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The effect of FDI on local suppliers:

Evidence from Audi in Hungary

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Abstract

In 1993 Audi opened a new plant in Hungary. This paper examines the long-term effects of this large foreign direct investment on local firms operating in supplier industries. I use firm-level panel data with long time series. Using the method of triple difference-in-differences I compare outcomes of firms in supplier and control industries, close and far from the Audi plant, before and after the entry. My main findings are: (1) after the Audi entry the average annual growth rate of local firms increased by 3 percentage points for sales and 2 percentage points for employment. The effect is visible only five years after the entry of Audi. I find no positive effect on productivity. (2) Firms with foreign owners account for all the positive effect on sales and employment, suggesting a foreign-to-foreign complementarity in investments. Firms with higher productivity gained more. Consequently, the low initial productivity of domestic firms may explain the lack of an effect in this group. (3) New entrants in the supplier industry locating close to Audi are larger and grow faster, suggesting that Audi also had an effect on the extensive margin.

JEL: F23, R12

Keywords: foreign direct investment, vertical spillovers, agglomeration.

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A győri Audi gyár hatása a beszállító iparágban működő környező vállalatokra

Bisztray Márta

Összefoglaló

A tanulmány az Audi 1993-as győri beruházásának a helyi beszállító iparágban működő cégekre gyakorolt hosszú távú hatását vizsgálja. Az elemzéshez hosszú időtartamot lefedő cég szintű paneladatokat használok. A háromdimenziós különbségek közti különbség módszerét alkalmazom, amellyel a beszállító és kontroll iparágban működő cégek teljesítményét hasonlítom össze az Audi gyárhoz közeli és egy távolabbi kontroll régióban az Audi-beruházás előtt és után. A főbb eredményeim a következők: (1) a beszállító iparágban működő helyi cégek körében az értékesítés éves átlagos növekedési rátája 3 százalékponttal lett magasabb a győri Audi gyár megnyitása után, a foglalkoztatás növekedési rátája pedig 2 százalékponttal emelkedett. Ez a hatás azonban csak az Audi-beruházás után öt évvel válik mérhetővé. Ugyanakkor a helyi cégek termelékenységére nézve nem tapasztalok pozitív hatást. (2) A beszállító iparágban működő helyi vállalatokra gyakorolt hatás csak a külföldi tulajdonossal rendelkező cégeknél tapasztalható, amely a külföldi cégek beruházásai közti komplementaritásra utal. A becslések alapján a magasabb termelékenységű cégek tudtak többet profitálni az Audi győri jelenlétéből. Emellett az adatok azt mutatják, hogy a kizárólagosan hazai tulajdonban levő cégek termelékenysége alacsonyabb volt az Audi beruházása előtt, mint a külföldi tulajdonossal rendelkező cégeké. Így a külföldi beruházó és a helyi beszállító iparágban működő hazai tulajdonú cégek közti nagy termelékenységi különbség magyarázhatja azt, hogy a hazai cégek körében nem mérhető hatás. (3) Azok a vállalatok, amelyek az Audi győri beruházása után léptek be a helyi beszállító iparágba, a kontroll csoporthoz képest nagyobbak és gyorsabban nőnek.

JEL: F23, R12

Tárgyszavak: külföldi működőtőke-beruházás, vertikális tovagyűrűző hatás (spillover), agglomeráció.

The effect of FDI on local suppliers: Evidence from Audi in Hungary

Márta Bisztray*

June 30, 2016

Abstract

In 1993 Audi opened a new plant in Hungary. This paper examines the long-term effects of this large foreign direct investment on local firms operating in supplier industries. I use firm-level panel data with long time series. Using the method of triple difference-in-differences I compare outcomes of firms in supplier and control industries, close and far from the Audi plant, before and after the entry. My main findings are: (1) after the Audi entry the average annual growth rate of local firms increased by 3 percentage points for sales and 2 percentage points for employment. The effect is visible only five years after the entry of Audi. I find no positive effect on productivity. (2) Firms with foreign owners account for all the positive effect on sales and employment, suggesting a foreign-to-foreign complementarity in investments. Firms with higher productivity gained more. Consequently, the low initial productivity of domestic firms may explain the lack of an effect in this group. (3) New entrants in the supplier industry locating close to Audi are larger and grow faster, suggesting that Audi also had an effect on the extensive margin.

I Introduction

Attracting foreign direct investment (FDI) is high on the agenda of governments and municipalities all over the world.[1] One reason for this preference is that FDI is believed to play an important role in the development of the local economy. Besides the advantage that FDI creates new workplaces, the economic motivation for giving subsidies to FDI is the assumed existence of spillover effects to local firms. At the same time, empirical evidence on the existence of these benefits is ambiguous. First, it is difficult to properly identify FDI effects. Second, results largely depend on the characteristics of the local firms. As a result, some studies find a positive effect of FDI on domestic firms while others find no significant effect (see for

*I am very grateful to Ádám Szeidl and Miklós Koren for their guidance throughout the whole project and to Christian Fons-Rosen and Sergey Lychagin for their useful insights. I also thank Thomas Sampson, Gianmarco Ottaviano, Emanuel Ornelas and audiences at the CEU PhD workshop, at the annual conference of the Hungarian Society of Economics, at the VSVK research group seminar in CERS and at the LSE CEP international trade workshop for helpful comments. I gratefully acknowledge the support of the Lendület Grant 'Firms, Strategy and Performance' of the Hungarian Academy of Sciences.

[1] E.g., USA: https://www.whitehouse.gov/the-press-office/2013/10/31/president-obama-announce-first-ever-federal-effort-attract-job-creating-; USA, China and India: http://www.cbi.org.uk/media-centre/news-articles/2012/09/how-the-us-china-and-india-try-to-attract-external-investment/; India: http://articles.economictimes.indiatimes.com/2014-09-23/news/54239387_1_much-fdi-foreign-direct-investment-gdp-growth.

example the meta-analysis of Bruno and Cipollina, 2014). It is still not properly understood to what extent and through which channels the FDI effect operates. This knowledge would also be crucial for evaluating policy decisions about how to subsidize FDI (see e.g. Haskel et al., 2007). I contribute to this topic using rich data that helps the identification and allows for measuring particular mechanisms.

I look at a single investment, which limits the external validity of my findings. On the other hand, it allows for a cleaner measurement of the FDI effect and its mechanism. The plant of Audi Hungaria Motor Kft in Győr is one of the largest foreign direct investments in Hungary (KSH, 2011). Based on Dusek et al. (2015), the direct contribution of Audi to the Hungarian GDP was around 1% in 2008. In this way it serves as a good case to investigate the effects of a large FDI in the setting of a middle-income country.

My identification strategy is similar to the approach of Greenstone et al. (2010). Using a firm-level panel data set of Hungarian firms[2] I do a triple difference-in-differences estimation. I assume that the effect of Audi is concentrated in firms operating in the supplier industries, especially when located close to Audi in Győr. I compare differences in the outcomes of firms located close to Audi in Győr versus in a control region, operating in supplier industries versus in control industries, before versus after the Audi entry in 1994. Following the strategy of Greenstone et al. (2010) I define the control region using the potential second best location choice of Audi. I determine this location combining two sources: the later location choice of Mercedes and a study of Empirica, a German research institute, which ranks the locations in the Central-Eastern European region based on attractiveness to foreign investment in 1992. As Javorcik (2004) showed for Lithuanian firms, a major channel for FDI spillovers is the link between the foreign firm and its local suppliers. Building on her findings, but using a different identification strategy, I focus on firms in the supplier industries of car manufacturing. I expect that benefits are the highest for these firms. I include both tier-1 and tier-2 supplier industries, which I determine based on 4-digit input-output table data. Firms in these industries are the most likely to interact with Audi or with its direct suppliers through business links or shared labor force. My identifying assumption is the following: without the presence of Audi inherent differences between close and far locations would have changed in the same way in supplier and control industries over time. I also account for yearly 2-digit industry-specific shocks.

I look at the net effect of Audi on various firm performance measures: sales, employment, productivity and trade of local firms operating in supplier industries. I choose these measures based on the potential effects of FDI. First, increased demand by Audi might positively affect sales, employment and productivity due to scale economies. Second, increased domestic demand might negatively affect exports. Third, knowledge spillovers might positively affect productivity and export capability. I have a firm-level panel data set with uniquely long time series, which allows me to look at long-term effects. I measure separately the average per firm effect using within-firm estimates (intensive margin) and the effect of Audi on new entrants and exitors (extensive margin). I further decompose the extensive-margin effect to differences in the number and composition of entrants and exitors, and also check the composition at entry and the subsequent growth of new entrants separately. Finally I capture the total effect using 4-digit industry level estimates, which also

[2]The data sets I use: "APEH Balance Sheet" and "Customs Statistics" are created by the Institute of Economics, Centre for Economic and Regional Studies, Hungarian Academy of Sciences (MTA KRTK) from the original data. The data sets are work in progress. Although the MTA KRTK made effort to clean the data, it cannot be held liable for any remaining error.

accounts for potential heterogeneity in the firm-level effects.

