The Covid-19 pandemic and international supply chains

Eva Kleifgen [a] Duncan Roth [b] Ignat Stepanok [c]

19 December 2022

Abstract

The Covid-19 pandemic has caused major disruptions in international trade and has raised concerns about adverse effects on international supply chains. Using a unique establishment survey matched with administrative data from Germany, we provide novel evidence on how establishments have adjusted their supply chains in response to pandemic-induced disruptions. We find that establishments that experienced difficulties in obtaining intermediate inputs as a result of the pandemic are significantly more likely to change their network of suppliers than establishments without such problems, especially if disruptions affected imports from abroad. Establishments experiencing supply chain difficulties are more likely to replace a distant with a closer supplier. However, these adjustments in response to the pandemic appear to be temporary.

JEL classification: D22, F14

Keywords: Covid-19 pandemic, establishments, supply chains, imports, Germany, intermediate inputs

[a] Eva Kleifgen: Institute for Employment Research, eva.kleifgen@iab.de

[b] Duncan Roth: Institute for Employment Research, duncan.roth@iab.de

[c] Ignat Stepanok: Institute for Employment Research, ignat.stepanok@iab.de

Acknowledgements

We would like to thank Abi Adams-Prassl, Wolfgang Dauth, Stefan Fuchs, Didier Fouarge, Eliza Forsythe, Christina Gathmann, Holger Görg, Philipp Jaschke, Sekou Keita, Annekatrin Niebuhr, Jens Stegmaier, Gesine Stephan and the participants from the 3rd IAB-LISER conference "Labour markets during and after the COVID-19 pandemic" for helpful comments and suggestions. Special thanks go to the team responsible for the survey "Establishments in the Covid-19 Crisis". Part of the data used in the empirical analysis of the paper is based on social security records and is therefore confidential. Under certain conditions, a sample of the data may be accessed through the Research Data Centre of the Institute for Employment Research.

1 Introduction

Germany's economy is deeply integrated into international supply chains. In this paper, we study how establishments in Germany have adjusted their supply chains in response to pandemic-induced difficulties in acquiring intermediate inputs. We show that such difficulties are associated with a higher likelihood of replacing suppliers as well as with a higher likelihood that the new suppliers are located closer to (or at) home relative to the replaced ones. We also find that these changes are more likely to be temporary rather than permanent.

Recent studies have used information on firm-level input-output linkages to show that economic shocks are propagated along supply chains (Carvalho et al, 2021; Barrot and Sauvagnat, 2016). Bonadino et al. (2021) estimate that a significant share of the global decline in GDP growth during the Covid-19 pandemic was spread through global value chains (GVCs). They also find that international trade can make countries more resilient to the negative pandemic effects, since the local labor markets are also prone to lockdowns. Borino et al. (2021) find that international firms, compared to domestic ones, are more resilient to the disruptions caused by the pandemic. The nature of the GVCs, the type of shocks and also the response of firms are therefore an important topic for research. In light of the disruption the Covid-19 pandemic caused to international trade, the question whether firms adjusted their supply chains by reducing exposure to international shocks and re-shoring production has received renewed attention.

Global value chains have experienced disruptions and problems long before the pandemic or the war in Ukraine. Trade tensions between the US and China, and Brexit are just two examples for hurdles leading to changing trade patterns. Each crisis has its specificities with the pandemic being of a more global nature, while Brexit had a more regional character. Establishments' responses to disruptions in GVCs during the pandemic are therefore not easily generalizable to other disruptive events like the current war in Ukraine for instance, we think nevertheless that our study offers a valuable glimpse at the responses of establishments.

In our analysis we use two data sources, a high-frequency establishment survey, which is representative for the population of private German establishments and combine that with administrative records. This gives us an opportunity to analyse the responses from the survey while controlling for the characteristics and composition of the workforce at the establishment level using high-quality administrative data.

Firm-to-firm relationships in GVCs are shown to be sticky, especially in periods of high uncertainty (see Martin et al., 2020). We provide evidence that German establishments switched suppliers in response to the pandemic, a time marked by high uncertainty. Moreover, we find that experiencing problems with imports of intermediate goods is associated with a higher likelihood of switching to suppliers nearby.

Borin and Mancini (2019) provide a measure of the importance of GVCs as a share of all trade and show that it has been declining since the Great Recession. Our establishment-level study seems to point in a similar direction[1]. Antràs (2020) however argues that the evidence in Borin and Mancini (2019) can be a reason for the decline in trade growth but cannot be seen as a sign for de-globalization. Indeed, we do not find evidence that the switches of suppliers were of a permanent nature.

[1] Borin and Mancini (2019) define their measure of GVC prevalence as the share of exports of a country which cross at least two borders. In our data, we see imports of intermediate goods and services without further knowledge whether they crossed one or more borders.

2 Data and variables

2.1 Data sources

The empirical analysis is based on a combination of a unique establishment survey and administrative data. The first data source is the survey *Establishments in the Covid-19 Crisis*. This survey has been carried out by the Institute for Employment Research (IAB) at regular intervals since August 2020 to collect up-to-date information that allows drawing conclusions about how establishments in Germany have been affected by the Covid-19 pandemic. Each survey wave contains approximately 2,000 establishments which constitute a representative sample of private-sector establishments in Germany with at least one employee subject to social security contributions. The survey contains establishments from all size classes and economic sectors with the exception of the public sector and extraterritorial organisations. To account for non-random sampling, weights are provided to ensure that valid population estimates can be computed.

