Dissecting Global Value Chains: Evidence from the global automotive industry

Márta Bisztray[1]

December 23, 2021

Abstract

The potential restructuring of global value chains is a widely discussed question in current debates. At the same time, a proper way of capturing these value chains is challenging, given the complex structure of production in many industries. It requires micro-level data to learn more about how entering the global value chain affects the operation of firms. This paper focuses on the automotive industry, using detailed data on firm-to-firm transactions in Hungary, as well as on cross-border sales and purchases, which enables identifying global value chain connections using both within-firm and cross-border links. Its aim is twofold, capturing to what extent firms being connected to a global value chain differ from other firms in the same industry, and what is the impact of integration into global value chains. Findings suggest that firms being part of global value chains tend to be larger, more productive, more likely to be foreign-owned and having a higher level of intangible capital, but there is variation across the type of connection. There is some suggestive evidence that entering the global value chain has a positive impact on size, productivity and per capita wage for certain firm groups and it is preceeded by increased imports of capital. Finally, there are also differences by employee composition captured with a health index.

keywords: global value chains, supplier links, automotive industry

JEL-codes: F23, F61

1 Introduction

Global value chains (GVCs) and their potential transformation is in the forefront of current discussions about the global organization of economic activity and about the international connections between firms. Technological change, automation and digitization, as well as recent trade disputes have all been playing a role in that, while the ongoing pandemic created the already existing challenges even more transparent. At

[1]Centre for Economic and Regional Studies, Budapest, Corvinus University of Budapest, CERGE-EI Foundation Teaching Fellow. Corresponding address: Institute of Economics, Centre for Economic and Regional Studies (KRTK), 1097 Tóth Kálmán u. 4., Budapest, Hungary. Email: bisztray.marta@krtk.hu. I gratefully acknowledge funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 822390, the MICROPROD project. I thank Diána Kimmer and Martin Neubrandt for excellent research assistance. I also thank Rita Pető for calculating and providing the health index data. The present study has been produced using the corporate financial statement, firm registry, customs and VAT transactions data files of the Hungarian Central Statistical Office. The health index data was created using the linked employer-employee database provided by the Databank of the Centre for Economic and Regional Studies (KRTK). The calculations and the conclusions within the document are the intellectual product of the author.

the same time, the complexity of global value chains makes it difficult to capture them properly. This paper combines a rich set of firm-level and firm-to-firm transaction-level data from Hungary to identify a segment of GVCs operating in a specific industry: motor vehicle manufacturing. By doing this, my aim is to answer two major questions: To what extent are firms participating in GVCs different from other firms operating in the same industry? What is the effect of entering the GVC for the firm?

The main challenge in capturing firms being part of GVCs is that both within-country and cross-country supplier links should be considered. There is a large literature about the impact of foreign direct investment on the productivity of local firms operating in the supplier industry (see e.g. Javorcik 2004, Blalock & Gertler 2008, Bruno & Cipollina 2018). We also know that exporters tend to be more productive (Bernard & Jensen 2004, De Loecker 2007, Wagner 2012). One channel of this pattern is a productivity increase resulting from knowledge spillovers and technology transfer through supplier links to 'high-quality' buyers. At the same time, we also know that firms need to have specific characteristics to be able to export or to supply multinationals (e.g. Javorcik & Spatareanu 2009b,a). Consequently, firms being able to enter automotive GVCs are expected to be more productive than the average firm of the industry, and GVC participation is expected to have a positive impact on firm outcomes. Del Prete et al. (2017), who have a similar approach to the current study, show that North African firms participating in GVCs are both more productive before entering the GVC and have productivity gains after the GVC entry. In that paper GVC participation is captured by the use of internationally recognized quality certification. In this study I use direct information about supplier-buyer links and exported products to identify GVC participation, which allows me to compare firms with different types and depths of GVC connection. While external validity is somewhat limited by looking at a specific industry, it enables a more precise identification and classification of GVC-connected firm. As I could not use and combine such rich firm-level data from multiple countries, I only focus on the segment of automotive GVCs within Hungary.

First, I use within-country firm-to-firm transaction data to identify direct suppliers of multinationals operating automotive plants in Hungary. Then I take the suppliers of these firms to capture indirect suppliers as well, up to two iterations. In the second part of the study I identify firms being connected to GVCs via cross-border supplier links. As I have no information on buyers abroad, I use the set of exported products to determine if a firm supplies inputs used in the automotive-industry. With a simple cross sectional analysis I show that suppliers tend to be larger, more productive (in the case of indirect links), rather foreign-owned, located closer to the automotive manufacturer and tend to have more intangibles. GVC-connected firms are indeed different from the average firm operating in the same industry. Higher productivity and a higher level of intangibles suggest that these might also play a role in GVC entry. These differences are weaker for firms connected to GVCs via cross-border supplier links.

Next, I look at GVC entry, defined only for firms supplying automotive manufacturing multinationals in Hungary. I assign controls based on pre-entry characteristics using propensity score matching. With an event-study approach, comparing the outcomes of treated and controls around the time of entry, I find that GVC entry increases firm size in some firm groups and productivity in others. For manufacturing firms it is also coupled with increased capital imports right before the entry.

Finally, I look at worker outcomes, finding that per capita wage tends to increase in manufacturing firms after the GVC entry. This might refer to a change in worker composition after the GVC entry. While data limitations do not allow me to get conclusive results, I also find some further supporting evidence by showing that on average employees of direct suppliers tend to be healthier. This pattern is likely a result of

selection, but it requires further investigations to detetmine if changes in worker composition precede or are rather a consequence of GVC entry.

2 Background

I start with giving a brief overview of the automotive industry in Hungary. For further details see for example Molnár et al. (2020) or Bisztray (2016). Motor vehicle manufacturing is a key industry in Hungary. There are four major multinational automotive manufacturers operating plants in Hungary: Audi located in Győr, Suzuki in Esztergom, Opel in Szentgotthárd, all in the Western part of the country, and Mercedes in Kecskemét, the only one in the Eastern region. Opel and Suzuki started their operations in 1991-1992, right after the transition, Audi started to produce in 1994 and Mercedes entered only later, in 2012. The largest from these four is Audi, constantly expanding its production facilities over time. While the number of local firms supplying these automotive MNEs has been increased over time, it is still an ongoing issue how to help firms becoming a supplier. In case of Audi, a considerable part of major direct suppliers located in Hungary are foreign-owned firms, following their buyer when entering the country. There are more domestic firms among the indirect suppliers. In the next sections I will provide further statistics to characterize the supplier firms of automotive MNEs operating in Hungary.

3 Data

I combine three micro-level panel datasets on Hungarian firms for the main analysis: the corporate financial statement panel, the value added tax (VAT) database and the customs database. All of these are administrative datasets containing the universe of firms which correspond to a specific definition as detailed below. Due to a common anonymized firm identifier information on firms in these three datasets can be matched in a clear way.

The corporate financial statement panel is collected by the National Tax and Customs Administration (NTCA) and provides a rich set of firm characteristics. It includes balance sheet and profit&loss statements data, information on industry, the number of employees, foreign ownership and the location of the headquarters for all double-entry bookkeping firms in Hungary. It is a long panel between 2000 and 2018. The dataset is extensively cleaned, smoothing variables from one-time large outliers within a firm and imputing missing information. For total factor productivity (TFP) estimation capital is cleaned using the perpetual inventory method, and TFP is calculated by 2-digit NACE categories following the method of Ackerberg et al. (2015), assuming a Cobb-Douglas production function.

The value added tax database is collected by the National Tax and Customs Administration and it is available for the years 2015-2019. It contains all within-country firm-to-firm transactions above a small value threshold (around EUR 10,000), which are between taxable firms liable for the payment of VAT. As the value threshold became even lower in 2018, I included only those firm pairs in each year for which the total annual value of transaction was above 3M HUF. The unit of observation is a firm pair in a year. Unique identifiers allow to connect observations of the same firm on the buyer and supplier side and to connect additional firm characteristics from other firm-level data. I use this dataset to determine direct and indirect

suppliers of large multinational automotive manufacturers with plants located in Hungary.

The customs database is a yearly administrative dataset of the value of exported and imported goods at the firm-level by destination/source country and product, using the 8-digit combined nomenclature classification. Like the financial statement panel, it is also available until 2018. This dataset allows me to identify firms participating in automotive GVCs via cross-border links based on the products they export.

In the final part of the study I look at worker outcomes, including the state of health. This is captured with a health index[1], calculated using a rich set of health indicators. This information is available in a monthly linked employer-employee panel dataset from Hungary, which contains a random 50% sample of the population in 2003, following them until 2017. The dataset combines administrative data from the National Health Insurance Fund Administration, the Hungarian State Treasury, the National Tax and Customs Administration, and the Ministry of Finance and the Educational Authority, and it is cleaned and provided by the Databank of the Centre for Economic and Regional Studies(Sebők 2019). Firms can't be matched to the other datasets based on firm identifier. Instead, I do a probabilistic matching based on firm characteristics available in both datasets, which allows a higher than 99% match rate.

4 Determining the direct and indirect suppliers

As a starting point of the further analysis I need to determine the firms connected to global automotive value chains. As no direct firm-level information is available on that, I construct multiple measures to capture automotive GVC connections. This requires looking at both within-country and cross-border supplier links. I have more detailed data on within-country supplier links including direct information about the characteristics of the buyer. Therefore in the first part of the analysis I focus on within-country supplier connections to multinationals operating plants in the automotive industry in Hungary. Then in section 8 I extend the investigation to cross-border supplier links.

To capture within-country supplier links to automotive GVCs, I take the four large automotive-industry plants in Hungary which are owned by multinational firms: Audi in Győr, Mercedes in Kecskemét, Suzuki in Esztergom and Opel in Szentgotthárd. As a simplification, I refer to these companies as the *automotive MNEs*. While firm-level data are anonymized, I can identify the group of companies as the four firms having the largest sales in the industry 'Manufacture of motor vehicles' (NACE Rev.2. category 29.10). In each year I take the suppliers of these firms from the VAT data. In the followings, I refer to these firms as *direct suppliers*. As there is a considerable heterogeneity across these suppliers by the value of the transaction and the repeated or one-time nature of the relationship, I aim to distinguish stronger or more important supplier links. I do so by taking those supplier connections in which at least 10% of the supplying firm's annual transaction value in the VAT-data goes to an automotive MNE buyer and label them *≥10% direct suppliers*. I consider supplier firms both in manufacturing and services. I always make it clear if I only focus on manufacturing firms in some parts of the analysis.

To establish automotive GVC connections, indirect supplier links to automotive MNEs are also crucial. It is an important limitation of the VAT transaction data, that I don't have any information about the product or service which a firm sells to the other one. As many firms produce multiple products, I

[1]Health indices were calculated and provided by Rita Pető.

can't be sure if an input bought from a supplier is used for a product sold to a specific buyer. The only information I can use which can help me to capture indirect links is the industry of the buyer and the supplier, the importance of the specific buyer in the supplier's buyer portfolio and the stability of the supplier link between the two firms. I take those ≥10% direct suppliers which have a stable link with the automotive MNE, measured as remaining a direct supplier also in the subsequent year. Then I define their suppliers as *round-1 indirect suppliers*. Following this iteration process, I define those firms as *round-2 indirect suppliers* which supply stable ≥10% round-1 indirect suppliers. A firm is classified as a stable ≥10% round-1 indirect supplier if at least 10% of its annual transaction value in the VAT-data is sold to a direct supplier and this supplier link is also present in the next year. When I determine manufacturing round-2 indirect suppliers, I look at only manufacturing round-1 indirect suppliers among their buyers. While this approach helps me to focus on important connections from the perspective of the supplier firm, a limitation is that buyer shares being above the 10% threshold in one year but below in another result in artificial entries into and exits out of supplier status. To mitigate this problem when I look at firms entering the automotive GVC, I consider only those firms which haven't been classified as a supplier ever before in the data.

Table 1 shows the yearly number of suppliers by type. From all the firms classified as suppliers about 1.5% are direct suppliers and 20% are round-1 indirect suppliers. The same shares are 10% and 25% among ≥10% manufacturing suppliers. About 50-60% of the direct suppliers and 70-90% of the indirect suppliers are ≥10% suppliers. 25% of these direct suppliers are manufacturing firms, while the share of manufacturing firms is only 2-5% among all the ≥10% indirect suppliers. Finally, the share of domestic firms around 60% in the ≥10% direct manufacturing suppliers, while it is above 80% for the indirect suppliers.

As Table 2 shows, except for round-2 indirect (non-manufacturing) suppliers, the majority of firms has a strong link (i.e. selling ≥ 10% of total VAT transaction value) to only one of the four automotive MNEs in Hungary. Multiple strong links are more prevalent for indirect suppliers.

Tables 3 and 4 show the share of continuing and the share of new strong (≥ 10%) supplier links. Strong links tend to be stable, especially for manufacturing suppliers of which typically more than 90% stay a strong supplier in the subsequent year, and somewhat less stable for indirect suppliers. New suppliers which become stable suppliers (i.e. stay suppliers in the subsequent two years) are relatively few among the ≥ 10% suppliers. For most of the new indirect suppliers the new link is between the indirect supplier and its buyer (new direct link) and not between a buyer and an automotive MNE.

Focusing on manufacturing suppliers, most of the direct suppliers are concentrated in a few industries, mostly within rubber and plastic product, fabricated metal product and motor vehicle manufacturing, and repair and installation of machinery (industries 22,25,29 and 33 in NACE Rev 2. classification), others being in textiles, computers and electronics, and machinery and equipment manufacturing (industries 13,26 and 28). These are also the industries in which the majority of indirect suppliers operate, but there a number of additional industries containing only indirect suppliers, typically within basic metal, fabricated metal, and machinery and equipment manufacturing (NACE codes 24,25 and 28). I present further details in Appendix Tables A1-A2.

Figure 1 shows that direct manufacturing suppliers tend to be located closer to the supplier automotive MNE than indirect suppliers. In the case of direct suppliers, ≥ 10% suppliers are also located closer than the others. But even for ≥ 10% direct suppliers only about 30% is located within a distance of 30 km and another 30% is located farther than 100 km away. The same numbers are around 10% and 50% for round-1 indirect suppliers.