I find a significantly positive effect on the intensive margin for sales, domestic sales and employment. For firms located close to Győr and operating in the supplier industries the average annual growth rate of sales increased by 3 percentage points and the annual growth rate of employment increased by 2 percentage points after the Audi entry. This observation is in line with a positive demand effect. Yearly patterns show that the effect was not immediate, suggesting that local supplier-industry firms needed some time to be able to benefit from the foreign investment. At the same time, I do not find a positive effect on productivity or exports, except for a higher export value to the neighboring Austria. These results suggest that there were no sizable knowledge spillovers from Audi to local supplier-industry firms, or spillovers were only concentrated in a few directly linked supplier firms. The missing productivity effect is in line with the findings of Javorcik (2004) in case of greenfield investments, but the presence of a positive demand effect without any effect on productivity is surprising.

In order to solve this puzzle I look at the mechanism of the FDI effect. Allowing for heterogeneity of the effect across firm groups, I find that only firms with foreign owners could increase their sales and employment after the Audi entry. I also estimate a larger demand effect for firms with a higher initial productivity. As domestically-owned firms were less productive before the Audi entry than foreign-owned firms, the productivity gap might have prevented domestically-owned firms from enjoying the benefits of Audi's presence. This conclusion is also supported by other studies based on interviews with managers (e.g. Bödör 2007), which claim that especially initially, domestically-owned local firms were not ready to qualify as suppliers of Audi. Additionally, highly productive firms with foreign owners might have had less room to learn from Audi, which could explain the missing productivity effect. Still, I cannot conclude that the presence of Audi was not beneficial for the local economy. My back of the envelope calculation suggests that the indirect contribution of Audi to the Hungarian GDP through the demand effect was about 50% of its direct contribution. At the same time, my results suggest that the complementarity of policies attracting FDI and promoting improvement of local firms is crucial for being able to enjoy the potential benefits of FDI in the local economy.

My firm-level estimates do not capture the effect of Audi on new entrants. The literature on the location choice of FDI showed that foreign investors attract additional foreign investments in the same industry (Head et al., 1995). For the identification of extensive-margin and total effects I assume that except the presence of Audi all other factors attracting firms to locate close to Győr are common in the supplier and control industries. Concerning the extensive margin, I find no significant effect on the the number of entrants and exitors, but firms entering into supplier industries close to Győr after the Audi entry were larger and also grew faster. Their sales in the second year after the entry was 35 percentage points higher than in the estimated counterfactual case without Audi, and their growth rate was 4.8 percentage points higher in sales, 3.4 percentage points higher in employment and 18.5 percentage points higher in exports. I capture the total effect of Audi on the local supplier industries by an industry-level analysis. I find that the average growth rate of 4-digit industry level sales weighted by the size of the industry increased by 8.3 percentage points and the growth rate of employment increased by 3.8 percentage points due to Audi. I also estimate a positive

effect on industry-level exports, but there is no significant effect on average productivity.

I.A Literature

Vertical FDI spillovers. The current study is related to the literature on spillovers from a foreign direct investment to local firms. There are many papers examining FDI spillovers, but findings on the scope and magnitude of these effects are mixed.[3] Starting with Javorcik (2004) a large strand of the literature focuses on vertical spillover effects: the effect of an FDI on local suppliers.[4] These papers measure FDI as the foreign ownership share in a given industry, neglecting the role of geographical closeness to FDI in spillover effects. My main contribution to this literature lies in my identification strategy, where I use information on the distance of firms from the FDI. My approach is also supported by Girma and Wakelin (2007) who find only within-region vertical FDI spillovers in the UK electronics industry.

Agglomeration spillovers. This study can also be related to the agglomeration spillover literature. I build my identification on Greenstone et al. (2010) and Greenstone and Moretti (2003) who estimate the productivity improving and welfare increasing effect of new plants opening in the US. My study differs in both the scope and the setting. I focus on a foreign direct investment in a Central Eastern European country, looking at its effect on various firm-level outcomes. We could expect a higher scope for learning in a middle-income country, but my results suggest that the productivity gap hinders local firms to benefit from the FDI.

Heterogeneity of FDI spillovers. We know from the literature that characteristics of both the local firms and the FDI matter for the estimated size of the spillover effect. Sinani and Meyer (2004) find that horizontal spillovers in Estonia vary with size, ownership and export activity of the affected firm. I find a similar variation for vertical spillovers in Hungary. Javorcik and Spatareanu (2011) claim that FDI with a remote home country applies more local suppliers. Javorcik (2004) finds no vertical spillovers for fully foreign-owned foreign investment. Lin et al. (2009) show that the FDI spillover effect is weaker for export-oriented foreign entrants. As Audi Hungaria has a close home country: Germany, it is fully foreign-owned and export-oriented, we could expect no spillovers on local firms. On the other hand, spillovers might increase with the scale of the investment, and Audi Hungaria is one of the largest firms in Hungary. In spite of that, I don't find any evidence for significant knowledge spillovers from Audi.

FDI effect on exports. One of the outcomes I investigate is exports. As Kneller and Pisu (2007) state, there are surprisingly few studies on the export promoting effect of FDI, although FDI might help local firms to export by increasing their productivity and showing the foreign standards. Harding and Javorcik (2012) find that FDI increased the export quality of local firms. Greenaway et al. (2004) and Kneller and Pisu (2007) estimate a significantly positive effect on both the export probability and the exported value of local firms in the UK. Franco and Sasidharan (2009) find a heterogeneous effect for different types of FDI in India. I add to these papers by looking at the export promoting effect in a middle-income small open economy.

[3] See Görg and Strobl (2001), Crespo and Fontoura (2007), Smeets (2008) and Meyer and Sinani (2009) for comprehensive analysis of the FDI spillover literature.

[4] Javorcik (2004) finds evidence of positive productivity spillovers to supplier-industry firms in Lithuania. As further examples Kugler (2006) and Lin et al. (2009) report positive vertical spillover effects in Colombia and China.

FDI spillovers in Hungary. There are some papers which estimate FDI spillovers using Hungarian data. Halpern and Muraközy (2007) find significant vertical spillovers in domestically-owned firms, also emphasizing the role of distance to FDI. Békés et al. (2009) show that larger and more productive firms located in the same county can benefit more from the presence of a foreign multinational. As opposed to my event-study type identification strategy, both papers use an identification strategy following Javorcik (2004). Additionally, I use a finer, 4-digit industry classification to determine the supplier industries. Also Iwasaki et al. (2012) use 4-digit industry classifications, emphasizing the multi-layered nature of vertical links, but they look at horizontal spillovers.[5]

This study is structured as follows: Section II gives a brief overview of the motor vehicle manufacturing industry in Hungary and describes the data. Section III discusses the identification strategy. Section IV presents the results and section V concludes.

II Background and data

II.A Motor vehicle manufacturing industry in Hungary

Audi Hungaria Motor Kft. was established in 1993 by the German Audi AG. The new production plant built up in Győr started to operate in 1994. Its first activity was manufacturing of engines. Then from 1998 on cars were also assembled in Hungary, for which body elements were brought from Germany. Finally, from 2005 on tools manufacturing was also added to the line of activities. The plant has been continuously expanded over the years, the most recent large investment occurred in 2013. Currently, Audi is one of the largest employers of the country. The number of employees was about 11,300 in 2015 January. Audi is also one of the largest firms in Hungary in terms of sales. The net revenues of Audi Hungaria were €5588 million in 2013.[6] Consequently, Audi is a highly important FDI in Hungary.

Audi is not the only large player in the motor vehicle and engine manufacturing industry in Hungray. Figure 1 shows the location of the four large car manufacturers. Opel Szentgotthárd Kft., located in Szentgotthárd, and Magyar Suzuki Zrt, located in Esztergom, were established in 1991, two years before the entry of Audi. Mercedes-Benz Manufacturing Hungary Kft, located in Kecskemét, was built only recently and started to operate in 2012. The Suzuki plant manufactures cars and the Opel plant manufactures engines. Opel also assembled cars initially, but this activity ended in 1996. The sales of Suzuki and Opel are about 1/3 of Audi's sales (see Figure A1 of the Appendix). The different timing of entry and the different location of the plants helps to separate the effect of Audi.

According to industrial experts, Audi initially had very few suppliers located in Hungary. Though the number of local suppliers increased over time, there are still only a few primary suppliers located in Hungary,

[5]Some recent papers use cross-country data for estimating vertical spillover effects. Alfaro and Chen (2013) emphasize the reallocation channel in the productivity effect of FDI. Fons-Rosen et al. (2013) find a very small but positive aggregate impact of FDI on country-level productivity growth. As I have a database from a single country, the external validity of my findings is more limited, but the rich information on firms can add to the identification where I also exploit spatial differences within the country.