The survey is carried out in the form of computer-assisted telephone interviews (CATI). It consists of a set of so-called panel questions, which are included in (almost) all waves, and questions on specific topics. Examples of panel questions are the impact of the pandemic on an establishment in general, on an establishment's liquidity level, the use of short-time work, or whether an establishment has recently hired or laid off workers. Moreover, the survey collects information about the economic sector an establishment belongs to as well as its size (in terms of the number of employees) and location. Further information about the survey can be found in Bellmann et al (2022).

In this paper, we use data from wave 16, which was carried out between 2 and 8 August 2021. The specific topic of that wave focussed on intermediate inputs and establishments' supply chains. In particular, establishments were asked whether they experienced difficulties in obtaining intermediate inputs since March 2020 that were due to the Covid-19 pandemic. Information about exposure to pandemic-related difficulties in receiving intermediate inputs is self-reported, but, crucially, the question does not ask for an assessment of the strength of the difficulties experienced. Use of a binary indicator should therefore reduce concerns that the extent of self-reported difficulties might not be comparable across establishments. The wave also contains information about whether establishments changed one or more of their suppliers in 2020 as a result of the pandemic. Moreover, the survey provides information about the nature of these changes. First, establishments were asked whether this change involved replacing a supplier from a specific geographic area with a supplier in another area, for example by substituting a supplier outside the EU by one in the EU or in Germany. This information allows us to assess whether establishments adjusted their supply chains by making them less international. To do so, we construct a measure for whether establishments replaced suppliers located further away with ones that are closer. Second, establishments provided information about whether they expected changes in their network of suppliers to be permanent or temporary.

The second data source is the *Establishment History Panel (BHP)* which contains information on the population of establishments in Germany that is derived from administrative records. An important feature of the establishment survey is that it contains a unique identifier that allows linking the data from the survey with the administrative data from the BHP for those establishments that agree to the linkage. The BHP dataset is constructed once per year (data refers to the 30th of June) based on notifications made by employers to the social security systems which therefore make the information highly reliable. In addition to information about the location and the sector that an establishment belongs to, the BHP also provides detailed information about the structure of employment. Among other things, it contains the total number of employees, the number of employees by sex, age, qualification, and full-time status. The version of the BHP used here spans the years 1975 to 2019 (for West German establishments) and 1992 to 2019 (for East German establishments). Further

information on the BHP data can be found in Ganzer et al. (2021). For our empirical analysis, we employ information about the pre-pandemic composition of an establishment's workforce. Specifically, we use the share of skilled workers, defined as having a completed apprenticeship or university degree, in the year 2019.

The final data source is also derived from administrative records and contains the estimated establishment fixed effects from an AKM-style wage decomposition (Abowd et al., 1999) that are described in Card et al. (2013). These so-called CHK effects are estimated based on the population of workers and establishments in Germany. Further information on the CHK effects can be found in Bellman et al. (2020). We use the estimated establishment fixed effects as a measure of establishment quality in order to control for unobserved heterogeneity.

2.2 Sample and variables

Our analysis is based on 912 establishments that report receiving intermediate inputs from within Germany or from abroad. These establishments can be linked to administrative records from the BHP as well as to the estimated CHK effects. [2] Table A1 provides descriptive statistics on all variables used in the analysis.

According to the sample, about two thirds of establishments in Germany (63.6%) experienced difficulties in obtaining intermediate inputs. The survey further provides information about whether the supply chain disruptions occurred in connection with suppliers in Germany or abroad. 29% of establishments experienced difficulties in obtaining intermediate inputs exclusively from suppliers in Germany, while 35% suffered from supply chain disruptions abroad.[3]

Figure 1 shows that establishments across all sectors and size categories experienced difficulties with supply chain disruptions. There are, however, differences with respect to the incidence of disruptions as well as where they occurred. A high incidence can be found in manufacturing as well as retail and maintenance with approximately half of the establishments being affected by disruptions involving suppliers from abroad, while an additional quarter reports difficulties with suppliers within Germany. By contrast, establishments in the sectors transportation, hospitality and tourism as well as other services primarily report disruptions related to suppliers within Germany.

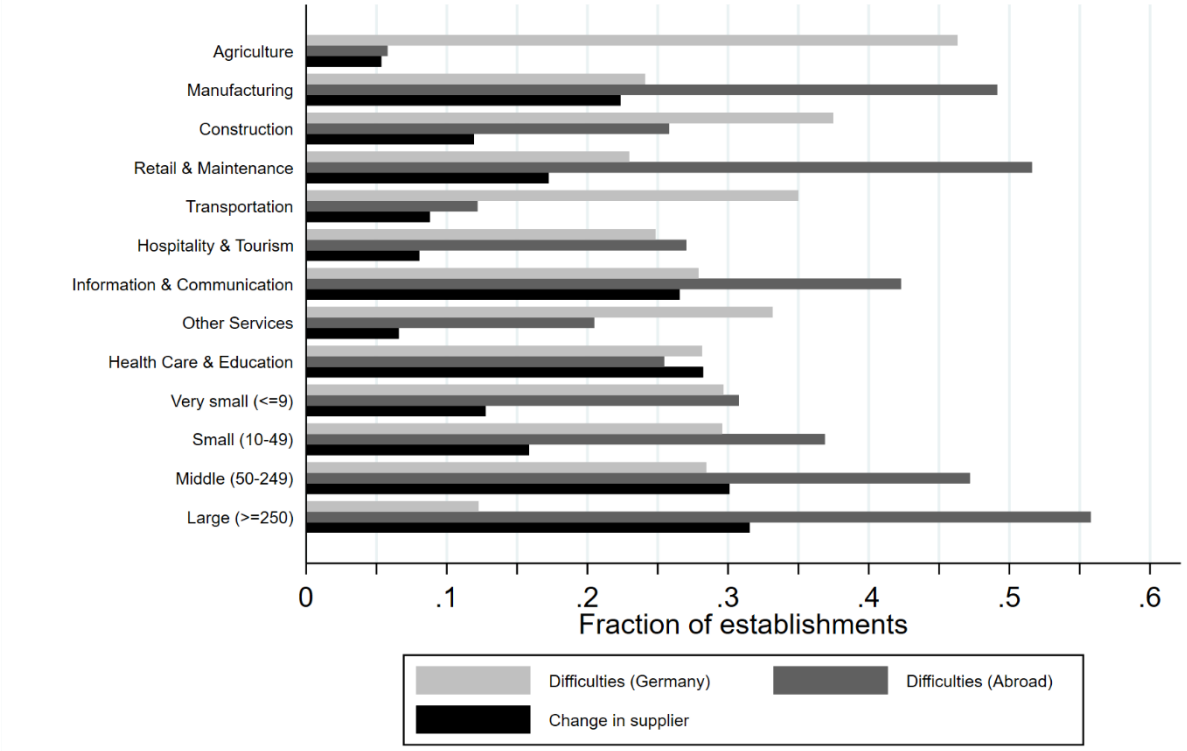
The share of establishments experiencing difficulties increases with the size of the establishment. About 55% of large establishments report difficulties with suppliers abroad compared to about 30% in the case of small establishments. Interestingly, the differences in the source of the disruptions (abroad or within Germany) is more pronounced than the total fraction of establishments affected by supply chain disruptions: approximately 60% of small establishments experienced difficulties which is close to the value of 68% among large establishments.

