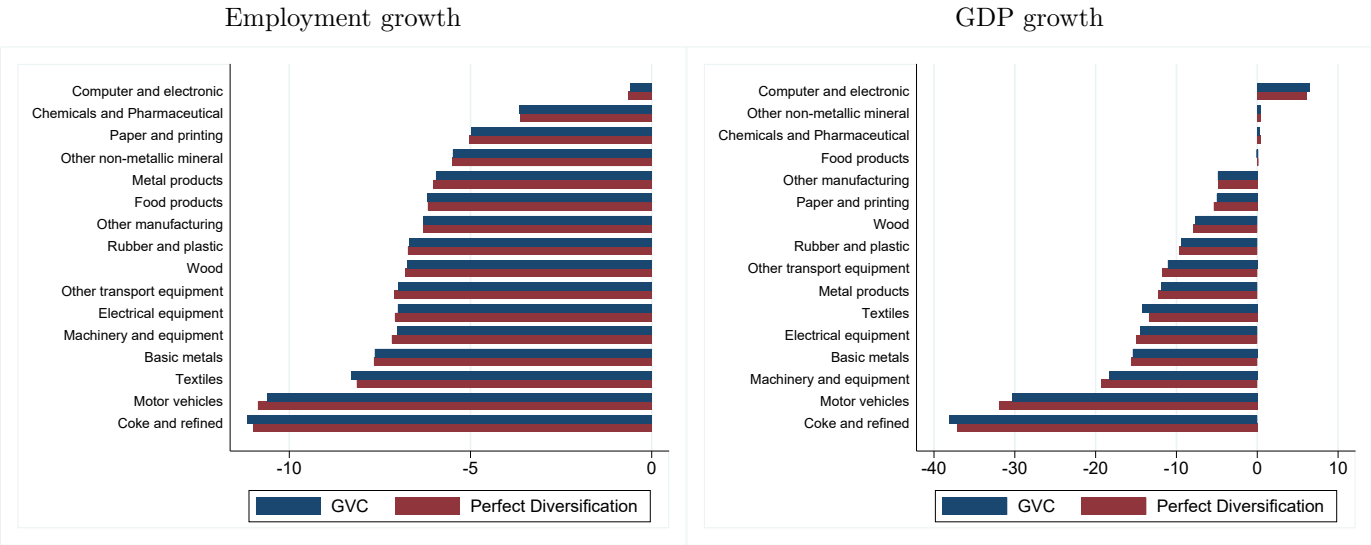
We then use the estimates from the previous section (Table 1) to compute the predicted change in employment and output for each industry under the exposure index corresponding to a perfectly diversified global value chain. We contrast these changes in employment and output relative to those implied by the baseline specification. Figure 6 plots the results.

We find that, overall, an additional 9,500 jobs would have been lost had global value chains been perfectly diversified among source countries. These results vary across industries. While motor vehicles would have experienced a larger decline of employment (growth would have been -0.27 percentage points lower than otherwise), coke and petroleum would have experienced a smaller decline of employment (growth would have been 0.15 percentage points higher than otherwise).

[10] Kalyvas, James, Vanessa Miller, Ann Marie Uetz, and Kate Wegrzyn. "Global Supply Chain Disruption and Future Strategies," September 29, 2020, https://www.natlawreview.com/article/global-supply-chain-disruption-and-future-strategies.

[11] This ensures that cross-country differences in the stringency index are preserved, while altering the relative exposure to such cross-country heterogeneity.

Figure 6: Perfectly Diversified Global Value Chains



Our findings also imply that there would have been an additional decline of GDP by $12.7 billion under perfect diversification. As with employment, the effects are heterogeneous across industries. GDP growth would have declined an additional 1.6 percentage points in motor vehicles, whereas the decline would have been 0.94 percentage points smaller in coke and petroleum products.