[6]`http://evesjelentes2013.audiportal.hu/felelosseg/penzugyi_jelentes.pdf`

and most of them are foreign owned. There are much more Hungarian firms among the secondary or tertiary suppliers (Bödör, 2007). Unfortunately, no full list of the Audi suppliers is available, neither for research purposes. I could still identify some suppliers mentioned in the press. Most of these known suppliers are located in Győr or nearby (see Figure A2 of the Appendix). This observation supports my assumption that firms located close to Győr are more likely to benefit from the presence of Audi than firms located in other parts of the country.

II.B Data

For the analysis I combine three firm-level panel data sources. The first is a data set from the Hungarian tax administration, which contains yearly balance sheet data for the universe of Hungarian firms between 1992-2011. The data set also includes 4-digit industry categorization corresponding to NACE Rev. 1.1 and the shares owned by foreign, local private and public agents. This allows me to create firm groups by industry and ownership. The second data set is the firm information database of CompLex Kiadó Kft. The CompLex database contains the precise address of the headquarters for all firms in Hungary between 1992-2012. Using this information I assign firms to groups by location. The third data source includes detailed customs data for all Hungarian firms between 1992-2003. It contains the yearly total value a firm exported to or imported from a country by 8-digit product category. This allows me to look at the export activity of firms by destination, which helps to identify potential country-specific spillover effects on exports.

I estimate the effect of Audi on various firm performance measures. I use sales, domestic sales and employment data from the balance sheet. I correct all the monetary values for inflation using two-digit sectoral price indices: producer price index for sales and imports, export price index for exports, a weighted average of supplier sectors' PPI for material and a simple average PPI of five sectors manufacturing machinery and transport equipment for capital. I express all values in 1998 HUF. I measure productivity in two alternative ways, using labor productivity and total factor productivity. I calculate labor productivity as value added per capita, where value added is defined as sales minus material costs. For total factor productivity estimates I assume a Cobb-Douglas production function with coefficients varying by 2-digit industries. For firm i operating in industry j the production function in year t is:

$$Y_{ijt} = A_{ijt} L_{ijt}^{\alpha_j} K_{ijt}^{\beta_j} M_{ijt}^{\gamma_j}. \tag{1}$$

Y denotes sales, A is total factor productivity, L is labor measured by the number of employees, K is capital measured by the value of capital assets and M is material measured as material costs from the balance sheet. I estimate the log of the above equation:

$$log(Y_{ijt}) = log(A_{ijt}) + \alpha_j log(L_{ijt}) + \beta_j log(K_{ijt}) + \gamma_j log(M_{ijt}) + \varepsilon_{ijt}. \tag{2}$$

Using the method of Levinsohn and Petrin I estimate a separate production function for each 2-digit industry. Table A1 of the Appendix presents the estimated coefficients in each industry.

Figure 1: Treated and control regions within Hungary, also indicating Pest and Csongrád counties and the location of the four motor vehicle plants

III Empirical strategy

In order to identify the effect of Audi on the local supplier industry I need a proper counterfactual. I use a triple difference-in-differences strategy, comparing outcomes of firms in supplier and control industries, near and far from Audi, before and after the entry of Audi. In the following I refer to closely located firms operating in the supplier industry as the treated group.

III.A Regional and industrial categorization

I define the region affected by the entry of Audi as a 80 km radius circle around Győr. Since I only have Hungarian data, I take the part of the circle which falls within the territory of Hungary as the treated region. I follow the strategy of Greenstone et al. (2010) and use the same circular area around the second best location choice of Audi as the control region. I regard Kecskemét as the potential second best location choice, where another auto manufacturer, Mercedes located two decades later. More importantly, the area around Kecskemét includes Csongrád, which was the second most attractive location in the region for foreign investors, just after Győr. This ranking is based on a 1992 survey of Empirica, a German research institute from Bonn. Figure 1 shows the map of Hungary with the treated and control regions. I assign a firm to the treated or control region based on its location in 1993, the year before the Audi plant started to operate in Győr. For new entrants after 1993 I take the first location. I neglect location changes over time. This simplification does not cause a large distortion as 86% of the firms stayed in the same county over the years.

I classify firms to supplier and control industries based on their main four-digit NACE category. I consider only manufacturing firms. I look at both tier 1 (direct) and tier 2 (indirect) suppliers, as it is easier to become a secondary supplier, and these firms might also have enjoyed the benefits from the presence of Audi. I define supplier industries as those 4-digit manufacturing industries which provide a considerable share of inputs for car manufacturing or for its largest direct supplier industries. I use the 1997 US input-output table, which is detailed enough to differentiate between 4-digit industries. As automobile manufacturing has a similar technology all over the world, it is not necessary to use Hungarian input-output tables, which are only available at the 2-digit level. The Audi plant in Győr assembles cars and manufactures engines as well, so the industries of interest are *Automobile Manufacturing* (NAICS 336111), *Motor Vehicle Body Manufacturing* (NAICS 336211) and *Gasoline Engine and Engine Parts Manufacturing* (NAICS 336312). I classify a 4-digit industry as a direct supplier if its output is used by any of these three industries and its contribution to total spending on manufacturing inputs by the given industry is at least 0.1%. These 4-digit NACE categories are the tier 1 supplier industries. I determine the tier 2 supplier industries in the same way, but using the aggregate spending of tier 1 suppliers instead of the three car manufacturing industry categories. The control industries are all those 4-digit manufacturing industries which do not sell any inputs to the three car manufacturing industries or to the tier 1 supplier industries. I assign firms to supplier and control industries based on their main activity. If a firm's activity changed over time I take the industry category with the longest duration. I present the full list of supplier and control industries in Table A2-A4 of the Appendix. Table A5 of the Appendix shows the number of firms by 2-digit industries and their composition before the Audi entry in the four firm groups by industry and region.

III.B Estimation

For the identification strategy I make three assumptions. First, I assume that the effect of Audi was locally concentrated. Many of the known suppliers are located close to Győr (see Figure A2 of the Appendix), which supports this assumption. Second, I assume that Audi had no effect on firms operating in the control industries. Those firms can benefit from the presence of an FDI which operate in related industries. This assumption is also supported by Javorcik (2004), who finds that the major form of FDI spillovers is the vertical spillover between the investing firm and its local suppliers. If any of these assumptions is not true, my results still provide a lower bound of the true Audi effect. Third, I assume that after controlling for inherent and regional differences, firms operating in the supplier industries and located in the control region can provide a proper counterfactual. As comparable data are only available two years before the entry of Audi, I can only compare levels before the Audi entry but not pre-trends. Still, I choose the control region in such a way that it is comparable to the treated region. Table 1 shows that suppliers near and far are indeed similar in terms of various characteristics (column (3)). The only exception is the higher share of exporters in the treated region, which is closer to Austria. This difference becomes only marginally significant when I control for regional differences in control-industry firms. Column (7) shows the p-values of the interaction term coefficients from a difference-in-differences estimation in the period before the Audi entry. The similar

Table 1: Comparison of firm groups before the entry of Audi

Period: 1992-1993 Industry group:	supplier			control			Diff-in-diff
Location:	near	far	p-value	near	far	p-value	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of firms	239	544		403	814		
Sales (MHUF)	196 (562)	192 (622)	0.929	489 (1482)	432 (1539)	0.419	0.568
Domestic sales (MHUF)	132 (398)	145 (514)	0.638	409 (1249)	328 (1089)	0.133	0.189
Employment (capita)	46 (136)	47 (117)	0.850	86 (218)	91 (256)	0.668	0.823
Log total factor productivity	4.66 (0.94)	4.74 (0.97)	0.176	5.09 (1.13)	5.21 (1.04)	0.022	0.649
Value added per worker (MHUF)	4.09 (6.79)	3.54 (7.37)	0.236	4.2 (8.72)	4.38 (13.58)	0.822	0.422
Export value (MHUF)	62 (270)	45 (186)	0.175	110 (469)	132 (660)	0.433	0.288
Export value to Germany (MHUF)	55 (175)	73 (219)	0.392	142 (453)	209 (728)	0.187	0.461
Export value to Austria (MHUF)	37 (159)	19 (71)	0.138	65 (221)	32 (92)	0.020	0.467
Import value (MHUF)	64 (266)	40 (215)	0.082	92 (336)	57 (306)	0.016	0.601
Share of exporters	0.4 (0.49)	0.33 (0.47)	0.012	0.39 (0.49)	0.32 (0.47)	0.003	0.875
Share of exporters to Germany	0.22 (0.42)	0.22 (0.41)	0.773	0.22 (0.42)	0.2 (0.40)	0.321	0.708
Share of exporters to Austria	0.19 (0.39)	0.11 (0.31)	0.000	0.16 (0.36)	0.12 (0.33)	0.023	0.084

Columns 1-2 and 4-5 show yearly averages per firm within a group in the period before the Audi entry. Standard deviations are in parentheses. Columns 3 and 6 show the p-value of comparing means within an industry group, where the alternative hypothesis is the difference of means. Column 7 shows the p-value of comparing the difference in means between the two groups. It is the p-value of the interaction term coefficient from a diff-in-diff regression with industry group and region as the two dimensions, using only pre-entry data, and the corresponding variable of the row on the left-hand side. Monetary values are given in million HUF, deflated to 1998 values. As a comparison, in 1998 December the exchange rate was around 1 USD = 219.03 HUF.

industry composition within the supplier industry group across regions also support the comparability of the treated and the control region. Table A5 of the Appendix shows the 2-digit industry composition in the four firm groups before the entry of Audi. I consider further potential threats to the identification after showing the results.