Likewise, changes in suppliers can be observed in each sector and size category. The probability of establishments who changed their supply network are not necessarily highest in sectors with the highest incidence of supply chain disruptions: the highest fractions are recorded in the information and communication as well as the health care and education sectors, followed by manufacturing. Middle-sized and large establishments are also more likely to have adjusted their supply networks compared to very small or small establishments.

[2] The sample increases to 1,078 establishments without data from the BHP. Table A3 shows that the regression results are very similar when the larger sample is used.

[3] The latter group includes establishments that experienced difficulties with suppliers abroad *and* in Germany. To ensure a unique assignment, we include these establishments in the same group.

Figure 1: Incidence of supply chain disruptions and adjustments by sector and establishment size



Notes: Unit of observation is establishment. Sampling weights are used.

A central aim of the empirical analysis is to evaluate whether establishments that experienced supply chain disruptions reacted by adjusting their supply chains. One concern is that our dataset does not contain information about the size of an establishment's network of suppliers or the number of cases in which disruptions were experienced or the network was adjusted. Specifically, establishments with larger networks – possibly because they are larger or more integrated into (international) supply chains, as for example establishments in manufacturing – have a higher probability to experience disruptions and to change their suppliers. In such a case the relationship between difficulties and the adjustment of supply chains might be spurious. To address this issue, we first control for sectors and size categories in the empirical analysis to account for differences in the size of supply chain networks. To further mitigate concerns, we show that, second, the results are not driven by individual sectors or size categories and, third, that the effects can be identified within sector groups and size categories.

3 Estimation strategy

To assess the probability that an establishment changed their supply chains in response to pandemic-induced difficulties in obtaining intermediate inputs, we estimate the following logit model:

$$Pr(y_i = 1|D_i, \boldsymbol{x_i}) = e^{\left(\beta_0+\beta_1 D_i^{Germany}+\beta_2 D_i^{Abroad}+\boldsymbol{\gamma' x_i}\right)} \Big/ \left[1 + e^{\left(\beta_0+\beta_1 D_i^{Germany}+\beta_2 D_i^{Abroad}+\boldsymbol{\gamma' x_i}\right)}\right] \quad (1)$$

In the first specification, the dependent variable, y_i, is an indicator that takes the value 1 if an establishment replaced one or more of its suppliers. The main explanatory variable, D_i, indicates whether an establishment experienced difficulties due to the pandemic in obtaining intermediate inputs from either within Germany, $D_i^{Germany}$, or abroad, D_i^{Abroad} (the reference category consists of establishments without such problems). Positive coefficient estimates of β_1 and β_2 would provide evidence in favour of the hypothesis that disruptions caused by the pandemic led establishments to

adjust their supply chains. As the probability of changing one's network of suppliers as well as the extent of supply chain disruptions are likely to differ between establishments (see discussion in Section 2.2), we include two sets of control variables. Vector $\boldsymbol{x}_i$ contains various observable characteristics that are taken from the establishment survey: dummy variables for nine sectors, four establishment size categories and two regions (East, West). Moreover, we control for establishment quality by including the share of skilled workers as well as the CHK establishment effect as a measure of unobserved establishment heterogeneity.

In a second step, we further assess the type of changes that establishments made to their network of suppliers. As we focus on the nature of the change, we condition on a change of supplier having taken place and remove establishments from the sample which do not report to have adjusted their supply chains. We start by evaluating the hypothesis that the pandemic led to a re-structuring of supply chains away from international suppliers. For this purpose, we define a dependent variable that takes the value 1 in case of changes in which a more distant supplier was replaced by a less distant one and 0 otherwise. Specifically, these changes refer to cases in which an establishment reported that they replaced a supplier from outside the EU with one inside the EU or in Germany or when a supplier from inside the EU was replaced by one in Germany. The reference category contains cases in which an establishment changed its suppliers, but not by replacing a more with a less distant supplier. Primarily, these changes refer to cases in which one supplier in Germany was replaced by another supplier in Germany. However, they also comprise changes in which suppliers were replaced within the EU or outside the EU or, in a very small number of cases, when a closer supplier was replaced by one further away.

