INSTITUTE FOR EMPLOYMENT RESEARCH
The Research Institute of the Federal Employment Agency

IAB-FORSCHUNGSBERICHT

Results from the project work of IAB

10|2023 Local labor market effects of global value chain disruptions – evidence from the COVID-19 crisis

Anne Meisiek, Moritz Meister, Annekatrin Niebuhr, Meike Rudolph

Local labor market effects of global value chain disruptions – evidence from the COVID-19 crisis

Anne Meisiek (IAB),
Moritz Meister (IAB),
Annekatrin Niebuhr (IAB, CAU Kiel),
Meike Rudolph (IAB)

In brief

- This study investigates the impact of disrupted global value chains (GVC) during the COVID-19 crisis on local labor markets in Germany. We examine whether the integration into GVC has influenced the size of the initial shock and the subsequent recovery process of regions until December 2021.
- We use administrative labor market data and information on trade in intermediate goods from the OECD Inter-Country Input-Output tables in a difference-in-differences analysis to investigate the effects of GVC disruptions on regional short-time work take-up and regional employment, focusing on the bilateral GVC relationship between China and Germany.
- There is a clustering of highly integrated regions in southern Germany that appears to be slightly more pronounced for GVC trade with China than for GVC trade with the rest of the world. In contrast, many regions in the Northeast of Germany show a below average GVC integration.
- Regression results show that short-time work increased more strongly in 2020 in local labor markets which are characterized by an above average GVC integration with China. We detect significant effects of both an integration through exports and imports of intermediate goods, with the impact of GVC-related imports from China being somewhat stronger.
- The significant effects that we observe for GVC integration with China are, however, temporary and decline quickly during the second half of 2020.
- Regions that are highly integrated with the rest of the world, however, do not stand out from other regions in Germany in terms of the impact of the COVID-19 crisis.

Contents

Summary

This study investigates the importance of global value chain (GVC) integration for local labor market outcomes in Germany during the COVID-19 pandemic. Although COVID-19 can be considered as a global crisis, there are at the same time strong geographical differences in its impact. We observe pronounced spatial variation in infection rates, policy responses, and behavioral changes. A rapidly growing number of studies provide evidence of heterogeneous effects of the COVID-19 pandemic on local labor markets, most of them focusing on the initial shock and often on the effects of lockdowns and economic policy measures.

This paper takes a different perspective on the regional economic effects of the pandemic. We focus on the impact of disrupted GVC during the COVID-19 crisis on local labor markets and investigate whether GVC integration influenced the magnitude of the initial shock and the subsequent recovery process of regions in Germany until December 2021. Our analysis of the regional effects of GVC disruptions in Germany focuses on the bilateral GVC relationship between China and Germany because the two countries are important agents in GVC. Moreover, China was hit early and severely by the pandemic which led to a sizeable decline in the country's production and exports at the beginning of 2020.

To measure regional and sectoral GVC integration, we use the 2021 edition of the OECD's Inter-Country Input-Output tables, which provide detailed information on trade in intermediate goods between 45 industries and 66 countries up to the year 2018. Using this data on international trade in intermediate products, we apply different indicators to measure the GVC integration of German sectors via imports and exports of intermediate inputs. To measure the integration of local labor markets in GVC, we quantify the regional variation in trade in intermediate goods using the variation in sectoral specialization across labor market regions.

Our main outcome variable is the regional employment share of workers receiving a short-time work allowance. The extensive use of short-time work (STW) was one reason why the unemployment rate showed a relatively moderate increase during the COVID-19 pandemic in Germany. Therefore, we apply STW rather than regional unemployment rates to measure the labor market effects of GVC disruptions caused by the COVID-19 crisis. As a second outcome variable, we consider regional employment.

Our descriptive results point to a clustering of highly integrated regions in southern Germany that appears to be slightly more pronounced for GVC trade with China than for GVC trade with the rest of the world. In contrast, many regions in the Northeast of Germany show a below average GVC integration. A decomposition GVC-related trade into imports and exports shows that the export component is almost twice as large as GVC-related imports in Germany. However, the export and import measures are highly correlated, indicating that when a region is strongly integrated into GVC-related trade, it is usually through both imports and exports.

Regression results show that short-time work increased more strongly in 2020 in local labor markets which are characterized by an above average GVC integration with China. We detect significant effects of both an integration through exports and imports of intermediate goods,

with the impact of GVC-related imports from China being somewhat stronger. The effects that we find for GVC integration with China are, however, only temporary and decline quickly during the second half of 2020. Regions that are highly integrated with the rest of the world, in contrast, do not stand out from other local labor markets in Germany when it comes to the effects of GVC disruptions. There are different potential reasons behind the swift recovery of those regions that show a high GVC integration with China. First of all, China does not differ that much from other important trade partners of Germany in 2021 when it comes to trade disruptions. Moreover, there is some first evidence on firms adjusting their production process and the procurement of inputs in response to value chain disruptions.

Zusammenfassung

Diese Studie untersucht die Bedeutung der Integration von Produktionsprozessen in globale Wertschöpfungsketten (GVC) für die Entwicklung regionaler Arbeitsmärkte in Deutschland während der COVID-19 Pandemie. Die COVID-19 Pandemie ist eine globale Krise. Dennoch ist sie durch starke geografische Unterschiede gekennzeichnet, unter anderem bezüglich der Infektionsraten, aber auch mit Blick auf die Intensität der ergriffenen Eindämmungs- und Hilfsmaßnahmen und der zu beobachtenden Verhaltensänderungen. Eine rasch wachsende Zahl von Studien liefert Belege für die heterogenen räumlichen Effekte der COVID-19 Pandemie, wobei sich die meisten Untersuchungen auf den anfänglichen Schock und die Auswirkungen von Lockdowns und wirtschaftspolitischen Unterstützungsmaßnahmen konzentrieren.

Die vorliegende Studie betrachtet die Folgen der COVID-19 Pandemie aus einer anderen Perspektive als die bisherige Forschung zu den regionalwirtschaftlichen Auswirkungen der Krise. Wir betrachten die Effekte der Störung globaler Wertschöpfungsketten durch die Pandemie und untersuchen, ob das Ausmaß der Integration von Produktionsprozessen in globale Wertschöpfungsketten die Stärke des anfänglichen Schocks und die anschließende Erholung lokaler Arbeitsmärkte in Deutschland bis Dezember 2021 beeinflusst hat. Unsere Analyse konzentriert sich dabei auf die bilateralen Handelsbeziehungen zwischen China und Deutschland, da die beiden Länder wichtige Akteure in globalen Wertschöpfungsketten sind. Zudem war China sehr früh und sehr stark von der Pandemie betroffen, was Anfang 2020 zu einem erheblichen Rückgang der Produktion und der Exporte des Landes führte.

Um die Integration von Wirtschaftszweigen und Regionen in globale Wertschöpfungsketten zu messen, verwenden wir die länderübergreifenden Input-Output-Tabellen (ICIO) der OECD von 2021, die detaillierte Informationen über den Handel mit Vorleistungsgütern zwischen 45 Branchen und 66 Ländern bis zum Jahr 2018 enthalten. Anhand dieser Daten zum internationalen Handel mit Zwischenprodukten berechnen wir verschiedene Indikatoren für die Integration deutscher Branchen über Importe und Exporte von Vorleistungsgütern. Um die Integration lokaler Arbeitsmärkte in globale Wertschöpfungsketten zu messen, quantifizieren wir die regionalen Unterschiede im Handel mit Zwischenprodukten anhand der Unterschiede in der sektoralen Spezialisierung zwischen den Arbeitsmarktregionen.

Unsere zentrale Ergebnisvariable ist der regionale Anteil der Beschäftigten in Kurzarbeit an der Gesamtbeschäftigung. Die intensive Nutzung von Kurzarbeit war ein Grund für den relativ

moderaten Anstieg der Arbeitslosigkeit während der COVID-19 Pandemie in Deutschland. Daher verwenden wir den Kurzarbeitsanteil anstelle von regionalen Arbeitslosenquoten, um die Arbeitsmarkteffekte der durch die COVID-19 Krise verursachten Störungen globaler Wertschöpfungsketten zu messen. Als zweite Ergebnisvariable betrachten wir die regionale Beschäftigung.

Unsere deskriptiven Ergebnisse weisen darauf hin, dass insbesondere Regionen in Süddeutschland stark in globale Wertschöpfungsketten integriert sind. Die räumliche Ballung im Süden des Bundesgebiets scheint für den Handel mit Zwischenprodukten mit China etwas stärker zu sein als für den Vorprodukt-Handel mit dem Rest der Welt. Im Gegensatz dazu weisen viele Regionen im Nordosten des Landes eine unterdurchschnittliche Einbindung in globale Wertschöpfungsketten auf. Eine Zerlegung des Zwischenprodukthandels in Importe und Exporte zeigt, dass die Exportkomponente in Deutschland fast doppelt so groß ist wie die Importkomponente. Die Export- und Importmaße korrelieren jedoch stark, was darauf hindeutet, dass eine Region in der Regel sowohl über Im- als auch Exporte von Vorleistungen stark in globale Wertschöpfungsketten integriert ist.

Unseren Ergebnissen zufolge hat die Kurzarbeit im Jahr 2020 insbesondere in denjenigen Regionen sehr stark zugenommen hat, die ökonomisch sehr eng mit China verflochten sind. Wir stellen signifikante Effekte sowohl einer Integration durch Exporte als auch durch Importe von Vorleistungsgütern fest, wobei die Auswirkungen über die Importverbindung mit China etwas stärker sind. Die Effekte, die wir für die Integration mit China beobachten, sind jedoch nur temporärer Natur und laufen bereits in der zweiten Hälfte des Jahres 2020 schnell aus. Regionen, die stark mit dem Rest der Welt integriert sind, heben sich dagegen nicht von anderen lokalen Arbeitsmärkten in Deutschland ab, wenn es um die Auswirkungen der COVID-19 Krise geht. Für die rasche Erholung der Regionen, die eine hohe Integration mit China aufweisen, gibt es verschiedene mögliche Erklärungsansätze. Zunächst einmal unterscheidet sich China im zweiten Jahr der Pandemie nicht mehr so sehr von anderen wichtigen Handelspartnern Deutschlands was die Störung internationaler Handelsströme betrifft. Darüber hinaus lassen die Befunde erster Studien vermuten, dass Unternehmen ihre Produktionsprozesse und die Beschaffung von Vorleistungen als Reaktion auf Störungen der Wertschöpfungsketten während der COVID-19-Krise angepasst haben.

Acknowledgements

We thank Huiwen Gong, Robert Hassink, Frank Jicha, Canfei He, Michele Mancini, Duncan Roth, Hantian Sheng, Ignat Stepanok, Wolfgang Dauth, Philipp vom Berge, Demiaan Persyn and Stefan Tübbicke for helpful comments and suggestions.

Financial support from the German Research Foundation (Deutsche Forschungsgemeinschaft) is gratefully acknowledged as part of the project “Exploring the impact of Covid-19 on regional resilience and disparities in Germany and China” (NI 596/7-1).

1 Introduction

The COVID-19 pandemic has far-reaching and possibly persistent labor market effects. Dolado et al. (2021) note that the health crisis gave rise to both negative demand and supply shocks by reducing consumption and labor supply. Several studies provide evidence on important short-run effects on various national labor markets (e.g. Bauer & Weber, 2021; Lemieux et al., 2020), and individual labor market outcomes in different countries (e.g. Chetty et al., 2020; Marcén & Morales, 2021). Although COVID-19 can be considered a global crisis, it is at the same time characterized by strong geographical differences. We observe a pronounced spatial variation in infection rates (Ascani et al., 2021; Desmet & Wacziarg, 2022), policy responses (Kosfeld et al., 2021), and behavioral changes (Chetty et al., 2020; Couture et al., 2022).

A rapidly increasing number of studies provides evidence on heterogeneous effects of the COVID-19 pandemic on local labor markets, most of them focusing on the initial shock and often on the effects of non-pharmaceutical interventions and other policy measures (e.g. Juranek et al., 2021; Schmidt & Mitze, 2023). There is also evidence on the role of the sectoral structure (Kim et al., 2022; Partridge et al., 2022), pre-crisis labor market conditions (Houston, 2020) and other characteristics of local labor markets (Cochrane et al., 2022; Hamann et al., 2023) during the early phase of the crisis. Another group of studies examines how regionally differentiated changes in behavior such as the expansion of working-from-home and variation in mobility patterns affect local labor market dynamics and spending (see Alipour et al., 2022; Ben Yahmed et al., 2022; Carvalho et al., 2022). However, whether the disruptions of global value chains (GVC) caused by the COVID-19 pandemic have affected local labor markets differently is not considered in this strand of literature.

This paper takes a different perspective than previous research on the regional economic effects of the pandemic. We focus on the impact of disrupted GVC during the COVID-19 crisis on local labor markets and investigate whether the integration into GVC has influenced the size of the initial shock *and* the subsequent recovery of regions in Germany until December 2021. This is in contrast to most studies on the effects of the COVID-19 crisis on local labor markets which primarily examine the early phase, i.e. the initial shock in spring 2020 and the (first) recovery in the months thereafter. We use administrative data on employment and short-time work as well as the OECD Inter-Country Input-Output (ICIO) tables in a difference-in-differences analysis. This approach allows us to examine whether regions that heavily rely on GVC integration in general and, in particular, show a strong exposure to trade in intermediate goods with China are more severely affected by the COVID-19 crisis.

The (potential) effects of GVC disruptions caused by the COVID-19 crisis are analyzed and discussed in numerous studies. Yet, regional economic effects of global value chains disruptions have not been considered in this strand of literature so far. Some authors analyze how firms adjust in response to value chain disruptions (e.g. Kleifgen et al., 2022) or discuss potential long-term effects of the pandemic on GVC and policy implications (Antràs, 2020; Miroudot, 2020). Other studies examine how the COVID-19 crisis has affected trade flows (Kejžar et al., 2022) or predict welfare and output effects of the adverse supply shock in China for a broad range of countries (Eppinger et al., 2021). Labor market effects are hardly considered in this literature up to now, with a study by Meier and Pinto (2020) being among the rare exceptions. They show that US sectors with a large exposure to intermediate goods imports from China suffered larger declines in production and employment in spring 2020 than other industries.

We pay special attention to the bilateral relationship between China and Germany because the two countries are important agents in GVC. Moreover, China was hit early and severely by the pandemic giving rise to a significant decline in production and exports (Qin et al., 2020). Lockdowns in key port cities added to the effect of the output drop with an important percentage of global container ship cargo capacity being tied up, especially during the first half of the year 2020 (see Figure 1 and Bai et al., 2022). Antràs (2020) shows that lockdowns in China led to a first significant decline in trade flows in late January and in February 2020, with a disproportionate effect on international trade in vehicles. After a short recovery in early March, trade flows collapsed once more in March and April, with again a much larger response for GVC trade than for other types of trade.

Figure 1: Status of important global container ship cargo capacity, 2020-2021

Note: Percentage of global container ship cargo capacity that is tied up and unable to be loaded or unloaded due to congestion in sea areas up to 500 kilometers from major ports worldwide. Calculations are made using real-time vessel position data and considering the technically possible maximum capacity of the container ships. Others include: Georgia, South Carolina, North Sea, S. California.

Source: FleetMon and IfW Kiel Trade indicator (https://www.ifw-kiel.de/topics/international-trade/kiel-trade-indicator/); own illustration. © IAB

Our results indicate that, in fact, short-time work increased more strongly in 2020 in local labor markets which are characterized by an above average GVC integration with China. We detect significant effects of both an integration through exports and imports of intermediate goods, with the impact of GVC-related imports from China being somewhat stronger. In contrast, regions that are highly integrated with the rest of the world do not stand out from other local labor markets in Germany. The significant effects that we observe for GVC integration with China are, however, temporary and decline quickly during the second half of 2020.

The remainder of this study proceeds as follows: Section 2 provides an overview of first evidence on the economic effects of GVC disruptions caused the pandemic. In section 3, we describe our main data sources, while we explain different indicators applied to measure GVC integration of regions and sectors in section 4. Based on these indicators we provide descriptive evidence on GVC integration of sectors and regions in Germany in section 5 with a focus on the bilateral relationship with China. In Section 6, we describe our empirical strategy and in Section 7, we present and discuss the results of the regression analysis. Section 8 concludes.

2 Propagation of COVID-19 shocks through GVC

This section provides an overview of first evidence on how the COVID-19 pandemic affects (regional) economies through global value chains. The concept of GVC captures the different stages of a production process where trade occurs across several national borders, with foreign value added at each stage until the assembly of the final product ready for consumption (World Bank, 2020). In order to determine the role of GVC during the COVID-19 crisis, expected effects on a theoretical basis will be briefly discussed in this section as well as first empirical evidence provided by recent studies.

The significance of GVC and the vulnerability of the global economy to supply chain disruptions has become apparent at the latest following the Suez Canal blockage (Ibrahim et al., 2021) and the war in Ukraine (Celi et al., 2022). Recent research suggests that GVC integration also plays an important role when it comes to the propagation and mediation of (economic) shocks caused by lockdown measures and closing of borders during the COVID-19 pandemic (Bonadio et al., 2021; Espitia et al., 2022; Hayakawa & Mukunoki, 2021; Kejžar et al., 2022; Miroudot, 2020). There is, in particular, a number of studies that discuss potential adjustment strategies employed by firms in response to value chain disruptions (Antràs, 2020; Gao & Ren, 2020; Hayakawa & Mukunoki, 2021) and future development of GVC (Kleifgen et al., 2022; Kolev & Obst, 2020; Pla-Barber et al., 2021), based on the early impacts of the pandemic.

Economic shocks might be transmitted through GVC bilaterally from downstream producers to upstream suppliers and vice versa. In theory, supply shocks propagate via backward linkages from upstream suppliers of raw materials and intermediate goods to downstream producers, while demand disturbances spread through forward linkages from downstream to upstream firms (Kejžar et al., 2022; Xu et al., 2020). This differentiation of input-output linkages as forward or backward helps to retrace the propagation of shocks through GVC. The World Bank (2020) defines backward GVC participation as a case where “a country’s exports embody value added previously imported from abroad” and forward participation as a situation where “a country’s exports are not fully absorbed in the importing country and instead are embodied in the importing country’s exports to third countries” (World Bank, 2020, p. 15).