I use the following econometric specification for the triple difference-in-differences estimation:

$$Y_{it} = \beta_0 + \beta_1 D_t + \beta_2 D_t Supplier_{j(i)} + \beta_3 D_t Near_i + \beta_4 D_t Supplier_{j(i)} Near_i + a_i + s_{jt} + u_{it}, \qquad (3)$$

where i stands for firm, j is industry and t is year. Y_{it} is an outcome variable, which can be the log of sales, employment, measures of productivity or export activity. $Supplier_{j(i)}$ is a dummy for firm i operating in industry j where j is a supplier industry. $Near_i$ is a dummy for firm i being located in the region close to the Audi plant in Győr. In the baseline specification D_t is an indicator for the period after the Audi entry, starting in 1994. In alternative specifications D_t either incorporates both a time dummy and a time

trend after the Audi entry, or it denotes a full set of sub-period dummies or year dummies. Assuming no differences in pre-trends, the specification with the time dummy and time trend allows me to separate the effect of Audi on the level and on the trend of the outcome variable. The gradual expansion of the Audi plant also suggests that the effect of Audi might have been increasing over time. I create sub-periods according to the different phases of investment in Audi. The specification with the full set of year dummies allows to estimate the dynamics of the effect in the most flexible way. The coefficients on the triple interaction terms (β_4, which is a vector in the alternative specifications) measure the average effect of Audi on a supplier firm located close to Győr. a_i denotes firm-fixed effect, s_{jt} is an industry-year-fixed effect and u_{it} is the error term. Firm-fixed effects ensure within-firm identification from firms already existing before the Audi entry and control for time-invariant composition differences across firm groups. I define industry-year-fixed effects using 2-digit industry categories, which are broader than the 4-digit industry classification I use to define the supplier and control industries. Industry-year-fixed effects correct for time-varying differences in industry composition across regions by controlling for yearly shocks common to a 2-digit industry. These industry-wide changes are not associated with the entry of Audi by assumption. Identification comes from those 2-digit industries which have both 4-digit treated and control industries. These industries contain about 3/4 of the supplier-industry firms (see Table A5 of the Appendix). I cluster the standard errors by 4-digit industry and county groups.

The set of outcomes I choose to investigate is suggested by the potential effects of an FDI. First, an FDI might increase sales and employment of local firms through a direct demand effect. Second, FDI can improve the productivity of local firms through knowledge spillovers. If there are increasing returns to scale in the industry, a higher demand also increases productivity. If local competition becomes higher, reallocation can also increase average productivity. Third, FDI can affect the export activity of local firms. Increased productivity also increases export capability. Additionally, FDI might make local firms aware of the international standards or it can help connecting local firms to potential foreign business partners. On the other hand, increased local demand can crowd out exports if there are capacity constraints in production. From the policy point of view the outcomes of the main interest are the number of additional workplaces created and the contribution to GDP, either through increased sales or increased productivity. The other outcomes I use, i.e. domestic sales and exports help to understand the Audi effect in more depth. Domestic sales should increase if there is a demand effect. Increased exports to Germany, the home country of Audi, or to Austria, a close country with similar culture and language can be a sign of knowledge spillovers from Audi.

In the estimation sample I include only those manufacturing firms which can be classified as treated or controls based on their industry and location. I exclude firms with a median number of employees below 5, as these firms tend to provide less reliable balance sheet data. I also expect that very small firms cannot benefit from the presence of Audi. I also exclude outliers with the largest 0.1% of sales or zero reported sales. I use the remaining 5448 firms in the estimations. From these firms 1855 were present both in the pre- and post-Audi entry period (222 in the treated group) and 3449 were new entrants following the Audi entry (625 in the treated group). Table 1 shows descriptive statistics of the outcome variables by firm group

for the period before the Audi entry.

IV Results

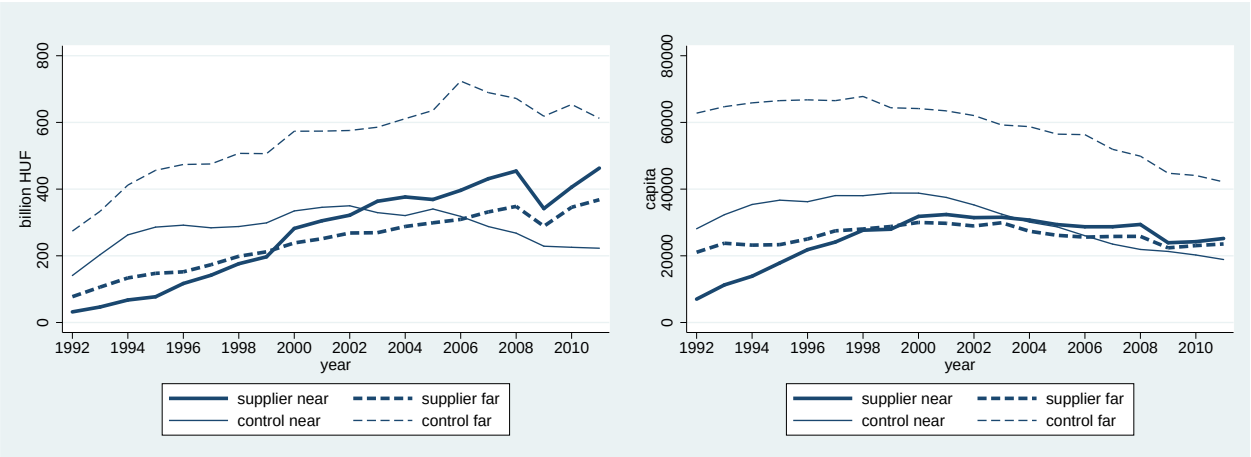
IV.A Suggestive evidence from aggregate data

I start with showing suggestive evidence of a non-negligible effect of Audi on the local supplier industry. In Figure 2 I plot the yearly aggregate values of the three most important outcome variables: sales, employment and average productivity, separately for the four groups. The patterns are in line with the effect of Audi on aggregate sales and employment, but not on productivity. Before 1995 total sales increased in a parallel way across regions within the same industry group, and total employment increased in a parallel way across industry groups within the same region. In the period 1996-2001 both supplier-industry sales and employment increased more in the region close to Audi than in the control region. In the same period control industries evolved in a parallel fashion in the two regions. After 2001 total sales and employment stayed higher in the treated group and evolved in a parallel way with the control region. At the same time, sales in the control industry started to decline in the region close to Audi, but they were still growing in the control region. Throughout the whole period the average productivity, which I measure using the weighted average of firm-level labor productivity, was rather lower in the treated group compared to the controls. Figure A3 of the Appendix shows similar plots for domestic sales and exports. Total exports in the treated group was growing clearly faster, but patterns are not so clear for domestic sales. Supplier industries evolved in a similar way in the two regions, but sales in the control industries declined in the region close to Audi compared to the control region. It can be a question how Audi could attract new entrants in the supplier industries if these firms sold so little to Audi, as the co-movement of aggregate domestic sales in the two regions suggests. First, it is possible that control industries capture regional shocks in a proper way and domestic sales in the supplier industry would have decreased in the treated region without the presence of Audi. Second, Audi could attract further FDI in related industries for reasons other than a direct supplier relationship. Agglomeration effects like sharing a common labor pool or other spillovers could also play a role in the location decisions of new entrants. Overall, these figures suggest that worsening of the control industry in the region close to Audi contributes to the estimated total effect of Audi, but does not move the results.[7]

Next, I use my triple difference-in-differences strategy to show that the contribution of Audi to the growth of the local supplier industry seems to be considerable. I look at the five-year growth rate from 1993 to 1998, where the end point is the middle of the fast-growth period in the treated group. In the treated firm group the 5-year growth rate of total sales was 2.79 and it was 1.46 for employment. Using the growth rates in the other three groups and applying the triple difference-in-differences strategy I find that 73% of total sales growth and 79% of total employment growth can be attributed to Audi. Then I decompose the calcu-

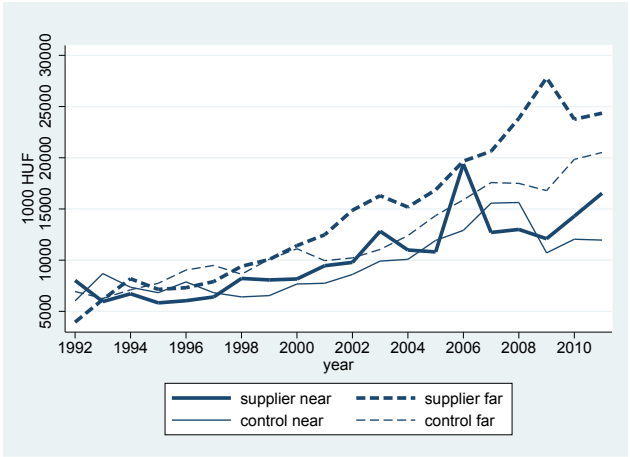
[7]Patterns are even clearer in Figure A4 of the Appendix. Taking the log of the same measures, Figure A4 shows the cross-region differences, normalized to zero just after the Audi entry.