In addition to the direction of the change, we also evaluate whether establishments intend the adjustments to their supply chains to be permanent or temporary. We define a further dependent variable which takes the value 1 if an establishment reports that it expects the change in the supplier to be permanent and 0 otherwise. [4]

4 Results

4.1 Adjustments in supply networks: baseline specification

Table 1 shows the average effect on the probability of an establishment replacing a supplier for a discrete change in the indicator for pandemic-induced difficulties in obtaining intermediate goods and services. Regardless of the specification, we find consistent evidence that exposure to such problems increased the probability for a change in suppliers, in particular if the difficulties are associated with imports from abroad. According to the results of the bivariate relationship in column 1, the probability to change a supplier is significantly larger by approximately 10 percentage points among establishments that faced difficulties in receiving intermediate goods from a supplier within Germany compared to establishments without such problems. This difference increases to about 28 percentage points for those establishments that faced difficulties with intermediate goods from abroad. Compared to an average probability of reporting a change in one's suppliers of 15.2%, these differences are economically large.

This association could be spurious if exposure to pandemic-induced difficulties and the frequency with which establishments change their suppliers are related to characteristics, such as an establishment's size or sector. To address this concern, we use information from the survey to control for sector, size category and location (East or West Germany) of an establishment in column 2. The estimated coefficients change only slightly after adding these control variables. Estimation could also be biased

[4] Establishment that report temporary and permanent adjustments are assigned to the category *Permanent*.

due to unobserved characteristics, for example if higher-quality establishments are more likely to change suppliers, but are less affected by difficulties in obtaining intermediate goods or services. The results remain very similar, when we add an establishment's share of skilled workers as well as the CHK effects as a measure of establishment quality in the final column.

Table 1: Probability of changing a supplier (average effects)

	(1)	(2)	(3)
Difficulties (Germany)	0.0987***	0.1004***	0.1029***
	(0.0306)	(0.0311)	(0.0320)
Difficulties (Abroad)	0.2777***	0.2645***	0.2600***
	(0.0405)	(0.0412)	(0.0406)
Control variables (Survey)	No	Yes	Yes
Control variables (Administrative)	No	No	Yes
Observations	912	912	912

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include dummies for sectors, employment size categories and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition. Full results are in Table A2.

4.2 Adjustments in supply networks: robustness and heterogeneity

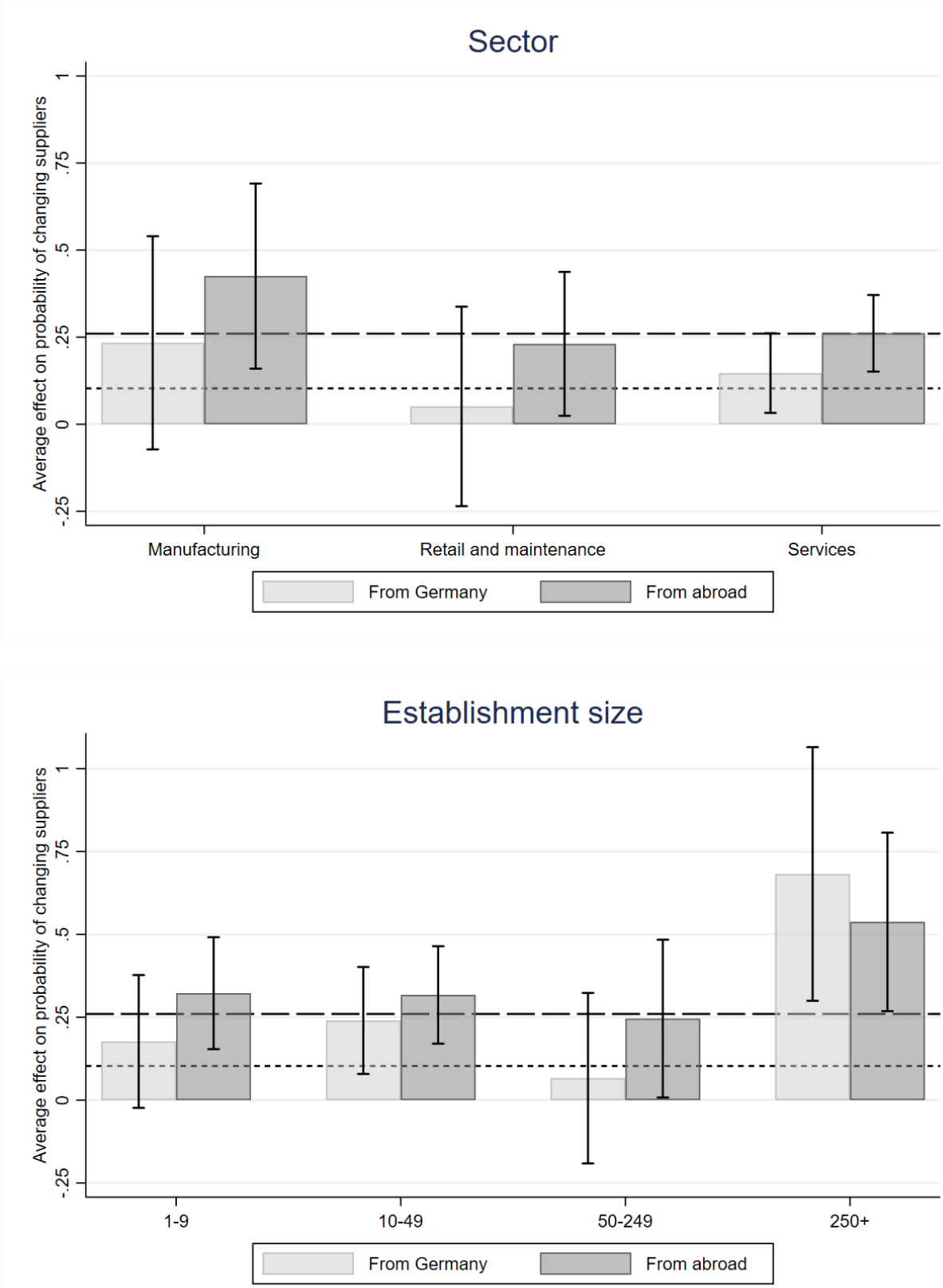
Our finding, that establishments whose supply of intermediate goods and services was disrupted due to the pandemic responded by changing their network of suppliers, remains robust in various sensitivity analyses. A potential concern with the results shown in Table 1 is that the large positive effects associated with disruptions abroad is due to comparing establishments whose supply chains extend abroad with establishments that only acquire intermediate inputs from within Germany, so that even after controlling for potentially confounding factors these establishments might still remain sufficiently different. However, as shown by Table A4, similar results are obtained when the sample is limited to establishments that receive intermediate goods from abroad.