Empirical research on the impact of the COVID-19 pandemic on GVC focuses in particular on supply chain interlinkages with China. Kejžar et al. (2022) coin the term "China effect", describing the amplification potential of supply chain integration with China. The authors hypothesize that for the effects of COVID-19-induced shocks on trade among EU countries forward linkages play a more significant role in the transmission of the COVID-19 shock than backward integration. Following this argument, demand shocks in the destination country propagate primarily from downstream firms to upstream suppliers of raw materials and intermediate goods. Kejžar et al. (2022) find that, in fact, exports of intermediate goods decline more strongly in response to an increase of COVID cases in the destination country if the exporting country has intense forward linkages with the destination country. Moreover, the study provides evidence for an additional China effect, meaning that the transmission of the COVID-19 shock is amplified if the exporting country shows a high share of supply chain trade with China.

There is also evidence pointing to the importance of backward linkages as transmission channel, in particular as regards spillover effects of lockdowns in China. Especially in the beginning of the crisis, when China was hit most severely and the shock had not yet reached a global dimension, many other countries were nonetheless affected via GVC due to China's significance as producer of intermediates and raw materials (Eppinger et al., 2021; Miroudot, 2020).[1] Meier and Pinto (2020) examine effects on the US economy and find that "China exposure" can explain roughly 10 percent of the variance in industrial production growth across sectors during March and April 2020. Sectors in the US that rely more heavily on imports of intermediate goods from China experienced a stronger decline in production, employment and trade. The effects are, however, transitory and dissipate quickly by July 2020. Findings by Qin et al. (2020) suggest that downstream producers are affected more severely than upstream suppliers with the US and Germany being among the most impacted countries. For Germany, Stepanok (2020) finds that imports of intermediate goods from China declined by more than 17 percent in February 2020 relative to February 2019.

So far there is no evidence on whether regions are affected differently by the GVC disruptions caused by the COVID-19 pandemic. Some studies examine the direct and indirect effects of (local) lockdowns and their transmission through *domestic* value chains applying an input-output framework. Results by Reissl et al. (2022), for instance, point to spatially heterogeneous effects of lockdown measures and important spillover effects across sectors and regions in Italy. Inoue et al. (2021) provide similar evidence for Japan. While most studies consider domestic value chains only, Sanguinet et al. (2021) investigate both how Brazilian regions are impacted by COVID-19 trade shocks and how the effects of partial lockdown measures in economic sectors spread along input-output linkages. Their results indicate that more prosperous regions are hit by trade shocks more severely, whereas poorer peripheral areas seem to be doubly affected by the foreign shock and declining demand from the rich core regions. All of these studies indicate a regionally differentiated impact of the pandemic, crucially mediated by value chain participation and positioning. However, most of these studies focus on domestic rather than global value chains. As a consequence, they do not address the role of GVC trade with China.

[1] For example, Hyundai was forced to stop production in Korea on 7 February as a consequence of the lockdown in Wuhan in January due to a lack of intermediate inputs that could not be supplied from China (Miroudot, 2020).

In a nutshell, there is no evidence on regionally differentiated labor market effects of GVC disruptions caused by the COVID-19 pandemic so far. Some studies examine how shocks triggered by (local) lockdowns propagate through domestic value chains (e.g. Reissl et al., 2022). Studies that investigate the consequences of GVC disruptions, in contrast, tend to focus on changes in trade flows as outcome (e.g. Kejžar et al., 2022) or analyze how production and welfare of countries and specific (manufacturing) sectors are affected by the distortions (Eppinger et al., 2021; Meier & Pinto, 2020). Labor market effects and spatially heterogeneous impacts of the COVID-19 crisis due to GVC integration received little attention up to now. Morever, most studies focus on short-term effects during the first year of the pandemic in (early) 2020.

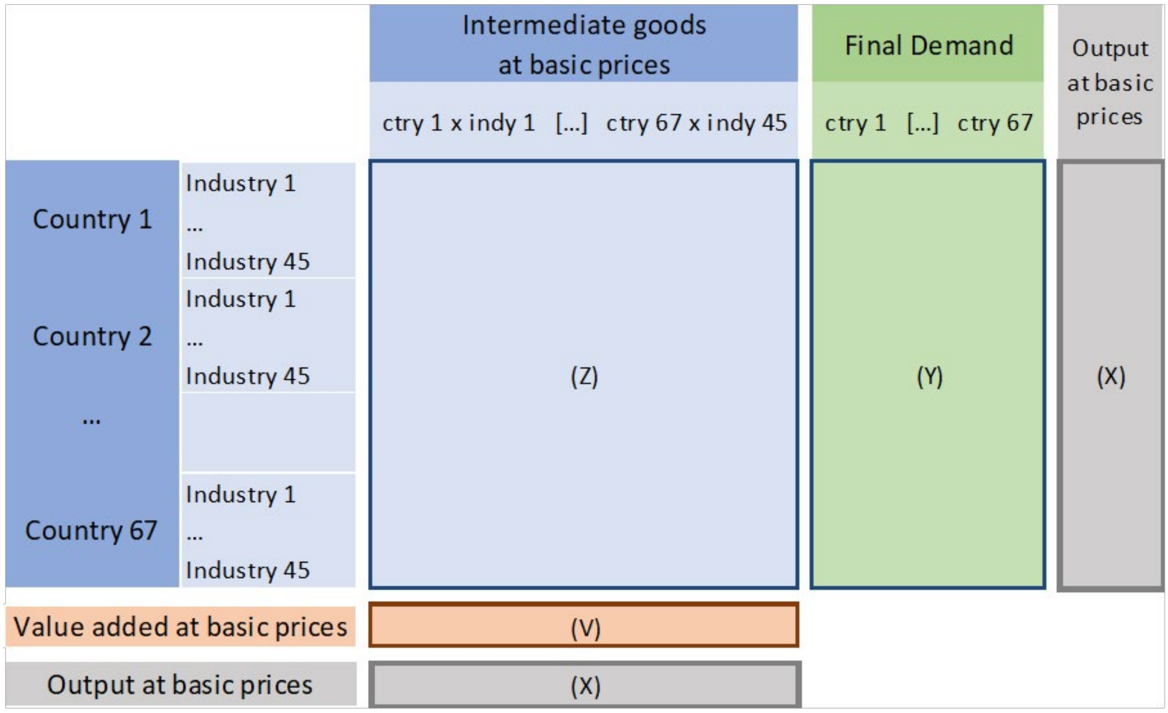
3 Data

3.1 Inter-Country Input Output dataset

To investigate how the integration into GVC has affected regional labor markets during the COVID-19 pandemic we apply indicators that make use of information on international trade in intermediate goods. To measure how different regions and sectors in Germany are integrated in GVC, we use the 2021 edition of the OECD Inter-Country Input-Output (ICIO) tables (OECD, 2021) which provides information until the year 2018.[2] The input-output tables show the monetary amount of inputs of each economic sector to produce the final amount of output of a specific industry. Further, they decompose output into final consumption and intermediate goods, and combine national input-output tables to describe the sale-purchase relationships between and within industries and countries (Belotti et al., 2020).

[2] For more information on the latest OECD ICIO database, see http://oe.cd/icio.

Figure 2: Conceptual framework of the OECD ICIO dataset



Source: ICIO database (http://oe.cd/icio); own illustration. © IAB

Figure 2 illustrates the conceptual framework of the OECD ICIO table for $G = 67$ countries[3] and $N = 45$ industries. For the most recent year, 2018, the dataset covers 93 percent of the worldwide GDP, 92 percent of all exports and 90 percent of all imports. Each matrix/vector V, X, Y, and Z consists of single elements for countries and industries which are:

- z_{ij}^{sv}: the flow of an intermediate good from industry i in country s to industry j in country v
- y_i^{sv}: final demand of goods and services in country v produced in industry i in country s
- x_i^s: gross output of industry i in country s
- v_i^s: value added in country s by industry i

We use in particular the information available in the matrix Z to calculate indices for the GVC participation of industries and regions (see section 4). Z is a $GN \times GN$ dimensional block matrix that includes all industry- and country-specific flows of inputs and outputs.

3.2 Labor market data

Our main outcome variable is the regional share of short-time work (STW) in total employment. Short-time work is one of the most important labor market policy instruments in Germany to avoid mass layoffs during major economic crises. One reason why the unemployment rate showed a relatively moderate increase during the COVID-19 pandemic in Germany was the extensive use of STW. Therefore, we use STW rather than unemployment to measure the labor market effects of GVC disruptions caused by the COVID-19 crisis.

[3] The dataset includes information on 66 single countries and a 67th category which represents an aggregate for the rest of the world.

Through STW governments temporarily subsidize a portion of the employer's payrolls when supply and demand collapse during a crisis. In Germany, firms which have to reduce their employees' working hours can apply for subsidies at the Federal Employment Agency (FEA) (Naujoks et al., 2022). For these reasons, we use administrative data on short-time work from the FEA as our main indicator of regional labor market performance. The data covers the period from January 2019 to December 2021 and is available for all 400 German counties.[4] STW data gives us the number of employees who work reduced hours and receive short-time allowance in a given month. The information is based on payroll lists and represents realized short-time work with economic conditions as basis for claims (i.e. only economic reasons, excluding seasonal or other exceptional reasons).

As an additional outcome, we consider changes in regional employment and use information available in the employment statistics provided by the FEA. We focus on employment subject to social security contributions and consider the monthly stock of employment. The retrieved data cover the period from January 2019 to December 2021, are differentiated by sector, occupation, firm size, skill level, and region, and are available on a monthly basis.

To be able to merge STW and employment outcomes with indicators for GVC integration, we use data for 88 2-digit sectors (German classification of Economic Activities, edition 2008) and aggregate it to 45 industries differentiated in the OECD ICIO dataset.

For our analysis, we aggregate employment and short-time work which is available at the NUTS3 level (400 counties) to 257 labor market regions based on the classification of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR).[5] These functional labor market regions are defined according to commuting intensity between counties.

We also use employment data to calculate control variables such as the regional firm size and skill structure, related and unrelated variety, economic specialization and a work-from-home potential of the labor market regions. More detailed information on control variables considered in the empirical analysis are provided in the appendix.

3.3 COVID-19 related control variables

In addition to the labor market information we described in the previous section, we also use variables that show regional exposure to the COVID-19 crisis. These variables capture regional differences in the COVID-19 shock that are not directly related to GVC disruptions. More specifically, we consider the regional stringency of containment measures, the regional rate of COVID-19 infections, and changes in mobility. Regional stringency is calculated as the average of 23 different policy responses. The index is taken from the Corona-Datenplattform[6] and ranges from 0 to 100, with higher values indicating greater stringency. From the same data source, we also use the monthly reported regional COVID-19 infections. Further, we use daily mobility flows

[4] Firms can request and report STW centrally, i.e. possibly also for branches located in other regions than the headquarter. Matching data on STW to small regions might therefore be subject to a measurement error, introducing an increasing imprecision to the data the smaller the regions are. However, the use of functional labor market regions that combine administrative units at the county level based on commuting patterns should help to reduce this problem.

[5] For more information, see: https://www.bbsr.bund.de/BBSR/DE/forschung/raumbeobachtung/Raumabgrenzungen/deutschland/regionen/arbeitsmarktregionen/Arbeitsmarktregionen.html

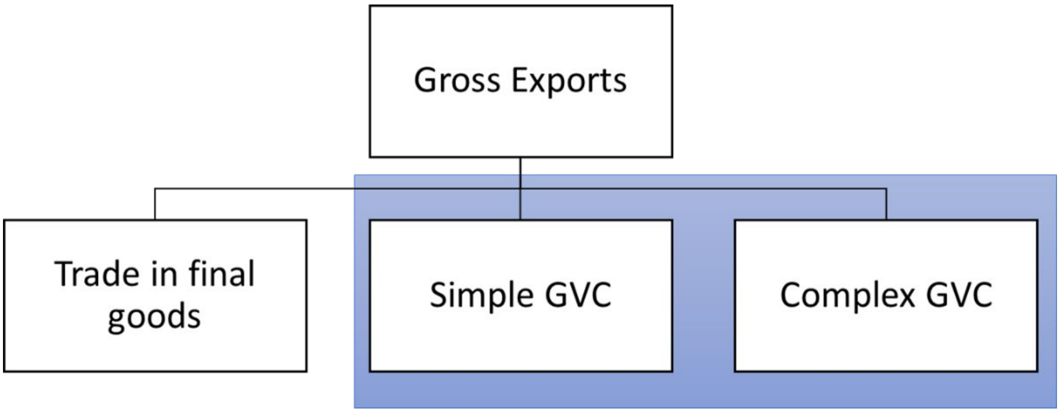
[6] For more information, see https://www.corona-datenplattform.de/.

which are derived from mobile phone data collected by the provider Telefónica and aggregated by Teralytics. The data enables us to include changes in mobility with reference to the average daily mobility in the corresponding month in 2019. To receive monthly data, we calculate the mean over all days of the relevant month. We aggregate all time-varying variables to labor market regions by calculating a weighted mean of the NUTS3 data where the weights equal the stock of employment in the respective month and district in 2019.[7]

4 Measuring GVC integration

Figure 3 shows the decomposition of international trade into three parts. Traditional trade refers to final goods which are shipped across a border for direct end use. The other two parts represent GVC related trade (blue box). The approach of what should be defined as a trade flow related to GVC activities originally comes from Hummels et al. (2001). The idea is that goods and services have to cross an international border more than once during the production process to be regarded as GVC-related activities. Borin and Mancini (2023) use the same definition in a more recent paper. Wang et al. (2022), in contrast, define this as complex GVC, while intermediate goods which are just shipped over one border are described as simple GVC related trade (Wang et al., 2022).

Figure 3: Decomposition of international trade



Source: Wang et al. (2022); own illustration. © IAB

We apply the definition proposed by Wang et al. (2022) and consider simple and complex GVC-related trade in this study because COVID-19 shocks should propagate through both types of relationships. Therefore, we use measures of GVC integration that base on the sum of trade in intermediate goods between countries.

[7] Summary statistics for the variables are listed in Table A 1 in the appendix.

4.1 GVC integration of sectors

In a first step, we need to determine exports and imports of intermediate goods of German industries for our measures of GVC integration. For the export perspective, i.e. GVC-related exports, we determine the sum of exports of intermediate goods of German industries to other countries:

$$EXP_i = \sum_{j=1}^{N} \sum_{v \neq GER}^{G} z_{ij}^{s=GER,\, v}, \tag{1}$$

where $z_{ij}^{s,v}$ denotes the value of intermediate goods that are produced in country s by industry i and used in country v by industry j. For the export perspective, we fix the exporter country s to Germany and calculate the sum of exports of intermediate goods for every German sector i, EXP_i. To measure the intensity of GVC integration of exporting sectors in Germany, we divide the value of exported intermediate goods (EXP_i) by the value of total output of the sector x_i:

$$EXP_i^{GVC} = \frac{EXP_i}{x_i} \tag{2}$$

The measure EXP_i^{GVC} thus gives us the share of intermediate goods in total output of sector i that cross at least once an international border.

The second indicator reflects the import perspective. We first sum up the intermediate imports which are shipped from other countries to Germany, i.e. the sum of intermediate goods that sector j in Germany imports from the rest of the world:

$$IMP_j = \sum_{i=1}^{N} \sum_{s \neq GER}^{G} z_{ij}^{s,\, v=GER} \tag{3}$$

We also divide the imports by total output of the sector x_j:

$$IMP_j^{GVC} = \frac{IMP_j}{x_j} \tag{4}$$

The measure IMP_j^{GVC} gives us the share of intermediate inputs from abroad in total output of sector j in Germany. We use the sum of the output shares of GVC-related imports and exports as a measure of overall GVC integration of the sector.

The OECD ICIO dataset enables us to calculate these measures for all countries included in the data base and also for groups of countries. In this analysis, we focus on the bilateral relationship between China and Germany.

4.2 GVC integration of regions

In this section, we regionalize imports and exports of intermediate goods using the variation in sector specialization across labor market regions. Our indicators make use of an approach proposed by Autor et al. (2013) and also applied by Dauth et al. (2014) to measure exposure of local labor markets to international trade. In equation (5), the intermediate goods that are imported by industry j in Germany are distributed across regional labor markets by multiplying the imported inputs of this sector IMP_j with the region's share of national industry employment in j in 2019 (e_{rj}/e_j). The sum over all N industries is then divided by the region's total employment (e_r):

$$RIMP_r = \sum_{j=1}^{N} \frac{e_{rj}}{e_j} \frac{IMP_j}{e_r} \quad (5)$$

where e_{rj} denotes the employment in region r and sector j. The measure gives us an estimate of the value of imports of intermediate goods per worker in region r. An analogous approach is applied to exports of intermediate goods:

$$REXP_r = \sum_{i=1}^{N} \frac{e_{ri}}{e_i} \frac{EXP_i}{e_r}. \quad (6)$$

The two indicators can refer to the region's global GVC-related trade or to bilateral GVC-related trade with a specific country such as China. We use the sum of regionalized imports and exports to measure the overall GVC integration of region r $(RGVC_r)$:

$$RGVC_r = RIMP_r + REXP_r\,. \quad (7)$$

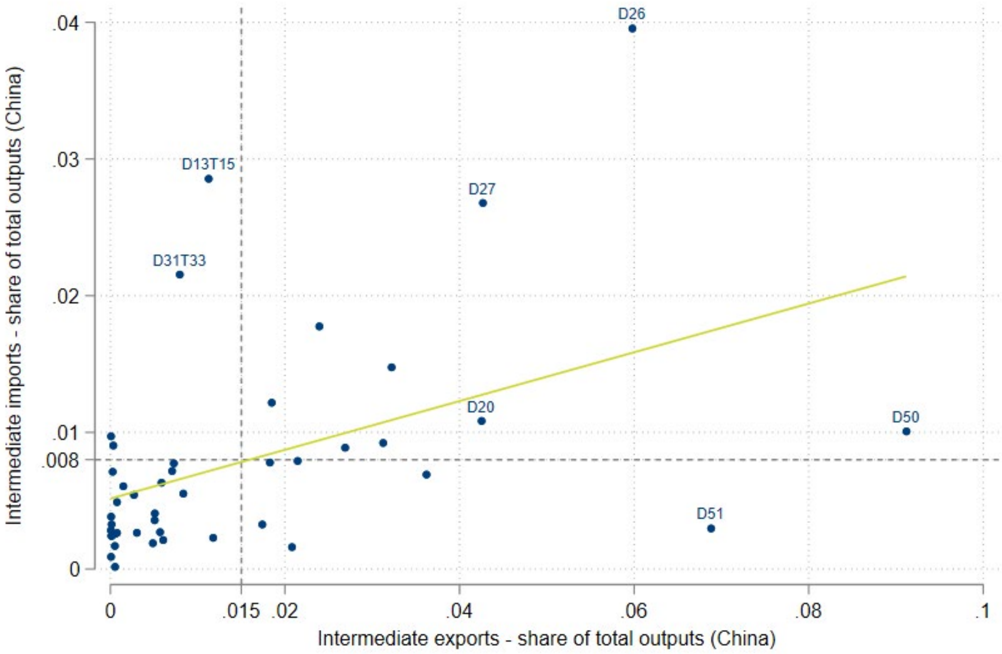
5 Descriptive results

5.1 GVC integration of sectors

This section provides a short overview on GVC integration of economic sectors in Germany by exploiting the information in the OECD ICIO dataset (OECD, 2021). We focus on the German perspective, especially with respect to China as bilateral trading partner, but also examine the Chinese as well as the worldwide GVC integration. China is one of the most important trading partners for Germany as 2.7 percent of the German value added is absorbed, i.e. imported by China in 2018. Only the amount of value added absorbed by the USA (3.8 percent) and domestic absorption (69.5 percent) are higher. From a Chinese perspective, Germany absorbs 0.6 percent of the value added in China, and thus ranks fifth among the most important trading partners. Hence, for both countries the respective other country is of major importance.