Figure 2: The evolution of total sales, total employment and average productivity in the different firm groups



(a) Sales

(b) Employment



(c) Average productivity

lated total Audi effect to the contribution of firms being present both in 1993 and 1998, exiting before 1998 and entering after 1993. Following Eaton et al. (2007) for each of the four industry-region groups I calculate

$$\frac{Y_{98}-Y_{93}}{Y_{93}} = \frac{\sum_{i\in C}(y_{i,98}-y_{i,93})}{\sum_{i\in C} y_{i,93}} \frac{\sum_{i\in C} y_{i,93}}{Y_{93}} + \frac{NE\bar{y}_{93}}{Y_{93}} + \frac{\sum_{i\in E}(y_{i,98}-\bar{y}_{93})}{Y_{93}} - \frac{NX\bar{y}_{93}}{Y_{93}} - \frac{\sum_{i\in X}(y_{i,93}-\bar{y}_{93})}{Y_{93}}, \quad (4)$$

where Y_t is total sales or employment in year t, $y_{i,t}$ denotes firm-level sales or employment and $\bar{y}_t$ denotes average sales or employment in year t. C is the group of continuing firms being present both in 1993 and 1998, E is the group of new entrants from 1993 to 1998 and X is the group of exitors in the same period. N denotes the number of firms in a given group. The first term is the share of continuing firms, the second and fourth are the shares of entrants and exitors assuming no composition effect. The third and fifth terms measure the contribution of composition change coming from entrants and exitors. I do the triple difference-in-differences calculations for each of the five terms separately. With this back of the envelope calculation I find that the share of the continuing firms in the total effect of Audi is 18% for sales and 19% for employment. The share of entrants neglecting composition change is 21% for sales and 37% for employment. The share of composition change coming from entrants is 59% for sales and 41% for employment. The total share of exitors is negligible. This suggests that it is important to take into account both the incumbents and the new entrants when I want to capture the total effect of Audi. These calculations are only approximations, as I neglect potential composition differences across the firm groups. In the followings I provide more precise estimates using firm-level regressions.

In this section I first present estimates of the average firm-level effect and show heterogeneity by firm characteristics (intensive-margin effect). Next, I look at the number and the composition of new entrants and exitors (extensive-margin effect). I also check separately the characteristics of entrants by the time of entry and their growth afterwards. Finally, I provide industry-level estimates which incorporate the effect on both the intensive and extensive margin and also capture heterogeneity in the firm-level effects (total effect).

IV.B The effect of Audi on the intensive margin

IV.B.1 Demand effect

My baseline firm-level estimates use the simplest version of equation 3, where I include a single indicator for the entire period after the Audi entry. The first three columns of Table 2 show the estimated effect of Audi on sales, domestic sales and employment. In the average firm located nearby and operating in a supplier industry, yearly sales and domestic sales increased by 35 percentage points and employment increased by 31 percentage points after the entry of Audi. These results are in line with a demand effect of Audi.

Using the more flexible versions of equation 3 I check the dynamics of the estimated demand effect. Columns (4)-(6) of Table 2 present estimation results from the specification which allows a separate effect

Table 2: The effect of Audi on sales and employment

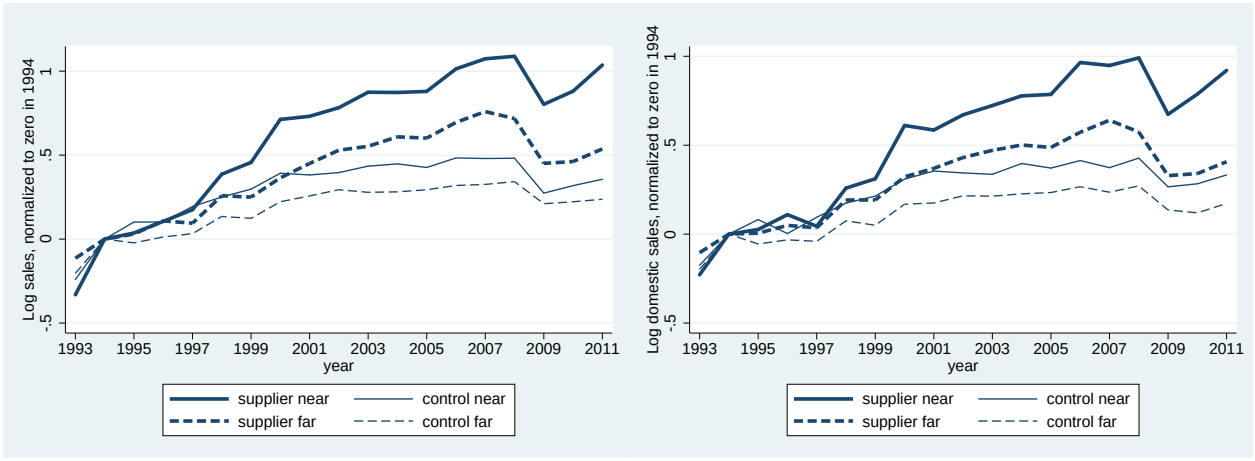
Dep. var.:	log sales	log domestic sales	log employment	log sales	log domestic sales	log employment
	(1)	(2)	(3)	(4)	(5)	(6)
Triple interaction term	0.347**	0.346**	0.309***	0.140	0.129	0.141
with after dummy	(0.151)	(0.159)	(0.105)	(0.139)	(0.152)	(0.099)
Triple interaction term				0.028**	0.030**	0.023***
with after trend				(0.011)	(0.012)	(0.009)
Double interaction terms	YES	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	NO	NO	NO
After entry trend	NO	NO	NO	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES	YES	YES
Observations	54,017	51,857	53,394	54,017	51,857	53,394
Number of firms	5,427	5,410	5,434	5,427	5,410	5,434

Triple interaction term: time dummy or time trend for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry period interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Year-industry fixed effects use 2-digit industry classifications.

on the level and the trend of the outcome variables. Results suggest that most of the effect comes from a significantly positive break in the trend rather than a jump in the level. Assuming that growth rates across firm groups before the Audi entry were the same, I find that the average annual growth rate of sales and domestic sales increased by 2.8 and 3 percentage points and the growth rate of employment increased by 2.3 percentage points after the Audi entry. Estimating the Audi-effect by sub-periods suggests that this pattern is partly driven by the time lag between the entry of Audi and its effect on local firms. Table A6 of the Appendix shows no significant effect on sales and only marginally significant effect on employment in the sub-period 1994-1997. Coefficient estimates by sub-periods increasing over time are in line with a positive effect on the growth rate of sales and employment. Table A8 of the Appendix shows similarly increasing patterns from first, second, third and fifth difference estimation results.

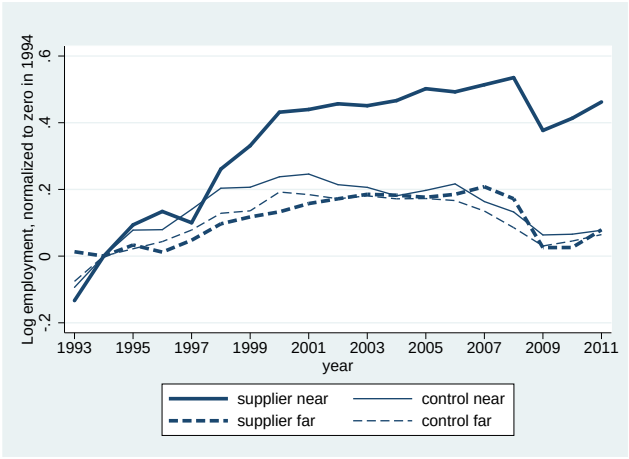
I use the most flexible specification to see the full dynamics of the Audi effect. I estimate a version of equation 3 with a full set of year dummies and without year-industry-fixed effects. This allows me to plot the estimated pattern of log sales, log domestic sales and log employment in the four firm groups over time. In each firm group I normalize the values to zero in 1994. Figure 3 presents the normalized value of the estimated coefficients on the year dummies in the corresponding firm group: β_1 for control-industry firms in the control region, $\beta_1 + \beta_3$ for control-industry firms in the treated region, $\beta_1 + \beta_2$ for supplier-industry firms in the control region and $\beta_1 + \beta_2 + \beta_3 + \beta_4$ for supplier-industry firms in the treated region. Figure 3 shows that sales, domestic sales and employment moved together in control-industry firms located near Audi and in the control region. Apart from a moderate shift in levels the figure shows no systematic difference between close and far regions. The average employment of supplier-industry firms in the control region also evolved in a similar way. Though average sales and domestic sales of supplier-industry firms increased more rapidly even in the control region, sales of supplier-industry firms increased in the treated region even more than that. Figure 3 suggests that the positive effect of Audi on local firms was not immediate. This pattern