Next, we show that the results in Table 1 are not driven by establishments from a single sector or size category. In Table A5 and Table A6, we estimate the model on restricted samples which each exclude establishments from a single sector or size category. The estimated coefficients from the full specification (based on column 3 in Table 1) for difficulties that were experienced abroad (in Germany) are all statistically significant and range from 0.2289 (0.0752) to 0.2854 (0.1242) when observations from individual sectors are removed. Likewise, the range of the estimates when observations from individual size categories are dropped lies between 0.2499 (0.0816) and 0.2735 (0.1378).

We proceed by assessing the relationship between disruptions and changes in supply networks separately by sector and establishment size. The upper panel of Figure 2 shows the results by sector, where – due to sample size – we distinguish between three broad sector categories: manufacturing, retail and maintenance as well as a pooled service sector which combines hospitality and tourism, information and communication, other services as well as health care and education. In each of these sectors, establishments that experienced difficulties with imports from abroad are significantly more likely to have changed their suppliers compared to establishments without such difficulties. The impact of disruptions within Germany is smaller and statistically insignificant in two cases. In terms of the point estimates, the results also reveal differences in the magnitude of the effect between sectors. Manufacturing establishments are about 50% more likely to adjust their supply network in response to disruptions abroad than establishments in retail or the service sector. One reason for the stronger response among manufacturing establishments could be the formers' deeper integration into global value chains (Wang et al. 2017). However, despite the larger point estimate in the case of

manufacturing, the confidence interval overlaps with those of the other two sector groups, suggesting that the difference is not statistically significant.

Figure 2: Probability of changing a supplier – by sector and size (average effects)



Notes: Unit of observation is establishment. Sampling weights are used. The graph shows the estimated average effect on the probability of changing one or more suppliers by sector (top) and by establishment size (bottom). The solid vertical bars represent the 95% confidence interval. The vertical long-dash (short-dash) line represents the corresponding effect of

disruptions with obtaining intermediate goods from abroad (within Germany) for the full sample of establishments (as shown in the final column of Table 1). The specification includes survey control variables (dummies for sectors, employment size categories and East Germany) and administrative control variables (the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition). Results are in Table A7 and Table A8.

The lower panel of Figure 2 shows the results for four establishment size categories. Within each of these groups, we find that having experienced disruptions abroad significantly increases the probability of a change in supplier. Evidence for a corresponding effect due to disruptions in Germany is mixed as the former is statistically insignificant for two categories. Moreover, the magnitude of the response to difficulties with suppliers appears to vary non-linearly with size. While the size of the effect is relatively similar for establishments with up to 249 employees, large establishments are considerably more likely to change their supply networks in response to difficulties – abroad and in Germany. A possible explanation is that the costs of adjustment are smaller for larger establishments as they are likely to have a larger supply network which could make the shifting from one supplier to another or to locate new suppliers easier. By contrast, this might be more difficult for smaller establishments, especially if they rely on specialised intermediate inputs. If the relationship between disruptions and changes in supplier were spurious due to larger establishments or establishments in specific sectors having larger supply networks (see Section 2.2), we would expect that the relationship to be found in selected establishment groups. However, our results show that the effects in Table 1 are not due to a single sector or establishment size category and that, despite differences in magnitude, they can be found in every broad sector and size category.

4.3 Direction and duration of changes

Having established that pandemic-induced disruptions of supply chains led establishments to replace suppliers, we further analyse the nature of these changes. Table 2 shows results from estimating Equation 1 based on the sample of establishments that report to have changed a supplier. In panel A, the results refer to the specification in which an indicator for a more distant supplier having been replaced by a one closer-by is used as the dependent variable. Column 1 presents the effect on the probabilities for such a change when the model does not contain further control variables. Compared to establishments that changed their suppliers but did not experience supply chain disruptions, establishments with difficulties in procuring intermediate inputs are, on average, 42 percentage points more likely to substitute for a closer supplier. The estimated change in probability becomes slightly smaller when we include the survey-based control variables (column 2). It decreases slightly more when we include measures for establishment quality, but remains statistically significant at the 10% level. By contrast, the corresponding change in probability due to difficulties experienced with suppliers in Germany are considerably smaller and not statistically significant in any of the specifications. These results suggest that establishments not only reacted to supply chain disruptions by replacing suppliers, but, moreover, by substituting away from distant suppliers.