In the bilateral case for GVC-related imports of German sectors from China, the three most integrated sectors are “Computer, electronic and optical equipment” (D26), “Textiles, textile products, leather and footwear” (D13T15) and “Electrical equipment” (D27) (see Figure 4). From the exporter perspective, hence when considering GVC-related exports of German sectors to China, the three most integrated sectors are “Water transport” (D50), “Air transport” (D51) and “Computer, electronic and optical equipment” (D26). Further, we see that the average share of GVC-related exports in total output is almost twice as large as the average output share of GVC-related imports. Figure 4 also indicates a moderate positive correlation of GVC integration via imports and exports with China as bilateral trade partner (correlation coefficient $\rho = 0.45$).

Figure 4: Bilateral GVC-related imports and exports with China
GVC-related imports and exports as share of total output by sector, 2018

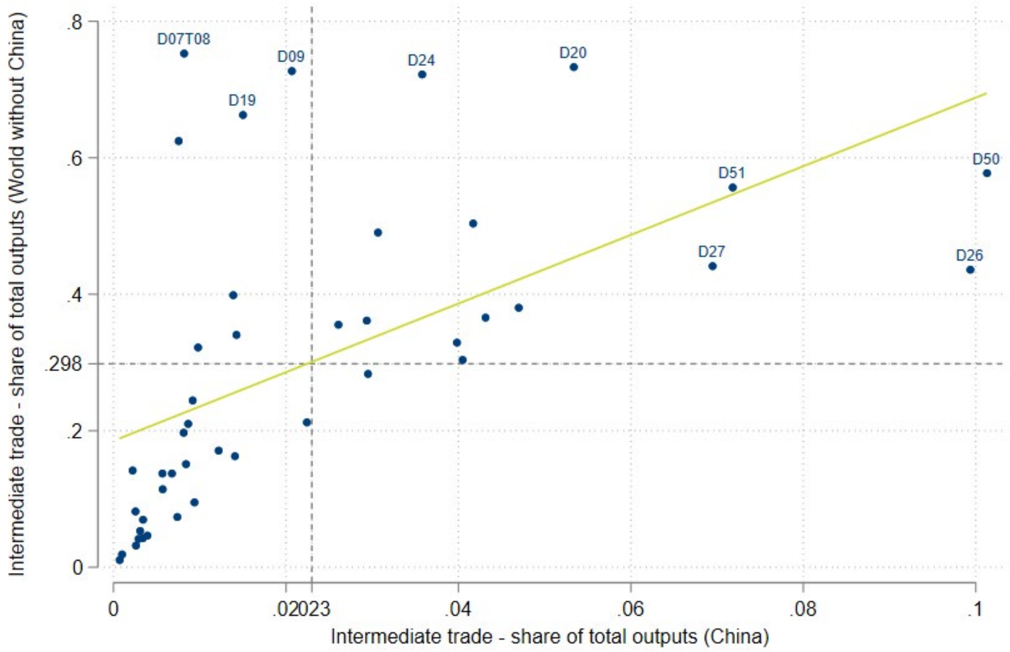


Notes: The figure shows the correlation of sector-specific GVC integration via imports and exports with China ($\rho = 0.45$). The horizontal and vertical dashed lines show the average GVC-related integration via imports and exports.
Sectors: D13T15: Textiles, textile products, leather and footwear; D20: Chemical and chemical products; D26: Computer, electronic and optical equipment; D27: Electrical equipment; D31T33: Manufacturing nec; repair and installation of machinery and equipment; D50: Water transport, D51: Air transport.
Source: OECD ICIO data (OECD, 2021); own calculations. © IAB

When we examine the GVC integration with the rest of the world without China via imports and exports (see appendix Figure A 1), the correlation between GVC-related imports and exports is almost identical ($\rho = 0.44$). However, the sectors showing the highest integration differ from those in Figure 4. For GVC-related imports, the top three sectors in Germany are “Coke and refined petroleum products” (D19), “Basic metals” (D24) and “Mining and quarrying, energy producing products” (D05T06). For exports the three most highly integrated industries are “Mining and quarrying, non-energy producing products” (D07T08), “Mining support service activities” (D09) and “Chemical and chemical products” (D20). It is further interesting to note here that the most integrated sectors are not necessarily the largest ones in Germany when measured e.g. by the gross value added or employment.

Figure 5 shows the overall GVC integration of German sectors (sum of GVC-related imports and exports) with China and with the rest of the world. Both globally and bilaterally with China, overall GVC integration is strongly driven by the export component. For this reason, the most integrated sectors are almost identical to those with high GVC-related exports from the previous figures. Further, the correlation between the worldwide (except China) GVC integration and the GVC integration with China is $\rho = 0.56$. This means that industries which are highly integrated worldwide also tend to show a rather strong GVC relationship with China. However, there is also a significant proportion of sectors where integration is more specific, meaning that high integration with the rest of the world (with China) is not accompanied by above average integration with China (the rest of the world). This applies, for instance, to the sectors "Mining and quarrying, non-energy producing products" (D07T08), "Mining support service activities" (D09) as well as "Coke and refined petroleum products" (D19) which do not show a very strong integration with China but with the rest of the world.

Figure 5: GVC integration of sectors in Germany with China and the rest of the world
GVC-related trade as share of total outputs by sector, 2018



Notes: The figure shows the correlation of sector-specific GVC-related trade (sum of imports and exports) for Germany with China and the rest of the world ($\rho = 0.56$). The horizontal and vertical dashed lines show the average GVC-related trade integration with China and the rest of the world.

Sectors: D07T08: Mining and quarrying, non-energy producing products; D09: Mining support service activities; D19: Coke and refined petroleum products; D20: Chemical and chemical products; D24: Basic metals; D26: Computer, electronic and optical equipment; D27: Electrical equipment; D50: Water transport; D51: Air transport.

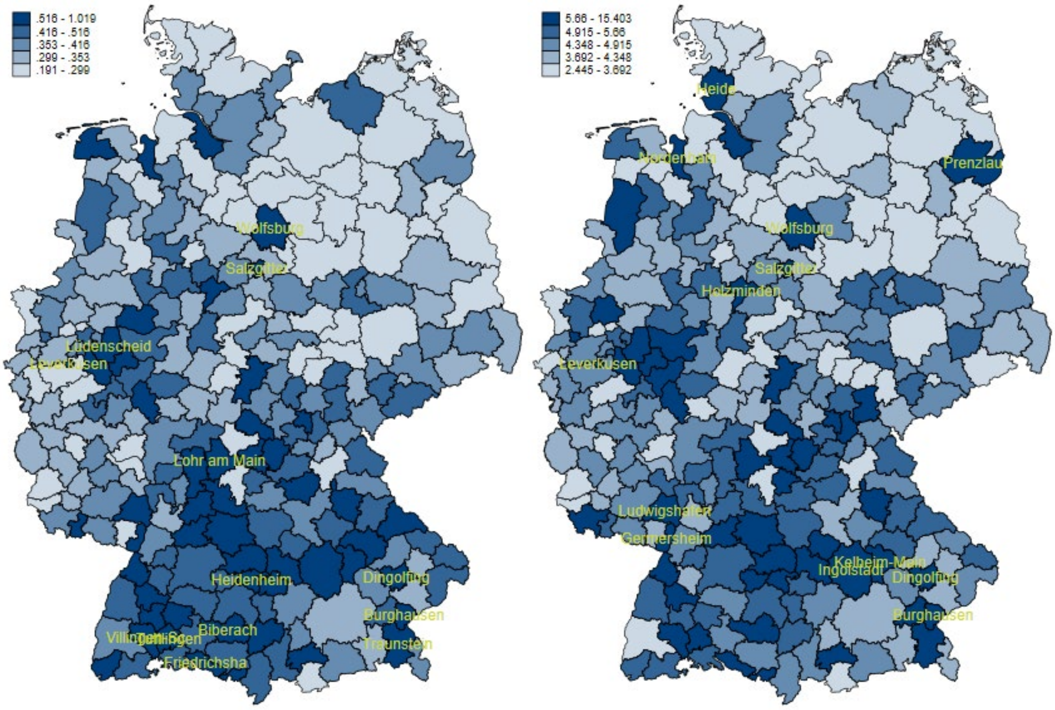
Source: OECD ICIO data (OECD, 2021); own calculations. © IAB

5.2 GVC integration of local labor markets in Germany

This section summarizes descriptive results on regional GVC integration in Germany. As we examine the effects of GVC disruptions on regional labor markets in Germany in our regression analysis (see section 7), we focus on the GVC integration of German regions. We provide evidence on GVC integration of 257 labor market regions using the regional indices introduced in section 4.2. Based on the combined measure described in equation (7), Figure 6 shows total regionalized GVC integration via intermediate goods in Mio. US $ per 100 employees with China (left) and the rest of the world (right), respectively. The color intensity indicates how strongly a German labor market region is interconnected with its respective trading partner(s) when it comes to GVC-related trade. Specifically, the darker a region is colored, the more intermediate goods per 100 workers are used and created in regional production. The most highly integrated regions are labeled.

Figure 6: Total regional GVC integration with China and the rest of the world

GVC integration in Mio. US $ per 100 employees



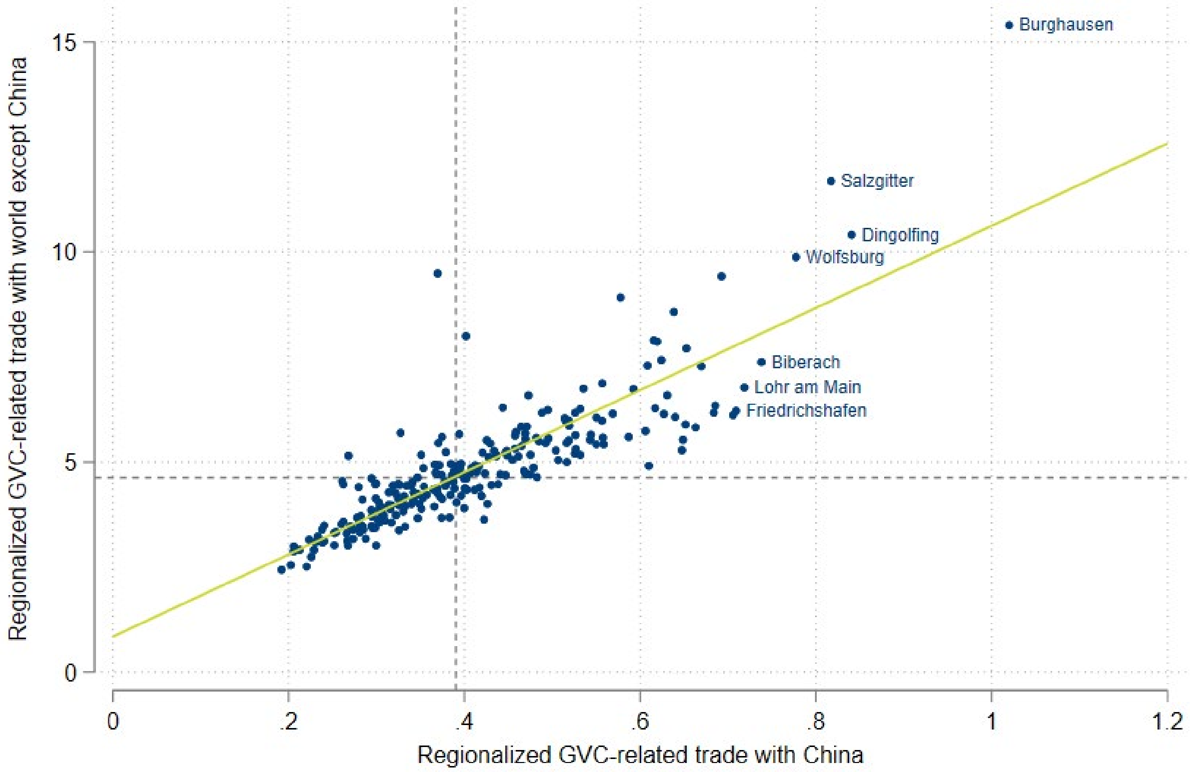
Notes: Total regional GVC integration as given by equation (7) with China (left) and the rest of the world (right) in Mio. US $ per 100 employees (in 2019 measured at the place of work). Most highly integrated regions are labeled.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations.

When comparing the two maps, it becomes apparent that while there is a general clustering of highly integrated regions in southern Germany, this appears to be slightly more pronounced for GVC trade with China than it is for GVC trade with the rest of the world. In contrast, many regions in the northeastern part of the country show a below average GVC integration. Thus, these spatial patterns reflect to some extent regional differences in basic trade orientation caused by a specialization of regions in export-oriented industries such as the automotive industry and manufacturing of machinery (see e.g. Dauth et al., 2014).

For a more detailed view on the dependence of German regions on GVC-related trade, Figure 7 plots the regionalized GVC integration with China against those with the rest of the world. The regions especially reliant on intermediate inputs are also labeled. The green line indicates the correlation between the indices. The indices are highly correlated ($\rho = 0.86$). Burghausen exhibits the strongest GVC linkages with China as well as the rest of the world which is not surprising considering the region's importance within the so-called "Bayerisches Chemiedreieck" (*Bavarian chemical triangle*) and this sector's embeddedness into GVC in general. Further highly integrated regions are Salzgitter, Dingolfing and Wolfsburg which are well known for their economic specialization in manufacturing and, in particular, the automotive sector. The average GVC-related trade with China is almost 0.4 Mio. US $ per 100 employees. In contrast, Dingolfing as a highly integrated region has a GVC-related trade integration of 0.84 Mio. US $ per 100 employees with China.

Figure 7: Correlation of regionalized GVC integration with China and the rest of world
GVC integration in Mio. US $ per 100 employees



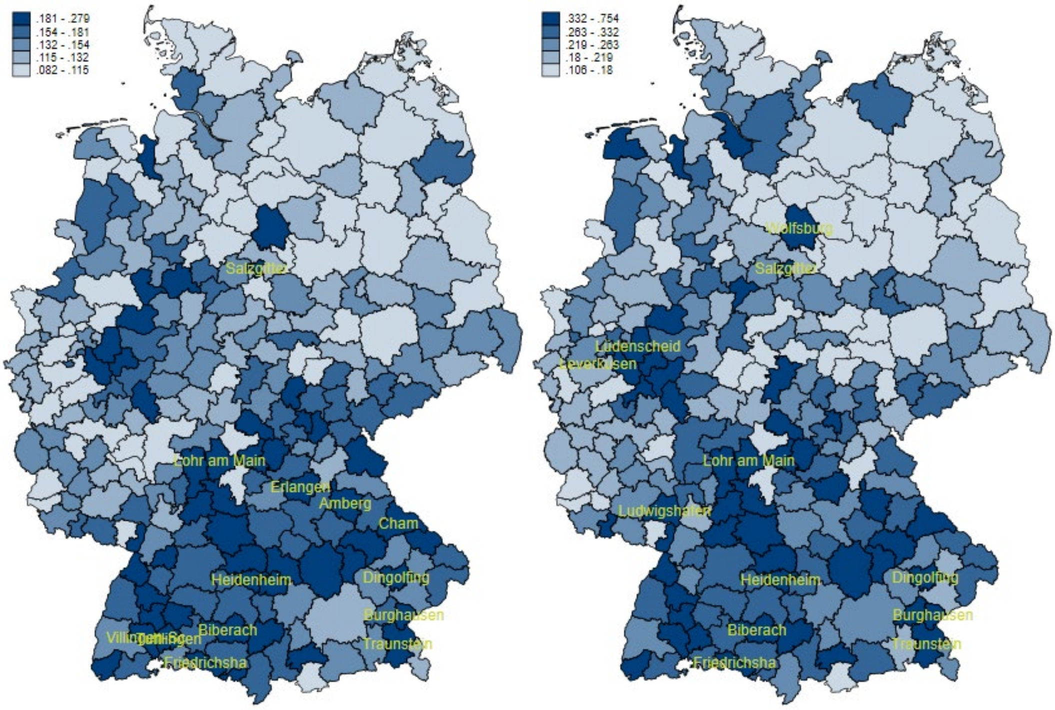
Notes: Total regionalized GVC integration with China on the x-axis, corresponding GVC integration with the rest of the world on the y-axis. Both indices are given in Mio. US $ per 100 employees (in 2019 measured at the place of work). The dashed lines indicate the average GVC integration of German labor market regions with China and the rest of the world. The green line represents the correlation between the indicators ($\rho = 0.86$)

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations.

In the next step, we decompose GVC-related trade into imports and exports of intermediate inputs. In general, we see that the export component is more important in Germany. For the export GVC integration with China, the German average is roughly 0.26 Mio. US $ per 100 employees whereas the import average amounts to 0.15 Mio. US $ per 100 employees. Figure 8 shows regional disparities in GVC trade integration with China via imports (left) and exports (right). Both maps basically show the same regional pattern with only a few exceptions. A high correlation (correlation coefficient $\rho = 0.87$) is confirmed by a corresponding scatterplot (see Figure A 3 in the appendix).