5 Characteristics of suppliers

After I have provided an overview of the main characteristics of supplier firms, I estimate the role of different observable firm characteristics in distinguishing suppliers from non-supplier firms. Here I focus on $\geq 10\%$ manufacturing suppliers, using a cross-section from year 2015. I separately look at direct, round-1 and round-2 indirect suppliers. Among the non-suppliers I only consider those manufacturing firms which ever had at least 5 employees in the period of observation and which operate in a 4-digit industry with at least one direct or indirect automotive MNE supplier in 2015. For non-suppliers I calculate the distance from the closest automotive MNE within Hungary.

As a baseline, I estimate simple linear probability regressions of the form

$$Y_i = \beta_1 + \beta_2 X_i + \alpha_{j(i)} + \epsilon_i, \tag{1}$$

in which i is a firm and j is an industry, Y is an indicator of being a (direct or indirect) automotive MNE supplier, X is a set of firm characteristics including firm size, productivity, tangible and intangible assets, export share and distance from the closest (or the supplied) automotive MNE, α_j is 2-digit industry-fixed effect and ϵ is the error term.

Columns (1)-(3) of Tables 5-7 show the results of the estimated linear probability regressions by supplier group. In all supplier groups suppliers tend to be larger, foreign-owned, located closer to the automotive MNE and have a higher value of intangibles and a lower export share compared to non-suppliers in the same 2-digit industry. Indirect suppliers also have on average a higher value of fixed assets than non-suppliers. While there is no significant productivity difference between direct suppliers and non-suppliers, indirect suppliers have a higher productivity on average than non-suppliers. Most of results are reinforced by alternative probit specifications presented in columns (4)-(6). As a robustness check, in Appendix Tables A3-A5 I also present similar linear probability regressions with 4-digit industry-fixed effects, as well as conditional logit regressions, in which the choice set contains all the firms in a 4-digit industry. If multiple firms are automotive MNE suppliers from the same 4-digit industry, then these are regarded as the outcome of multiple choices. The main patterns stay the same in these specifications as well.

These regressions only show correlations between firm characteristics and supplier status, and most of the results are not surprising, and similar to the characteristics of exporter firms being larger and more productive (see Greenaway et al. 2005). Having a lower export share is also intuitive, as these firms have large domestic sales by definition. At the same time, the lack of evidence for a productivity advantage of direct suppliers is a puzzle which calls for further investigations. Finally, the higher value of intangibles is in line with the results of other papers emphasizing the role of intangibles in increasing firm productivity (Demmou & Franco 2021, Andrews et al. 2016, Bloom et al. 2012) and forming high-quality supplier links or exporting (Hagsten & Kotnik 2017).

6 Event study for firms entering the GVC

While the previous section presents simple correlations between firm characteristics and supplier status, in this section my aim is to make a causal analysis. For this end, I look at the sub-sample of firms which became a direct or indirect automotive MNE supplier in the period of observation. I assign a comparable control group from the non-suppliers with propensity score matching on firm characteristics from earlier years, and I do an event study estimation on the matched sample in which the event corresponds to entering the automotive GVC. I capture automotive GVC entry as becoming a direct or indirect supplier of any automotive MNE in Hungary for the first time. I also include those cases in which the firm was a lower-level (e.g. round-2 indirect) supplier before and became a higher-level (e.g. round-1 indirect) supplier for the first time. I do not regard those cases as automotive GVC entries in which the firm has already been observed as a same- (e.g. round-1 indirect) or higher-level (e.g. direct) supplier of one of the four automotive MNE-s located in Hungary. I consider also those cases as an indirect entry, in which an established buyer forms a new link with the automotive MNE, but these are relatively few (see Table 4. I look at suppliers in both manufacturing and services, but indirect suppliers of services should be connected to the automotive MNE via manufacturing buyers.

A major limitation of this approach is the low number of firms becoming direct or indirect automotive MNE suppliers for the first time in the period 2016-2018. This is the case even if I consider all the new direct suppliers and not only the $\geq 10\%$ ones. To be more conservative, due to a higher uncertainty in the indirect supplier definition, I keep only the $\geq 10\%$ indirect suppliers, which might introduce some noise in the time of entry. As a partial remedy for the low number of automotive GVC entries which I can capture, I exploit the fact that one of the four automotive MNEs located in Hungary, the Mercedes plant in Kecskemét started to produce in 2012. This means that firms being a direct or indirect supplier of only Mercedes but not of the other three automotive MNEs in 2015 are likely to become a supplier for the first time in the period 2012-2015. Here I assume that starting a supplier link with Mercedes was not coupled with ending a similar supplier link with another automotive MNE. While this solution introduces noise concerning the time of entry and makes patterns over time less clear, by choosing 2011 as the pre-event year for these firms still allows me to capture the impact of entry if it results in a more persistent change. I also do robustness checks including only those firms in my sample for which the exact year of becoming an automotive MNE supplier for the first time is known.

Another limitation is not regarding already prevalent supplier links to automotive MNEs operating abroad. This can lead to underestimating the impact of entering the automotive GVC with the current approach. In section 8, I consider this firm group as well, but I don't do a similar event study with these firms, as the way I define them — using the share of exported automotive-industry inputs in their total sales — makes the time of automotive GVC entry highly imprecise. Still, I expect that participation in automotive GVCs via exports previous to becoming a supplier of an automotive MNE in Hungary for the first time, does not have a large effect on my estimates. As Appendix Table A17 shows, the average export share of direct or indirect within-country automotive-MNE suppliers is rather low.

For the control assignment I consider only those firms which are never defined as a similar or higher-level (e.g. direct for a round-1 indirect) within-country automotive MNE supplier in the period of observation, taking the weakest supplier definitions. The matching is based on firm characteristics one year before the new supplier becomes an automotive MNE supplier for the first time and based on year 2011 characteristics for the firms supplying only Mercedes in 2015. A do an exact matching on 4-digit industry

and use propensity score matching for the other firm characteristics, estimating the following regression:

$$Probit(Y_{i,t+1}) = \beta_1 + \beta_2 X_{i,t} + \alpha_{j(i)} + \alpha_t + \epsilon_{i.t}, \tag{2}$$

in which i stands for a firm, j stands for a 4-digit industry and t is calendar year. Y is an indicator for the firm becoming a direct or an indirect supplier for the first time in the following year $(t+1)$. X is a set of firm characteristics, which include the number of employees, total domestic sales in the VAT data, exporter status, foreign-owned status, labour productivity, and distance from the directly or indirectly supplied automotive MNE or from the closest automotive MNE in the case of controls. In the baseline version I also include growth in employment and sales between year $t-2$ and t in which t stands for the year preceding the event of becoming a supplier. As a robustness check I exclude these in an alternative control assignment. I do a separate matching for direct, round-1 and round-2 indirect suppliers. Appendix Table A9 shows the estimated coefficients of probit regressions for the first two, as I will use these groups in the event study regressions. As a final step of the control assignment I take the nearest neighbors based on the propensity score, dropping those firms for which the propensity score difference from the closest control is more than 0.01 percentage points for the direct and more than 0.05 percentage points for the round-1 indirect suppliers.[2] Appendix Tables A10 and A11 present balance tests with the baseline and alternative controls, separately by the sector and type (direct or indirect) of the new supplier. These suggest that three years before the event the two groups are not significantly different in terms of number of employees, sales, productivity, exporter status or average wage paid.

I present further descriptive statistics about new suppliers and assigned controls in the Appendix. Appendix Table A6 shows the number of new suppliers by sector and level. There are about half as many new suppliers in manufacturing than in services. The most numerous category is the round-1 suppliers, which contains more than twice as many firms as the other two. The majority of new suppliers is domestically owned in all the categories, but the share of foreign-owned new suppliers is higher among the direct suppliers. Appendix Table A7 shows the top six 2-digit manufacturing and service industries based on the number of new suppliers. Most of the new manufacturing suppliers operate in fabricated metal product manufacturing (NACE 25) and the top categories within services are wholesale trade (NACE 46), services to buildings (NACE 81) and architectural and engineering activities (NACE 71). Finally, Appendix Table A8 gives the yearly number of new suppliers and the number of unique firms assigned as controls for a specific supplier group, considering both the baseline and the alternative control assignment. Although the same firm can be a control for multiple new suppliers, the numbers show that it is not frequently the case.

With these matched controls I estimate simple event study regressions of the following form:

$$Y_{it} = \beta_0 + \sum_{s=-8}^{1} \beta_1 D_t^s + \sum_{s=-8}^{1} \beta_2 D_t^s Sup_{it} + \alpha_i + \epsilon_{it}, \tag{3}$$

in which i is a firm and t is a year. Y is a specific firm characteristic, D^s is a set of event-year dummies between event-year -8 and 1 and Sup is an indicator for the firm becoming direct or indirect automotive MNE supplier in event-year 0. α_i is firm-fixed effect and ϵ is the error term. I run separate

[2]There are more potential controls for direct suppliers, as also round-1 indirect suppliers can be considered, which explains the higher cutoff in the case of indirect suppliers.

regressions for direct and round-1 indirect suppliers, as well as for manufacturing and service firms. To be conservative, I use event-year -5 as the reference period in the main regressions. This corresponds to year 2010 for the suppliers of Mercedes in 2015, which is two years before the potential earliest year of being a supplier of Mercedes. In this case, differences in event-year -4 (but not before) might be associated with preparations for becoming a supplier. In robustness checks excluding 2015 suppliers of Mercedes I use event-year -3 as the reference period.

Tables 8-10 present the main findings. As the number of new suppliers is small, estimates are noisy and not always reinforced by robustness checks using the alternative control assignment or excluding Mercedes suppliers with an unclear year of entry (presented in Appendix Table A14. Still, there is suggestive evidence for some tendencies around the time of becoming a new supplier. Table 8 suggests that new service supplier firms tend to increase their employment after becoming a supplier, while new manufacturing suppliers tend to be larger even before. Patterns are similar but significant for sales (see Appendix Table A12). While results are not robust across specifications, estimates for TFP (in Table 9) and labour productivity (in Appendix Table A13 provide some suggestive evidence for manufacturing firms becoming more productive after starting to supply automotive MNEs in an indirect way, while there is no similar pattern for service firms. There is no evidence for any effect of the supplier status on export activity. Finally, results for imports in Table 10 suggest that starting a new supplier relationship with an automotive MNE requires capital investment from manufacturing suppliers, as they tend to increase their imports of capital goods before the start to supply the automotive MNE.

To summarize my findings, starting to supply (directly or indirectly) an automotive MNE tends to be coupled with an increase in size or in productivity for some groups of suppliers, and it is preceded by investments into imported capital, but there are differences across supplier groups. These findings are in line with previous literature on FDI increasing the productivity of firms in supplier industries (e.g. Javorcik 2004), and on previous findings connected to the importance imported inputs in firm performance (e.g. Halpern et al. 2015).

7 Cross-border links to the automotive GVC

Now I turn to firms being connected to an automotive GVC by exporting intermediate inputs. I refer to these firms as *cross-border suppliers*. As I have no information about the identity of the buyer located abroad, I use the set of exported products to classify firms as cross-border suppliers in an automotive GVC. To this end, first I determine the set of products which are likely to be inputs used in the automotive industry. Then I define firms as cross-border suppliers for which a high share of their total sales comes from exporting these types of products.

To get the list of products which can be considered as automotive industry inputs, I combine information on the imports of automotive MNEs in Hungary and on the exports of their direct suppliers. Here I focus on manufacturing suppliers. I have no information on the products sold domestically, and firms might sell domestically and export different goods. Still, by looking at multiple automotive manufacturers with a different supplier portfolio within the country and located abroad, and by looking at multiple suppliers, I expect that I can capture the most important set of products. Throughout this exercise I use 6-digit product classifications based on the combined nomenclature and look at data from year 2015.

I take all the intermediate goods — classified using Broad Economic Categories — imported by any of the four automotive MNEs in Hungary and rank them by the total imported value. I define those products which account for a cumulated share of 99% in the total value of intermediates imported jointly by the four automotive MNEs as *top imports of automotive MNEs*. I do the same for the intermediate products exported by direct manufacturing suppliers, defined as *top exports of direct suppliers*. Then I add those intermediate goods which can be regarded as an automotive-industry input based on the name of the product category. These include categories referring to motor vehicles or any parts thereof, like engines, breaks, rear-view mirrors or windshields of cars which are clearly used in automotive manufacturing. I create a narrow (including motor vehicles and engines) and a broad set (including other parts as well) of these additional inputs. Appendix Table A16 presents the number of products by different classifications. Finally I classify a narrow set of automotive-industry inputs as those good which are either top imports of automotive MNEs, or can be considered as such using the broad list of motor vehicle or automotive part inputs based on the product description. A medium-size set of automotive-industry inputs also includes top exports of direct suppliers. Finally the broad set of such products includes also those goods which are not in the top list, but which are both imported by automotive MNEs and exported by direct suppliers.

Then I consider those firms as cross-border automotive suppliers which are not direct or indirect within-country suppliers, and for which at least 30% of total sales comes from the export of automotive-industry inputs. The 30% cutoff corresponds to the lowest decile of the share of total sales to within-country automotive MNEs by direct suppliers. I classify cross-country suppliers as type-1 when I use the narrow set of automotive-industry inputs for the categorization, type-2 corresponds to the medium-size set and type-3 to the broad and least precisely measured set. Appendix Table A17 shows the share of within-country and cross-border automotive input sales in total sales by supplier group. As the measurement of indirect cross-border suppliers would be even more noisy, I only focus on direct suppliers defined as above.

Table 11 shows that the industry composition of direct within-country suppliers and cross-border suppliers is quite similar, most of the firms operating in fabricated metal, rubber and plastic product, machinery and equipment and motor vehicle manufacturing, while a higher share of cross-border suppliers operate in electrical equipment manufacturing. Differences in industry composition get larger when I use a broader set of products as automotive-industry inputs in the definition (type-2 and type-3 cross-border suppliers).

I take this additional set of cross-border suppliers and rerun my previous estimates for supplier characteristics on a broader set of suppliers, including both within-country direct and cross-border suppliers. Results presented in Table 12 are similar to previous ones. Suppliers are on average larger, located closer to automotive MNEs in Hungary, but not more productive than non-suppliers. The broader set is not more likely to be foreign, but has a higher export share on average, due to the inclusion of cross-border suppliers. I also check if there is a difference between within-country direct suppliers and cross-border suppliers. the regression sample in Table 13 includes only these two types of firms with an indicator for a direct within-country supplier status as the dependent variable. The two sets of firms are not very different, within-country suppliers tend to be larger and have an - obviuously - lower export share than cross-country suppliers. Finally, I compare only cross-country suppliers with firms not being any type of automotive industry suppliers in Table 14. The only significant and robust difference for these firms is the higher export share, which is so by definition. However, these patterns might be the result of a less reliable definition of cross-border suppliers.