Panel B addresses the question whether adjustments in supply chains were permanent or temporary. Regardless of whether control variables are included in the estimation, we find no evidence that pandemic-induced disruptions make it more likely that establishments changed their network of suppliers permanently. By contrast, establishments which experienced disruptions in Germany or abroad and which changed one or more of their suppliers have a significantly smaller probability of making a permanent adjustment compared to establishments that changed their suppliers but did not experience disruptions in their supply chains. These results suggest that establishments that were exposed to disruptions used changes in their supply network as a short- to medium-term response to cope with pandemic-induced difficulties. Establishments without disruptions are more likely to make a permanent change, which might represent long-term plans that were carried out independently of the pandemic.

Table 2: Probability of different types of changes (average effects)

	(1)	(2)	(3)
Panel A: Probability of replacing a more with a less distant supplier			
Difficulties (Germany)	0.2230	0.2607	0.2124
	(0.2301)	(0.2162)	(0.2358)
Difficulties (Abroad)	0.4198**	0.3982**	0.3686*
	(0.2002)	(0.1943)	(0.2079)
Panel B: Probability of permanently changing a supplier			
Difficulties (Germany)	-0.2753**	-0.3232**	-0.3178**
	(0.1338)	(0.1581)	(0.1305)
Difficulties (Abroad)	-0.2017***	-0.1944***	-0.2042***
	(0.0772)	(0.0666)	(0.0636)
Control variables (Survey)	No	Yes	Yes
Control variables (Administrative)	No	No	Yes
Observations	153	153	153

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include dummies for sectors, employment size categories and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition. Complete results are in Table A9 and A10.

5 Conclusion

We provide novel and robust evidence from Germany that establishments that suffered pandemic-induced disruptions of their supply chains are significantly more likely to have changed their suppliers. This is especially the case when disruptions occurred in connection with supply chains extending abroad. While the magnitude of the response is found to be larger for establishments in the manufacturing sector as well as for large establishments, the results are not driven by these two groups. Rather, adjustments of supply chain networks in response to the pandemic appears to be an economy-wide phenomenon that can be found across sectors and establishment sizes.

Conditional on changing suppliers, establishments are more likely to replace a distant with a closer supplier if disruptions affect imports from abroad. We are, however, hesitant to interpret these findings as evidence in favour of the hypothesis that the Covid-19 pandemic has contributed to a lasting reduction in the relevance of global supply chains. Rather, our findings suggest that establishments intend these adjustments to be temporary, which makes a return to the initial levels of international supply networks appear likely.

While this paper has provided insights into how establishments adjusted their supply chains in response to a global shock in form of the Covid-19 pandemic, open questions remain. For example, this paper has focussed on the impact from supply chain adjustments along the extensive margin by comparing the behaviour of establishments with and without such disruptions. Better understanding how the intensity of the disruption is related to the extent of the supply chain adjustments would be of interest in itself, but also to facilitate the comparison with supply chain adjustments made in other countries or in response to other crises.

References

Abowd, John M., Francis Kramarz and David N. Margolis (2003): "High wage workers and high wage firms," Econometrica 67(2): 251 – 333.

Antràs, Pol (2020): "De-Globalisation? Global Value Chains in the Post-COVID-19 Age", NBER Working Paper 28115.

Barrot, Jean-Noël, Sauvagnat Julien (2016): “Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks.” Quarterly Journal of Economics 131: 1543 – 1592.

Bellmann, Lisa, Ben Lochner, Stefan Seth and Stefanie Wolter (2020): „AKM effects for German labour market data“, FDZ-Methodenreport 01/2020 EN.

Bellmann, Lutz; Gleiser, Patrick; Hensgen, Sophie; Kagerl, Christian; Leber, Ute; Roth, Duncan; Stegmaier, Jens; Umkehrer, Matthias (2022): Establishments in the Covid-19-Crisis (BeCovid): A High-Frequency Establishment Survey to Monitor the Impact of the Covid-19 Pandemic, Jahrbücher für Nationalökonomie und Statistik, 242(3): 421-431.

Borin, Alessandro and Michele Mancini (2019): “Measuring What Matters in Global Value Chains and Value-Added Trade”, Policy Research Working Paper; no. WPS 8804. Washington, D.C.: World Bank Group.

Borino, Floriana, Eric Carlson, Valentina Rollo and Olga Solleder (2021), “International Firms and COVID-19: Evidence from a global survey,” *Covid Economics*, 75, 30—59.

Bonadino, Barthélémy, Zhen Huob, Andrei A. Levchenko and Nitya Pandalai-Nayarde (2021): “Global Supply Chains in the Pandemic”, Journal of International Economics, 133.

Card, David, Jörg Heining and Patrick Kline (2013): “Workplace heterogeneity and the rise of West German wage inequality “, Quarterly Journal of Economics 128(3): 967 – 1015.

Carvalho, Vasco M., Makoto Nirei, Yukiko U. Saito, and Alireza Tahbaz-Salehi (2021): “Supply Chain Disruptions: Evidence from the Great East Japan Earthquake.” Quarterly Journal of Economics 136 (2):1255– 1321.

Ganzer, Andreas, Lisa Schmidtlein, Jens Stegmaier and Stefanie Wolter (2020): „Establishment History Panel 1975-2019 (revised version (v2) from April 2021)“, FDZ-Datenreport 16/2020 EN.

Martin, Julien, Isabelle Méjean, and Mathieu Parenti (2020): “Relationship Stickiness and Economic Uncertainty”, CEPR Discussion Paper 15609.

Wang, Zhi, Shang-Ji Wei, Xinding Yu, and Kunfu Zhu (2017): “Measures of participation in global value chains and global business cycles”, NBER Working Paper 23222.