Figure 8: Regionalized GVC integration via imports and exports with China

GVC integration in Mio. US $ per 100 employees



Notes: Regionalized GVC integration with China via imports (left) and exports (right) in Mio. US $ per 100 employees (in 2019 measured at the place of residence). Most highly integrated regions are labeled.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations. © IAB

Figure A 2 in the appendix shows the regional GVC integration with the world except China via imports and exports. In general, we can see that compared to the integration with China, the pattern is less concentrated on regions in the southern part of Germany. The distribution for both indicators is also very similar ($\rho = 0.86$). So, we can note that when a region is highly integrated into GVC-related trade, it is usually through both imports and exports.

6 Econometric strategy

6.1 Identifying assumptions and model

We apply a difference-in-differences (DiD) approach to examine how the disruptions of GVC caused by the COVID-19 pandemic affected local labor markets in Germany using monthly information on regional short-time work and our regionalized GVC indices described in the chapters 4.2 and 5.2. The DiD design is a quasi-experimental identification strategy which aims at determining causal effects by comparing the outcome of a treatment and control group. In our setting, the DiD approach compares changes in short-time work before and after the COVID-19 shock across regions. To apply the DiD estimator in a typical regression framework, we use a two-way fixed effects (TWFE) estimator. In the standard case, with R regions r and T time periods t, the TWFE model is given by:

$$STW_{rt} = \sum_{t \neq 2020m2} \beta_t \mathbb{I}(t = T) RGVC_r^{CHN} + \gamma_r + \tau_t + \epsilon_{rt} \quad (8)$$

In equation (8), STW_{rt} is the share of short-time work in total employment in region r and month t.[8] $RGVC_r^{CHN}$ represents our indicator of GVC integration with China, i.e. our main treatment variable. $\mathbb{I}(t = T)$ is an indicator function for month-year pairs and we use February 2020, the month before the COVID-19 shock in Germany, as our reference. γ_r and τ_t are fixed effects for labor market regions and month-year pairs and ϵ_{rt} is a white noise error term. As described in section 3.2, we use the stock of employment EMP_{rt} in region r and month t as an alternative dependent variable.

We apply a special form of DiD design since regional GVC integration ($RGVC_r^{CHN}$) is a continuous variable, in contrast to a binary variable that indicates the treatment in the standard case.[9] Every region shows a GVC integration larger than zero in 2018. So basically, we have no explicit control group (regions), i.e. the GVC indicator does not divide the regions into a clear treatment group and a control group, but represents a so-called treatment exposure (Callaway et al., 2021).

In this setting, the identification of causal effects of GVC integration on short-time work relies on some assumptions. The first assumption is the well-known parallel trends assumption (Cunningham, 2021). However, this assumption needs to be adjusted because our treatment is continuous. Callaway et al. (2021) modify the assumption and call it the strong parallel trends assumption, which must be met in order to identify an average treatment effect of the treated (ATT). Applied to our study, we assume that regions with different levels of GVC integration would show the same trend in short-time work if they had been exposed to the same level of GVC integration and the COVID-19 shock had not occurred. In other words, we could say that in the absence of the COVID-19 crisis, short-time work would have followed parallel trends along all levels of GVC integration, our continuous treatment (see Ben Yahmed et al. (2022) for a recent application with a similar reasoning). As a simple preliminary check, we report pre-crisis results of the outcome variable short-time work and look for any recognizable differences in trends. In addition, we implement a weighting procedure (see section 6.2 for details) to further comply with the assumption.

Second, we might face the well-known sorting problem or, in other words, the conditional independence assumption has to hold. Regions with different levels of GVC exposure may behave differently during the pandemic due to other regional characteristics which influence short-time work rates during the pandemic such as the firm size structure or the industry composition of the region (see e.g. Bartik et al., 2020; Kim et al., 2022; Partridge et al., 2022). The weighting procedure mentioned above makes use of different pre-crisis characteristics of regional labor markets and thereby controls for them.

Furthermore, the level of COVID-19 infections or the strictness of policy responses could affect regional short-time work rates as well. We account for regional differences in the COVID-19 shock that are not linked to the disruptions of GVC via including time-varying control variables directly

[8] We use the pre-crisis employment stock in June 2019 to calculate the percentage of short-time work.

[9] See Card (1992) for a one of the first applications with a continuous treatment variable and more recently Bauernschuster et al. (2016).

in the regression model. More precisely, we consider the regional strictness of containment measures, the regional rate of COVID-19 infections and changes in mobility (see section 3.3 for details). Including these variables in equation (8) the extended model is given by:

$$STW_{rt} = \sum_{t \neq 2020m2} \beta_t \mathbb{I}(t = T) RGVC_r^{CHN} + \sum_{l=1}^{L} \beta_l CONT_{rlt} + \gamma_r + \tau_t + \epsilon_{rt} \tag{9}$$

where $CONT_{rlt}$ represent all L time-varying control variables. Both the weighting and the controls should ensure that the conditional independence assumption holds.

To make sure that we are able to calculate relevant inverse probability weights, we need the common support assumption (Cunningham, 2021). In the standard setting with a binary treatment common support means that regions with the same characteristics have a positive probability of being both treated and untreated (see Caliendo & Kopeinig, 2008), i.e. we can build an adequate control group. In the present setting, it ensures that our weights are different from zero and do not become extreme.

Last, the stable unit treatment value assumption has to hold. This assumption involves three issues (Cunningham, 2021). The first one is that all regions with the same level of GVC integration face the same shock induced by the COVID-19 pandemic. Second, it says that the outcome is independent of spillovers. In the setup used here, this means that there are no spillover effects between regions with respect to their level of GVC integration. In other words, the GVC integration of one region should not affect the STW of another region during the COVID-19 crisis. The third aspect is that we rule out general equilibrium effects. We think that this is quite plausible in the short run. In the medium and long run, adjustment effects should indeed play a role for the effects of GVC integration. As we might perceive a period of almost two years after the COVID-19 shock as medium term, we investigate how the effects change over time.

6.2 Entropy balancing for continuous treatments

To ensure that the strong parallel trends assumption is met and to address the sorting problem, we use Entropy Balancing for Continuous Treatments (EBCT) by Tübbicke (2021) for different pre-crisis characteristics of regions in addition to including time-varying variables directly as controls in the DiD model. The approach is an extension of the weighting procedure introduced by Hainmueller (2012) which is a covariance weighting scheme for binary treatment variables. It relies on a maximum entropy reweighting scheme that calibrates weights so that the reweighted control group does not differ from the treatment group with respect to predefined moment conditions of the covariate distributions. However, in the continuous treatment case the weighting is performed on the treated regions which is a necessary condition in our setting since we have no untreated controls. Additionally, the approach has the advantage to balance the observations for certain doses of the treatment. In the continuous case, the moment conditions must be modified because the covariate distributions may vary across the treatment intensity distribution (Tübbicke, 2021).[10]

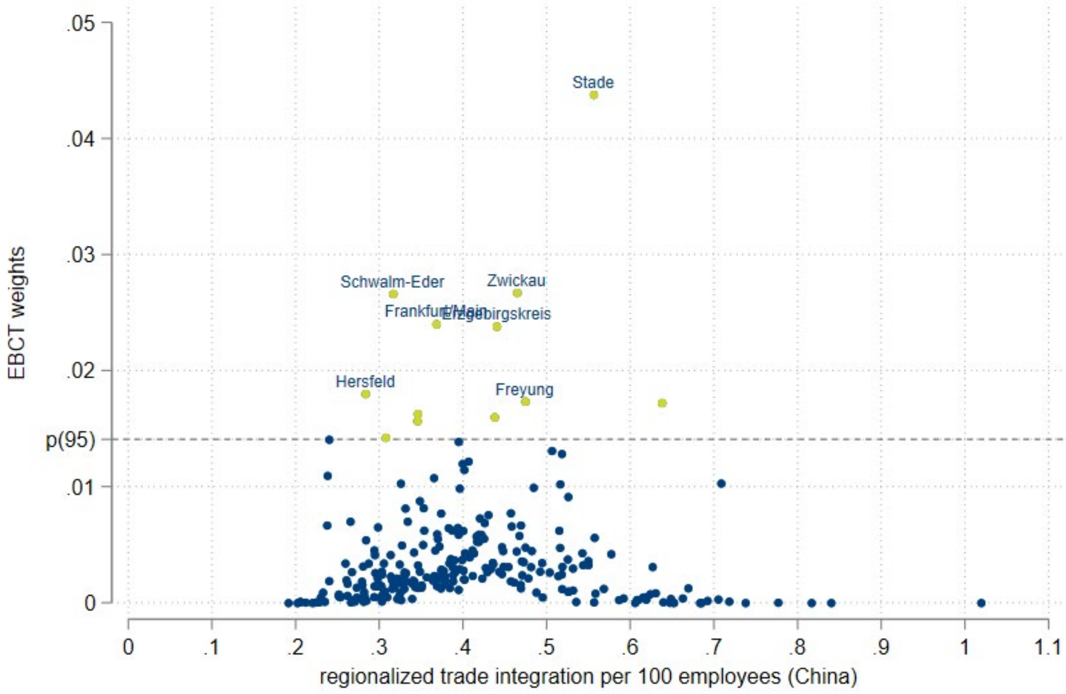
[10] We address differences in the size of regional labor markets in the EBCT procedure via weighting the observations with the employment stock in 2019 of the regions.

Table A 1 in the appendix shows summary statistics of the variables we use in the weighting procedure. All variables are averages for the pre-crisis year 2019. First, to control for different skill levels in the labor market regions we include the share of low, medium and high-skilled workers in the model. Furthermore, we consider the population density to capture potential agglomeration effects. As mentioned e.g. by Kleifgen et al. (2022) and Birinci and Amburgey (2022), firms of different size were affected differently by the crisis. For this reason, we also consider the regional firm size structure. To control for the industry composition, we include measures for economic variety and specialization. Since working-from-home might shelter workers from short-time work and unemployment, we include a regional working-from-home potential derived by Alipour et al. (2023). Moreover, we include the industry shares of accommodation and food services and arts, entertainment and recreation since these industries are especially affected by containment policies and therefore show high short-time work rates. We weight the regions in the EBCT according to their employment stock in 2019 to account for the relative importance of each labor market region.

As mentioned in section 6.1, the DiD approach assumes common support. Figure 9 shows the correlation between the entropy balancing weights (y-axis) and total GVC integration with China ($RGVC_r^{CHN}$) of the regions, i.e. our main treatment variable (x-axis). The results show that the majority of the weights lie in the bottom quarter of the figure, i.e. most weights are rather small.[11] For us, this is a desired outcome since it indicates that there is common support for the majority of the regions. To make sure that our results are not driven by extreme observations, we trim the sample and exclude those regions with the 5 percent largest weights from the analysis. Other papers propose to trim the sample on both sides of the distribution, but in our case, we see no extreme weights on the lower bound and decide to keep the 5 percent smallest weights. So, in the following, we exclude the regions colored in green in Figure 9. This should be a reasonable cutoff to ensure that we have common support and, moreover, the effective sample size remains sufficiently large (Imbens, 2004).

[11] By construction, all weights w_r are larger than 0 and sum up to unity ($\sum_r w_r = 1$).

Figure 9: Entropy balancing weights and trade integration with China

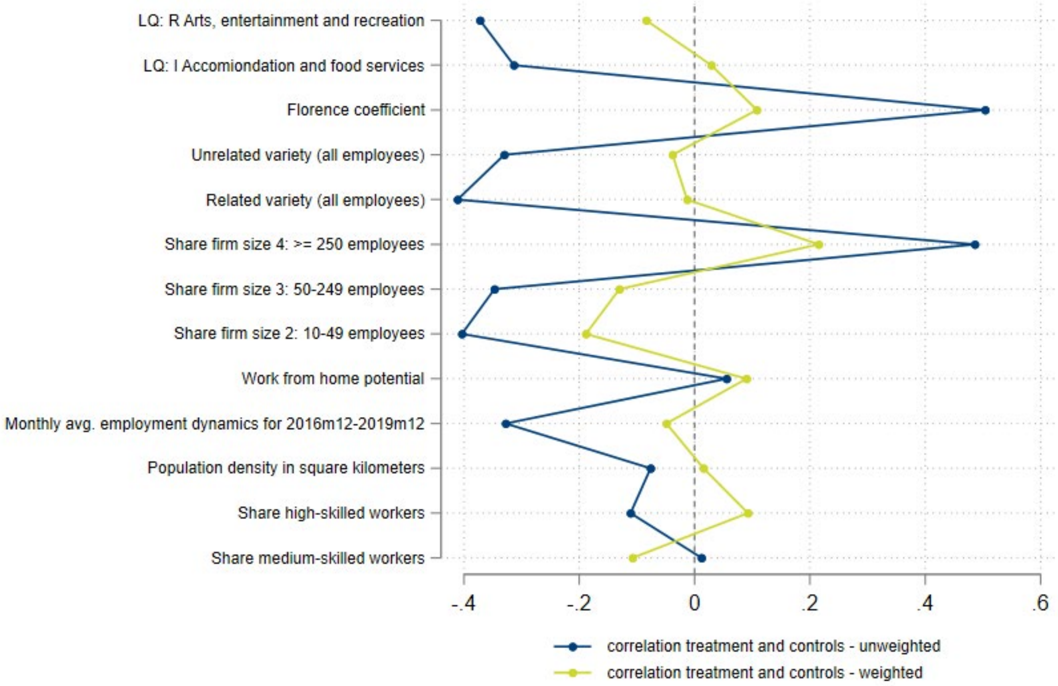


Note: Each dot represents a region's weight generated by EBCT with the variables presented in Table A 1 and its share of GVC-related trade with China as treatment variable. The green dots are the 5 percent largest regions which are trimmed in the following to guarantee common support.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations. © IAB

Figure 10 shows that our weighting procedure significantly improves the balance between the regions. The blue dots indicate the correlation between the treatment variable (GVC integration with China) and the respective covariate. We see that some covariates are significantly correlated with the treatment. After balancing, the correlation between the treatment variable and each covariate should be as small as possible. The green dots show the correlation after weighting and trimming (the 5 percent largest EBCT weights). As a result, no correlation after weighting exceeds the range of ±0.2 and some correlations are close to zero.

Figure 10: Covariate balance plot for GVC-related trade with China

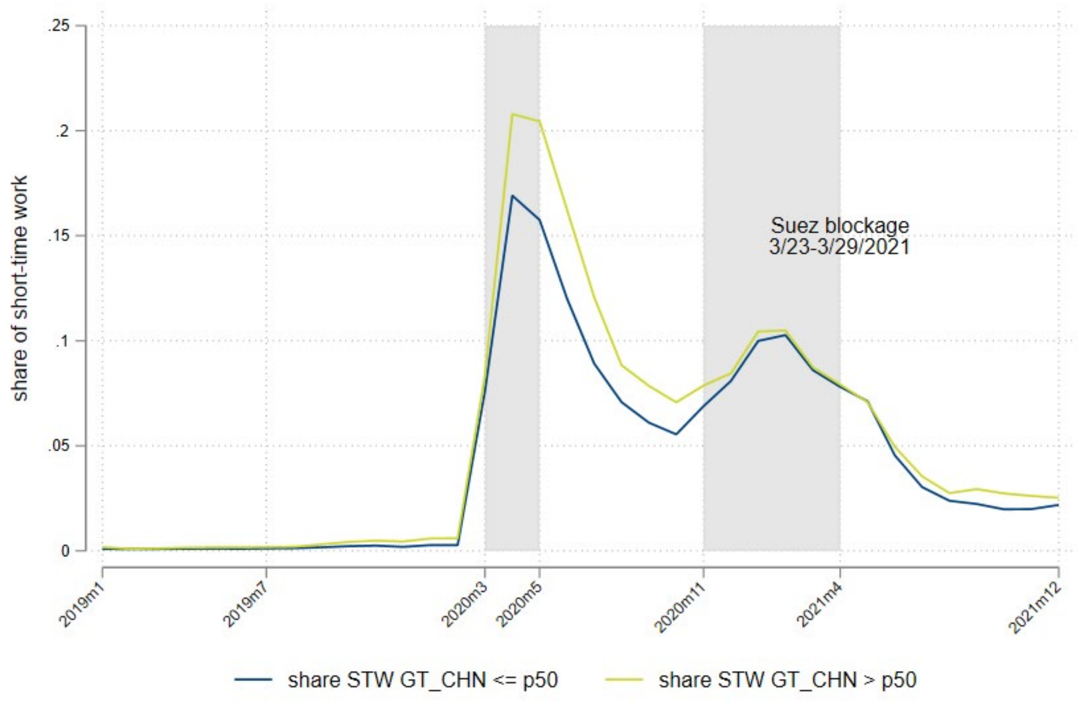


Note: Each dot represents the correlation between the treatment variable (GVC integration with China) and a covariate for all 257 labor market regions. The blue dots indicate the unweighted correlation, the green dots represent the correlation after weighting.
Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO "data (OECD, 2021); own calculations. © IAB

7 Effects of GVC integration on regional short-time work

Figure 11 shows the development of short-time work shares before and during the COVID-19 pandemic. The blue line represents the change in our outcome variable for those regions with below average GVC integration with China, i.e. regions up to the 50th percentile. The green line indicates the change in short-time work for the upper 50 percent of regions when GVC integration with China is concerned. The grey bars indicate the two lockdown periods in Germany. Further, we indicate the 6 days where the Suez Canal was blocked due to the accident of the container ship Ever Given. Both the lockdowns and the blockage could influence our results and for this reason we consider them in this figure.