8 Worker outcomes

As a final exercise, I look at what happens to workers in firms which became part of an automotive GVC. In a first approach I include per capita wages as outcome variables in the event study regressions considering new suppliers. Second, I use a proxy for the average health status of employees, and look at differences across supplier and non-supplier firms, as well as dynamics for new entrants.

Table15 presents the results of event study regressions with the log of per capita on the left-hand side, and tableA15 provides robustness checks including only suppliers with exactly known start years of the supplier relationship. Results suggests, that manufacturing firms becoming direct suppliers tend to pay higher wages on average. This might be the result of sharing the rents of a high-quality supplier relationship with the employees, or — more likely — from changing the employee portfolio and hiring more qualified employees. Due to data limitations I can't investigate this hypothesis more directly.

Then I look at the health status of employees, using an average health index which is calculated yearly by firm.[3] A yearly health index by person is calculated using a linked employer-employee database, which includes a random 50% of the population and which contains a detailed set of health indicators. A health index is estimated by predicting the probability of being hospitalized or dying in the subsequent year, based on age and on an extensive set of health indicators, including drug expenditures by different drug categories, number of visits to the doctor or days spent in the hospital in the current year. As a result, a higher health index captured a worsening state of health. The health index is only estimated for males of age 35-70. I take those firm-year observations for which there are at least three male employees with an estimated health index and calculate their average health index. As firms in the linked employer-employee dataset have a different identifier from the ones in the other datasets I use, I do a probabilistic matching based on firm characteristics which are observable in both datasets. These include the number of employees, sales, export sales, the foreign-owned part of subscribed capital, material and personal costs, and industry. I do exact matching on 4-digit industry and nearest neighbor matching on the other firm characteristics. Appendix Table A18 shows that focusing on manufacturing firms ever having at least 5 employees, more than 99% of the observations in which the firm has an assigned average health index can be matched to a firm-year observation in the main dataset I use. As a result, I have information on employees' health in at least one year for 45% of the manufacturing firms with at least 5 employees in the main sample, and the yearly share of firms with employee health information is 33-38%. Health index data are only available between 2009 and 2016.

First I look at the cross-section, comparing the average health index of male employees in firms being connected to automotive GVC-s and in other firms. Panel (b) of Figure 2 shows the average health index of firms in different categories in 2015. It suggests that suppliers — and especially direct suppliers — have a lower average employee health index, meaning that the average health status of their (male) employees is higher. This might be the result of selecting healthier and younger employees. Table 16 shows the result of t-tests, comparing the average health index of different supplier groups with that of the other firms not being an automotive-industry supplier. Results suggest that the employees of direct within-country suppliers indeed have a better state of health on average. The same is true including cross-border suppliers in the supplier category, while difference is not significant anymore when I also include indirect suppliers in the supplier group. While the number of firms for which I have more information on the distribution of the

[3] I thank Rita Pető for calculating and providing health index data.

employees' health index is lower, panels (a) and (c) of figure 2 present the average health index of the bottom and the top quartile of male employees with a health index by firm group. Patterns suggest that average differences between supplier and non-supplier firms are mainly driven by the top quartile, i.e. supplier firms having less employees with a worse health status.

As I showed before, supplier firms differ from non-suppliers in multiple aspects. To see if these differences are the main drivers of the difference in worker's average health index between supplier and non-supplier firms, first I run a simple cross-sectional linear regression. I include the average health index of a firm on the left-hand side, the main variable of interest is an indicator for the firm not being an automotive supplier, and I control for observable firm characteristics including size, productivity, 4-digit industry, and foreign-owned and exporter status. Table 17 show the estimation results. These suggest that larger firms tend to have employees with a worse state of health on average, while foreign-owned or more productive firms have employees with a better health on average. Even after controlling for these firm characteristics, I find that direct within-country automotive MNE suppliers tend to have somewhat healthier employees on average compared to non-suppliers, though the coefficient of interest is only weakly significant.

Lastly, I check if there is any suggestive evidence for causality in that, i.e. whether the average health index of employees in firms becoming suppliers gets lower after the start of the supplier relationship. This could also refer to selection of healthier employees upon entering the automotive GVC. To look at this question, I repeat the previous event study for manufacturing firms becoming a supplier of a within-country automotive MNE for the first time. As only less than 40% of the firms have an assigned average employee health index in each year, moreover, health index data is only available until 2016, the sample of new manufacturing suppliers with a matched health index becomes quite low (see the last panel of Appendix Table A8). Consequently, I should consider direct suppliers and round-1 and round-2 indirect suppliers jointly, while in the cross-section I find no significant difference between the average health index of this firm group and that of the non-suppliers. Table 18 shows the estimation results, which show no evidence for a decrease in the average health index of employees after the firm becomes a direct or indirect supplier of a within-country automotive MNE. This is either because the estimates are noisy in the small sample, or improvements in average health due to changes in employee composition might be offset by the potentially negative impact of increased stress.

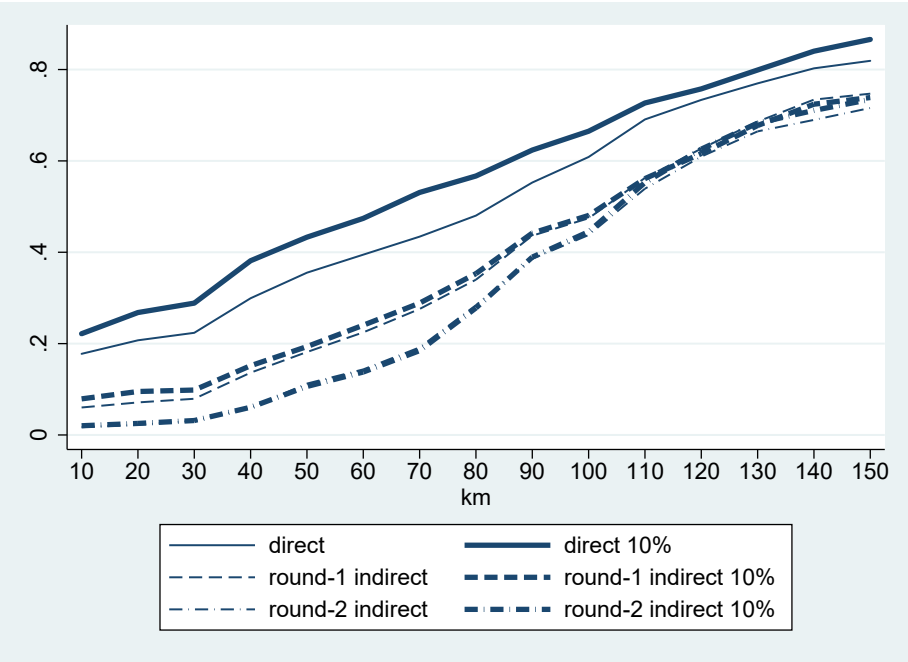
9 Conclusion

The aim of this study was to look into global value chains using detailed firm-level data. I used the case of the automotive industry, by focusing on firms operating in Hungary and being part of an automotive global value chain. I combined rich firm-level and transaction-level datasets which enable the identification of firms' links to automotive GVCs either by directly or indirect supplying automotive manufacturer MNEs operating plants in Hungary, or by exporting intermediate inputs to automotive-industry firms operating abroad. I identified within-country direct, round-1 and round-2 indirect suppliers with the help of transactions registered in the VAT database. I showed that compared to the average firm in the same 4-digit industry these firms tend to be larger, more likely being foreign owned, having a lower export share, more intangibles and also more productive in the case of indirect suppliers. Then I used an event study approach with controls assigned based on propensity score matching, in which I showed some evidence for some types of firms becoming larger or more productive after starting to supply directly or indirectly to an automotive MNE located

in Hungary. In the case of manufacturing firms, this event tends to be preceded by in increased amount of capital imports. Next, I captured cross-border auto GVC suppliers by looking at the product mix of exports in intermediate goods of firms. I classified 6-digit product categories as automotive-industry inputs based on the imported intermediates of the four automotive MNE-s operating in Hungary and the exported intermediaries of their direct manufacturing suppliers, also considering product description. I showed that these firms differ less from non-suppliers in the same industry than the previously identified direct or indirect suppliers of automotive MNEs operating in Hungary. Finally, I looked at worker outcomes, providing some evidence for increased per capita wages after entering the GVC and a better average health status of male employees in (direct) supplier firms compared to non-suppliers. These suggest that supplier status is also coupled with differences in employee composition, though data limitations do not allow me to establish a clear causality.

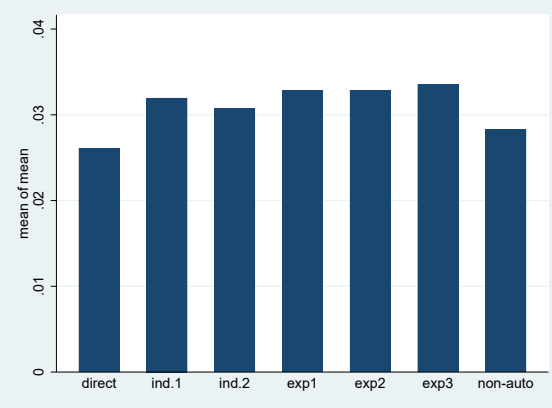
Figures

Figure 1: Share of manufacturing suppliers by distance

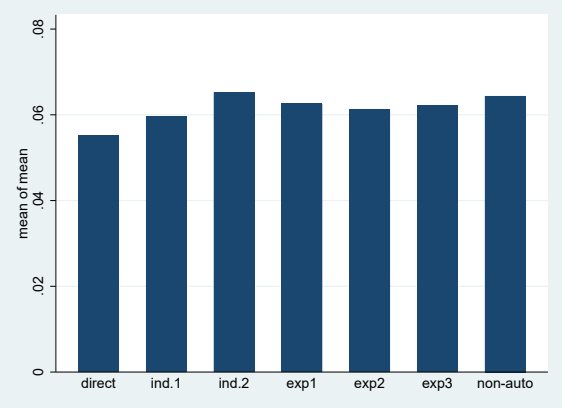


Notes: The figure shows the share of suppliers in a specific supplier type which are located within a given distance limit from the supplied automotive plant. I define supplier links based on transactions in 2015. Direct suppliers are manufacturing firms selling to an automotive MNE in Hungary. '10%-type' direct suppliers sell at least 10% of their total VAT sales to an automotive MNE in Hungary. Round-1 indirect suppliers are firms selling to stable '10%-type' direct suppliers, in which 'stable' refers to staying a supplier in the following two years. '10%-type' round-1 indirect suppliers sell at least 10% of their total VAT sales to a direct supplier. Round-2 indirect suppliers are firms selling to a stable '10%-type' round-1 indirect supplier. '10%-type' round-2 indirect suppliers sell at least 10% of their total VAT sales to a round-1 indirect supplier.

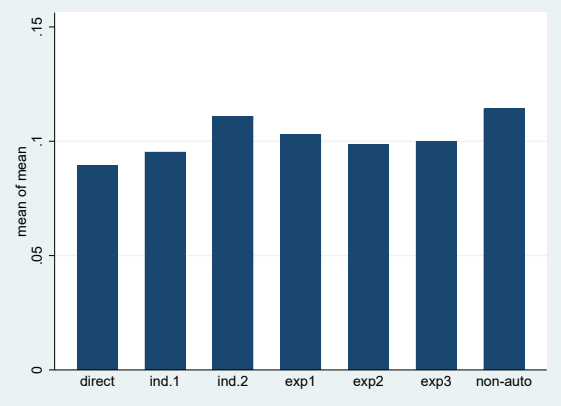
Figure 2: Health index comparison across firm groupss



(a) Average of bottom quartile



(b) Overall average



(c) Average of top quartile

Notes: The health index is calculated using detailed health-related characteristics and age of a person, capturing the probability of being hospitalized or dead next year. A higher health index refers to a worse state of health. The average health index of a firm is calculated based on male employees of age 35-70. Bottom and top quartiles refer to employees being in the lowest and highest 25% based on their health index. 'Direct' refers to direct suppliers of automotive MNEs in Hungary. 'Ind1' and 'ind2' refer to round-1 and round-2 indirect within-country suppliers. 'Exp1'-'exp3' refer to cross-border automotive suppliers using a narrow (1) or broader (2-3) set of products in the definition. 'Non-auto' refers to other firms not being automotive suppliers.

Tables

Table 1: Yearly number of suppliers by group

Year	2015	2016	2017	2018	2019
All direct	1039	1048	954	1229	1214
All direct with ≥10% share	662	656	495	693	662
Direct with ≥10% share, manufacturing	175	190	119	188	182
Direct with ≥10% share, manufacturing and domestic	104	114	72	115	113
All round-1 indirect	12883	12229	14823	20642	21390
All round-1 indirect with ≥10% share	9108	8668	10409	14615	15042
Round-1 indirect with ≥10% share, manufacturing	402	447	338	549	561
Round-1 indirect with ≥10% share, manufacturing and domestic	330	366	282	472	480
All round-2 indirect	47308	46493	57772	79973	85427
All round-2 indirect with ≥10% share	42439	41710	51612	72290	77316
Round-2 indirect with ≥10% share, manufacturing	982	1033	882	1329	1528
Round-2 indirect with ≥10% share, manufacturing and domestic	842	899	774	1200	1370

Notes: Direct suppliers are firms selling to an automotive MNE in Hungary. '≥10%' direct suppliers sell at least 10% of their total VAT sales to an automotive MNE in Hungary. Round-1 indirect suppliers are firms selling to stable '≥10%' direct suppliers, in which 'stable' refers to staying a supplier in the following two years. '≥10%' round-1 indirect suppliers sell at least 10% of their total VAT sales to a direct supplier. Round-2 indirect suppliers are firms selling to a stable '≥10%' round-1 indirect supplier. '≥10%e' round-2 indirect suppliers sell at least 10% of their total VAT sales to a round-1 indirect supplier. For indirect manufacturing suppliers I only consider links to manufacturing buyer.