Perfectly diversifying global value chains implies that industries become equally exposed to the lockdown policies of every other country. To illustrate how this works, consider the case of the coke and petroleum industry. Canada and Saudi Arabia make up 60% of the foreign value added of exports and have an average stringency index of 85 (vs. a world average of 81). Perfect diversification consists of adjusting global value chains away from the top 60% of suppliers, which have relatively stricter policies, and giving them an equal share of foreign value added to all other countries in the sample, which have lower stringency indices on average. Thus, the coke and petroleum industry ends up less exposed to the global shock under perfect diversification.

On the other end, consider the motor vehicle industry: the top 10 source countries make up 75% of the foreign value added of this industry. Those 10 countries have a stringency index of 73, well below the world average of 81. In this case, perfectly diversifying makes the industry more exposed to global shocks. Thus we find a negative impact from diversifying.

Our results suggest that perfectly diversifying global value chains would not have led

to substantially different effects on output and employment during COVID-19. The reason turns out be driven by the global nature of the pandemic, in which most countries introduced strict containment policies. Thus, we conclude that increased diversification would have had limited success in increasing the economy's resilience to foreign shocks.

4.2 Perfectly Diversified Global Value Chains across Countries with Comparative Advantage

One limitation of the previous exercise is that it abstracts from the potential costs of perfect diversification: Even if it increases resilience, it may force industries to source their inputs from countries that are less productive and/or more expensive than the current arrangements.

We now consider an alternative experiment designed to address this concern. To do so, we investigate the implications of diversifying global value chains of a given industry across countries that have revealed comparative advantage in that industry.

We begin by defining revealed comparative advantage of country i in industry j, $RCA_{i,j}$:

$$RCA_{i,j} = \frac{E^i_j / E^i}{E_j / E} \tag{4}$$

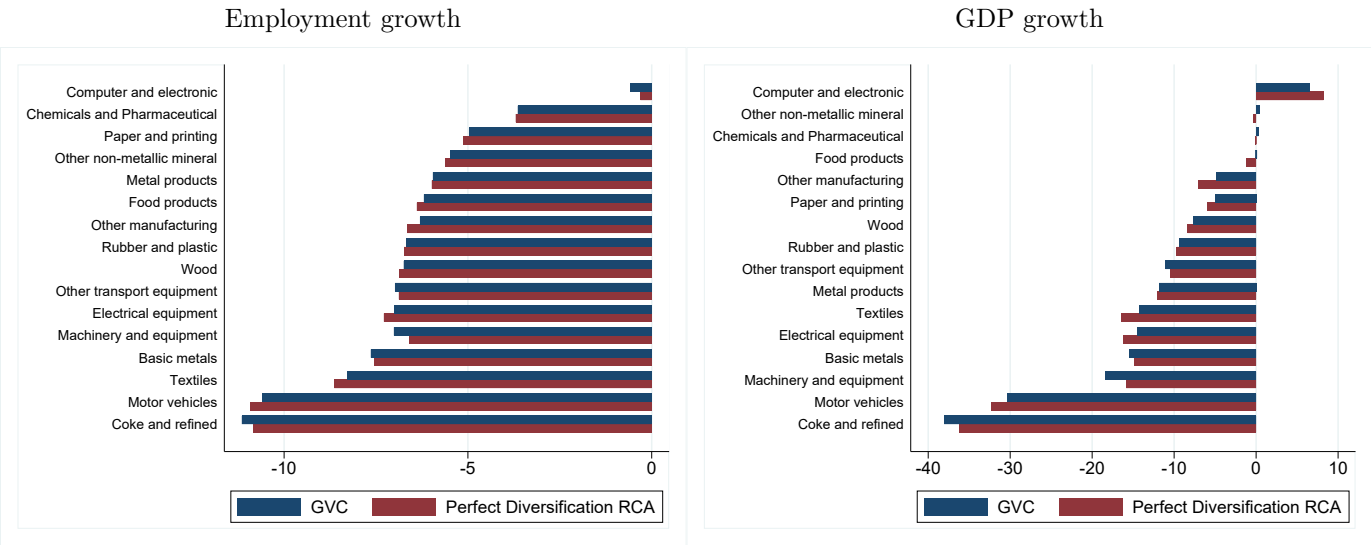
where E^i_j denotes the value added content of exports of industry j supplied by country i, E^i denotes the value added content of exports supplied by country i across all industries, E_j denotes the value added content of exports of industry j supplied from all countries, and E denotes the total value added content of exports across all industries and source countries.