Figure 11: Regional short-time work by intensity of GVC integration with China

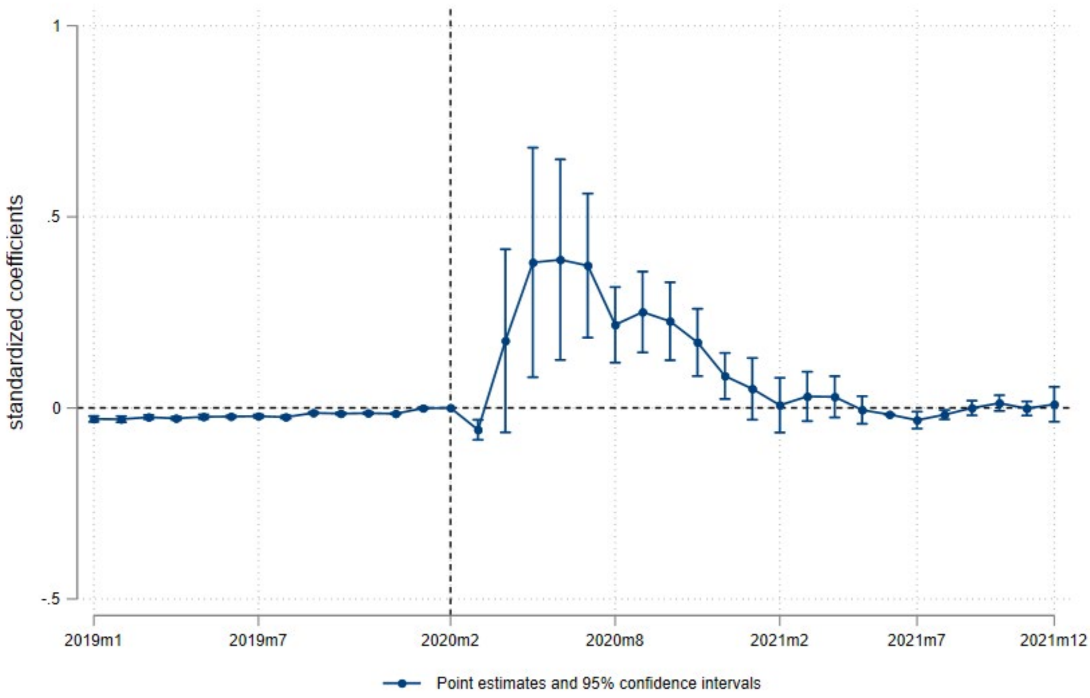


Note: Short-time work (STW) is presented in relation to the employment level in June 2019. Regions are split by the median of their GVC integration with China ($RGVC_r^{CHN}$). The grey bars indicate the German lockdown periods.
Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations.

In the pre-crisis period, STW levels for both groups of regions are almost zero. In Spring 2020, all regions show a steep increase in short-time work. However, we observe that regions with higher trade-integration with China face higher STW after the emergence of the COVID-19 crisis. Especially during the first lockdown and the months thereafter until Winter 2020 the gap in short-time work is significant. In contrast, differences between the two region groups decline during the second lockdown but higher integrated regions still face slightly higher STW until the end of our observation period. Therefore, it is not very likely that the substantial gap in STW in 2020 is primarily driven by lockdowns in Germany. Only with the beginning of the second lockdown, the line gap narrows.

In the next step, we estimate the extended model given by equation (9) and the corresponding EBCT weights and trim the sample. Figure 12 shows the results in an event study plot from January 2019 until December 2021 for GVC integration ($RGVC_r^{CHN}$). We use February 2020 as the reference (vertical dashed line) and the bars indicate the 95 percent confidence intervals for the point estimates. To ease interpretation, we show standardized coefficients and the dashed horizontal line indicates an effect equal to zero.

Figure 12: Event study estimates of regional GVC integration with China and short-time work

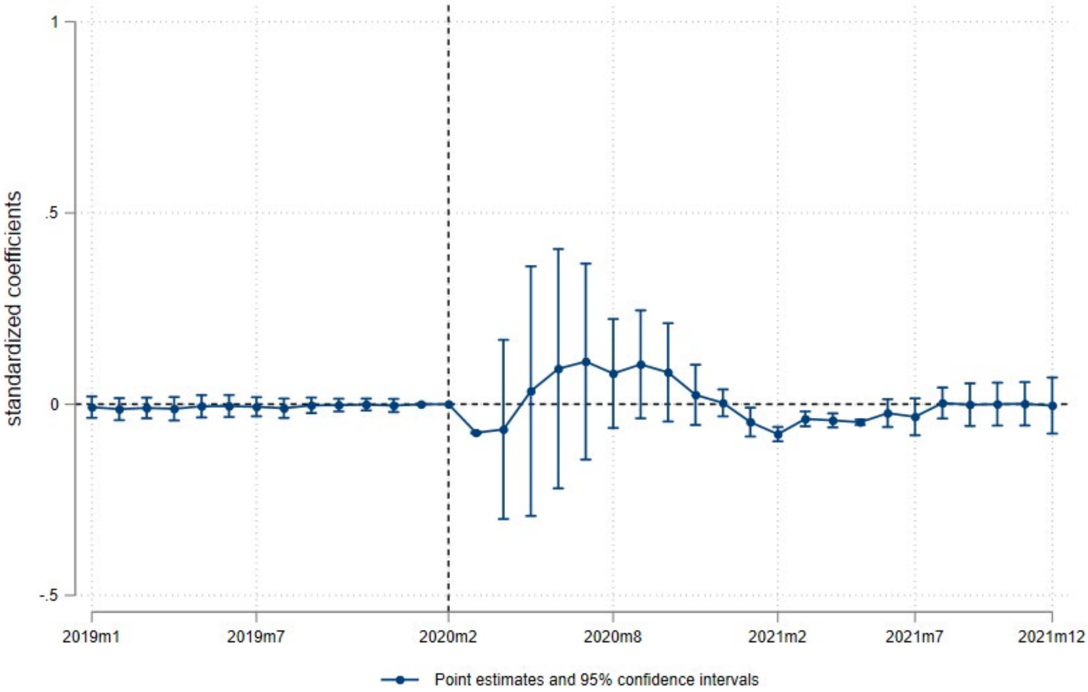


Note: All variables are standardized, EBCT weights are calculated for GVC integration with China. Top 5 percent regions are trimmed in the model. The standard errors for the confidence intervals are clustered on the labor market region level.
Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations.

In the pre-crisis period, the effects of GVC integration on short-time work are close to zero. Since we have a very small variation of STW before March 2020, the confidence intervals are also narrow and partly not identifiable in the figure. In general, we see no important trends in the pre-crisis period, confirming the strong parallel trends assumption. From May 2020 on, we see positive and significant effects and a peak in May 2020 with 40 percent of a standard deviation. This means that if we increase a region's GVC integration with China by one standard deviation, the region roughly faces 2.20 percentage points more short-time work in Mai 2020.

The regionalized GVC-related trade with China ranges from 0.19 Mio. US $ per 100 employees in Garmisch-Partenkirchen to 1.02 Mio. US $ per 100 employees in Burghausen. If we keep everything else fixed and apply the difference in GVC integration with China between Garmisch-Partenkirchen and Burghausen (6.2 standard deviations), the resulting difference in STW amounts to 13.7 percentage points. For a better classification of the effect size, Figure A 4 in the appendix shows the time fixed-effects τ_t from the full model (equation (9)), i.e. the average regional change in STW. The time effect in May 2020 points to an increase in STW of approximately three standard deviations compared to a half standard deviation caused by the GVC integration with China. Moreover, we observe a significant increase in average regional STW during the second lockdown, while there is no evidence for corresponding changes in Figure 12. In fact, we see that the effect of GVC integration with China declines until the end of 2020 and remains at a relatively low level thereafter. From February 2021 until the end of our observation time, we still observe positive estimates but they are small in magnitude and not significant.

Figure 13: Event study estimates of regional GVC integration with the world without China and short-time work



Note: All variables are standardized, EBCT weights are calculated for GVC integration with the world excluding China. Top 5 percent regions are trimmed in the model. The standard errors for the confidence intervals are clustered on the labor market region level.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations. © IAB

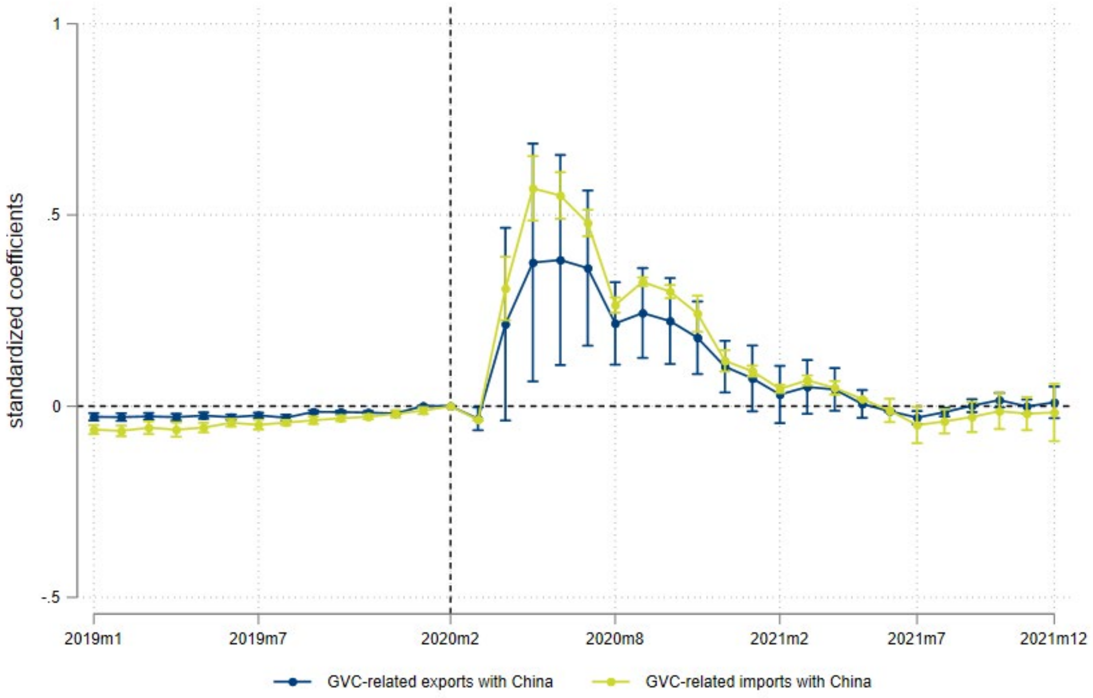
As a next step, we change the treatment variable and consider regional GVC integration with the whole world excluding China (see Figure 13). We do this to check whether GVC integration with China merely acts as a proxy for GVC integration in general. The results for the pre-crisis period indicate that the strong parallel trends assumption (still) holds. However, in contrast to GVC integration with China, the estimates for GVC integration with the rest of the world do not significantly differ from zero in Spring 2020. The estimated effects are much smaller compared to the results for GVC integration with China and not precisely estimated. Moreover, from November 2020 until May 2021 we observe significant negative point estimates. For this period, regions with a higher worldwide GVC integration excluding China face slightly lower STW than local labor markets that show a below average integration. However, the point estimates are small in magnitude. Altogether it seems that worldwide GVC integration without China has almost no effect of regional STW, while GVC integration with China has increased regional STW during the early period of the COVID-19 crisis.

As a robustness check we estimate the same model but exclude the top ten percent of regions dominated by the automotive industry[12] because it is one of the most important industries in Germany and highly integrated in GVC. Moreover, Antràs (2020) notes that the first lockdowns in

[12] We eliminate from the estimation sample those regions with a Florence coefficient in industry 20 (motor vehicles, trailers and semi-trailers) that is above the 90th percentile.

China gave rise to a significant decline in trade flows in early 2020 with an above-average effect on international trade in vehicles. The results for the regional GVC integration with China excluding the automotive industry are illustrated in Figure A 5 in the appendix. One can see that the estimates of the standardized coefficients are slightly larger for this sample. Thus, the effect of GVC integration with China is not primarily caused by regions such as Wolfsburg, Ingolstadt or Dingolfing where local labor markets heavily rely on this industry. In contrast, it seems that the impact of GVC integration was below average in these regions and dissipates more quickly than in other highly integrated regions.

Figure 14: Event study estimates of regional GVC integration with China decomposed by imports and exports



Note: The results originate from two separately estimated models. All variables are standardized, EBCT weights are calculated separately for GVC integration with China via imports or exports. Top 5 percent regions are trimmed in the models. The standard errors for the confidence intervals are clustered on the labor market region level.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations. © IAB

As shown in chapter 4.2 we are able to decompose the overall trade integration with China into linkages via imports and exports of intermediate goods. In Figure 14, the green line indicates the STW effects for imports and the blue line represents the STW effects via exports. Regarding the parallel trends assumption, we observe some differences in the patterns for imports and exports in the first months of 2019. However, the differences are small and the confidence intervals start to overlap as of summer 2019. The decomposed effects show that the point estimates for the import component is somewhat higher in the first lockdown period compared to the export component. The maximum difference in May 2020 is 0.16 standard deviations. Yet, the confidence intervals overlap and therefore the differences are not significant.

Finally, we also look at the changes in employment in regions that are more involved in GVCs. Figure A 6 in the appendix shows an event study plot for employment as an outcome. Based on the pre-crisis development in Figure A 6, it appears that the assumption of parallel trends is not met. The results suggest that from June 2019 to the end of 2019, there was already an unfavorable development of employment in regions with relatively high GVC integration with China before the pandemic shock. In contrast, there are no significant differences between highly integrated regions and other local labor markets during the early phase of the crisis in March/April 2020. After the initial shock phase, the adverse trend continues and the negative coefficients significantly differ from zero from September 2020 onwards. However, due to the unfulfilled assumption of parallel trends, it is not possible to draw reliable conclusions on how the COVID-19 pandemic has affected employment in regions with high GVC integration with China.

8 Conclusions

We apply a DiD approach to investigate how the disruptions of GVC caused by the COVID-19 pandemic affected local labor markets in Germany using monthly administrative data on regional short-time work and information about GVC integration. In contrast to most other studies that tend to focus on the early phase of the pandemic, this paper takes a medium-term perspective and examines whether the integration into GVC has influenced the size of the initial shock *and* the subsequent recovery of regions in Germany until December 2021. We pay special attention to the bilateral relationship between China and Germany because the two countries are important agents in GVC and China was hit early and severely by the pandemic giving rise to major disruptions of GVC.

Our results indicate that, in fact, short-time work increased more strongly in 2020 in local labor markets which are characterized by an above average GVC integration with China. We detect significant effects of both an integration through exports and imports of intermediate goods, with the impact of GVC-related imports from China being somewhat stronger. In contrast, there are no important effects on STW if regions are more integrated with the rest of the world. Hence, it seems to be the GVC integration with China that matters for the labor market effects of GVC disruptions in Germany. However, the local labor markets that are hit above average due to their dependence on trade in intermediate goods recover quickly and do not differ that much from other regions in the second year of the pandemic. Temporary effects of GVC integration that decline quickly after the first shock are in line with evidence provided by Meier and Pinto (2020) for the US.

There are different potential reasons behind the swift recovery of those regions that show a high GVC integration with China. First of all, China does not differ that much from other important trade partners of Germany in 2021 when it comes to trade disruptions as indicated by Figure 1. Moreover, there is some first evidence on firms adjusting their production process and the procurement of inputs in response to value chain disruptions (e.g. Kleifgen et al., 2022). When intensity and/or complexity of interlinkages are regarded as a vulnerability, firms might be inclined to shorten their supply chains, a phenomenon which is discussed in the literature as

„reshoring“ (Kolev & Obst, 2020; Pla-Barber et al., 2021; Strange, 2020). Some authors argue, however, that decoupling GVC in an attempt to stabilize production might incur significant welfare losses (Eppinger et al., 2021; Hayakawa & Mukunoki, 2021; Miroudot, 2020).

Pinna and Lodi (2021) note that the COVID-19 shock, being temporary in nature, can potentially alter firms‘ decision making and governments’ views on trade and globalization permanently. It is likely that future supply chains will put more emphasis on diversifying suppliers, localizing parts of the value chain, and improving inventory management (Antràs, 2020; Hayakawa & Mukunoki, 2021). In an attempt to stabilize value chains and increase resilience, firms may also resort to so-called “dynamic balancing”, i.e. establishing interchangeable, complementary value chains that do not exclusively/primarily rely on one specific trade partner (Gao & Ren, 2020). Findings by Kleifgen et al. (2022) suggest, however, that observed adjustments such as a regionalization of value chains and, more generally, a restructuring supplier networks might be only temporary. Whether the COVID-19 shock will actually induce long-term changes of GVC is thus uncertain.

References

Alipour, J.-V.; Falck, O.; Krause, S.; Krolage, C.; Wichert, S. (2022). The Future of Work and Consumption in Cities after the Pandemic: Evidence from Germany (CESifo Working Paper, No. 10000). Retrieved from http://hdl.handle.net/10419/267233

Alipour, J.-V.; Falck, O.; Schüller, S. (2023). Germany's capacities to work from home. European Economic Review, 151(104354). doi:https://doi.org/10.1016/j.euroecorev.2022.104354

Antràs, P. (2020). De-Globalisation? Global value chains in the post-COVID-19 age (NBER Working Paper No. w28115). Retrieved from http://www.nber.org/papers/w28115

Ascani, A.; Faggian, A.; Montresor, S. (2021). The geography of COVID-19 and the structure of local economies: The case of Italy. In: Journal of Regional Science, 61(2), p. 407441. doi:https://doi.org/10.1111/jors.12510

Autor, D. H.; Dorn, D.; Hanson, G. H. (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States. In: American Economic Review, 103(6), p. 21212168. doi:https://doi.org/10.1257/aer.103.6.2121

Bai, X.; Xu, M.; Han, T.; Yang, D. (2022). Quantifying the impact of pandemic lockdown policies on global port calls. Transportation Research Part A: Policy and Practice, 164, p. 224241. doi:https://doi.org/10.1016/j.tra.2022.08.002

Bartik, A. W.; Bertrand, M.; Cullen, Z. B.; Glaeser, E. L.; Luca, M.; Stanton, C. T. (2020). How Are Small Businesses Adjusting to COVID-19? Early Evidence from a Survey. National Bureau of Economic Research Working Paper Series, No. 26989. doi:https://doi.org/10.3386/w26989

Bauer, A.; Weber, E. (2021). COVID-19: how much unemployment was caused by the shutdown in Germany? Applied Economics Letters, 28(12), p. 1053-1058. doi:https://doi.org/10.1080/13504851.2020.1789544

Bauernschuster, S.; Hener, T.; Rainer, H. (2016). Children of a (policy) revolution: The introduction of universal child care and its effect on fertility. In: Journal of the European Economic Association, 14(4), p. 975-1005. doi:https://doi.org/10.1111/jeea.12158

Belotti, F.; Borin, A.; Mancini, M. (2020). icio: Economic Analysis with Inter-Country Input-Output Tables in Stata. Retrieved from https://EconPapers.repec.org/RePEc:wbk:wbrwps:9156

Ben Yahmed, S.; Berlingieri, F.; Brüll, E. (2022). Adjustments of local labour markets to the COVID-19 crisis: The role of digitalisation and working-from-home (ZEW Discussion Paper No. 22-031). doi:http://dx.doi.org/10.2139/ssrn.4217981

Birinci, S.; Amburgey, A. (2022). Hires and Separations During the COVID-19 Crisis by Firm Size. Economic Synopses, 8. doi:https://doi.org/10.20955/es.2022.8

Bonadio, B.; Huo, Z.; Levchenko, A. A.; Pandalai-Nayar, N. (2021). Global supply chains in the pandemic. In: Journal of International Economics, 133, 103534. doi:https://doi.org/10.1016/j.jinteco.2021.103534

Borin, A.; Mancini, M. (2023). Measuring what matters in value-added trade. Economic Systems Research, p. 1–28. doi:https://doi.org/10.1080/09535314.2022.2153221

Caliendo, M.; Kopeinig, S. (2008). Some Practical Guidance for the Implementation of Prospensity Score Matching. In: Journal of Economic Surveys, 22(1), p. 31–72. doi:https://doi.org/10.1111/j.1467-6419.2007.00527.x

Callaway, B.; Goodman-Bacon, A.; Sant'Anna, P. H. C. (2021). Difference-in-Differences with a Continuous Treatment. arXiv e-prints. doi:https://doi.org/10.48550/arXiv.2107.02637 doi:arXiv:2107.02637v2

Card, D. (1992). Using Regional Variation in Wages to Measure the Effects of the Federal Minimum Wage. In: Industrial and Labor Relations Review, 46(1), p. 22–37. doi:https://doi.org/10.2307/2524736

Carvalho, B. P.; Peralta, S.; Pereira dos Santos, J. (2022). Regional and sectorial impacts of the Covid-19 crisis: Evidence from electronic payments. In: Journal of Regional Science, 62(3), p. 757–798. doi:https://doi.org/10.1111/jors.12575

Celi, G.; Guarascio, D.; Reljic, J.; Simonazzi, A.; Zezza, F. (2022). The Asymmetric Impact of War: Resilience, Vulnerability and Implications for EU Policy. In: Intereconomics, 57(3), p. 141–147. doi:https://doi.org/10.1007/s10272-022-1049-2

Chetty, R.; Friedman, J. N.; Hendren, N.; Stepner, M. (2020). The economic impacts of COVID-19: Evidence from a new public database built using private sector data (NBER Working Paper No. w27431). doi:https://doi.org/10.3386/w27431

Cochrane, W.; Poot, J.; Roskruge, M. (2022). Urban Resilience and Social Security Uptake: New Zealand Evidence from the Global Financial Crisis and the COVID-19 Pandemic (IZA Discussion Paper No. 15510). doi:https://dx.doi.org/10.2139/ssrn.4198748

Couture, V.; Dingel, J. I.; Green, A.; Handbury, J.; Williams, K. R. (2022). Measuring movement and social contact with smartphone data: a real-time application to COVID-19. Journal of Urban Economics, 127. doi:https://doi.org/10.1016/j.jue.2021.103328

Cunningham, S. (2021). Causal Inference: The Mixtape. New Haven & London: Yale University Press.