Figure 3: The evolution of average log sales, log domestic sales and log employment in the different firm groups, normalized to zero for all groups in 1994



(a) Sales

(b) Domestic sales



(c) Employment

Table 3: The effect of Audi on productivity and trade

Dep. var.:	labor productivity	total factor productivity	log exported value			probability of starting to export	log imported value
			to all destinations	to Germany	to Austria		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Triple interaction term	-0.087	-0.114*	0.223	0.275	1.165**	0.049	-0.277
	(0.089)	(0.063)	(0.319)	(0.410)	(0.483)	(0.038)	(0.277)
Double interaction terms	YES	YES	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES	YES	NO	YES
Observations	51,663	50,341	12,681	6,944	4,472	21,862	13,798
Number of firms	5,409	5,233	2,424	1,488	1,096		2,694

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Year-industry fixed effects use 2-digit industry classifications.

is in line with the information that Audi built up its local supplier links gradually. Most of the difference between treated and control firms comes from the larger growth rate of treated firms between 1998-2000. This period corresponds to the second phase of the Audi investment, when the sales of Audi also increased to a large extent (see Figure A1 of the Appendix). After 2000 the difference in levels remained, but growth rates became similar for supplier-industry firms in the treated and control regions. Figure A5 of the Appendix presents coefficient estimates on the triple interaction terms using the most flexible specification with 2-digit industry-year-fixed effects. With 1992-1993 as the reference period, Figure A5 shows that the effect of Audi increased over time and became significant only in 1998 for employment and in 2000 for sales and domestic sales.

IV.B.2 The effect on productivity and trade

The next set of firm-level outcomes I look at is productivity and exports. In Table 3 I present estimation results using the baseline specification with a single indicator for the whole period after the entry of Audi. The first two columns show that Audi did not increase significantly the productivity of local supplier-industry firms. Estimates using either productivity measures are negative and even marginally significant for total factor productivity. Estimates are noisy and significance is not robust to specification changes. I conclude that Audi had no significant effect on the productivity of closely located firms operating in the supplier industry. This result is in line with Javorcik (2004), who finds no significant productivity increasing effect of foreign greenfield investments. Still, a positive demand effect combined with no effect on productivity is a puzzle.

Columns (3)-(7) of Table 3 show the effect of the Audi entry on the extensive and intensive margin of exports and on imports. I measure the extensive margin effect by changes in the probability of starting to export, conditional on not exporting before. I use changes in the exported value to measure the effect on the intensive margin. For estimating the extensive margin I use a simple linear probability model without

firm-fixed effects, where the left-hand side variable is a dummy being one if the firm started to export in the given year. I include firms only in those years when they start to export or when they haven't started to export yet. I use the sample of firms which already existed before the entry of Audi. I also estimate intensive- and extensive-margin effects separately for Germany and Austria. Spillovers might be specific to these countries, as Germany is the home country of Audi and also the largest trade partner of Hungary, and Austria is the neighboring country of the county Győr with cultural links to Germany. Table 3 shows no significant impact of Audi on exports or imports. The only exception is a significantly positive effect on the exported value to Austria, which is the closest and easiest export destination for firms located close to Győr. This might suggest an export promoting effect of Audi specifically to Austria. Firms in the treated group might have used better marketing techniques or got better foreign contacts which helped them to sell their products abroad even without any productivity increase. Alternatively, country-specific export activity of firms in the treated and control industry differs in such extent that the design I use cannot account for regional differences. Overall, I conclude that Audi did not have a clearly positive effect on trade. Table A6 and A7 of the Appendix show similar patterns separately by sub-periods.

IV.B.3 Heterogeneity of the effect by firm groups

After estimating average firm-level effects, I allow for heterogeneous effects by different types of local firms. In this way I can learn more about the mechanism of the Audi effect. I check if the effect of Audi varies by ownership structure, size or initial productivity of the local firms. I differentiate firms with foreign owners and firms which have only domestic owners. I classify a firm as domestic if it never has a foreign owner in the period of 1992-2011. In this way I can separate firms with foreign owners, which might have had access to resources or knowledge directly through their foreign owners and not through their contacts with Audi. I assign firms to size and productivity tertiles based on their employment and estimated total factor productivity in 1993, one year before the Audi entry. I create productivity tertiles for each 2-digit industry separately. For estimating heterogeneous effects I use a modified version of the baseline specification:

$$\begin{aligned} Y_{it} = \gamma_0 + \sum_k \gamma_1 D_t Group_{k,i} + \sum_k \gamma_2 D_t Supplier_{j(i)} Group_{k,i} + \sum_k \gamma_3 D_t Near_i Group_{k,i} \\ + \sum_k \gamma_4 D_t Supplier_{j(i)} Near_i Group_{k,i} + a_i + s_{jt} + u_{it}. \end{aligned} \tag{5}$$

As before, i stands for firm, j is industry group and t is year. $Group_{k,i}$ is a dummy variable being 1 if firm i belongs to group k. Group k can be a size or productivity tertile, or it can refer to domestic ownership. Coefficient vector γ_4 shows the estimated effect of Audi in the different subgroups. In the estimations by ownership group, γ_4 shows the additional effect on domestic firms compared to the reference group. As in equation 3, D_t is a time indicator, which can either be a single dummy for the period after the Audi entry, a dummy and a trend after the Audi entry, or a full set of year dummies. $Supplier$ is an indicator of supplier-industry firms and $Near$ is an indicator for firms located close to Audi.

Table 4 shows the estimated effects by ownership group. The coefficient on the triple interaction term

Table 4: The effect of Audi by ownership

Dep. var.:	log sales (1)	log domestic sales (2)	log employment (3)	labor productivity (4)	total factor productivity (5)	log exported value (6)	log imported value (7)
Triple interaction term	0.878***	1.014***	0.892***	-0.252	-0.155	1.041**	0.410
	(0.317)	(0.375)	(0.215)	(0.190)	(0.150)	(0.479)	(0.385)
Triple interaction term x domestic dummy	-0.775**	-0.923**	-0.843***	0.197	0.048	-1.456**	-1.458**
	(0.363)	(0.416)	(0.252)	(0.208)	(0.164)	(0.657)	(0.583)
Double interaction terms	YES	YES	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES	YES	YES	YES
Observations	51,287	49,166	50,658	49,008	47,937	12,466	13,571

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. All these also interacted with domestic dummy being one if 100% domestic ownership in every year. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs. Only domestic (always 100%) and foreign (minimum 20% foreign ownership at some point) owned firms included. Year-industry fixed effects use 2-digit industry classifications.

$D_t Supplier_i Near_i$ measures the effect on firms having foreign owners at any point in time. Adding up this term and its interaction with the *Domestic* dummy gives the effect of Audi on domestic firms. The patterns are clear, employment, sales, domestic sales and exports became significantly higher in firms with foreign owners after the Audi entry. The same effects are close to zero for domestic firms and the estimated effect on imports is significantly negative. Imported inputs might have been substituted by the output of expanding local firms having foreign owners. Productivity estimates are negative but insignificant in both firm groups. The estimated positive demand effect of Audi is driven by firms with foreign owners and already existing before the entry of Audi. This finding is in line with the commonly held view that Audi had only few local suppliers and most of these were foreign-owned. Though the difference is not significant, Table A9 of the Appendix suggests that the effect was even larger for those firms where the owners come from countries in which Germans have more trust according to the Eurobarometer survey. On average, domestic firms in the supplier industries could not benefit from the presence of Audi, even if I include tier 2 supplier industries in the estimation. At the same time, this finding suggests a foreign-to-foreign complementarity in investments. A new FDI can have a positive effect on other FDI-s being already present in the host country. This channel should be taken into account in evaluations of the FDI effect.

The effect of Audi also differs by the initial productivity of the local firms. Table 5 shows that the estimated effect on sales, domestic sales and employment is smaller and insignificant in the lowest productivity tertile. Medium- and high-productivity firms can benefit from a demand effect to the same extent. Productivity estimates are always negative but insignificant, and only marginally significant for medium-productivity firms. Exports and imports are not affected in any productivity group either. Table A10 of the Appendix shows that not the largest firms move the results. The employment and sales effects are even larger for small or medium-size firms, and the effect on domestic sales is similar across size groups. Sales and domestic sales effects are not significant any more, presumably due to the lower sample size within a group.