We then define source countries i in industry j with $RCA_{i,j} > 1$ as having comparative advantage in that industry. The contribution of such countries to exports of industry j relative to their contribution to other industries is larger than the share of industry j in aggregate exports.

We then compute the exercise from the previous subsection with one fundamental difference: We now diversify the global value chain of a given industry across countries with comparative advantage. Thus, we consider an alternative exposure index computed as:

$$\widetilde{\widetilde{E_j}} = \sum_{i=1}^{M_j} \left(\frac{1}{M_j} \times S_i \right) \tag{5}$$

Figure 7: Perfectly Diversified Global Value Chains across Countries with Comparative Advantage



where M_j is the number of countries who have comparative advantage in industry j. As indicated by the j subindex, the number of countries with comparative advantage is industry-specific: e.g., out of the 64 countries in our sample, 37 have comparative advantage in Food Products whereas only 6 have a comparative advantage in Transport Equipment.

We then use the estimates from the previous section (Table 1) to compute the predicted change in employment and output for each industry under exposure index $\widetilde{\widetilde{E_j}}$. We contrast these changes in employment and output relative to those implied by the baseline specification. Figure 7 plots the results.

We find that an extra 15,500 jobs would have been lost had global value chains been perfectly diversified across countries with comparative advantage. As above, the results vary across industries. Employment in Textiles and Apparel would have declined 0.36 percentage points more than in the data. In contrast, employment in Machinery and Equipment would have decline 0.21 percentage points less than in the data.

We also find that GDP would have declined by an additional $4.6 billion, with cross-industry heterogeneity similar to employment. Textiles would have done slightly worse (a 2.16 percentage point greater decline) while Machinery and Equipment would have done slightly better (2.5 percentage point smaller decline).

Our findings are accounted by the cross-country heterogeneity in the policies implemented to contain COVID-19. Across the countries with comparative advantage in Machinery and

Equipment, the average stringency index is 73, making the industry less exposed than under its current global value chain pattern. Instead, the countries with comparative advantage in Textiles have an average stringency index of 86, making this industry much more exposed to the shock if global value chains were to be restructured in this fashion.

4.3 Renationalizing Chinese Global Value Chains

The experiments conducted in the previous subsections suggest that the impact of diversifying global value chains across all sources or across all sources with comparative advantage would have had a limited impact on the effects of foreign shocks on the U.S. economy.

We now consider an alternative policy change discussed in recent years: Renationalizing global supply chains away from big countries like China.[12] We thus ask: How would have employment and GDP changed across industries if intermediate inputs purchased from China would have been purchased domestically? As above, we answer this question by computing an alternative exposure index computed as in Equation 1 except that we replace China's stringency index with its value for the U.S.