Dauth, W.; Findeisen, S.; Suedekum, J. (2014). The rise of the East and the Far East: German labor markets and trade integration. In: Journal of the European Economic Association, 12(6), p. 1643–1675. doi:https://doi.org/10.1111/jeea.12092

Desmet, K.; Wacziarg, R. (2022). JUE Insight: Understanding spatial variation in COVID-19 across the United States. Journal of Urban Economics, 127, 103332. doi:https://doi.org/10.1016/j.jue.2021.103332

Dolado, J. J.; Fernández, F. F.; Jimeno, J. F. (2021). Past, present and future of the Spanish labour market: when the pandemic meets the megatrends. In: Applied economic analysis, 29(85), p. 21–41. doi:https://doi.org/10.1108/AEA-11-2020-0154

Eppinger, P.; Felbermayr, G. J.; Krebs, O.; Kukharskyy, B. (2021). Decoupling global value chains (CESifo Working Paper No. 9079). doi:https://dx.doi.org/10.2139/ssrn.3848341

Espitia, A.; Mattoo, A.; Rocha, N.; Ruta, M.; Winkler, D. (2022). Pandemic trade: COVID-19, remote work and global value chains. In:The World Economy, 45(2), p. 561–589. doi:https://doi.org/10.1111/twec.13117

Frenken, K.; Van Oort, F.; Verburg, T. (2007). Related Variety, Unrelated Variety and Regional Economic Growth. Regional Studies, 41(5), 685-697. doi:10.1080/00343400601120296

Gao, H.; Ren, M. (2020). Overreliance on China and dynamic balancing in the shift of global value chains in response to global pandemic COVID-19: an Australian and New Zealand perspective. In: Asian Business & Management, 19(3), p. 306–310. doi:https://doi.org/10.1057/s41291-020-00121-3

Hainmueller, J. (2012). Entropy Balancing for Causal Effects: A Multivariate Reweighting Method to Produce Balanced Samples in Observational Studies. In: Political Analysis, 20(1), 25–46. doi:https://doi.org/10.1093/pan/mpr025

Hamann, S.; Niebuhr, A.; Roth, D.; Sieglen, G. (2023). How does the COVID-19 pandemic affect regional labour markets and why do large cities suffer most? Journal of Regional Science (online first). doi: https://doi.org/10.1111/jors.12662

Hart, P. E. (1971). Entropy and Other Measures of Concentration. Journal of the Royal Statistical Society. In: Series A (General), 134(1), p. 73–85. doi:https://doi.org/10.2307/2343975

Hayakawa, K.; Mukunoki, H. (2021). Impacts of COVID-19 on global value chains. In: The Developing Economies, 59(2), p. 154–177. doi:https://doi.org/10.1111/deve.12275

Houston, D. (2020). Local resistance to rising unemployment in the context of the Covid-19 mitigation policies across Great Britain. In: Regional Science Policy & Practice, 12(6), p. 1189–1209. doi:https://doi.org/10.1111/rsp3.12364

Hummels, D.; Ishii, J.; Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade. In: Journal of International Economics, 54(1), p. 75–96. doi:https://doi.org/10.1016/S0022-1996(00)00093-3

Ibrahim, S. E.; Centeno, M. A.; Patterson, T. S.; Callahan, P. W. (2021). Resilience in Global Value Chains: A Systemic Risk Approach. Global Perspectives, 2(1), 27658. doi:https://doi.org/10.1525/gp.2021.27658

Imbens, G. W. (2004). Nonparametric Estimation of Average Treatment Effects Under Exogeneity: A Review. In: The Review of Economics and Statistics, 86(1), p. 4–29. doi:https://doi.org/10.1162/003465304323023651

Inoue, H.; Murase, Y.; Todo, Y. (2021). Do economic effects of the anti-COVID-19 lockdowns in different regions interact through supply chains? In: PLoS ONE, 16(7), p. 1–19. doi:https://doi.org/10.1371/journal.pone.0255031

Juranek, S.; Paetzold, J.; Winner, H.; Zoutman, F. (2021). Labor market effects of COVID-19 in Sweden and its neighbors: Evidence from administrative data. In: Kyklos, 74(4), p. 512–526. doi:https://doi.org/10.1111/kykl.12282

Kejžar, K. Z.; Velić, A.; Damijan, J. P. (2022). COVID-19, trade collapse and GVC linkages: European experience. In: The World Economy, p.1–32. doi:https://doi.org/10.1111/twec.13314

Kim, A.; Lim, J.; Colletta, A. (2022). How regional economic structure matters in the era of COVID-19: resilience capacity of U.S. states. The Annals of Regional Science. doi:https://doi.org/10.1007/s00168-022-01134-w

Kleifgen, E.; Roth, D.; Stepanok, I. (2022). The Covid-19 pandemic and international supply chains (IAB-Discussion Paper No. 5/2022). doi:https://doi.org/10.48720/IAB.DP.2205

Kolev, G. V.; Obst, T. (2020). Die Abhängigkeit der deutschen Wirtschaft von internationalen Lieferketten (IW-Report, No. 16/2020). Retrieved from http://hdl.handle.net/10419/216214

Kosfeld, R.; Mitze, T.; Rode, J.; Wälde, K. (2021). The Covid-19 containment effects of public health measures: A spatial difference-in-differences approach. In: Journal of Regional Science, 61(4), p. 799–825. doi:https://doi.org/10.1111/jors.12536

Lemieux, T.; Milligan, K.; Schirle, T.; Skuterud, M. (2020). Initial impacts of the COVID-19 pandemic on the Canadian labour market. In: Canadian Public Policy, 46(S1), p. S55–S65. doi:https://doi.org/doi:10.3138/cpp.2020-049

Marcén, M.; Morales, M. (2021). The intensity of COVID-19 nonpharmaceutical interventions and labor market outcomes in the public sector. In: Journal of Regional Science, 61(4), p. 775–798. doi:https://doi.org/doi:10.1111/jors.12535

Meier, M.; Pinto, E. (2020). Covid-19 supply chain disruptions. In: Covid Economics, 48, p. 139–170.

Miroudot, S. (2020). Resilience versus robustness in global value chains: Some policy implications. In R. E. Baldwin & S. J. Evenett (Eds.), COVID-19 and Trade Policy: Why turning inward won’t work (pp. 117-130). London: CEPR Press.

Naujoks, T.; Kreyenfeld, M.; Dummert, S. (2022). The division of child care during the coronavirus crisis in Germany: How did short-time work affect fathers' engagement? Journal of Family Research, 34(1). doi:https://doi.org/10.20377/jfr-717

OECD. (2021). OECD Inter-Country Input-Output Database. Retrieved from: http://oe.cd/icio

Partridge, M.; Chung, S.-h.; Wertz, S. S. (2022). Lessons from the 2020 Covid recession for understanding regional resilience. In: Journal of Regional Science, 62(4), p. 1006–1031. doi:https://doi.org/10.1111/jors.12584

Pinna, A. M.; Lodi, L. (2021). Trade and global value chains at the time of COVID-19. In: The International Spectator, 56(1), p. 92–110. doi:https://doi.org/10.1080/03932729.2020.1846278

Pla-Barber, J.; Villar, C.; Narula, R. (2021). Governance of global value chains after the Covid-19 pandemic: A new wave of regionalization? In: BRQ Business Research Quarterly, 24(3), p. 204–213. doi:https://doi.org/doi:10.1177/23409444211020761

Qin, M.; Liu, X.; Zhou, X. (2020). COVID-19 shock and global value chains: Is there a substitute for China? In: Emerging Markets Finance and Trade, 56(15), p. 3588–3598. doi:https://doi.org/doi:10.1080/1540496X.2020.1855137

Reissl, S.; Caiani, A.; Lamperti, F.; Guerini, M.; Vanni, F.; Fagiolo, G.; Ferraresi, T.; Ghezzi, L.; Napoletano, M.; Roventini, A. (2022). Assessing the economic impact of lockdowns in italy: A computational input–output approach. In: Industrial Corporate Change, 31(2), p. 358–409. doi:https://doi.org/10.1093/icc/dtac003

Sanguinet, E. R.; Alvim, A. M.; Atienza, M.; Fochezatto, A. (2021). The subnational supply chain and the COVID-19 pandemic: Short-term impacts on the Brazilian regional economy. In: Regional Science Policy Practice, 13, p. 158–186. doi:https://doi.org/doi:10.1111/rsp3.12442

Schmidt, T. D.; Mitze, T. (2023). Epidemic–economic complexity of COVID-19 policies across skill groups and geographies. In: Regional Studies, p. 1–14. doi:https://doi.org/doi:10.1080/00343404.2023.2183945

Stepanok, Ignat (2020): Germany's trade with China at the beginning of the global COVID-19 pandemic (Series "COVID-19 Crisis: Consequences for the Labour Market"). In: IAB-Forum H. 01.10.2020 Nürnberg. Retrieved from https://www.iab-forum.de/en/germanys-trade-with-china-at-the-beginning-of-the-global-covid-19-pandemic/

Strange, R. (2020). The 2020 Covid-19 pandemic and global value chains. In: Journal of Industrial Business Economics, 47(3), p. 455–465. doi:https://doi.org/10.1007/s40812-020-00162-x

Tübbicke, S. (2021). Entropy Balancing for Continuous Treatments. In: Journal of Econometric Methods, 11(1), p. 71–89. doi:https://doi.org/doi:doi:10.1515/jem-2021-0002

Wang, Z.; Wei, S.-J.; Yu, X.; Zhu, K. (2022). Global value chains over business cycles. Journal of International Money and Finance, 126, 102643. doi:https://doi.org/10.1016/j.jimonfin.2022.102643

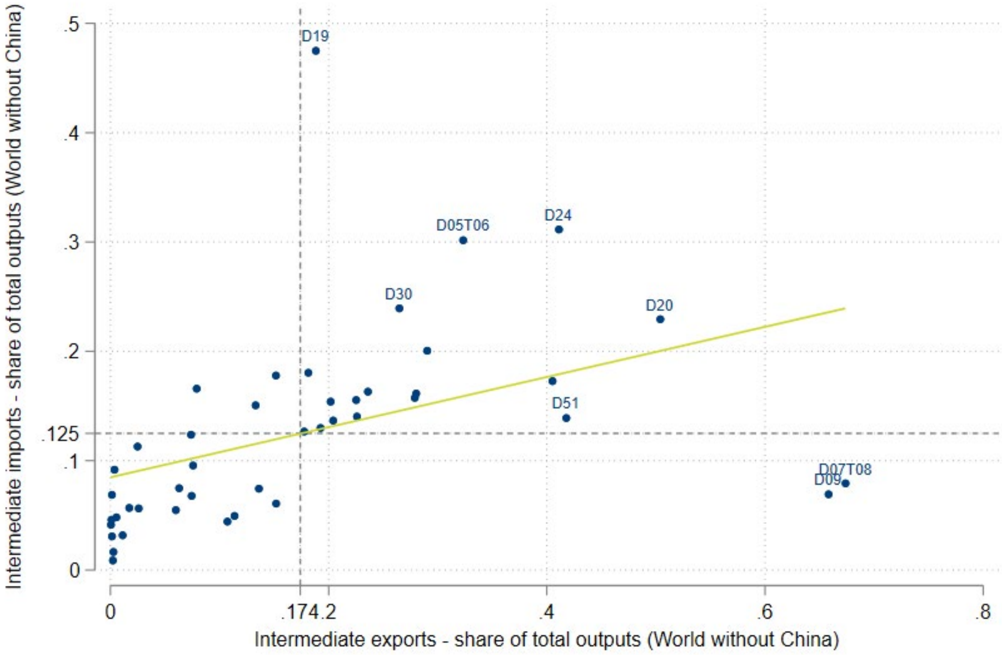
World Bank. (2020). World development report 2020: Trading for development in the age of global value chains. The World Bank. Retrieved from https://www.worldbank.org/en/publication/wdr2020

Xu, Z.; Elomri, A.; Kerbache, L.; El Omri, A. (2020). Impacts of COVID-19 on global supply chains: Facts and perspectives. In: IEEE Engineering Management Review, 48(3), p. 153–166. doi:https://doi.org/doi:10.1109/EMR.2020.3018420

Appendix

Figure A 1: Bilateral GVC-related imports and exports with the world except China

GVC-related imports and exports as share of total output by sector, 2018



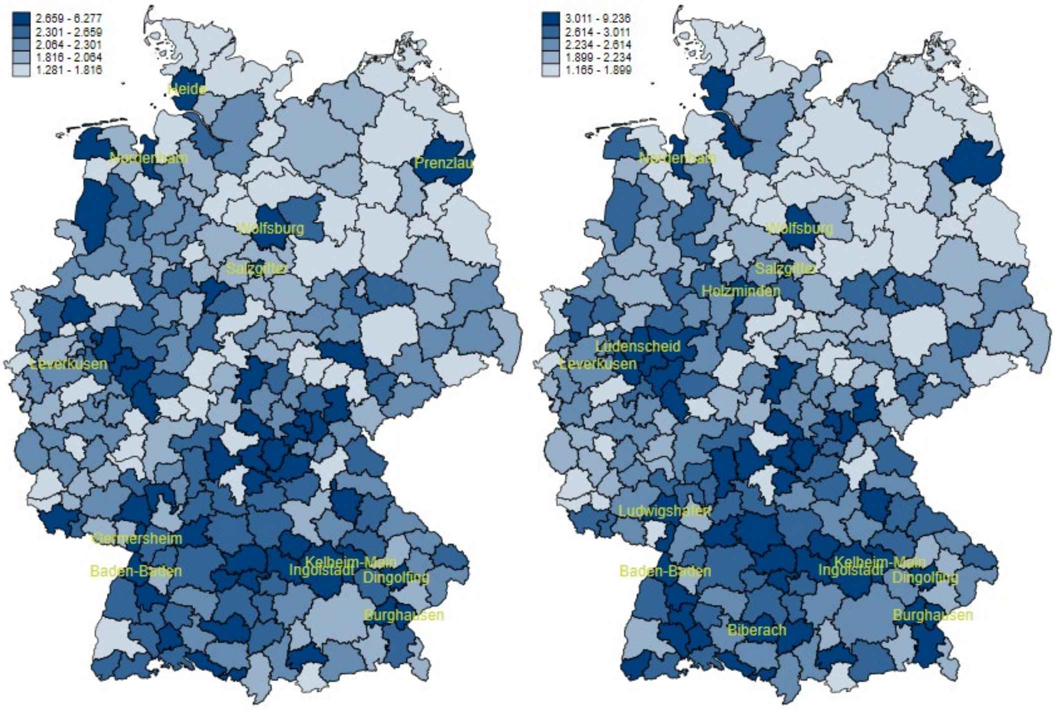
Notes: The figure shows the correlation of sector-specific GVC integration via imports and exports with the world except China ($\rho = 0.44$). The horizontal and vertical dashed lines show the average GVC-related integration via imports and exports.

Sectors: D05T06: Mining and quarrying, energy producing products; D07T08: Mining and quarrying, non-energy producing products; D09: Mining support service activities; D19: Coke and refined petroleum products; D20: Chemical and chemical products; D24: Basic metals; D30: Other transport equipment; D51: Air transport.