Table 5: The effect of Audi by productivity

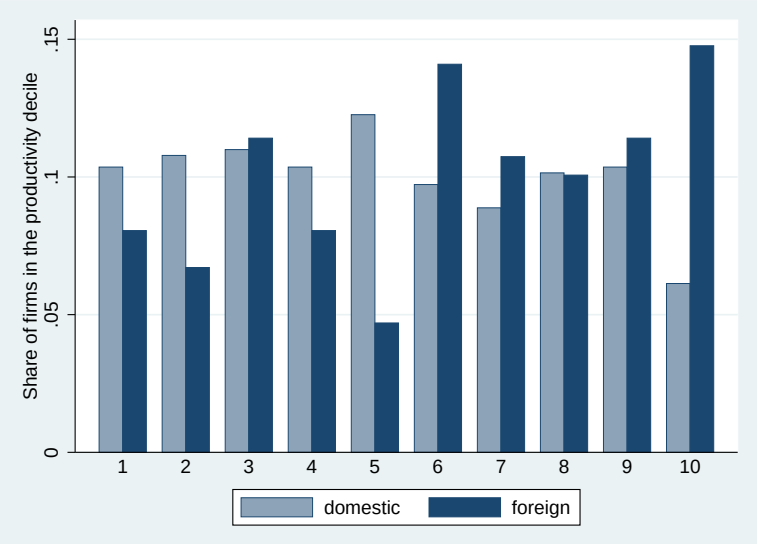
Dep. var.:		log sales	log domestic sales	log employment	labor productivity	total factor productivity	log exported value	log imported value
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Triple interaction term X productivity tertiles	1st tertile	0.127	0.054	0.203	-0.225	-0.142	-0.746	-0.233
		(0.307)	(0.301)	(0.182)	(0.159)	(0.111)	(0.587)	(0.620)
	2nd tertile	0.459**	0.573**	0.363**	-0.034	-0.155*	0.831	-0.705
		(0.218)	(0.256)	(0.163)	(0.128)	(0.082)	(0.560)	(0.492)
	3rd tertile	0.464**	0.411	0.370**	-0.050	-0.098	-0.067	-0.298
		(0.222)	(0.267)	(0.185)	(0.166)	(0.136)	(0.512)	(0.401)
Double interaction terms		YES	YES	YES	YES	YES	YES	YES
After entry period dummy		YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects		YES	YES	YES	YES	YES	YES	YES
Firm-fixed effects		YES	YES	YES	YES	YES	YES	YES
Observations		21,456	20,796	21,203	20,735	20,527	7,053	7,622

Triple interaction term: time dummy for after Audi entry, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs. Productivity tertiles determined based on before Audi performance, within each 2-digit industry. Year-industry fixed effects use 2-digit industry categories.

The main patterns suggest that rather smaller and more productive firms could benefit from the presence of Audi. looking at the joint effect of different firm characteristics, Table A11 of the Appendix shows that the Audi effect is mainly driven by firms with foreign owners. The estimated effect on firms with foreign owners is higher in all size and productivity groups, though the difference is not always significant. Table A12 of the Appendix shows that the additional effect of higher productivity is not uniform across size groups. Overall, medium-size and medium-productivity firms gain the most.

Combining the results by ownership and productivity suggests a possible explanation for the puzzle of

Figure 4: Comparing the histogram of estimated total factor productivity for domestic and foreign firms in 1993



having a demand effect without any effect on productivity. Figure 4 presents the productivity distribution of local firms by ownership one year before the entry of Audi. Compared to those firms which ever have a foreign owner, the productivity distribution of domestic firms is shifted to the left. There are relatively more low-productivity firms among the domestic firms. This productivity gap might have prevented domestic firms from enjoying the benefits of Audi's presence. On the other hand, firms with foreign-owners might have had less room to increase their productivity.

IV.B.4 Robustness checks

The main concern with my identification strategy is whether firms in the treated group had a higher growth potential and would have grown more even without the entry of Audi. The treated region can be special in attracting investments into machinery and electronics due to its economic traditions. Unfortunately, as the Audi entry is close to the political transition in Hungary, I have only two years of pre-period data. This timing makes it impossible to compare pre-trends reliably. Still, there is some evidence that not pre-trend differences move my results. First, industry composition is similar in the two regions before the Audi entry (see Table A5 of the Appendix). Second, I can use an alternative approach to control for potential differences in pre-trends, exploiting the observation that I estimate an insignificant effect for the period 1994-1997. I extend the pre-entry period to 1992-1997, assuming that Audi had an effect on the local supplier-industry firms only after the second phase of the investment, which started in 1998. This assumption is in line with my previous estimates (see Figure A5 of the Appendix). Similarly to Figure 3, Figure A6 of the Appendix shows the evolution of sales, domestic sales and employment in the four firm groups separately, but with a different normalization, setting the values to zero in 1997. The plots suggest that sales evolved in a parallel fashion within the same region until 1997. The evolution of domestic sales is also similar within the supplier industry up to 1997. Pre-trend differences in employment are larger. Still, the evolution of employment within the treated region is fairly similar in the period 1992-1997 compared to the large differences after 1997. Additionally, employment evolved in a similar way within the control region even after 1997. Third, as a robustness check I use an alternative control region: Pest county and Budapest (also showed in Figure 1). This location is more similar to the treated region than the baseline control area in terms of economic development measured in GDP per capita. On the other hand, it is more different from the treated region in other aspects, like industrial composition. The last two columns of Table A14 in the Appendix show that the estimates for sales and employment are robust to changing the control region.

A second concern is the presence of Opel and Suzuki on the edge of the treated region. As a result, the measured effect might not be attributed to Audi only. On one hand, Opel and Suzuki are smaller than Audi (see Figure A1 of the Appendix). On the other hand, they are known to have more local suppliers. I cannot fully exclude the possibility that part of the measured effect comes from the presence of Opel or Suzuki, but the timing of my analysis makes this problem less relevant. Opel and Suzuki were already present before the entry of Audi, so pre-post analysis should control for their presence. Additionally, the dynamics of the measured effect correspond to the the dynamics of the Audi investment.

Third, if the presence of Audi had a negative effect on control firms, I might overestimate the effect of Audi. High-quality labor might have moved away into the treated region or moved from the control industry into the supplier industry within the treated region. This movement could lead to the worsening performance of firms in the control region or in the control industries. As a result, part of the estimated difference between treated and controls would come from the crowding-out effect on control firms. I cannot completely rule out this possibility, but patterns of increasing average firm-level sales in all the four firm groups seem to contradict a negative effect on controls (see Figure 3a).

Finally, some of the foreign-owned firms already existing before the entry of Audi might have located close to Győr because of Audi, if they were already aware of the location choice of Audi. For these firms the entry of Audi was not an exogenous shock, and I might overestimate the effect of Audi if these firms had a high growth potential even without Audi. On the other hand, these foreign-owned firms would not have come to Hungary if Audi had not located in Győr. Still, it is not part of the intensive-margin effect. A robustness check where I only include firms which were already present in 1992 gives similar results to my baseline estimates. This rules out the possibility that foreign firms entering in 1993 drive my results. As a related concern, I also rule out the possibility that different age composition across the four firm groups is the main driver of my estimates. If the growth rate of young firms is higher and there are more young firms in the treated group, my estimates might only reflect a different age structure. Yet, my results are robust to controlling for firm age. See both robustness checks in Table A13 of the Appendix.

As further robustness checks I compare estimates using the baseline specification with and without fixed effects. When I exclude firm-fixed effects I use the sub-sample of firms which were already present before the Audi entry. In this way I identify the effect from the same set of firms. Table A14 shows that the estimated coefficients are robust to these specification changes.

IV.B.5 Magnitude of the estimated demand effect

The specification including both a dummy and a trend for the period after the Audi entry suggests that the presence of Audi increased the average annual growth rate of sales and domestic sales by 2.8 and 3 percentage points and the annual growth rate of employment increased by 2.3 percentage points (see Table 2). For these estimates I assume that the pre-trends were the same in all the four firm groups. Although I cannot test this assumption, I can calculate the effect on the annual growth rates in an alternative way. For this calculation I use 1992-1997 as the pre-entry period, as I only estimate a significant Audi effect from 1998 on, when the second phase of the investment started. I also exclude the crisis years and use 1998-2008 as the period after the Audi entry. I use estimates from the flexible version of equation 3 with a full set of year dummies. I calculate the effect on the yearly growth rate as:

$$\frac{\beta_4^{2008} - \beta_4^{1997}}{11} - \frac{\beta_4^{1997} - \beta_4^{1993}}{4}, \tag{6}$$

where β_4^t refers to the estimated coefficient on the triple interaction term of *Supplier* and *Near* dummies with a dummy for year t.[8] As a result I get 0.3 percentage point increase in sales, 3 percentage points in domestic sales and the change is close to zero for employment. The estimated patterns using the flexible specification suggest that most of the change in trends comes from the period 1998-2000. When I repeat my calculations using 1998-2000 as the post-entry period I get 6 percentage points increase in sales and employment and 9 percentage points in domestic sales. My previous estimates assuming no differences in pre-entry trends across firms groups are larger than the calculated effect on growth rates for the period 1998-2008. As in the calculations I assume that Audi had no effect up to 1998, the true effects are likely to be in between the two results.