Appendix

Table A1: Summary statistics

	Mean	Standard deviation
Difficulties in obtaining intermediate inputs		
no difficulties	0.36	0.45
from within Germany	0.29	0.44
from abroad	0.34	0.50
Change in supplier		
overall	0.15	0.41
from a distant to a closer supplier (conditional on changing)	0.58	0.49
permanent (conditional on changing)	0.79	0.36
Survey control variables		
Establishment Size		
1 to 9 employees	0.21	0.40
10 to 49 employees	0.36	0.48
50 to 249 employees	0.35	0.48
250 or more employees	0.08	0.27
Sector		
Agriculture	0.03	0.16
Manufacturing	0.28	0.45
Construction	0.08	0.28
Retail & Maintenance	0.23	0.42
Transportation	0.02	0.15
Hospitality & Tourism	0.05	0.22
Information & Communication	0.03	0.16
Other Services	0.15	0.36
Health Care & Education	0.12	0.33
Region		
West Germany	0.83	0.38
East Germany	0.17	0.38
Administrative control variables		
Share of skilled employees	0.83	0.17
CHK-Effects	0.38	0.35
Observations	912	

Notes: Sampling weights are used.

Table A2: Probability of changing a supplier (average effects)

	(1)	(2)	(3)
Difficulties (Germany)	0.0987***	0.1004***	0.1029***
	(0.0306)	(0.0311)	(0.0320)
Difficulties (Abroad)	0.2777***	0.2645***	0.2600***
	(0.0405)	(0.0412)	(0.0406)
Establishment Size (reference category: 1-9 employees)			
10 to 49 employees	-	0.006	-0.0008
	(.)	(0.0339)	(0.0356)
50 to 249 employees	-	0.081**	0.0631
	(.)	(0.0393)	(0.0443)
250 or more employees	-	0.0737	0.0519
	(.)	(0.061)	(0.0637)
Sector (reference category: Agriculture)			
Manufacturing	-	0.0884	0.0799
	(.)	(0.0712)	(0.0772)
Construction	-	0.0518	0.0411
	(.)	(0.0766)	(0.0816)
Retail & Maintenance	-	0.052	0.0469
	(.)	(0.0695)	(0.0748)
Transportation	-	0.0418	0.0308
	(.)	(0.0897)	(0.0926)
Hospitality & Tourism	-	0.0108	0.011
	(.)	(0.0742)	(0.0786)
Information & Communication	-	0.1283	0.111
	(.)	(0.0943)	(0.0987)
Other Services	-	0.0031	-0.0034
	(.)	(0.0707)	(0.0773)
Health Care & Education	-	0.2285***	0.2272**
	(.)	(0.061)	(0.09)
Region (reference category: West Germany)			
East Germany	-	0.058	0.0717
	(.)	(0.0444)	(0.0459)
Share of skilled employees	-	-	0.0206
	(.)	(.)	(0.0732)
CHK effects	-	-	0.044
	(.)	(.)	(0.0489)
Observations	912	912	912

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level.

Table A3: Probability of changing a supplier – all available observations (average effects)

	(1)	(2)
Difficulties (Germany)	0.098**	0.092**
	(0.0.039)	(0.039)
Difficulties (Abroad)	0.2467 ***	0.241***
	(0.042)	(0.525)
Control variables (Survey)	No	Yes
Control variables (Administrative)	No	No
Observations	1,000	1,000

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include dummies for sectors, employment size categories and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition.

Table A4: Probability of changing a supplier – only establishments that receive intermediate inputs from abroad (average effects)

	(1)	(2)	(3)
Difficulties (Germany)	0.006	0.013	0.012
	(0.038)	(0.039)	(0.038)
Difficulties (Abroad)	0.265***	0.284***	0.291***
	(0.0389)	(0.048)	(0.046)
Control variables (Survey)	No	Yes	Yes
Control variables (Administrative)	No	No	Yes
Observations	503	503	503

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include Survey control variables include dummies for sectors, employment size categories and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition.

Table A5: Probability for change in supplier – excluding individual sectors (average effects)

	Excluded sectors			
	Agriculture	**Manufacturing**	**Construction**	**Retail & Maintenance**
Difficulties (Germany)	0.103***	0.0986***	0.1061***	0.1242***
	(0.0332)	(0.035)	(0.0363)	(0.0342)
Difficulties (Abroad)	0.2638***	0.2556***	0.2586***	0.2762***
	(0.0412)	(0.0451)	(0.0413)	(0.0468)
Control variables (Survey)	Yes	Yes	Yes	Yes
Control variables (Administrative)	Yes	Yes	Yes	Yes
Observations	889	657	836	698

	Excluded sectors				
	Transportation	**Hospitality & Tourism**	**Information & Communication**	**Other Services**	**Health Care & Education**
Difficulties (Germany)	0.1064***	0.108***	0.1056***	0.0997***	0.0752**
	(0.0332)	(0.0333)	(0.0329)	(0.0346)	(0.0322)
Difficulties (Abroad)	0.2563***	0.2773***	0.2468***	0.2854***	0.2289***
	(0.0407)	(0.0427)	(0.0415)	(0.046)	(0.0425)
Control variables (Survey)	Yes	Yes	Yes	Yes	Yes
Control variables (Administrative)	Yes	Yes	Yes	Yes	Yes
Observations	891	865	887	773	800

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include dummies for sectors, employment size categories and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition. Each column shows the estimation results when observations from the corresponding sector are excluded.