Table 2: Share of suppliers with ≥10% share selling to a single automotive MNE in Hungary

Year	2015	2016	2017	2018	2019
All direct	95%	94%	96%	95%	95%
Manufacturing direct	93%	93%	95%	94%	94%
All round-1 indirect	61%	63%	67%	60%	60%
Manufacturing round-1 indirect	78%	78%	76%	83%	87%
All round-2 indirect	29%	32%	32%	29%	25%
Manufacturing round-2 indirect	69%	70%	69%	64%	71%

Notes: The table shows the share of suppliers having a strong link to only one of the four automotive MNEs in Hungary. '≥10%' direct suppliers sell at least 10% of their total VAT sales to an automotive MNE in Hungary. '≥10%' round-1 indirect suppliers sell at least 10% of their total VAT sales to a stable '≥10%' direct supplier, in which 'stable' refers to staying a supplier in the following two years. '≥10%e' round-2 indirect suppliers sell at least 10% of their total VAT sales to a stable '≥10%e' round-1 indirect supplier. For indirect manufacturing suppliers I only consider links to manufacturing buyer.

Table 3: Share of suppliers staying ≥10% suppliers next year

Year	2015	2016	2017	2018
All direct	83%	62%	72%	85%
Manufacturing direct	90%	73%	92%	92%
All round-1 indirect	65%	67%	61%	73%
Manufacturing round-1 indirect	78%	82%	86%	84%
All round-2 indirect	57%	63%	56%	73%
Manufacturing round-2 indirect	75%	78%	80%	86%

Notes: The table shows the share of suppliers with a strong (direct or indirect) link to an automotive MNE in Hungary which stay a strong supplier in the subsequent year. '≥10%' direct suppliers sell at least 10% of their total VAT sales to an automotive MNE in Hungary. '≥10%' round-1 indirect suppliers sell at least 10% of their total VAT sales to a stable '≥10%' direct supplier, in which 'stable' refers to staying a supplier in the following two years. '≥10%e' round-2 indirect suppliers sell at least 10% of their total VAT sales to a stable '≥10%e' round-1 indirect supplier. For indirect manufacturing suppliers I only consider links to manufacturing buyer.

Table 4: Share of new ≥10% suppliers

Year	2016	2017
All direct	19%	30%
Manufacturing direct	17%	8%
All round-1 indirect - new direct link	29%	40%
All round-1 indirect - new indirect link	1%	1%
Manufacturing round-1 indirect - new direct link	16%	18%
Manufacturing round-1 indirect - new indirect link	1%	2%
All round-2 indirect - new direct link	21%	29%
All round-2 indirect - new indirect link	3%	10%
Manufacturing round-2 indirect - new direct link	13%	11%
Manufacturing round-2 indirect - new indirect link	4%	7%

Notes: The table shows the share of new firms among all the suppliers with a strong link to an automotive MNE in Hungary by type of the supplier. '≥10%' direct suppliers sell at least 10% of their total VAT sales to an automotive MNE in Hungary. '≥10%' round-1 indirect suppliers sell at least 10% of their total VAT sales to a stable '≥10%' direct supplier, in which 'stable' refers to staying a supplier in the following two years. '≥10%e' round-2 indirect suppliers sell at least 10% of their total VAT sales to a stable '≥10%e' round-1 indirect supplier. For indirect manufacturing suppliers I only consider links to manufacturing buyer. A new direct link refers to a situation in which the firm itself becomes a new supplier of a (direct or indirect) automotive MNE supplier. A new indirect link refers to a situation in which the firm has an established (direct or indirect) link to a buyer which becomes a new (direct or indirect) automotive MNE supplier.

Table 5: Probability of being a direct supplier

Dep.var.: direct supplier

spec.:	(1) lin.prob	(2) lin.prob	(3) lin.prob	(4) probit	(5) probit	(6) probit
log employees	0.00426***	0.00347***	0.00166	0.185***	0.163**	0.0679
	(0.00135)	(0.00134)	(0.00138)	(0.0630)	(0.0665)	(0.0658)
log sales	0.00490***	0.00558***	0.00583***	0.158**	0.177***	0.159**
	(0.00125)	(0.00126)	(0.00145)	(0.0626)	(0.0652)	(0.0657)
exporter	-0.000589	-0.000207	-0.00188	0.217*	0.249**	0.187
	(0.00267)	(0.00265)	(0.00276)	(0.114)	(0.114)	(0.117)
export share	-0.0119**	-0.0130**	-0.0137**	-0.716***	-0.794***	-0.777***
	(0.00529)	(0.00527)	(0.00555)	(0.162)	(0.167)	(0.171)
foreign	0.0175***	0.0170***	0.0159***	0.211*	0.194	0.204
	(0.00479)	(0.00478)	(0.00505)	(0.124)	(0.129)	(0.130)
labour productivity	-0.001000	-0.00171		0.109	0.0788	
	(0.00139)	(0.00139)		(0.0887)	(0.0897)	
TFP			-0.00326**			0.00201
			(0.00161)			(0.0997)
log distance	-0.00620***			-0.350***		
	(0.00158)			(0.0742)		
log fixed assets			0.000168			0.0515
			(0.000451)			(0.0344)
log intangibles			0.00129***			0.0343**
			(0.000371)			(0.0137)
distance indicators		YES	YES		YES	YES
2-digit NACE FE	YES	YES	YES	YES	YES	YES
Observations	12,458	12,458	11,463	9,645	9,645	8,862
Adjusted R-squared	0.066	0.071	0.075			

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation. The dependent variable is an indicator for the firm being a $\geq$ 5% direct supplier, i.e. selling at least 10% of its total VAT sales to an automotive MNE in Hungary. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations include 2-digit industry-fixed effects. Robust standard errors are in parentheses.

Table 6: Probability of being a round-1 indirect supplier

Dep.var.: round-1 indirect supplier

spec.:	(1) lin.prob	(2) lin.prob	(3) lin.prob	(4) probit	(5) probit	(6) probit
log employees	0.0108***	0.00843***	0.00326	0.136***	0.103**	0.0352
	(0.00278)	(0.00277)	(0.00292)	(0.0428)	(0.0436)	(0.0445)
log sales	0.00936***	0.0115***	0.0113***	0.114***	0.149***	0.132***
	(0.00240)	(0.00239)	(0.00270)	(0.0401)	(0.0409)	(0.0416)
exporter	0.00468	0.00540	0.00188	0.129**	0.152**	0.123*
	(0.00512)	(0.00507)	(0.00526)	(0.0646)	(0.0649)	(0.0666)
export share	-0.0332***	-0.0370***	-0.0390***	-0.543***	-0.606***	-0.598***
	(0.00887)	(0.00888)	(0.00929)	(0.0941)	(0.0979)	(0.100)
foreign	0.0398***	0.0375***	0.0381***	0.202***	0.169**	0.196**
	(0.00786)	(0.00781)	(0.00833)	(0.0735)	(0.0759)	(0.0780)
labour productivity	0.00948***	0.00722***		0.245***	0.209***	
	(0.00285)	(0.00278)		(0.0538)	(0.0541)	
TFP			0.00546*			0.177***
			(0.00310)			(0.0580)
log distance	-0.0133***			-0.211***		
	(0.00280)			(0.0415)		
log fixed assets			0.00355***			0.0748***
			(0.00100)			(0.0203)
log intangibles			0.00260***			0.0147*
			(0.000699)			(0.00824)
distance indicators		YES	YES		YES	YES
2-digit NACE FE	YES	YES	YES	YES	YES	YES
Observations	12,458	12,458	11,463	12,373	12,373	11,383
Adjusted R-squared	0.080	0.092	0.097			

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation. The dependent variable is an indicator for the firm being a $\geq 5\%$ round-1 indirect supplier, i.e. selling at least 10% of its total VAT sales to a $\geq 5\%$ direct supplier which stays an automotive MNE supplier in the subsequent year. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations include 2-digit industry-fixed effects. Robust standard errors are in parentheses.

Table 7: Probability of being a round-2 indirect supplier

Dep.var.: round-2 indirect supplier

spec.:	(1) lin.prob	(2) lin.prob	(3) lin.prob	(4) probit	(5) probit	(6) probit
log employees	0.0319***	0.0308***	0.0207***	0.186***	0.179***	0.120***
	(0.00439)	(0.00442)	(0.00471)	(0.0327)	(0.0331)	(0.0341)
log sales	0.0158***	0.0170***	0.0168***	0.124***	0.134***	0.126***
	(0.00374)	(0.00375)	(0.00422)	(0.0299)	(0.0303)	(0.0316)
exporter	0.0186**	0.0195**	0.0118	0.104**	0.112**	0.0811*
	(0.00803)	(0.00800)	(0.00822)	(0.0465)	(0.0465)	(0.0473)
export share	-0.0991***	-0.102***	-0.103***	-0.688***	-0.711***	-0.695***
	(0.0130)	(0.0130)	(0.0136)	(0.0756)	(0.0767)	(0.0784)
foreign	0.0376***	0.0352***	0.0322***	0.0444	0.0261	0.0346
	(0.0109)	(0.0109)	(0.0115)	(0.0606)	(0.0612)	(0.0630)
labour productivity	0.0286***	0.0268***		0.253***	0.238***	
	(0.00445)	(0.00442)		(0.0381)	(0.0382)	
TFP			0.0235***			0.218***
			(0.00482)			(0.0409)
log distance	-0.0142***			-0.101***		
	(0.00410)			(0.0287)		
log fixed assets			0.0101***			0.0786***
			(0.00171)			(0.0146)
log intangibles			0.00334***			0.00406
			(0.00110)			(0.00614)
distance indicators		YES	YES		YES	YES
2-digit NACE FE	YES	YES	YES	YES	YES	YES
Observations	12,458	12,458	11,463	12,458	12,458	11,463
Adjusted R-squared	0.124	0.130	0.132			

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation. The dependent variable is an indicator for the firm being a $\geq 5\%$ round-2 indirect supplier, i.e. selling at least 10% of its total VAT sales to a $\geq 5\%$ round-1 indirect supplier which stays a round-1 indirect supplier in the subsequent year. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations include 2-digit industry-fixed effects. Robust standard errors are in parentheses.

Table 8: Event study regressions - employment

Dep. var.: log employment

Sector:	(1)	(2)	(3)	(4)	(5)	(6)
	Manufacturing		Services			
Supplier type:	Direct	Indirect	Direct		Indirect	
Controls:	baseline	baseline	baseline	alternative	baseline	alternative
entry year - 8	0.465	0.171	-0.486**	0.234	0.146	0.204
* supplier	(0.422)	(0.244)	(0.235)	(0.270)	(0.169)	(0.187)
entry year - 7	0.282	0.207	-0.018	0.138	0.022	-0.013
* supplier	(0.297)	(0.190)	(0.141)	(0.152)	(0.093)	(0.092)
entry year - 6	0.130	0.088	-0.037	-0.031	-0.021	-0.083
* supplier	(0.255)	(0.161)	(0.100)	(0.105)	(0.089)	(0.081)
entry year - 4	0.244	0.132	0.025	-0.029	0.010	-0.003
* supplier	(0.236)	(0.128)	(0.092)	(0.085)	(0.072)	(0.072)
entry year - 3	0.374*	0.278**	0.020	0.022	0.006	-0.001
* supplier	(0.211)	(0.122)	(0.080)	(0.084)	(0.069)	(0.070)
entry year - 2	0.480**	0.237**	0.111	0.063	0.086	0.073
* supplier	(0.208)	(0.119)	(0.086)	(0.090)	(0.068)	(0.069)
entry year - 1	0.548**	0.126	0.165*	0.084	0.124*	0.003
* supplier	(0.216)	(0.124)	(0.086)	(0.087)	(0.070)	(0.073)
entry year	0.514**	0.167	0.254***	0.175**	0.180**	0.084
* supplier	(0.244)	(0.132)	(0.092)	(0.089)	(0.075)	(0.076)
entry year + 1	0.526*	0.264*	0.302**	0.234**	0.231**	0.187**
* supplier	(0.272)	(0.142)	(0.122)	(0.106)	(0.090)	(0.084)
Event year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	311	766	1,238	1,263	1,941	2,057
R-squared	0.915	0.852	0.909	0.917	0.900	0.902

Notes: Event study estimates for manufacturing (columns (1)-(2)) and service suppliers (columns (3)-(6)) around the time of becoming a direct (columns (1), (3) and (4)) or round-1 indirect (columns (2) and (5)-(6)) within-country automotive MNE supplier in event-year 0. The dependent variable is log number of employees. A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -5. Baseline controls refer to nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. For alternative controls I considered only the pre-event level of employment and domestic sales but not their growth rate. Robust standard errors are in parentheses.

Table 9: Event study regressions - productivity

Dep. var.: total factor productivity

	(1)	(2)	(3)	(4)	(5)
Sector:	Manufacturing			Services	
Supplier type:	Direct	Indirect		Direct	Indirect
Controls:	baseline	baseline	alternative	baseline	baseline
entry year - 8	0.053	0.332	0.004	0.271	-0.024
* supplier	(0.289)	(0.284)	(0.218)	(0.314)	(0.226)
entry year - 7	-0.188	0.108	-0.102	-0.188	-0.249*
* supplier	(0.362)	(0.191)	(0.191)	(0.158)	(0.133)
entry year - 6	0.021	0.134	-0.125	-0.086	-0.137
* supplier	(0.259)	(0.172)	(0.173)	(0.128)	(0.119)
entry year - 4	0.106	0.154	0.006	0.049	-0.032
* supplier	(0.251)	(0.154)	(0.147)	(0.122)	(0.109)
entry year - 3	0.164	0.087	-0.063	-0.044	-0.103
* supplier	(0.254)	(0.131)	(0.142)	(0.118)	(0.106)
entry year - 2	-0.042	0.134	-0.001	-0.088	-0.111
* supplier	(0.234)	(0.139)	(0.137)	(0.118)	(0.107)
entry year - 1	-0.152	0.196	0.006	-0.041	-0.080
* supplier	(0.250)	(0.138)	(0.136)	(0.126)	(0.115)
entry year	-0.035	0.300**	-0.161	-0.098	0.033
* supplier	(0.265)	(0.141)	(0.148)	(0.120)	(0.120)
entry year + 1	0.006	0.499***	0.112	-0.016	-0.026
* supplier	(0.352)	(0.165)	(0.175)	(0.151)	(0.126)
Event year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Observations	285	730	798	1,182	1,832
R-squared	0.615	0.729	0.716	0.719	0.645

Notes: Event study estimates for manufacturing (columns (1)-(3)) and service suppliers (columns (4)-(5)) around the time of becoming a direct (columns (1) and (4)) or round-1 indirect (columns (2)-(3) and (5)) within-country automotive MNE supplier in event-year 0. The dependent variable is total factor productivity. A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -5. Baseline controls refer to nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. For alternative controls I considered only the pre-event level of employment and domestic sales but not their growth rate. Robust standard errors are in parentheses.