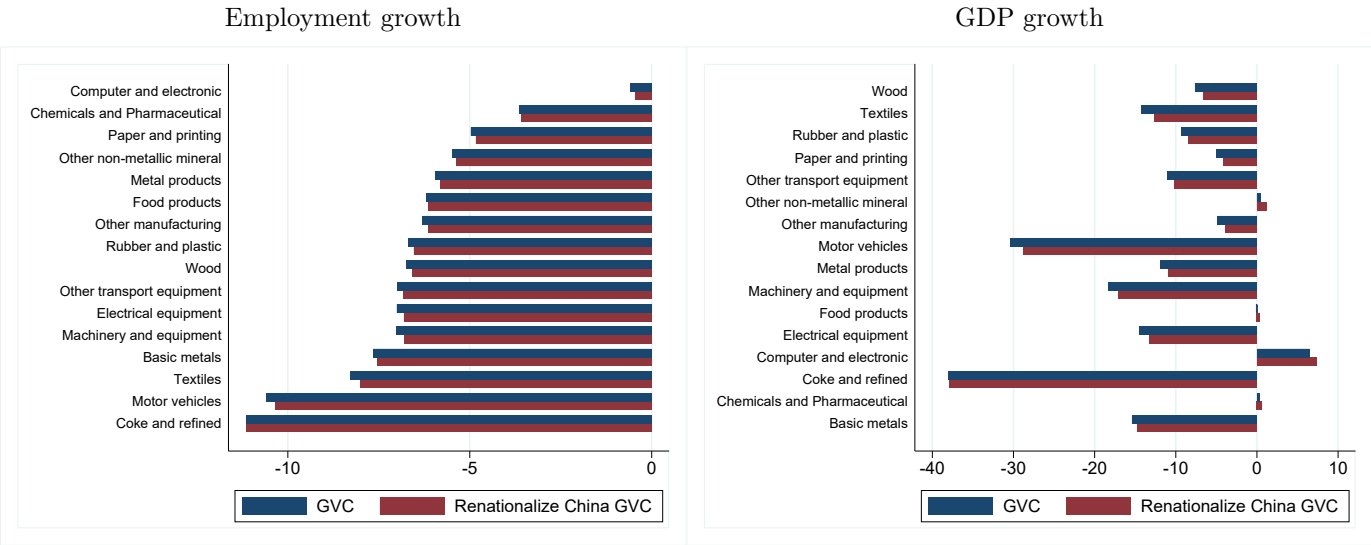
We then use the estimated coefficients from Table 1 to compute the predict change in employment and output growth for each industry under this alternative index. The results are report in Figure 8.

We find that the U.S. would have lost 23,000 less manufacturing jobs if Chinese intermediate inputs had been sourced domestically during the pandemic. That is, renationalization of Chinese global value chains would have saved 2.4 percent of the total manufacturing jobs lost during "The Great Lockdown." Across industries, the employment effects range from 0.02 percentage point smaller job losses in Coke and Refined Petroleum, to 0.28 lower percentage point job losses in Textiles and Wearing Apparel.

Our findings imply that the U.S. would have experienced a $45.5 billion smaller decline of manufacturing GDP; reducing the GDP losses during the pandemic by approximately 6%. Across industries, the output effects range from 0.11 percentage point smaller GDP losses in Coke and Refined Petroleum, to 1.7 lower percentage point GDP losses in Textiles and Wearing Apparel.

[12]Stonnington, Nick. "Council Post: Why Reshoring U.S. Manufacturing Could Be The Wave Of The Future." Forbes, Forbes Magazine, 9 Sept. 2020,http://www.forbes.com/sites/forbesbusinesscouncil/2020/09/09/why-reshoring-us-manufacturing-could-be-the-wave-of-the-future/.

Figure 8: Renationalizing Chinese Global Value Chains



While these industries would have benefited from bypassing China's relatively stricter stringency index of 81 they would still have had to face the domestic index of 73 causing the improvement to be marginal. These results are consistent with Bonadio et al. (2020).

5 Concluding Remarks

In this paper we investigated the role of global value chains on the decline of output and employment across U.S. manufactures. While we find that global value chains played a significant role in transmitting the effect of foreign containment policies to combat COVID-19, we do not find evidence that restructuring global value chains could have helped to mitigate this exposure. Our findings are driven by the global nature of the shock: Diversifying the exposure of global value chains or re-nationalizing them would have had limited success in shielding U.S. manufactures from the virus, since all countries have been hit with the virus, and most have implemented restrictive policies in order to contain it.

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