Source: OECD ICIO data (OECD, 2021); own calculations. © IAB

Figure A 2: Regionalized GVC integration via imports and exports with the world except China

GVC integration in Mio. US $ per 100 employees

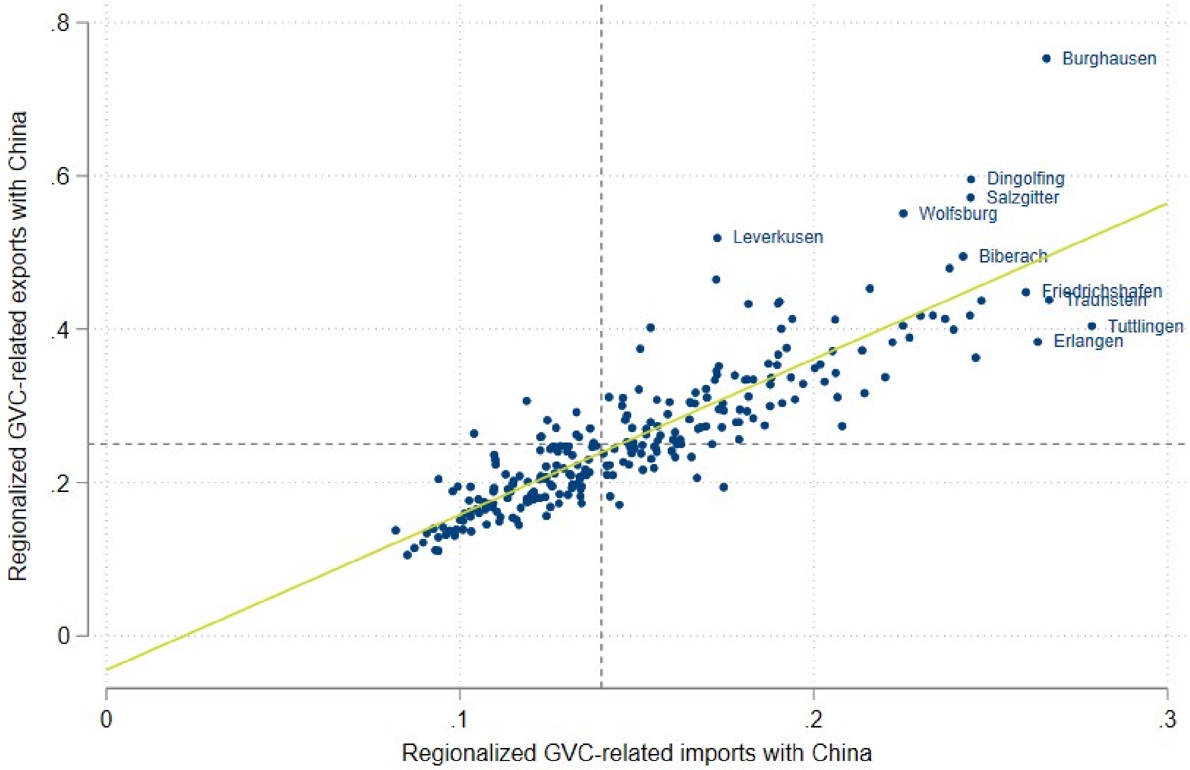


Notes: Regionalized GVC integration with the world except China via imports (left) and exports (right) in Mio. US $ per 100 employees (in 2019 measured at the place of residence). Most highly integrated regions are labeled in green.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations.

Figure A 3: Correlation of regionalized GVC integration with China via imports and exports

GVC integration in Mio. US $ per 100 employees



Notes: Regionalized GVC integration with China via imports on the x-axis, corresponding GVC integration via exports on the y-axis. Both indices are given in Mio. US $ per 100 employees (in 2019 measured at the place of work). The dashed lines indicate the average GVC integration with China via imports and exports. The green line represents the correlation between the indicators ($\rho = 0.87$)

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations.

Table A 1: Summary statistics of time-varying and time-constant variables

	N	min	mean	p50	max	sd
Time-varying variables						
STW (number of short-time workers / emp. stock in June 2019)	9,252	0	0.05	0.026	0.389	0.055
Policy response stringency index	9,252	0	25.94	31.203	66.675	22.933
COVID-19 infections	9,252	0	16.06	1.29	1797.53	48.847
Mobility index	9,252	-0.574	-0.01	0	1.327	0.136
Time-constant variables						
Share low-skilled workers	257	0.048	0.12	0.12	0.18	0.032
Share medium-skilled workers	257	0.54	0.74	0.75	0.84	0.059
Share high-skilled workers	257	0.069	0.14	0.13	0.34	0.048
Population density	257	35.6	297.0	165.3	4117.8	433.2
Employment dynamics	257	0.032	0.049	0.048	0.12	0.0078
Working-from-home potential	257	0.50	0.54	0.53	0.61	0.020
Share firm size 1: 1-9 employees	257	0.082	0.17	0.16	0.28	0.030
Share firm size 2: 10-49 employees	257	0.14	0.26	0.26	0.36	0.038
Share firm size 3: 50-249 employees	257	0.14	0.29	0.29	0.37	0.034
Share firm size 4: >= 250 employees	257	0.096	0.28	0.28	0.64	0.083
Related variety	257	0.84	1.46	1.48	1.78	0.14
Unrelated variety	257	2.76	3.60	3.61	3.79	0.12
Regional economic specialization	257	0.083	0.21	0.20	0.48	0.057
LQ: I Accommodation and food service activities	257	0.36	0.99	0.85	4.55	0.50
LQ: R Arts, Entertainment and recreation	257	0.25	0.84	0.77	3.02	0.41

Note: All time-varying variables are observed on the labor market level ($R = 257$) from January 2019 until December 2021 ($T = 36$) and $N = RxT = 9{,}252$. All time-constant variables (used for EBCT) are averages for the pre-crisis year 2019. For the weighting procedure we use the share of low-skilled workers and the first firm size category as reference categories.

Source: Employment statistic provided by the Federal Employment Agency and Alipour et al. (2023). © IAB

Definition of different variables

Regional employment dynamics

To capture former employment dynamics in the regions, we compare the number of transitions from employment into unemployment and vice-versa at a regional level. We compute the average employment dynamic for the years y 2017 until 2019 for region r and month t:

$$ED_{rt} = \frac{1}{3}\sum_{y=2017}^{2019}\frac{entry_{rty} - exit_{rty}}{stock_{rty}} \quad (10)$$

Where $entry_{rty}$ are the transitions from unemployment to employment and $exit_{rty}$ are the transitions from employment to unemployment in region r, month t and year y. Further, $stock_{rty}$ denotes the employment stock in region r, month t and year y.

Related and unrelated economic variety

The industry composition of our labor market regions could affect the regions' exposure to specific shocks. Regional variety can be considered as a moderator to reduce or increase the exposure of local labor markets to industry-specific shocks. Frenken et al. (2007) refer to portfolio theory to describe that regions with a high share of related industries might be particularly affected by sector-specific shocks. To measure the relatedness, they derive an industry variety index which is based on the entropy concept of information theory (Hart, 1971).

Starting point for the measures of relatedness is p_{ri}, the employment share of sector i in region r at the 5-digit level with $\sum_i p_{ri} = 1$.[13] All 5-digit sectors can be mutually exclusively aggregated to one 2-digit division S_g with $g = 1, \dots, G$. The regional 2-digit share p_{rg} can be derived by summing up the 5-digit sub-classes within one 2-digit division $p_{rg} = \sum_{i \in S_g} p_{ri}$. The unrelated variety for a region UV_r is then given by:

$$UV_r = \sum_{g=1}^{G} p_{rg} \log\left(\frac{1}{p_{rg}}\right) \tag{11}$$

The related variety for a region RV_r can be interpreted as the weighed sum of the entropy within each 2-digit division and is given by:

$$RV_r = \sum_{g=1}^{G} p_{rg} \sum_{i \in S_g} \frac{p_i}{p_{rg}} \log\left(\frac{1}{p_i/p_{rg}}\right) \tag{12}$$

Regional economic specialization

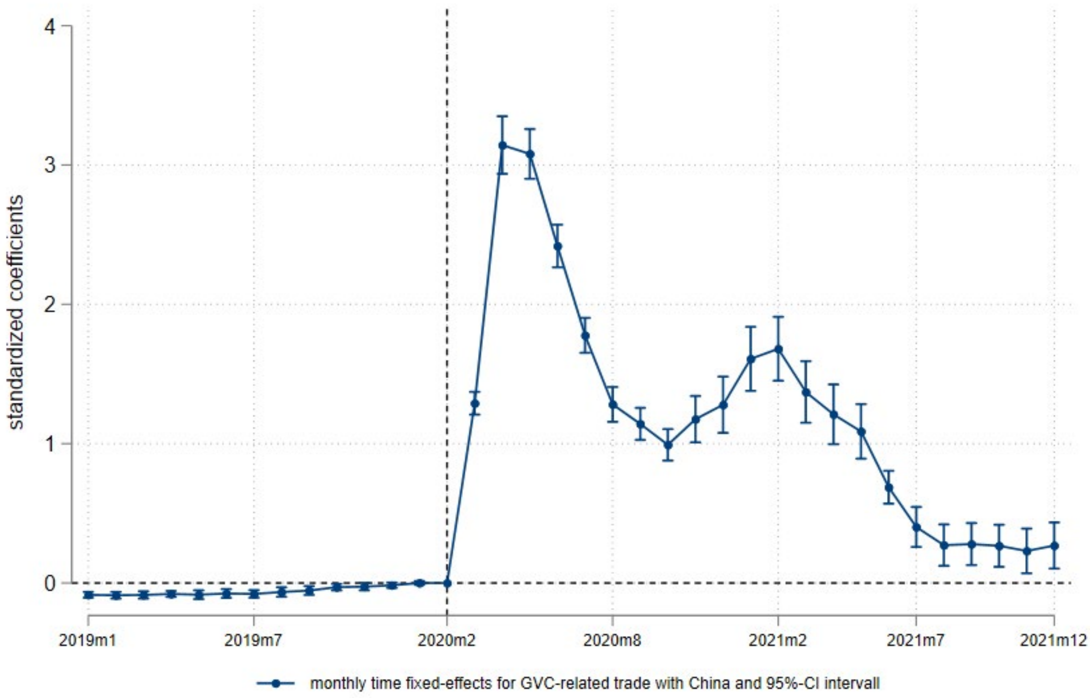
We use the Florence index to measure regional economic specialization. The Index compares the sectoral structure of a region and that of Germany as a whole. The Florence measure F_r indicates the proportion of employees in a region r that would have to change from one industry to another in order for the region to have the same sectoral structure than the reference area. F_r is defined as follows:

$$F_r = \frac{1}{2} \sum_i |e_{ri} - e_{.i}| \tag{13}$$

where e_{ri} stands for the share of sector i in region r and $e_{.i}$. is the share of sector i in the reference area, in our case the sector share in Germany. The Florence measure has a maximum value of 1 and a minimum value of 0.

[13] To avoid potential endogeneity, we use pre-crisis employment information from June 2019.

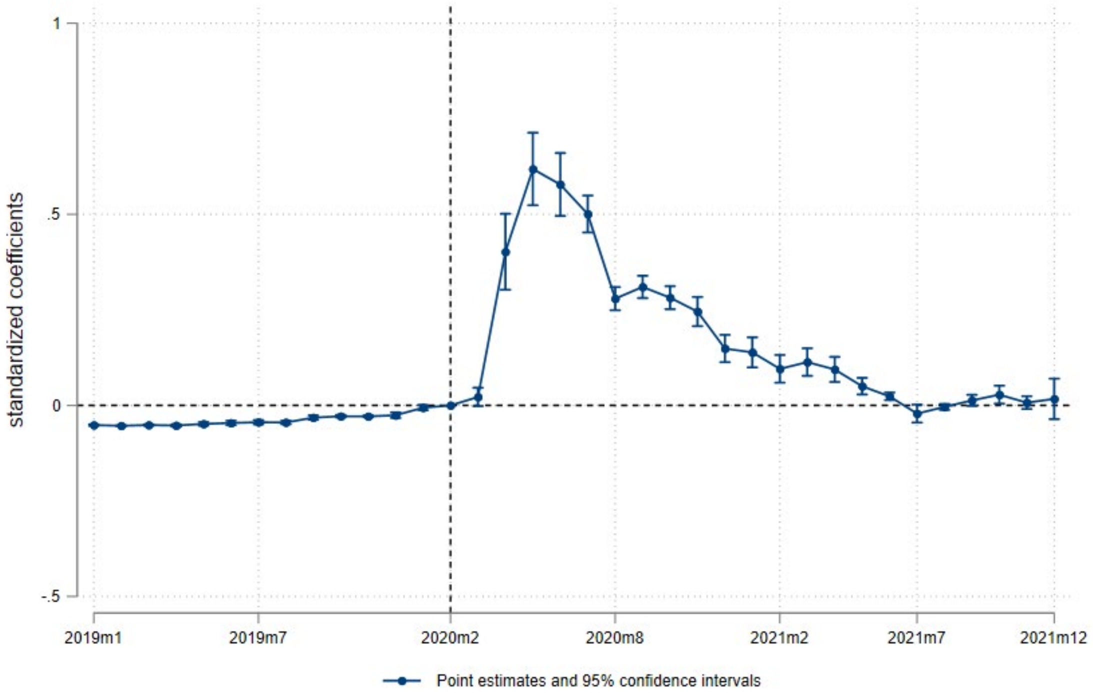
Figure A 4: Event study plot of time fixed effects



Note: Coefficients indicate the effects of τ_t from equation (9). All variables are standardized, EBCT weights are calculated for GVC integration with China. Top 5 percent regions are trimmed in the model. The standard errors for the confidence intervals are clustered on the labor market region level.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own representation. © IAB

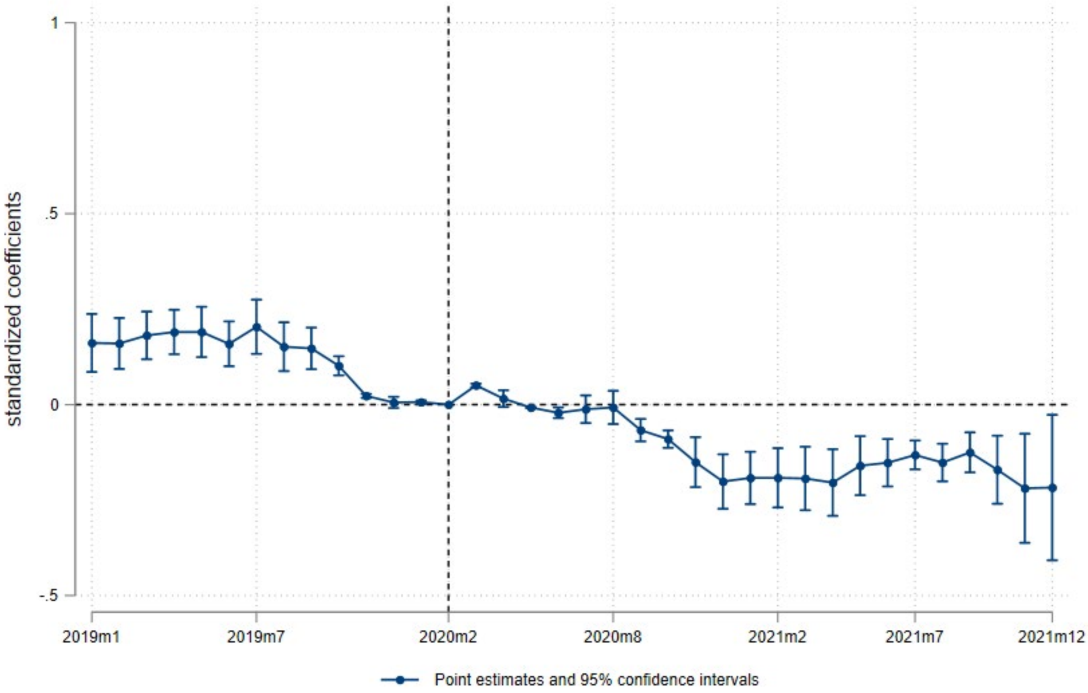
Figure A 5: Event study estimates of GVC integration with China and regional short-time work (without automotive industry)



Note: All variables are standardized, EBCT weights are calculated for GVC integration with China without the automotive industry. Top 5 percent regions are trimmed in the model. The standard errors for the confidence intervals are clustered on the labor market region level.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own representation. © IAB

Figure A 6: Event study estimates of GVC integration with China and regional employment



Note: The monthly employment level is presented in relation to the employment level in June 2019. All variables are standardized, EBCT weights are calculated for GVC integration with China. Top 5 percent regions are trimmed in the model. The standard errors for the confidence intervals are clustered on the labor market region level.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations.

Table A 2: GVC integration of sectors in Germany

Nr.	ISCO code	Industry	GVC integration of sectors China	World without China	World
1	01-02	Agriculture, hunting, forestry	0.008	0.198	0.206
2	3	Fishing and aquaculture	0.010	0.323	0.332
3	05-06	Mining and quarrying, energy producing products	0.008	0.625	0.632
4	07-08	Mining and quarrying, non-energy producing products	0.008	0.753	0.761
5	9	Mining support service activities	0.021	0.728	0.748
6	10-12	Food products, beverages and tobacco	0.009	0.245	0.254
7	13-15	Textiles, textile products, leather and footwear	0.040	0.330	0.369
8	16	Wood and products of wood and cork	0.014	0.341	0.355
9	17-18	Paper products and printing	0.014	0.399	0.413
10	19	Coke and refined petroleum products	0.015	0.663	0.678
11	20	Chemical and chemical products	0.053	0.733	0.787
12	21	Pharmaceuticals, medicinal chemical and botanical products	0.043	0.366	0.409
13	22	Rubber and plastics products	0.031	0.491	0.522
14	23	Other non-metallic mineral products	0.026	0.356	0.382
15	24	Basic metals	0.036	0.723	0.758
16	25	Fabricated metal products	0.040	0.304	0.345
17	26	Computer, electronic and optical equipment	0.099	0.436	0.536
18	27	Electrical equipment	0.069	0.442	0.511
19	28	Machinery and equipment, nec	0.047	0.381	0.428
20	29	Motor vehicles, trailers and semi-trailers	0.029	0.362	0.391
21	30	Other transport equipment	0.042	0.504	0.546
22	31-33	Manufacturing nec; repair and installation of machinery and equipment	0.029	0.284	0.313
23	35	Electricity, gas, steam and air conditioning supply	0.006	0.138	0.143
24	36-39	Water supply; sewerage, waste management and remediation activities	0.003	0.054	0.057
25	41-43	Construction	0.009	0.095	0.105
26	45-47	Wholesale and retail trade; repair of motor vehicles	0.014	0.163	0.177
27	49	Land transport and transport via pipelines	0.022	0.213	0.235
28	50	Water transport	0.101	0.578	0.679
29	51	Air transport	0.072	0.557	0.629
30	52	Warehousing and support activities for transportation	0.007	0.138	0.145
31	53	Postal and courier activities	0.003	0.082	0.085
32	55-56	Accommodation and food service activities	0.003	0.070	0.073
33	58-60	Publishing, audiovisual and broadcasting activities	0.009	0.210	0.219
34	61	Telecommunications	0.007	0.074	0.081
35	62-63	IT and other information services	0.012	0.171	0.184
36	64-66	Financial and insurance activities	0.002	0.142	0.144
37	68	Real estate activities	0.001	0.011	0.012
38	69-75	Professional, scientific and technical activities	0.008	0.152	0.160
39	77-82	Administrative and support services	0.006	0.115	0.120
40	84	Public administration and defense; compulsory social security	0.003	0.042	0.045
41	85	Education	0.001	0.019	0.020
42	86-88	Human health and social work activities	0.004	0.047	0.051
43	90-93	Arts, entertainment and recreation	0.003	0.043	0.046
44	94-96	Other service activities	0.003	0.032	0.035
45	97-98	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	-	-	-

Note: The first, second and third column depict the 45 industries used within this analysis. The sector-specific GVC integration is given for Germany as exporter country and China (fourth column), the world without China (fifth column), and the whole world (sixth column) as importer. All values are shares in total output of German sectors. For a explanation of the index, see section 4.1.