Table 10: Event study regressions - importing capital

Sector: Manufacturing

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Log of total imports			Log of capital imports		
Supplier type:	Direct	Indirect		Direct	Indirect	
Controls:	baseline	baseline	alternative	baseline	baseline	alternative
entry year - 8	4.849*	2.270*	3.258**	5.256*	0.642	1.354
* supplier	(2.737)	(1.189)	(1.338)	(3.024)	(1.244)	(1.146)
entry year - 7	-1.017	0.228	0.005	1.210	-0.653	0.017
* supplier	(2.517)	(1.355)	(1.138)	(2.211)	(1.137)	(1.031)
entry year - 6	-0.278	0.990	0.389	-0.231	-0.415	-0.491
* supplier	(2.398)	(1.216)	(1.044)	(2.086)	(1.008)	(0.887)
entry year - 4	2.178	1.082	1.128	-0.808	-0.440	-0.362
* supplier	(1.889)	(1.052)	(0.795)	(1.757)	(0.969)	(0.766)
entry year - 3	2.250	1.164	1.914**	0.778	1.099	1.094
* supplier	(1.900)	(0.980)	(0.798)	(2.041)	(1.168)	(0.986)
entry year - 2	1.530	1.602	2.372***	3.039	1.706	1.815*
* supplier	(1.981)	(1.047)	(0.840)	(2.142)	(1.130)	(1.002)
entry year - 1	0.994	2.965***	3.393***	2.647	2.871**	2.432**
* supplier	(2.228)	(1.058)	(0.937)	(2.395)	(1.129)	(0.990)
entry year	-0.435	1.316	2.466**	-1.896	0.546	0.261
* supplier	(2.248)	(1.120)	(0.970)	(2.170)	(1.050)	(0.915)
entry year + 1	-1.594	1.783	1.791**	-0.920	1.503	1.119
* supplier	(2.151)	(1.130)	(0.912)	(2.349)	(1.099)	(0.942)
Event year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	319	781	867	319	781	867
R-squared	0.805	0.724	0.762	0.627	0.564	0.592

Notes: Event study estimates for manufacturing suppliers around the time of becoming a direct (columns (1) and (4)) or round-1 indirect (columns (2)-(3) and (5)-(6)) within-country automotive MNE supplier in event-year 0. The dependent variable is the log of the yearly total value of imports in columns (1)-(3) and the log of the yearly total value of imported capital goods in columns (4)-(6). A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -5. Baseline controls refer to nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. For alternative controls I considered only the pre-event level of employment and domestic sales but not their growth rate. Robust standard errors are in parentheses.

Table 11: Share of firms by 2-digit industry if above 1% within category

2-digit industry	Within-country suppliers			Cross-border suppliers			Not auto suppliers
	direct	indirect		type-1	type-2	type-3	
		round-1	round-2				
10 Manufacture of food products							11.5%
11 Manufacture of beverages							4.4%
13 Manufacture of textiles	2.3%	1.6%			1.3%	1.9%	2.2%
14 Manufacture of wearing apparel							5.0%
16 Manufacture of wood and of products of wood and cork		1.4%	4.5%			1.5%	6.5%
17 Manufacture of paper and paper products		2.7%	2.9%		1.1%	1.0%	1.3%
18 Printing and reproduction of recorded media		1.6%	2.7%			2.1%	8.8%
20 Manufacture of chemicals and chemical products			1.9%	1.3%		1.0%	1.8%
22 Manufacture of rubber and plastic products	9.7%	9.3%	9.2%	11.7%	11.3%	12.9%	4.4%
23 Manufacture of other non-metallic mineral products			1.9%	1.3%	1.1%	1.7%	4.2%
24 Manufacture of basic metals		2.9%	2.7%	3.1%	3.5%	3.1%	
25 Manufacture of fabricated metal products	25.0%	38.5%	37.9%	27.4%	23.7%	28.7%	16.4%
26 Manufacture of computer, electronic and optical products	3.4%	5.2%	2.5%	4.5%	10.8%	8.9%	3.6%
27 Manufacture of electrical equipment	3.4%	3.4%	2.8%	11.7%	13.7%	12.0%	2.1%
28 Manufacture of machineryand equipment n.e.c.	10.2%	14.3%	13.6%	18.4%	14.8%	13.2%	5.8%
29 Manufacture of motor vehicles, trailers and semi-trailers	30.1%	6.6%	2.5%	16.6%	11.9%	7.9%	
31 Manufacture of furniture		1.4%	2.4%		1.6%	1.0%	5.6%
32 Other manufacturing					1.1%	1.0%	5.4%
33 Repair and installation of machinery and equipment	8.5%	7.2%	9.3%				7.5%
Total number of firms	177	444	919	320	526	850	35233

Notes: Within-country suppliers sell either directly or indirectly to an automotive MNE in Hungary. Cross-border suppliers are defined based on a high ($\geq$ 30%) share of exported automotive-industry inputs in total sales. Type-1 definition uses the narrowest set of products classified as automotive-industry inputs and type-3 definition uses the broadest set. Industry shares within a group are only presented if these are higher than 1% and contain at least 3 firms.

Table 12: Characteristics of within-country and cross-border suppliers

Sample: suppliers and not auto suppliers
Dep.var.: direct within-country or cross-border suppliers

	(1)	(2)	(3)	(4)	(5)	(6)
Cross-border supplier def.:	type 1		type 2		type 3	
log employees	0.175***	0.0767	0.205***	0.131**	0.130**	0.0551
	(0.0595)	(0.0591)	(0.0564)	(0.0569)	(0.0507)	(0.0518)
log sales	0.127**	0.109*	0.0983*	0.0792	0.158***	0.136***
	(0.0536)	(0.0559)	(0.0510)	(0.0530)	(0.0470)	(0.0493)
exporter	0.260**	0.226**	0.321***	0.286***	0.426***	0.371***
	(0.106)	(0.109)	(0.101)	(0.104)	(0.0950)	(0.0985)
export share	1.030***	1.090***	1.259***	1.315***	1.514***	1.572***
	(0.118)	(0.123)	(0.104)	(0.109)	(0.0917)	(0.0964)
labour productivity	0.0916		0.0732		0.0182	
	(0.0693)		(0.0635)		(0.0596)	
TFP		0.00154		0.00656		-0.0509
		(0.0743)		(0.0682)		(0.0638)
foreign	0.133	0.103	0.150*	0.112	0.112	0.0791
	(0.0962)	(0.101)	(0.0846)	(0.0880)	(0.0757)	(0.0785)
log fixed assets		0.0562**		0.0497*		0.0574**
		(0.0280)		(0.0256)		(0.0240)
log intangibles		0.0278**		0.0209**		0.0172*
		(0.0114)		(0.0103)		(0.00929)
log distance	-0.160***		-0.173***		-0.165***	
	(0.0592)		(0.0534)		(0.0484)	
distance indicators		YES		YES		YES
2-digit NACE FE	YES	YES	YES	YES	YES	YES
Observations	9,501	8,682	10,852	9,928	11,030	10,100

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation, being direct suppliers of automotive MNE-s in Hungary, cross-border automotive-industry suppliers or not defined as any type of automotive-industry supplier. The dependent variable is an indicator for the firm being a $\geq$ 5% direct suppliers of an automotive MNE in Hungary or a cross-border automotive-industry supplier. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations are based on probit regressions and include 2-digit industry-fixed effects. Robust standard errors are in parentheses. Type-1 uses the narrowest set of product for cross-border supplier definition and type-3 uses the broadest set.

Table 13: Characteristics of within-country compared to cross-border suppliers

Sample: direct within-country and cross-border suppliers
Dep.var.: direct within-country suppliers

	(1)	(2)	(3)	(4)	(5)	(6)
Cross-border supplier def.:	type 1		type 2		type 3	
log employees	0.0810	0.0917	0.0551	0.0369	0.285*	0.223
	(0.199)	(0.233)	(0.175)	(0.183)	(0.152)	(0.160)
log sales	0.413**	0.278	0.404**	0.273*	0.157	0.0739
	(0.181)	(0.182)	(0.165)	(0.163)	(0.139)	(0.138)
export share	-4.164***	-4.484***	-3.759***	-3.993***	-3.579***	-3.848***
	(0.434)	(0.476)	(0.366)	(0.407)	(0.343)	(0.393)
labour productivity	-0.0740		-0.151		0.0398	
	(0.265)		(0.230)		(0.207)	
TFP		-0.0298		-0.204		-0.0602
		(0.281)		(0.245)		(0.219)
foreign	0.0460	0.0656	-0.0295	0.0331	0.161	0.158
	(0.239)	(0.244)	(0.198)	(0.208)	(0.181)	(0.181)
log fixed assets		0.0614		0.0759		0.107
		(0.124)		(0.108)		(0.0979)
log intangibles		0.0427		0.0317		0.0305
		(0.0402)		(0.0356)		(0.0300)
log distance	-0.219		-0.299*		-0.247	
	(0.182)		(0.168)		(0.155)	
distance indicators		YES		YES		YES
2-digit NACE FE	YES	YES	YES	YES	YES	YES
Observations	267	265	382	377	543	534

Notes: The estimation sample includes manufacturing firms being direct suppliers of automotive MNE-s in Hungary or cross-border automotive-industry suppliers. The dependent variable is an indicator for the firm being a $\geq$ 5% direct supplier of an automotive MNE in Hungary. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations are based on probit regressions and include 2-digit industry-fixed effects. Robust standard errors are in parentheses. Type-1 uses the narrowest set of product for cross-border supplier definition and type-3 uses the broadest set.

Table 14: Characteristics of cross-border suppliers

Sample: auto industry exporters and not auto suppliers
Dep.var.: cross-border suppliers

	(1)	(2)	(3)	(4)	(5)	(6)
Cross-border supplier def.:	type 1		type 2		type 3	
log employees	0.121	0.0488	0.183**	0.143**	0.0829	0.0340
	(0.0837)	(0.0814)	(0.0737)	(0.0729)	(0.0627)	(0.0632)
log sales	0.103	0.0731	0.0698	0.0380	0.168***	0.132**
	(0.0737)	(0.0762)	(0.0655)	(0.0671)	(0.0578)	(0.0597)
export share	1.938***	2.082***	1.911***	2.013***	2.018***	2.117***
	(0.134)	(0.141)	(0.108)	(0.113)	(0.0919)	(0.0977)
labour productivity	-0.00484		-0.0115		-0.0718	
	(0.0934)		(0.0797)		(0.0720)	
TFP		-0.103		-0.0722		-0.129*
		(0.0952)		(0.0818)		(0.0751)
foreign	0.0133	-0.0164	0.0464	0.00590	0.0228	-0.0113
	(0.112)	(0.116)	(0.0938)	(0.0965)	(0.0810)	(0.0831)
log fixed assets		0.0510		0.0408		0.0529*
		(0.0391)		(0.0329)		(0.0294)
log intangibles		0.0152		0.0101		0.00696
		(0.0157)		(0.0127)		(0.0108)
log distance	0.0757		-0.00325		-0.0416	
	(0.0719)		(0.0596)		(0.0527)	
distance indicators		YES		YES		YES
2-digit NACE FE	YES	YES	YES	YES	YES	YES
Observations	2,926	2,850	3,838	3,739	4,016	3,911

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation, being cross-border automotive-industry suppliers or not defined as any type of automotive-industry supplier. The dependent variable is an indicator for the firm being a cross-border automotive industry supplier. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations are based on probit regressions and include 2-digit industry-fixed effects. Robust standard errors are in parentheses. Type-1 uses the narrowest set of product for cross-border supplier definition and type-3 uses the broadest set.

Table 15: Event study regressions - wage

Dep. var.: log per capita wage

	(1)	(2)	(3)	(4)	(5)
Sector:	Manufacturing			Services	
Supplier type:	Direct		Indirect	Direct	Indirect
Controls:	baseline	alternative	baseline	baseline	baseline
entry year - 8	0.071	-0.017	0.141	0.043	0.109
* supplier	(0.157)	(0.196)	(0.145)	(0.104)	(0.109)
entry year - 7	0.116	0.058	0.153	0.096	0.029
* supplier	(0.120)	(0.161)	(0.118)	(0.090)	(0.086)
entry year - 6	0.089	0.122	-0.047	0.048	-0.029
* supplier	(0.127)	(0.169)	(0.145)	(0.070)	(0.088)
entry year - 4	-0.011	0.036	0.015	0.024	-0.006
* supplier	(0.090)	(0.144)	(0.087)	(0.086)	(0.080)
entry year - 3	0.076	0.105	-0.086	0.022	0.000
* supplier	(0.082)	(0.157)	(0.091)	(0.067)	(0.078)
entry year - 2	0.133	0.094	-0.017	0.036	0.041
* supplier	(0.091)	(0.149)	(0.093)	(0.065)	(0.071)
entry year - 1	0.206**	0.053	0.033	0.043	0.097
* supplier	(0.101)	(0.150)	(0.089)	(0.071)	(0.074)
entry year	0.160	0.175	0.042	0.009	0.113
* supplier	(0.101)	(0.153)	(0.091)	(0.076)	(0.077)
entry year + 1	0.269***	0.274*	0.083	0.052	0.117
* supplier	(0.103)	(0.152)	(0.093)	(0.085)	(0.080)
Event year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Observations	306	315	758	1,226	1,919
R-squared	0.836	0.782	0.700	0.834	0.749

Notes: Event study estimates for manufacturing (columns (1)-(3)) and service suppliers (columns (4)-(5)) around the time of becoming a direct (columns (1)-(2) and (4)) or round-1 indirect (columns (3) and (5)) within-country automotive MNE supplier in event-year 0. The dependent variable is log per capita wage. A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -5. Baseline controls refer to nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. For alternative controls I considered only the pre-event level of employment and domestic sales but not their growth rate. Robust standard errors are in parentheses.