Table A6: Probability for change in supplier – excluding individual sectors (average effects)

	Excluded size categories			
	Very small (up to 9 employees)	**Small (10-49 employees)**	**Middle (50-249 employees)**	**Large (250+ employees)**
Difficulties (Germany)	0.1378	0.0816*	0.1007***	0.1025***
	(0.0432)	(0.0414)	(0.0337)	(0.0322)
Difficulties (Abroad)	0.2499***	0.2735***	0.2602***	0.2588***
	(0.0426)	(0.0532)	(0.0435)	(0.0409)
Control variables (Survey)	Yes	Yes	Yes	Yes
Control variables (Administrative)	Yes	Yes	Yes	Yes
Observations	724	581	593	838

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include dummies for sectors, employment size categories and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition. Each column shows the estimation results when observations from the corresponding sector are excluded.

Table A7: Probability for change in supplier – by sector (average effects)

	Manufacturing	Retail & Maintenance	Services
Difficulties (Germany)	0.2338	0.0511	0.1468**
	(0.1561)	(0.1461)	(0.0583)
Difficulties (Abroad)	0.4253***	0.2307**	0.2611***
	(0.1356)	(0.1054)	(0.0561)
Control variables (Survey)	Yes	Yes	Yes
Control variables (Administrative)	Yes	Yes	Yes
Observations	255	214	323

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include dummies for employment size categories and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition. The results in the column "Service" include establishments from the following sectors: Hospitality & Tourism, Information & Communication, Other Services and Health Care & Education.

Table A8: Probability for change in supplier – by establishment size (average effects)

	Very small (up to 9 employees)	Small (10-49 employees)	Middle (50-249 employees)	Large (250+ employees)
Difficulties (Germany)	0.1770*	0.2404***	0.0663	0.6824***
	(0.1022)	(0.0823)	(0.1312)	(0.1952)
Difficulties (Abroad)	0.3227***	0.3174***	0.2460**	0.5378***
	(0.0861)	(0.0750)	(0.1215)	(0.1374)
Control variables (Survey)	Yes	Yes	Yes	Yes
Control variables (Administrative)	Yes	Yes	Yes	Yes
Observations	175	331	319	71

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level. Survey control variables include dummies for sectors and East Germany. Administrative control variables include the share of skilled employees and the establishment fixed effects from an AKM-style wage decomposition.

Table A9: Probability of replacing a more with a less distant supplier (average marginal effects)

	(1)	(2)	(3)
Difficulties (Germany)	0.2230	0.2607	0.2124
	(0.2301)	(0.2162)	(0.2358)
Difficulties (Abroad)	0.4198**	0.3982**	0.3686*
	(0.2002)	(0.1943)	(0.2079)
Establishment Size (reference category: 1-9 employees)			
10 to 49 employees	-	-0.3737***	-0.3567**
	(.)	(0.1243)	(0.1442)
50 to 249 employees	-	-0.0586	-0.0482
	(.)	(0.126)	(0.161)
250 or more employees	-	0.0446	0.0531
	(.)	(0.1346)	(0.1913)
Sector (reference category: Agriculture)			
Manufacturing	-	-	-
	(.)	(.)	(.)
Construction	-	0.0414	0.0683
	(.)	(0.1605)	(0.1558)
Retail & Maintenance	-	-0.0887	-0.8
	(.)	(0.1559)	(0.1881)
Transportation	-	-	-
	(.)	(.)	(.)
Hospitality & Tourism	-	-	-
	(.)	(.)	(.)
Information & Communication	-	0.0649	0.0961
	(.)	(0.1798)	(0.1795)
Other Services	-	-	-
	(.)	(.)	(.)
Health Care & Education	-	-0.0241	-0.0118
	(.)	(0.1719)	(0.1524)
Region (reference category: West Germany)			
East Germany	-	-0.0239	-0.0553
	(.)	(0.1186)	(0.1643)
Share of skilled employees	-	-	0.2865
	(.)	(.)	(0.5385)
CHK effects	-	-	0.0183
	(.)	(.)	(0.3355)
Observations	153	153	153

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level.

Table A10: Probability of permanently changing a supplier (average marginal effects)

	(1)	(2)	(3)
Difficulties (Germany)	-0.2753**	-0.3232**	-0.3178**
	(0.1338)	(0.1581)	(0.1305)
Difficulties (Abroad)	-0.2017***	-0.1944***	-0.2042***
	(0.0772)	(0.0666)	(0.0636)
Establishment Size (reference category: 1-9 employees)			
10 to 49 employees	-	-0.1006	-0.1538
	(.)	(0.2688)	(0.107)
50 to 249 employees	-	-0.0323	-0.1154
	(.)	(0.104)	(0.1096)
250 or more employees	-	0.132	0.06287
	(.)	(0.093)	(0.123)
Sector (reference category: Agriculture)			
Manufacturing	-	-	-
	(.)	(.)	(.)
Construction	-	-0.1893	-0.2789
	(.)	(0.2688)	(0.2059)
Retail & Maintenance	-	0.0249	0.0485
	(.)	(0.1168)	(0.1007)
Transportation	-	-	-
	(.)	(.)	(.)
Hospitality & Tourism	-	-	-
	(.)	(.)	(.)
Information & Communication	-	0.1425	.1079
	(.)	(0.1206)	(0.1366)
Other Services	-	-	-
	(.)	(.)	(.)
Health Care & Education	-	0.0433	0.0168
	(.)	(0.1537)	(0.1632)
Region (reference category: West Germany)			
East Germany	-	0.2958***	0.3426***
	(.)	(0.0749)	(0.0702)
Share of skilled employees	-	-	-0.4696
	(.)	(.)	(0.2959)
CHK effects	-	-	0.2359
	(.)	(.)	(0.1655)
Observations	153	153	153

Notes: Unit of observation is establishment. Sampling weights are used. Robust standard errors are shown in parentheses. ***/**/* indicate statistical significance at the 0.01/0.05/0.1 level.