Source: OECD ICIO data (OECD, 2021); own calculations. © IAB

Table A 3: Regional integration into GVC (GVC integration in Mio. US $ per 100 employees)

Nr.	Region	Exports China	Exports World without China	Imports China	Imports World without China	Nr.	Region	Exports China	Exports World without China	Imports China	Imports World without China
1	Husum	0.205	1.504	0.094	1.519	131	Mosbach	0.337	2.876	0.188	2.333
2	Heide	0.242	3.350	0.160	4.656	132	Pforzheim	0.328	3.011	0.188	2.452
3	Itzehoe	0.263	2.233	0.133	1.977	133	Calw	0.262	2.188	0.157	2.020
4	Flensburg	0.151	1.489	0.100	1.540	134	Freudenstadt	0.350	3.174	0.200	2.894
5	Lübeck	0.260	1.964	0.123	1.728	135	Freiburg	0.227	1.968	0.146	1.716
6	Kiel	0.162	1.600	0.110	1.582	136	Offenburg	0.290	2.813	0.159	2.353
7	Ratzeburg	0.193	1.897	0.109	1.752	137	Rottweil	0.418	3.061	0.230	2.482
8	Hamburg	0.282	2.540	0.125	2.210	138	Villingen-Schwenningen	0.418	3.292	0.244	2.541
9	Braunschweig	0.209	2.083	0.123	1.865	139	Tuttlingen	0.405	3.376	0.279	2.806
10	Salzgitter	0.572	6.193	0.244	5.503	140	Konstanz	0.301	2.845	0.146	2.380
11	Wolfsburg	0.551	4.965	0.225	4.922	141	Lörrach	0.367	3.132	0.190	2.457
12	Göttingen	0.176	1.831	0.119	1.609	142	Waldshut	0.283	2.906	0.165	2.367
13	Goslar	0.230	2.625	0.110	1.905	143	Reutlingen/Tübingen	0.293	2.582	0.181	2.132
14	Helmstedt	0.142	1.563	0.095	1.839	144	Balingen	0.317	2.806	0.214	2.373
15	Einbeck	0.238	2.571	0.151	2.345	145	Ulm	0.322	2.961	0.169	2.500
17	Hannover	0.198	2.066	0.115	1.927	146	Biberach	0.495	4.121	0.242	3.267
18	Sulingen	0.241	2.679	0.130	2.255	147	Friedrichshafen	0.449	3.460	0.260	2.766
19	Hameln	0.257	2.294	0.162	1.904	148	Ravensburg	0.304	2.518	0.166	2.204
20	Hildesheim	0.244	2.349	0.143	2.030	149	Sigmaringen	0.296	2.551	0.173	2.184
21	Holzminden	0.433	4.789	0.181	3.115	150	Bad Reichenhall	0.261	2.234	0.123	1.992
22	Nienburg	0.202	2.197	0.119	2.079	151	Traunstein	0.439	3.533	0.266	2.594
23	Stadthagen	0.176	1.755	0.107	1.745	152	Burghausen	0.754	9.236	0.266	6.168
24	Celle	0.162	1.681	0.103	1.628	153	Mühldorf	0.334	3.211	0.181	2.774
25	Lüneburg	0.173	1.737	0.108	1.698	154	Rosenheim	0.214	2.043	0.136	1.853
26	Zeven	0.137	1.615	0.103	1.886	155	Bad Tölz	0.271	2.638	0.137	2.228

Nr.	Region	Exports		Imports		Nr.	Region	Exports		Imports	
		China	World without China	China	World without China			China	World without China	China	World without China
27	Soltau	0.160	1.826	0.101	1.769	156	Garmisch-Partenkirchen	0.106	1.165	0.085	1.281
28	Stade	0.402	3.412	0.154	2.582	157	Weilheim	0.436	3.414	0.190	2.739
29	Uelzen	0.138	1.451	0.097	1.667	158	Landsberg	0.253	2.183	0.138	1.862
30	Verden	0.210	2.061	0.131	2.064	159	München	0.221	2.255	0.124	1.978
31	Emden	0.375	2.913	0.151	2.737	160	Ingolstadt	0.413	3.911	0.206	3.966
32	Westerstede	0.168	1.774	0.109	1.914	161	Kelheim-Mainburg	0.372	3.921	0.205	5.005
33	Oldenburg	0.131	1.531	0.098	1.565	162	Landshut	0.263	2.484	0.153	2.417
34	Osnabrück	0.180	2.076	0.119	2.070	163	Dingolfing	0.596	5.192	0.244	5.226
35	Wilhelmshaven	0.189	1.853	0.114	1.971	164	Eggenfelden/Pfarrkirchen	0.183	2.002	0.134	1.983
36	Cloppenburg	0.240	2.405	0.156	2.564	165	Passau	0.274	2.340	0.156	2.122
37	Lingen	0.274	2.912	0.169	3.392	166	Freyung	0.295	2.680	0.179	2.502
38	Nordhorn	0.180	1.996	0.123	1.913	167	Regen-Zwiesel	0.274	2.444	0.208	2.204
39	Leer	0.237	1.959	0.110	1.715	168	Deggendorf	0.211	2.059	0.141	2.093
40	Vechta	0.217	2.533	0.135	2.327	169	Straubing	0.224	2.152	0.148	2.033
41	Nordenham	0.418	4.195	0.234	3.517	170	Cham	0.363	2.663	0.246	2.255
42	Bremen	0.272	2.440	0.127	2.182	171	Regensburg	0.355	2.917	0.187	2.621
43	Bremerhaven	0.195	1.722	0.103	1.720	172	Schwandorf	0.304	2.954	0.165	2.606
44	Höxter	0.212	2.244	0.131	2.019	173	Amberg	0.400	3.404	0.239	2.677
45	Düsseldorf	0.224	2.493	0.110	1.954	174	Neumarkt	0.272	2.492	0.174	2.204
46	Duisburg	0.244	2.854	0.125	2.608	175	Weiden	0.248	2.406	0.138	2.140
47	Essen	0.156	1.798	0.103	1.730	176	Marktredwitz	0.275	2.695	0.186	2.449
48	Krefeld	0.322	3.790	0.150	2.806	177	Hof	0.207	2.490	0.167	2.212
49	Viersen	0.212	2.343	0.127	2.107	178	Bayreuth	0.168	1.730	0.125	1.761
50	Mönchengladbach	0.185	2.010	0.128	2.279	179	Bamberg	0.311	2.872	0.170	2.714
51	Heinsberg	0.188	1.879	0.121	1.731	180	Kulmbach	0.210	2.152	0.143	2.274
52	Wuppertal	0.248	2.439	0.130	2.003	181	Kronach	0.300	3.326	0.187	2.855
53	Schwelm	0.311	2.961	0.146	2.366	182	Coburg	0.279	2.962	0.178	2.677
54	Remscheid	0.334	2.747	0.172	2.309	183	Lichtenfels	0.247	2.801	0.148	2.159
55	Kleve	0.173	1.791	0.109	1.715	184	Erlangen	0.384	2.966	0.263	2.322

Nr.	Region	Exports		Imports		Nr.	Region	Exports		Imports	
		China	World without China	China	World without China			China	World without China	China	World without China
56	Aachen	0.185	2.050	0.120	1.825	185	Nürnberg	0.247	2.336	0.155	2.012
57	Köln	0.189	2.280	0.109	2.196	186	Weißenburg-Gunzenhausen	0.306	3.156	0.165	2.697
58	Leverkusen	0.519	6.020	0.173	3.410	187	Ansbach	0.257	2.741	0.179	2.411
59	Bonn	0.151	1.740	0.101	1.580	188	Neustadt/Aisch	0.223	2.563	0.142	2.383
60	Düren	0.175	2.482	0.119	2.140	189	Kitzingen	0.308	3.087	0.156	2.767
61	Euskirchen	0.203	2.406	0.115	2.043	190	Würzburg	0.174	1.775	0.107	1.566
62	Gummersbach	0.335	3.319	0.183	2.636	191	Schweinfurt	0.376	3.184	0.192	2.976
63	Gelsenkirchen	0.204	2.664	0.122	3.039	192	Haßfurt	0.355	3.651	0.202	3.228
64	Münster	0.200	2.134	0.115	1.811	193	Bad Neustadt/Saale	0.390	3.326	0.227	2.963
65	Borken	0.251	2.531	0.162	2.237	194	Bad Kissingen	0.139	1.495	0.099	1.590
66	Steinfurt	0.208	2.192	0.134	2.095	195	Lohr am Main	0.480	3.805	0.238	2.979
67	Bielefeld	0.205	2.134	0.134	1.872	196	Aschaffenburg	0.354	3.156	0.190	2.505
68	Gütersloh	0.304	2.913	0.191	2.659	197	Donauwörth-Nördlingen	0.332	3.548	0.203	3.207
69	Detmold	0.309	2.893	0.195	2.389	198	Dillingen	0.329	2.882	0.197	2.436
70	Minden	0.304	2.706	0.174	2.166	199	Günzburg	0.266	2.644	0.161	2.484
71	Paderborn	0.245	2.480	0.149	2.253	200	Augsburg	0.253	2.488	0.149	2.126
72	Bochum	0.140	1.669	0.092	1.567	201	Memmingen	0.373	3.098	0.214	2.511
73	Dortmund	0.192	2.058	0.113	1.872	202	Kaufbeuren	0.271	2.329	0.167	2.151
74	Hagen	0.248	2.837	0.126	2.770	203	Kempten	0.257	2.349	0.160	2.056
75	Lüdenscheid	0.453	4.102	0.216	3.186	204	Lindau	0.312	3.066	0.207	2.806
76	Meschede	0.294	3.106	0.174	2.586	205	Berlin	0.135	1.426	0.091	1.326
77	Siegen	0.341	3.358	0.173	2.694	206	Potsdam-Brandenburg	0.132	1.441	0.096	1.474
78	Olpe	0.401	3.713	0.191	3.031	207	Cottbus	0.149	2.306	0.111	2.251
79	Soest	0.343	2.954	0.206	2.476	208	Frankfurt/Oder	0.129	1.533	0.094	1.632
80	Korbach	0.210	2.432	0.136	2.209	209	Eberswalde	0.115	1.180	0.087	1.378
81	Kassel	0.271	2.674	0.148	2.558	210	Luckenwalde	0.205	2.056	0.124	2.013
82	Eschwege	0.167	1.729	0.117	1.669	211	Finsterwalde	0.195	1.947	0.134	2.052
83	Schwalm-Eder	0.171	1.829	0.145	1.738	212	Oranienburg	0.198	2.122	0.125	2.030

Nr.	Region	Exports		Imports		Nr.	Region	Exports		Imports	
		China	World without China	China	World without China			China	World without China	China	World without China
84	Hersfeld	0.178	2.286	0.105	1.831	213	Neuruppin	0.146	1.592	0.107	1.751
85	Marburg	0.292	2.934	0.133	2.596	214	Perleberg	0.157	1.848	0.124	1.879
86	Lauterbach	0.198	2.016	0.132	1.816	215	Prenzlau	0.194	3.219	0.174	6.277
87	Fulda	0.185	2.020	0.130	1.869	216	Rostock	0.307	2.189	0.119	1.824
88	Wetzlar	0.405	3.713	0.225	2.885	217	Schwerin	0.155	1.659	0.115	1.824
89	Gießen	0.208	1.846	0.124	1.623	218	Mecklenburgische Seenplatte	0.122	1.317	0.089	1.601
90	Limburg	0.195	1.935	0.126	1.810	219	Nordvorpommern	0.138	1.173	0.082	1.349
91	Wiesbaden	0.177	1.905	0.102	1.645	220	Südvorpommern	0.112	1.299	0.093	1.583
92	Frankfurt/Main	0.264	2.489	0.104	1.902	221	Chemnitz	0.183	1.798	0.120	1.772
93	Hanau	0.279	2.941	0.154	2.332	222	Erzgebirgskreis	0.272	2.437	0.168	2.282
94	Darmstadt	0.312	2.868	0.142	2.196	223	Mittelsachsen	0.249	2.501	0.151	2.188
95	Erbach	0.234	2.633	0.161	2.228	224	Vogtlandkreis	0.219	2.096	0.155	2.038
96	Altenkirchen	0.335	2.738	0.181	2.270	225	Zwickau	0.305	2.736	0.159	2.656
97	Montabaur	0.239	2.525	0.148	2.173	226	Dresden	0.193	1.737	0.131	1.647
98	Neuwied	0.270	2.614	0.153	2.123	227	Bautzen	0.217	2.175	0.152	2.103
99	Ahrweiler	0.209	2.203	0.117	1.959	228	Görlitz	0.183	1.973	0.142	2.004
100	Koblenz	0.211	2.372	0.113	2.118	229	Meißen	0.247	2.682	0.137	2.281
101	Bad Kreuznach	0.248	2.608	0.128	1.943	230	Leipzig	0.166	1.756	0.105	1.708
102	Idar-Oberstein	0.213	2.075	0.136	1.944	231	Dessau-Roßlau	0.243	2.094	0.123	1.856
103	Cochem	0.189	1.583	0.098	1.603	232	Halle	0.172	2.112	0.107	2.301
104	Simmern	0.238	2.351	0.140	2.134	233	Magdeburg	0.166	1.705	0.107	1.693
105	Trier	0.139	1.476	0.101	1.652	234	Salzwedel	0.145	2.102	0.117	2.373
106	Bernkastel-Wittlich	0.192	2.234	0.134	2.230	235	Anhalt-Bitterfeld	0.288	2.834	0.147	2.343
107	Daun	0.211	2.138	0.135	2.110	236	Burgenlandkreis	0.152	2.403	0.116	2.755
108	Bitburg	0.198	2.064	0.133	2.131	237	Harz	0.223	2.224	0.133	2.004
109	Kaiserslautern	0.236	2.509	0.132	2.214	238	Mansfeld-Südharz	0.178	2.231	0.121	2.267
110	Landau	0.180	1.884	0.113	1.981	239	Salzlandkreis	0.241	2.670	0.128	2.265
111	Mainz	0.195	2.023	0.099	1.690	240	Stendal	0.112	1.345	0.094	1.659

Nr.	Region	Exports		Imports		Nr.	Region	Exports		Imports	
		China	World without China	China	World without China			China	World without China	China	World without China
112	Alzey-Worms	0.223	2.666	0.127	2.512	241	Wittenberg	0.248	2.803	0.131	2.440
113	Pirmasens	0.245	2.377	0.155	1.999	242	Erfurt	0.156	1.503	0.111	1.516
114	Ludwigshafen	0.465	5.378	0.172	3.201	243	Gera	0.173	1.804	0.128	1.810
115	Germersheim	0.434	3.798	0.190	3.637	244	Jena	0.251	1.940	0.171	1.702
116	Merzig	0.179	1.836	0.105	1.637	245	Suhl	0.255	2.273	0.156	2.073
117	St. Wendel	0.173	1.768	0.134	1.968	246	Weimar	0.161	1.581	0.105	1.553
118	Saarbrücken	0.260	2.892	0.134	2.783	247	Eisenach	0.340	3.221	0.178	2.777
119	Homburg/Saar	0.346	2.979	0.172	2.547	248	Eichsfeld	0.223	2.149	0.141	2.205
120	Stuttgart	0.318	2.921	0.166	2.582	249	Nordhausen	0.182	1.899	0.124	1.854
121	Göppingen	0.313	2.993	0.181	3.254	250	Mühlhausen	0.180	2.036	0.122	2.011
122	Heilbronn	0.352	3.308	0.173	2.873	251	Sondershausen	0.234	2.009	0.165	1.900
123	Schwäbisch Hall	0.383	3.179	0.222	2.568	252	Meiningen	0.253	2.273	0.147	2.109
124	Tauberbischofsheim	0.338	2.946	0.220	2.484	253	Gotha	0.230	2.396	0.136	2.359
125	Heidenheim	0.438	3.569	0.247	2.782	254	Arnstadt	0.284	2.526	0.183	2.270
126	Aalen	0.414	3.213	0.237	2.688	255	Sonneberg	0.338	3.462	0.193	2.812
127	Baden-Baden	0.414	3.857	0.194	3.447	256	Saalfeld	0.250	2.588	0.161	2.343
128	Karlsruhe	0.231	2.374	0.154	2.317	257	Pößneck	0.279	3.059	0.179	2.668
129	Heidelberg	0.219	2.172	0.129	1.842	258	Altenburg	0.239	2.405	0.148	2.386
130	Mannheim	0.282	2.744	0.147	2.708						

Note: The region-specific GVC integration is given for Germany as exporter or importer country and China and the world without China as importer or exporter, respectively. All values are given as derived above in section 4.2.

Source: Employment statistic provided by the Federal Employment Agency and OECD ICIO data (OECD, 2021); own calculations. © IAB

Figures

Tables

Imprint

IAB-Forschungsbericht 10|2023

Date of publication
September 6, 2023

Publisher
Institute for Employment Research
of the Federal Employment Agency
Regensburger Str. 104
90478 Nürnberg Germany

Download of this IAB-Forschungsbericht
https://doku.iab.de/forschungsbericht/2023/fb1023.pdf

All publications in the series „IAB-Forschungsbericht“ can be downloaded from
http://www.iab.de/en/publikationen/forschungsbericht.aspx

Website
https://.iab.de

ISSN
2195-2655

DOI
10.48720/IAB.FB.2310

Corresponding author
Moritz Meister
Phone: +49 431 3395 1566
Email: Moritz.Meister@iab.de