Table 16: Comparing the average health index across firm groups

	N.obs.	Mean	St.error	P-value
Not auto suppliers	5011	.0643734	.0005323	
Direct suppliers	117	.0552081	.0024124	0.0089
Suppliers with round 1-2 indirect	863	.0624803	.0011112	0.1649
Direct suppliers and cross-border suppliers	528	.0606987	.001274	0.0298

Notes: The health index is calculated using detailed health-related characteristics and age of a person, capturing the probability of being hospitalized or dead next year. A higher health index refers to a worse state of health. The average health index of a firm is calculated based on male employees of age 35-70. In each case t-tests compare the average health index of male of employees in a specific group of supplier firms to that of firms not being classified as an automotive-industry supplier. Supplier classification is based on year 2015, and only manufacturing firms with at least 5 employees are considered.

Table 17: Comparing the average health index of suppliers and non-suppliers

Dep. var: average health index			
	(1)	(2)	(3)
Supplier def.:	direct	direct & indirect	direct & exporters
Non-supplier	0.008*	0.001	0.002
	(0.004)	(0.002)	(0.002)
Log emp.	0.002***	0.001**	0.001***
	(0.001)	(0.001)	(0.001)
Foreign	-0.006***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)
Exporter	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)
Productivity	-0.008***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)
4-digit industry FE	YES	YES	YES
Observations	4,878	5,618	5,282
R-squared	0.083	0.079	0.080

Notes: Estimates from a cross-section in 2015. The dependent variable is the average health index of male employees in a firm. Health index is calculated using detailed health-related characteristics and age of a person, capturing the probability of being hospitalized or dead next year. A higher health index refers to a worse state of health. The average health index of a firm is calculated based on male employees of age 35-70. Each column includes firms not being automotive suppliers and a specific group of suppliers. Column (1) includes direct within-country suppliers, column (2) also adds round-1 and round-2 indirect within country suppliers and column (3) includes direct within-country and cross-country suppliers. Supplier classification is based on year 2015, and only manufacturing firms with at least 5 employees are considered. Non-supplier is an indicator for the firm not being an automotive-industry supplier based on any of the classifications. Productivity is measured with TFP, the log number of employees, foreign and exporter status indicators and 4-digit industry-fixed effects are used as additional controls. Robust standard errors are in parentheses.

Table 18: The average health index of new suppliers in an event study

Dep.var.: average health index		
	(1)	(2)
Sector:	Manufacturing	
Supplier type:	Indirect - broad	
VARIABLES	baseline	alternative
entry year - 7	0.018	0.013
* supplier	(0.029)	(0.029)
entry year - 6	-0.005	-0.010
* supplier	(0.021)	(0.020)
entry year - 4	-0.012	-0.015
* supplier	(0.020)	(0.020)
entry year - 3	-0.013	-0.013
* supplier	(0.022)	(0.021)
entry year - 2	0.027	0.015
* supplier	(0.022)	(0.022)
entry year - 1	0.013	0.002
* supplier	(0.020)	(0.020)
entry year	-0.001	-0.004
* supplier	(0.021)	(0.021)
entry year + 1	0.050*	0.030
* supplier	(0.027)	(0.026)
Observations	166	179
R-squared	0.548	0.503

Notes: Event study estimates for manufacturing firms becoming a direct or indirect within-country automotive MNE supplier in event-year 0. The dependent variable is the average health index of male employees in the firm. Health index is calculated using detailed health-related characteristics and age of a person, capturing the probability of being hospitalized or dead next year. A higher health index refers to a worse state of health. The average health index of a firm is calculated based on male employees of age 35-70. A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -5. Baseline controls refer to nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. For alternative controls I considered only the pre-event level of employment and domestic sales but not their growth rate. Robust standard errors are in parentheses.

References

Ackerberg, D. A., Caves, K. & Frazer, G. (2015), 'Identification properties of recent production function estimators', Econometrica **83**(6), 2411–2451.

Andrews, D., Criscuolo, C. & Gal, P. N. (2016), The best versus the rest: the global productivity slowdown, divergence across firms and the role of public policy, Technical report, OECD Publishing.

Bernard, A. B. & Jensen, J. B. (2004), 'Exporting and productivity in the usa', Oxford Review of Economic Policy **20**(3), 343–357.

Bisztray, M. (2016), The effect of fdi on local suppliers: Evidence from audi in hungary, Technical report, Iehas Discussion Papers.

Blalock, G. & Gertler, P. J. (2008), 'Welfare gains from foreign direct investment through technology transfer to local suppliers', Journal of international Economics **74**(2), 402–421.

Bloom, N., Sadun, R. & Van Reenen, J. (2012), 'Americans do it better: Us multinationals and the productivity miracle', American Economic Review **102**(1), 167–201.

Bruno, R. L. & Cipollina, M. (2018), 'A meta-analysis of the indirect impact of foreign direct investment in old and new eu member states: Understanding productivity spillovers', The World Economy **41**(5), 1342–1377.

De Loecker, J. (2007), 'Do exports generate higher productivity? evidence from slovenia', Journal of international economics **73**(1), 69–98.

Del Prete, D., Giovannetti, G. & Marvasi, E. (2017), 'Global value chains participation and productivity gains for north african firms', Review of World Economics **153**(4), 675–701.

Demmou, L. & Franco, G. (2021), 'Mind the financing gap: Enhancing the contribution of intangible assets to productivity'.

Greenaway, D., Gullstrand, J. & Kneller, R. (2005), 'Exporting may not always boost firm productivity', Review of World Economics **141**(4), 561–582.

Hagsten, E. & Kotnik, P. (2017), 'Ict as facilitator of internationalisation in small-and medium-sized firms', Small Business Economics **48**(2), 431–446.

Halpern, L., Koren, M. & Szeidl, A. (2015), 'Imported inputs and productivity', American Economic Review **105**(12), 3660–3703.

Javorcik, B. S. (2004), 'Does foreign direct investment increase the productivity of domestic firms? in search of spillovers through backward linkages', American economic review **94**(3), 605–627.

Javorcik, B. S. & Spatareanu, M. (2009a), 'Liquidity constraints and firms' linkages with multinationals', The World Bank Economic Review **23**(2), 323–346.

Javorcik, B. S. & Spatareanu, M. (2009b), 'Tough love: do czech suppliers learn from their relationships with multinationals?', Scandinavian Journal of Economics **111**(4), 811–833.

Molnár, E., Kozma, G., Mészáros, M. & Kiss, É. (2020), 'Upgrading and the geography of the hungarian automotive industry in the context of the fourth industrial revolution', Hungarian Geographical Bulletin **69**(2), 137–155.

Sebők, A. (2019), 'The panel of linked administrative data of cers databank', Budapest Working Papers On The Labour Market (2).
URL: *https://www.mtakti.hu/wp-content/uploads/2019/12/BWP1902.pdf*

Wagner, J. (2012), 'International trade and firm performance: a survey of empirical studies since 2006', Review of World Economics **148**(2), 235–267.

Appendix

Table A1: List of direct supplier industries within manufacturing

direct 10%, top50%	
2229	Manufacture of other plastic products
2511	Manufacture of metal structures and parts of structures
2562	Machining
2932	Manufacture of other parts and accessor ies for motor vehicles
3312	Repair of machinery
direct 10%, top75%	
1392	Manufacture of made-up textile articles, except apparel
2219	Manufacture of other rubber products
2550	Forging, pressing, stampingand roll-forming of metal; powder metallurgy
2561	Treatment and coating of metals
2573	Manufacture of tools
2651	Manufacture of instruments and appliances for measuring, testing and navigation
2811	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
2849	Manufacture of other machine tools
2899	Manufacture of other special-purpose machinery n.e.c.
2931	Manufacture of electrical and electronic equipment for motor vehicles
3320	Installation of industrial machineryand equipment
direct 10%, top90%	
1399	Manufacture of other textiles n.e.c.
1412	Manufacture of workwear
1413	Manufacture of other outerwear
1512	Manufacture of luggage, handbags and the like, saddlery and harness
1610	Sawmilling and planing of wood
1624	Manufacture of wooden containers
1721	Manufacture of corrugated paper and paperboard and of containers of paper and paper
1812	Other printing
2016	Manufacture of plastics in primary forms
2222	Manufacture of plastic packinggoods
2312	Shaping and processing of flat glass
2530	Manufacture of steam generators, except central heating hot water boilers
2593	Manufacture of wire products, chain and springs
2594	Manufacture of fasteners and screw machine products
2599	Manufacture of other fabricated metal products n.e.c.
2620	Manufacture of computers and peripheral equipment
2630	Manufacture of communication equipment
2640	Manufacture of consumer electronics
2711	Manufacture of electric motors, generators and transformers
2712	Manufacture of electricity distribution and control apparatus
2733	Manufacture of wiring devices
2740	Manufacture of electric lighting equipment
2790	Manufacture of other electrical equipment
2815	Manufacture of bearings, gears, gearing and driving elements
2822	Manufacture of lifting and handling equipment
2829	Manufacture of other general-purpose machinery n.e.c.
2841	Manufacture of metal forming machinery
2910	Manufacture of motor vehicles
3102	Manufacture of kitchen furniture
3299	Other manufacturing n.e.c.
3314	Repair of electrical equipment

Notes: The industries of direct manufacturing suppliers selling at least 10% of their total VAT sales to an automotive MNE in Hungary, using NACE Rev.2 industry classification. I rank industries based on the number of direct suppliers operating in the industry. Top50% refers to the industries with the most direct suppliers, with a cumulative share of 50%. Top75% includes additional industries up to a cumulative share of 75% and top90% does the same up to a cumulative share of 90%.

Table A2: List of additional indirect supplier industries within manufacturing

round-1 indirect 10%, top75%	
2442	Aluminium production
2453	Casting of light metals
2512	Manufacture of doors and windows of metal
2732	Manufacture of other electronic and electric wires and cables
2751	Manufacture of electric domestic appliances
2821	Manufacture of ovens, furnaces and furnace burners
2825	Manufacture of non-domestic cooling and ventilation equipment
3109	Manufacture of other furniture
round-1 indirect 10%, top90%	
1395	Manufacture of non-wovens and articles made from non-wovens, except apparel
1623	Manufacture of other builders carpentry and joinery
1813	Pre-press and pre-media services
2011	Manufacture of industrial gases
2611	Manufacture of electronic components
2612	Manufacture of loaded electronic boards
2812	Manufacture of fluid power equipment
2813	Manufacture of other pumps and compressors
2893	Manufacture of machinery for food, beverage and tobacco processing
3101	Manufacture of office and shop furniture
round-2 indirect 10%, top90%	
1712	Manufacture of paper and paperboard
1729	Manufacture of other articles of paper and paperboard
1814	Binding and related services
2030	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
2221	Manufacture of plastic plates, sheets, tubes and profiles
2223	Manufacture of builders ware of plastic
2363	Manufacture of ready-mixed concrete
2391	Production of abrasive products
2399	Manufacture of other non-metallic mineral products n.e.c.
2432	Cold rolling of narrow strip
2441	Precious metals production
2444	Copper production
2452	Casting of steel
2454	Casting of other non-ferrous metals
2521	Manufacture of central heating radiators and boilers
2529	Manufacture of other tanks, reservoirs and containers of metal
2572	Manufacture of locks and hinges
2824	Manufacture of power-driven hand tools
2830	Manufacture of agricultural and forestry machinery
2892	Manufacture of machineryfor mining, quarrying and construction
2894	Manufacture of machineryfor textile, apparel and leather production
2895	Manufacture of machineryfor paper and paperboard production
3020	Manufacture of railway locomotives and rolling stock
3030	Manufacture of air and spacecraft and related machinery
3250	Manufacture of medical and dental instruments and supplies
3313	Repair of electronic and optical equipment

Notes: The industries of '≥10%' round-1 and round-2 indirect manufacturing suppliers, excluding the industries of '≥10%' direct suppliers presented in Table A1, using NACE Rev.2 industry classification. '≥10%' round-1 suppliers sell at least 10% of their total VAT sales to a stable '≥10%' direct supplier, in which 'stable' refers to staying a supplier in the following two years and direct suppliers sell to an automotive MNE in Hungary. '≥10%' round-2 indirect suppliers sell at least 10% of their total VAT sales to a stable '≥10%' round-1 indirect supplier. I rank industries based on the number of indirect suppliers operating in the industry. Top75% refers to the industries with the most indirect suppliers, having a cumulative share of 75%. Top90% includes additional industries up to a cumulative share of 90%.

Table A3: Probability of being a direct supplier with 4-digit industry FE

Dep.var.: direct supplier

spec.:	(1) lin.prob	(2) lin.prob	(3) lin.prob	(4) cond.logit	(5) cond.logit	(6) cond.logit
log employees	0.00298**	0.00215	0.000445	0.266*	0.223	0.00683
	(0.00136)	(0.00136)	(0.00142)	(0.147)	(0.151)	(0.157)
log sales	0.00565***	0.00637***	0.00688***	0.319**	0.349**	0.331**
	(0.00129)	(0.00131)	(0.00151)	(0.142)	(0.146)	(0.154)
exporter	0.000158	0.000533	-0.000958	0.709**	0.800***	0.714**
	(0.00263)	(0.00262)	(0.00273)	(0.293)	(0.292)	(0.298)
export share	-0.0130**	-0.0143***	-0.0151***	-1.317***	-1.504***	-1.480***
	(0.00517)	(0.00516)	(0.00544)	(0.299)	(0.305)	(0.314)
foreign	0.0167***	0.0161***	0.0152***	0.467	0.394	0.366
	(0.00475)	(0.00474)	(0.00502)	(0.292)	(0.293)	(0.299)
labour productivity	-0.00187	-0.00258*		0.0979	0.124	
	(0.00138)	(0.00138)		(0.216)	(0.215)	
TFP			-0.00383**			-0.0269
			(0.00159)			(0.222)
log distance	-0.00583***			-0.530***		
	(0.00159)			(0.150)		
log fixed assets			-0.000155			0.108
			(0.000442)			(0.0804)
log intangibles			0.00108***			0.0651*
			(0.000368)			(0.0338)
distance indicators		YES	YES		YES	YES
4-digit NACE FE	YES	YES	YES			
Choice FE				YES	YES	YES
Observations	12,457	12,457	11,462	31,949	31,949	29,300
Adjusted R-squared	0.093	0.097	0.102			

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation. The dependent variable is an indicator for the firm being a $\geq$ 5% direct supplier, i.e. selling at least 10% of its total VAT sales to an automotive MNE in Hungary. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations include 4-digit industry-fixed effects. Columns (4)-(6) include conditional logit estimations in which a choice set is defined as a 4-digit industry from which an automotive MNE has a direct supplier. Robust standard errors are in parentheses.

Table A4: Probability of being a round-1 indirect supplier with 4-digit industry FE

Dep.var.: round-1 indirect supplier

spec.:	(1) lin.prob	(2) lin.prob	(3) lin.prob	(4) cond.logit	(5) cond.logit	(6) cond.logit
log employees	0.00691**	0.00446	4.38e-07	0.183**	0.127	0.0161
	(0.00280)	(0.00280)	(0.00297)	(0.0835)	(0.0849)	(0.0864)
log sales	0.0122***	0.0144***	0.0148***	0.207***	0.255***	0.219***
	(0.00243)	(0.00243)	(0.00273)	(0.0764)	(0.0773)	(0.0774)
exporter	0.00466	0.00538	0.00226	0.326**	0.362***	0.313**
	(0.00509)	(0.00505)	(0.00525)	(0.131)	(0.130)	(0.132)
export share	-0.0351***	-0.0392***	-0.0419***	-0.937***	-1.062***	-1.045***
	(0.00861)	(0.00864)	(0.00905)	(0.167)	(0.175)	(0.178)
foreign	0.0373***	0.0351***	0.0354***	0.313**	0.234	0.266*
	(0.00769)	(0.00764)	(0.00815)	(0.141)	(0.147)	(0.150)
labour productivity	0.00595**	0.00375		0.368***	0.337***	
	(0.00281)	(0.00275)		(0.108)	(0.108)	
TFP			0.00250			0.293***
			(0.00306)			(0.112)
log distance	-0.0118***			-0.334***		
	(0.00278)			(0.0822)		
log fixed assets			0.00256***			0.139***
			(0.000976)			(0.0406)
log intangibles			0.00195***			0.0165
			(0.000690)			(0.0161)
distance indicators		YES	YES		YES	YES
4-digit NACE FE	YES	YES	YES			
Choice FE				YES	YES	YES
Observations	12,457	12,457	11,462	152,254	152,254	136,950
Adjusted R-squared	0.112	0.124	0.129			

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation. The dependent variable is an indicator for the firm being a $\geq 5\%$ round-1 indirect supplier, i.e. selling at least 10% of its total VAT sales to a $\geq 5\%$ direct supplier which stays a supplier in the subsequent year. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations include 4-digit industry-fixed effects. Columns (4)-(6) include conditional logit estimations in which a choice set is defined as a 4-digit industry from which an automotive MNE has a round-1 indirect supplier. Robust standard errors are in parentheses.

Table A5: Probability of being a round-2 indirect supplier with 4-digit industry FE

Dep.var.: round-2 indirect supplier

spec.:	(1) lin.prob	(2) lin.prob	(3) lin.prob	(4) cond.logit	(5) cond.logit	(6) cond.logit
log employees	0.0261***	0.0246***	0.0164***	0.232***	0.218***	0.152***
	(0.00443)	(0.00446)	(0.00479)	(0.0534)	(0.0543)	(0.0560)
log sales	0.0210***	0.0224***	0.0237***	0.180***	0.194***	0.183***
	(0.00378)	(0.00380)	(0.00428)	(0.0482)	(0.0489)	(0.0508)
exporter	0.0171**	0.0179**	0.0115	0.178**	0.191**	0.159**
	(0.00794)	(0.00791)	(0.00815)	(0.0775)	(0.0771)	(0.0775)
export share	-0.103***	-0.107***	-0.109***	-0.987***	-1.022***	-0.993***
	(0.0127)	(0.0128)	(0.0133)	(0.113)	(0.115)	(0.117)
foreign	0.0342***	0.0318***	0.0286**	0.0365	0.00489	0.0135
	(0.0106)	(0.0106)	(0.0112)	(0.0923)	(0.0937)	(0.0954)
labour productivity	0.0205***	0.0187***		0.294***	0.278***	
	(0.00439)	(0.00436)		(0.0628)	(0.0628)	
TFP			0.0157***			0.253***
			(0.00478)			(0.0654)
log distance	-0.0109***			-0.112**		
	(0.00404)			(0.0484)		
log fixed assets			0.00719***			0.0962***
			(0.00168)			(0.0245)
log intangibles			0.00237**			-0.00277
			(0.00107)			(0.0101)
distance indicators		YES	YES		YES	YES
4-digit NACE FE	YES	YES	YES			
Choice FE				YES	YES	YES
Observations	12,457	12,457	11,462	444,042	444,042	394,582
Adjusted R-squared	0.164	0.170	0.174			

Notes: The estimation sample includes manufacturing firms ever having at least 5 employees in the period of observation. The dependent variable is an indicator for the firm being a $\geq 5\%$ round-2 indirect supplier, i.e. selling at least 10% of its total VAT sales to a $\geq 5\%$ round-1 indirect supplier which stays a round-1 indirect supplier in the subsequent year. Distance measures the distance from the closest automotive MNE for non-suppliers and the distance from their automotive MNE buyer for suppliers. Distance indicators include a set of variables measuring the distance from all four automotive MNEs in Hungary. Estimations include 4-digit industry-fixed effects. Columns (4)-(6) include conditional logit estimations in which a choice set is defined as a 4-digit industry from which an automotive MNE has a round-2 indirect supplier. Robust standard errors are in parentheses.

Table A6: Number of new suppliers by sector, type and ownership

	Manufacturing	Services
All direct	42	123
Domestic direct	28	98
All round-1 indirect	139	295
Domestic round-1 indirect	126	275
All round-2 indirect	63	120
Domestic round-2 indirect	59	110

Notes: New suppliers are defined as firms being a direct or indirect supplier of any within-country automotive MNE for the first time, but these firms could be a lower-level supplier (e.g. round-2 indirect for a direct supplier link) before. New suppliers also include firms supplying only Mercedes and none of the other automotive MNE-s in 2015. Indirect suppliers should have links to an automotive MNE via a manufacturing buyer. I consider all direct suppliers, but only those indirect suppliers which have at least 10% of their total yearly VAT-data transaction value sold to a higher-level supplier of an automotive MNE.

Table A7: Top industries with new entrants by sector

NACE Rev.2.	N. entrant
Manufacturing	
25 Manufacture of fabricated metal products, except machinery and equipment	32
33 Repair and installation of machinery and equipment	12
28 Manufacture of machinery and equipment n.e.c	11
22 Manufacture of rubber and plastic products	9
26 Manufacture of computer, electronic and optical products	6
29 Manufacture of motor vehicles, trailers and semi-trailers	6
Services	
46 Wholesale trade, except of motor vehicles and motorcycles	43
81 Services to buildings and landscape activities	42
71 Architectural and engineering activities; technical testing and analysis	39
70 Activities of head offices; management consultancy activities	28
82 Office administrative, office support and other business support activities	26
85 Education	26

Notes: Top industries include the top 6 2-digit industries by sector in which new suppliers operate. New suppliers are defined as firms being a direct or indirect supplier of any within-country automotive MNE for the first time, but these firms could be a lower-level supplier (e.g. round-2 indirect for a direct supplier link) before. New suppliers also include firms supplying only Mercedes and none of the other automotive MNE-s in 2015. Indirect suppliers should have links to an automotive MNE via a manufacturing buyer. I consider all direct suppliers, but only those indirect suppliers which have at least 10% of their total yearly VAT-data transaction value sold to a higher-level supplier of an automotive MNE.

Table A8: Yearly number of new suppliers and control firms in the event study

year	2015	2016	2017	2018
new suppliers				
direct	29	38	29	52
indirect	44	69	73	118
direct manufacturing	4	8	7	9
indirect manufacturing	8	20	24	36
controls				
to direct - baseline	27	38	27	48
to direct - alternative	29	38	29	52
to indirect - baseline	35	62	63	109
to indirect - alternative	42	65	72	116
with health index data				
new suppliers	5	16	17	22
controls - baseline	3	11	12	9
controls - alternative	4	12	10	9

Notes: New suppliers are defined as firms being a direct or indirect supplier of any within-country automotive MNE for the first time, but these firms could be a lower-level supplier (e.g. round-2 indirect for a direct supplier link) before. New suppliers in 2015 are firms supplying only Mercedes and none of the other automotive MNE-s in 2015. Indirect suppliers should have links to an automotive MNE via a manufacturing buyer. I consider all direct suppliers, but only those indirect suppliers which have at least 10% of their total yearly VAT-data transaction value sold to a higher-level supplier of an automotive MNE. The panel of controls shows the number of unique firms being assigned to a direct or indirect new supplier in the given year. The same control firm can be assigned to multiple treated. I use propensity score matching for control assignment with variables presented in Appndix Table A9. Baseline version includes and alternative version excludes employment and sales growth in the estimations. I assign controls with nearest neighbor matching based on the estimated propensity score. I excluding pairs with a high difference in the propensity score, with a cutoff value of 1% for direct, 5% for round-1 indirect and 10% for round-2 indirect suppliers. The lowest panel contains the number of new suppliers and controls for which I have employee health information.

Table A9: Probit regression for control assignment

Supplier type:	(1)	(2)	(3)	(4)
	Direct		Indirect	
Controls:	baseline	alternative	baseline	alternative
log # employees	0.105***	0.112***	0.168***	0.156***
	(0.0219)	(0.0201)	(0.0140)	(0.0126)
tog total domestic sales	0.0652***	0.0597***	0.0987***	0.0907***
	(0.0167)	(0.0159)	(0.0107)	(0.00985)
exporter	0.168***	0.193***	0.273***	0.278***
	(0.0512)	(0.0488)	(0.0285)	(0.0260)
foreign-owned	0.392***	0.400***	0.191***	0.192***
	(0.0524)	(0.0498)	(0.0368)	(0.0339)
productivity	0.0313	0.0347	0.0768***	0.0774***
	(0.0260)	(0.0246)	(0.0162)	(0.0143)
log dist.	0.0287	0.0282	0.158***	0.160***
	(0.0391)	(0.0380)	(0.0268)	(0.0251)
emp. growth from t-2	-0.000222		-0.0101	
	(0.0405)		(0.0221)	
sales growth from t-2	0.0635***		0.0498***	
	(0.0231)		(0.0130)	
Year FE	YES	YES	YES	YES
4-digit industry FE	YES	YES	YES	YES
Observations	104,167	124,508	83,847	106,654

Notes: Estimation results of probit regressions used for assinging controls to new suppliers. Columns (1)-(2) include all new direct suppliers of automotive MNEs in Hungary and those firms which are never observed as a direct supplier in the data. Columns (3)-(4) include those new $\geq$ % round-1 suppliers of manufacturing direct suppliers which haven't been observed as a direct or round-1 indirect supplier before, as well as those potential controls which are never observed as a direct or round-1 indirect supplier. The dependent variable is an indicator for becoming a specific type of supplier in the next year ($t+1$). Total domestic sales is measured as the yearly total value of transactions in the VAT data. I use indicators for the exporter and foreign-owned status. I measure firm productivity with labour productivity. Distance refers to distance from the directly or indirectly supplied automotive MNE or from the closest automotive MNE in the case of potential controls. I take employment and productivity growth from $t-2$ to t in which t is the year preceding the start of the supplier relationship. Regressions include calendar year and 4-digit industry-fixed effects. Robust standard errors are in parentheses.

Table A10: Balance test with baseline controls

	N.obs.		Mean		St.dev.		p value
	new sup.	control	new sup.	control	new sup.	control	
Direct manufacturing suppliers							
Employment	18	18	3.13	2.93	1.59	1.46	0.70
Sales	18	18	12.39	12.58	1.90	1.64	0.75
Wage	18	18	7.62	7.76	0.52	0.48	0.40
Labour productivity	18	18	7.96	8.34	0.73	0.71	0.12
Exporter status	18	18	0.61	0.72	0.50	0.46	0.49
Indirect manufacturing suppliers							
Employment	44	44	1.86	2.21	1.14	1.12	0.16
Sales	44	44	11.49	11.63	1.16	1.16	0.58
Wage	44	44	7.67	7.64	0.46	0.44	0.76
Labour productivity	44	44	8.21	8.15	0.84	0.68	0.73
Exporter status	44	44	0.43	0.45	0.50	0.50	0.83
Direct service suppliers							
Employment	74	74	2.17	2.37	1.34	1.31	0.36
Sales	74	74	12.04	12.54	1.86	1.35	0.06
Wage	72	74	7.81	7.92	0.77	0.64	0.36
Labour productivity	72	72	8.47	8.61	0.83	0.78	0.27
Exporter status	74	74	0.38	0.46	0.49	0.50	0.32
Indirect service suppliers							
Employment	117	117	1.79	1.95	1.12	1.28	0.30
Sales	117	117	11.73	11.97	1.59	1.39	0.22
Wage	115	116	7.70	7.72	0.65	0.72	0.84
Labour productivity	111	115	8.52	8.53	0.95	0.78	0.90
Exporter status	117	117	0.28	0.38	0.45	0.49	0.13

Notes: T-tests for observable firm characteristics between the group of new suppliers and assigned controls three years before the start of the new supplier relationship. Indirect suppliers refer to suppliers of $\geq 10\%$ direct manufacturing suppliers. Nearest neighbor controls assigned with propensity score matching, including new supplier status in the following year as the dependent variable, number of employees, total value of transactions in the VAT data, exporter and foreign-owned status, labour productivity, distance to the supplied/nearest automotive MNE, employment and sales growth between $t-2$ and t, and 4-digit industry and year fixed effects on the right-hand side, in which t stands for the current year.

Table A11: Balance test with alternative controls

	N.obs.		Mean		St.dev.		p value
	new sup.	control	new sup.	control	new sup.	control	
Direct manufacturing suppliers							
Employment	18	19	2.94	2.83	2.13	1.48	0.86
Sales	18	19	12.67	12.50	1.94	1.63	0.77
Wage	17	19	7.63	7.78	0.74	0.47	0.44
Labour productivity	18	19	8.43	8.37	0.65	0.70	0.78
Exporter status	19	19	0.58	0.68	0.51	0.48	0.51
Indirect manufacturing suppliers							
Employment	47	47	1.85	2.09	1.32	1.19	0.37
Sales	49	49	11.39	11.45	1.39	1.33	0.83
Wage	45	47	7.60	7.60	0.49	0.63	0.98
Labour productivity	47	46	8.20	8.20	0.99	0.69	0.97
Exporter status	50	50	0.32	0.40	0.47	0.49	0.41
Direct service suppliers							
Employment	73	75	2.16	2.34	1.35	1.33	0.44
Sales	75	75	12.11	12.52	1.59	1.35	0.09
Wage	70	75	7.86	7.91	0.62	0.64	0.66
Labour productivity	71	73	8.65	8.65	0.95	0.82	0.98
Exporter status	77	77	0.39	0.44	0.49	0.50	0.52
Indirect service suppliers							
Employment	115	121	1.77	1.92	1.13	1.28	0.32
Sales	121	122	11.56	11.92	1.57	1.42	0.06
Wage	113	119	7.67	7.71	0.68	0.71	0.60
Labour productivity	108	119	8.39	8.54	0.95	0.80	0.21
Exporter status	131	131	0.24	0.34	0.43	0.47	0.10

Notes: T-tests for observable firm characteristics between the group of new suppliers and an alternative set of assigned controls three years before the start of the new supplier relationship. Indirect suppliers refer to suppliers of $\geq$ 10% direct manufacturing suppliers. Nearest neighbor controls assigned with propensity score matching, including new supplier status in the following year as the dependent variable, number of employees, total value of transactions in the VAT data, exporter and foreign-owned status, labour productivity, distance to the supplied/nearest automotive MNE, and 4-digit industry and year fixed effects on the right-hand side.

Table A12: Event study regressions - sales

Dep. var.: log sales

	(1)	(2)	(3)	(4)
Sector:	Manufacturing		Services	
Supplier type:	Direct	Indirect	Direct	Indirect
Controls:	baseline	baseline	baseline	baseline
entry year - 8	0.187	0.321	-0.548	-0.272
* supplier	(0.435)	(0.301)	(0.334)	(0.322)
entry year - 7	0.114	0.561**	-0.422*	-0.065
* supplier	(0.301)	(0.239)	(0.222)	(0.187)
entry year - 6	-0.165	0.059	-0.218	-0.008
* supplier	(0.346)	(0.265)	(0.170)	(0.180)
entry year - 4	0.367	0.369**	-0.090	-0.184
* supplier	(0.240)	(0.156)	(0.186)	(0.133)
entry year - 3	0.386*	0.259*	-0.090	-0.172
* supplier	(0.233)	(0.156)	(0.170)	(0.136)
entry year - 2	0.333	0.304*	-0.066	-0.129
* supplier	(0.231)	(0.169)	(0.171)	(0.130)
entry year - 1	0.340	0.179	-0.113	-0.147
* supplier	(0.263)	(0.166)	(0.173)	(0.132)
entry year	0.438	0.368**	0.023	0.000
* supplier	(0.267)	(0.170)	(0.183)	(0.142)
entry year + 1	0.658***	0.482***	0.147	0.146
* supplier	(0.249)	(0.177)	(0.195)	(0.154)
Event year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Observations	315	775	1,258	1,997
R-squared	0.922	0.812	0.846	0.776

Notes: Event study estimates for manufacturing (columns (1)-(2)) and service suppliers (columns (3)-(4)) around the time of becoming a direct (columns (1) and (3)) or round-1 indirect (columns (2) and (4)) within-country automotive MNE supplier in event-year 0. The dependent variable is log sales. A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -5. Baseline controls refer to nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. For alternative controls I considered only the pre-event level of employment and domestic sales but not their growth rate. Robust standard errors are in parentheses.

Table A13: Event study regressions - labour productivity

Dep. var.: labor productivity

	(1)	(2)	(3)	(4)	(5)
Sector:	Manufacturing			Services	
Supplier type:	Direct	Indirect		Direct	Indirect
Controls:	baseline	baseline	alternative	baseline	baseline
entry year - 8	0.153	0.414	0.233	0.280	-0.145
* supplier	(0.396)	(0.320)	(0.259)	(0.385)	(0.214)
entry year - 7	-0.252	0.038	-0.167	-0.135	-0.173
* supplier	(0.380)	(0.210)	(0.208)	(0.176)	(0.149)
entry year - 6	0.101	0.048	-0.116	-0.141	-0.109
* supplier	(0.266)	(0.195)	(0.221)	(0.121)	(0.118)
entry year - 4	0.112	0.120	-0.030	0.032	-0.066
* supplier	(0.235)	(0.199)	(0.190)	(0.124)	(0.116)
entry year - 3	0.108	0.075	0.039	-0.138	-0.167
* supplier	(0.243)	(0.158)	(0.173)	(0.118)	(0.110)
entry year - 2	-0.066	0.101	0.052	-0.205*	-0.151
* supplier	(0.226)	(0.159)	(0.157)	(0.122)	(0.112)
entry year - 1	-0.241	0.134	0.042	-0.113	-0.051
* supplier	(0.233)	(0.156)	(0.152)	(0.123)	(0.119)
entry year	-0.152	0.113	-0.218	-0.111	-0.024
* supplier	(0.296)	(0.186)	(0.175)	(0.127)	(0.134)
entry year + 1	0.067	0.393**	0.191	-0.079	-0.110
* supplier	(0.319)	(0.178)	(0.220)	(0.157)	(0.138)
Event year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Observations	307	755	820	1,214	1,883
R-squared	0.613	0.522	0.524	0.654	0.588

Notes: Event study estimates for manufacturing (columns (1)-(3)) and service suppliers (columns (4)-(5)) around the time of becoming a direct (columns (1) and (4)) or round-1 indirect (columns (2)-(3) and (5)) within-country automotive MNE supplier in event-year 0. The dependent variable is labour productivity. A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -5. Baseline controls refer to nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. For alternative controls I considered only the pre-event level of employment and domestic sales but not their growth rate. Robust standard errors are in parentheses.

Table A14: Event study regressions - robustness with exactly known link formation year

Dep. var.	(1) log employment	(2)	(3) labour prod.	(4) TFP	(5) log imp.	(6) log K imp.
Sector	Sevices			Manufacturing		
Supplier type	Direct	Indirect	Indirect	Indirect	Indirect	Indirect
entry year - 8	-0.508**	0.162	0.303	0.221	1.209	-0.621
* supplier	(0.236)	(0.171)	(0.318)	(0.273)	(1.160)	(1.435)
entry year - 7	-0.041	0.027	-0.073	-0.004	-0.832	-1.916
* supplier	(0.143)	(0.094)	(0.207)	(0.176)	(1.308)	(1.313)
entry year - 6	0.064	0.091	-0.078	0.060	0.208	-1.688
* supplier	(0.109)	(0.098)	(0.202)	(0.164)	(1.234)	(1.248)
entry year - 5	0.109	0.137*	-0.090	-0.080	-0.936	-1.215
* supplier	(0.094)	(0.077)	(0.173)	(0.139)	(1.067)	(1.304)
entry year - 4	0.066	0.088	0.009	0.042	-0.107	-1.750
* supplier	(0.115)	(0.081)	(0.209)	(0.145)	(1.049)	(1.196)
entry year - 2	-0.014	0.017	0.003	0.026	0.455	0.661
* supplier	(0.085)	(0.072)	(0.163)	(0.124)	(1.034)	(1.357)
entry year - 1	0.073	0.051	0.005	0.043	2.003*	1.645
* supplier	(0.093)	(0.076)	(0.162)	(0.125)	(1.052)	(1.341)
entry year	0.162	0.108	-0.013	0.164	0.138	-0.977
* supplier	(0.105)	(0.082)	(0.209)	(0.126)	(1.126)	(1.256)
entry year + 1	0.200	0.146	0.261	0.352**	0.657	0.088
* supplier	(0.153)	(0.099)	(0.185)	(0.160)	(1.147)	(1.317)
Event year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	867	1,454	675	651	701	701
R-squared	0.900	0.900	0.513	0.730	0.706	0.563

Notes: Event study estimates for manufacturing (columns (3)-(6)) and service suppliers (columns (1)-(2)) around the time of becoming a direct (column (1)) or round-1 indirect (columns (2)-(6)) within-country automotive MNE supplier in event-year 0. The estimation sample includes only those new suppliers and their matched controls for which the exact year of starting the supplier relationship is known, i.e. suppliers of Mercedes in 2015 are excluded. The dependent variable is log number of employees in columns (1)-(2), labour productivity in columns (3), total factor productivity in column (4), log value of yearly total imports in column (5) and log value of imported capital goods in column (6). A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -3. Controls are nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. Robust standard errors are in parentheses.

Table A15: Event study regressions - robustness with exactly known link formation year for wage

Dep. var.: log per capita wage

	(1)	(2)	(3)	(4)	(5)	(6)
Sector:	Manufacturing				Services	
Supplier type:	Direct		Indirect		Direct	Indirect
Controls:	baseline	alternative	baseline	alternative	baseline	baseline
entry year - 8	-0.011	-0.126	0.249*	0.311	0.000	0.135
* supplier	(0.153)	(0.194)	(0.138)	(0.253)	(0.104)	(0.109)
entry year - 7	0.033	-0.075	0.261**	0.058	0.053	0.048
* supplier	(0.115)	(0.159)	(0.112)	(0.101)	(0.092)	(0.080)
entry year - 6	-0.007	-0.035	0.067	0.035	-0.012	0.030
* supplier	(0.145)	(0.189)	(0.154)	(0.178)	(0.081)	(0.097)
entry year - 5	-0.100	-0.039	0.121	0.169	-0.069	0.063
* supplier	(0.097)	(0.169)	(0.101)	(0.106)	(0.093)	(0.094)
entry year - 4	-0.102	-0.119	0.117	0.100	-0.057	0.002
* supplier	(0.079)	(0.133)	(0.081)	(0.100)	(0.112)	(0.081)
entry year - 2	0.054	0.025	0.088	0.105	-0.019	0.060
* supplier	(0.083)	(0.148)	(0.091)	(0.109)	(0.070)	(0.067)
entry year - 1	0.134	-0.062	0.125	0.133	-0.022	0.077
* supplier	(0.112)	(0.149)	(0.084)	(0.103)	(0.080)	(0.071)
entry year	0.066	0.075	0.160*	0.080	0.028	0.107
* supplier	(0.103)	(0.153)	(0.085)	(0.092)	(0.085)	(0.078)
entry year + 1	0.211**	0.176	0.208**	0.181	0.042	0.112
* supplier	(0.102)	(0.147)	(0.085)	(0.135)	(0.104)	(0.083)
Event year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	259	252	679	720	857	1,438
R-squared	0.809	0.793	0.693	0.616	0.834	0.751

Notes: Event study estimates for manufacturing (columns (1)-(4)) and service suppliers (columns (5)-(6)) around the time of becoming a direct (columns (1)-(2) and (5)) or round-1 indirect (columns (3)-(4) and (6)) within-country automotive MNE supplier in event-year 0. The estimation sample includes only those new suppliers and their matched controls for which the exact year of starting the supplier relationship is known, i.e. suppliers of Mercedes in 2015 are excluded. The dependent variable is log per capita wage. A set of event-year indicators, their interaction with an indicator for the firm being a new supplier and firm-fixed effects are on the right-hand side. The reference period is event-year -3. Controls are nearest neighbor controls from a propensity score matching including pre-event growth rates in employment and sales and an exact matching on 4-digit industry. Robust standard errors are in parentheses.

Table A16: Number of products by different categorization

	N. products
Direct suppliers' export and automotive MNE's import	331
Only direct suppliers export	208
Only automotive MNE's import	154
Direct suppliers' top export and automotive MNE's top import	60
Only direct suppliers' top export	40
Only automotive MNEs' top import	107
Automotive MNE's top import	100
Automotive MNE's top import and narrow set based on product description	128
Automotive MNE's top import and broad set based on product description	133
All the above and top export of direct suppliers	196
All the above and goods both imported by automotive MNE's and exported by direct suppliers	389

Notes: Products include intermediate inputs. Automotive MNEs refer to the Audi, Mercedes, Suzuki and Opel firms in Hungary. Direct suppliers refer to direct manufacturing suppliers of these four. Top import and export refers to goods ranked by total value imported (for automotive MNEs) or exported (for direct suppliers) and having a 99% cumulated share in total intermediates imports or exports of the firm group.

Table A17: Average share of domestic and cross-border auto-industry sales by supplier group

	Within-country suppliers			Cross-border suppliers		
		indirect				
	direct	round-1	round-2	type-1	type-2	type-3
Export share	37%	24%	19%	82%	80%	78%
total auto sales with type-1	61%	55%	61%	68%	55%	44%
total auto sales with type-2	65%	58%	61%	71%	69%	55%
total auto sales with type-3	65%	60%	61%	74%	72%	69%
VAT auto sales	57%	58%	59%			
share of auto products with type-1	56%	21%	13%			
share of auto products with type-2	69%	32%	19%			
share of auto products with type-3	72%	41%	29%			

Notes: Total auto sales include both within-country direct and indirect sales to automotive MNEs and exports of automotive-industry inputs. VAT auto sales refer to within-country direct and indirect sales to automotive MNEs. Share of auto products using the narrow (type-1), medium-size (type-2) or broad (type-3) set refer to the share of such products in total intermediate exports.

Table A18: Health index information match statistics

Year	main data	health index	matched	% matched
2009	18531	6208	6166	33%
2010	18292	6259	6227	34%
2011	18305	6379	6353	35%
2012	18263	6368	6339	35%
2013	18056	6434	6403	35%
2014	17875	6604	6539	37%
2015	17732	6846	6815	38%
2016	17590	6729	6698	38%

Notes: *Main data* refer to all the manufacturing firms in the financial statement panel which ever have at least 5 employees. *Health index* refers to manufacturing firms with information about the average health index of male employees. *Matched* refers to the number of matched firms and textit% matched is the share of *Main data* firms which have matched health index information. Average health index in a firm is calculated if there are at least three male employees of age 35-70 which have a calculated health index.