In order to provide a benchmark for my estimates I compare them to other estimates in the literature measuring the effect of different interventions. Specifically, I use the effect of exporting on sales and employment as a comparison. Bernard and Jensen (1999) find that the annual growth rate of employment is 2-2.5 percentage points higher for exporters in the short run and 0.4-1.7 percentage points higher in the longer-run. After a firm starts to export, the average annual growth rate becomes higher by 5.6 percentage points. Girma et al. (2004) find that right after the export entry the growth rate of employment increases by 2-3.6 percentage points and the growth rate of sales increases by 1.3-2.8 percentage points. The estimated effect of export on sales and employment has a magnitude similar to my findings.

IV.C Extensive-margin effects

After estimating the intensive-margin effect on incumbent firms, I look at the extensive margin. I check separately the potential effect of Audi on the number and the composition of the entrant and exitor firms. I further divide the effect on the composition of new entrants to differences in size at entry and differences in growth. When I look at the effect on new entrants, I need an additional identifying assumption. As the presence of Audi is not an exogenous shock for firms entering after the Audi entry, I have to assume that the difference-in-differences strategy controls for any locating factors other than Audi which are specific for the region close to Audi.

IV.C.1 The number of entries and exits

I find no significant effect on the number of entries and exits. Figure A7 of the Appendix shows how the number of firms evolves over time in the four firm groups, separately by ownership. I use the same classification for firms with domestic or foreign owners as before. The number of firms in full domestic ownership evolved in a parallel way within the treated region and in the two supplier-industry groups. The number of firms with foreign owners started to decline later and declined less in the treated group than in the control industry group or in the control region. This pattern is in line with Audi attracting other FDI in related industries. At the same time, the yearly number of new entries is not significantly higher in the

[8] More precise calculations using the formula $e^{\beta} - 1$ for the estimated growth rate and calculating the average growth rate separately for all the four firm groups give very similar numbers.

Table 6: The characteristics of new firms by firm group

Dep. var.:	log sales (1)	log domestic sales (2)	log employment (3)	labor productivity (4)	total factor productivity (5)	log exported value (6)	log imported value (7)
Interaction term	0.355**	-0.010	0.151	0.143	0.058	0.611	-0.115
	(0.172)	(0.170)	(0.121)	(0.117)	(0.135)	(0.471)	(0.492)
Industry and region dummies	YES	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	2,978	2,822	2,965	2,893	2,797	751	804

Sample: new firms entering after the Audi entry in their third year of operation. Interaction term: region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs.

treated group.

Looking at exits, I use a modified version of equation 3. I use a dummy for exit in the next period as a dependent variable, and I estimate the baseline specification without firm-fixed effects. I also include time-varying firm-level controls: age, employment, productivity and exporter status. I present the estimation results in Table A17 of the Appendix. Estimates show no significant effect of Audi on the exit probability of firms. I conclude that Audi had no significant effect on the number of exits either.

IV.C.2 The composition of new entrants and exitors

Next, I check potential differences in the characteristics of the new entrants and the exiting firms. I start with those firms which enter after Audi. I look at their characteristics two years after they first appear in the balance sheet data. This time lag after the entry is necessary, as I would like to exclude any transitory period before full operation starts in the new firms. In this way I cannot do a comparison before and after the Audi entry, and I only estimate a simple difference-in-differences specification. Table 6 presents the estimation results. The interaction term coefficients show that new entrants operating in the supplier-industry and locating close to Audi are significantly larger, having 36 percentage points higher sales. The estimated difference in employment, productivity or exports is also positive but estimates are noisy and insignificant. Table A18 of the Appendix shows a similar comparison for exiting firms in their last year of existence. The estimates might suggest that exitors in the treated group are less productive and trade less, but the coefficients are not significant or only marginally significant.

I look at the effect of Audi on the growth of the new firms separately. I estimate similar regressions as in Table 6, with first differences of the log of firm characteristics on the left-hand side as the measure of growth, and also controlling for yearly 2-digit industry-level shocks. Table 7 shows that new entrants' growth in sales, employment, productivity and exports is significantly higher when they are located close to Audi and operate in a supplier industry. The estimates suggests, that the composition of the new entrants is different

Table 7: The growth of new firms by firm group

Sample: new firms entering from 1994 on

Dep. var.:	sales growth	domestic sales growth	employment growth	labor productivity growth	total factor productivity growth	export growth	import growth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction term	0.048*	0.043	0.034**	0.024*	0.020*	0.185**	0.080
	(0.025)	(0.026)	(0.017)	(0.015)	(0.010)	(0.084)	(0.101)
Near, supplier dummies	YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effect	YES	YES	YES	YES	YES	YES	YES
Observations	25,644	23,837	25,446	24,174	23,600	3,271	3,546

Sample: new firms entering after the Audi entry. Dependent variables are first differences of log values of firm characteristics. Interaction term: region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs. Year-industry-fixed effects use 2-digit industry classifications.

in the treated firm group, the firms are larger and grow faster compared to the controls. Concerning growth, I cannot distinguish two potential channels: this pattern might either be the direct effect of Audi on firm growth (intensive-margin effect on the new firms), or the effect of Audi on the composition of new entrants, i.e. firms with larger growth potential locate close to Audi.

IV.D The total effect of Audi

IV.D.1 Industry-level effects

So far I showed that Audi had a significant effect on the treated firm group both on the intensive and extensive margin. In this section I capture the total effect of Audi on the local supplier industry. As the firm-level effect is heterogeneous by different firm characteristics, the total effect is likely to differ from a simple aggregation of the firm-level estimates on the intensive and extensive margin. To capture the total effect, I estimate a modified version of equation 3, where the unit of observation is a 4-digit industry in one of the two regions. As before, I include 2-digit industry-year-fixed effects and cluster the standard errors by 2-digit industry within a supplier group and region. As a dependent variable I include the log of industry-level total sales, employment, domestic sales or exports. I use industry-level averages of the productivity measures and the share of exporters to capture the effect on export entry. I estimate weighted regressions, where the weight is the employment share of a 4-digit industry one year before the Audi entry. I expect that the estimated weighted average effect corresponds to the total effect of Audi. For the identification I assume that regional characteristics other than the presence of Audi (e.g. closeness to Austria) are similarly attractive for new entrants in supplier and control industries. Then the estimated coefficient on the triple interaction term captures the total effect of Audi on the aggregate performance of all the supplier industries in the treated region.

Table 8 and 9 show the results of industry-level estimates. As in the firm-level estimates, the effect on sales, domestic sales and employment is significantly positive. Estimated coefficients are about 3-times

Table 8: The effect of Audi across 4-digit industries: sales, employment and productivity

Unit of obs.: NACE 4 industry (employment-weighted regression)

Dep. var.:	log sales (1)	log domestic sales (2)	log employment (3)	labor productivity (4)	total factor productivity (5)
Triple interaction term	0.981***	0.966***	0.744***	-0.177	-0.050
	(0.269)	(0.312)	(0.175)	(0.180)	(0.101)
Double interaction terms	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES
Observations	6,387	6,322	6,283	6,212	6,109

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Control region: 80 km around Kecskemét. Labor productivity and total factor productivity are calculated as yearly 4-digit industry averages. Year-industry fixed effects use 2-digit industry classification. Weighted regressions, using total employment by NACE4 in 1993 as weights. Standard errors are clustered by 2-digit industry-supplier group-region.

Table 9: The effect of Audi across 4-digit industries: trade

Unit of obs.: NACE 4 industry (employment-weighted regression)

Dep. var.:	log exported value			share of exporters			log imported value
	to all destinations (1)	to Germany (2)	to Austria (3)	to all destinations (4)	to Germany (5)	to Austria (6)	(7)
Triple interaction term	1.021*	1.479***	1.455**	-0.004	0.045**	0.014	0.432
	(0.532)	(0.503)	(0.691)	(0.042)	(0.021)	(0.024)	(0.457)
Double interaction terms	YES	YES	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES	YES	YES
Observations	3,068	2,300	1,984	3,882	3,882	3,882	3,200

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Control region: 80 km around Kecskemét. Export probability is calculated as yearly share of exporters within a 4-digit industry. Year-industry fixed effects use 2-digit industry classification. Weighted regressions, using total employment by NACE4 in 1993 as weights. Standard errors are clustered by 2-digit industry-supplier group-region.

higher than before, which suggests that Audi had a sizable effect on new firms entering after 1993. There is no significant effect on average productivity, but the effect on industry-level exports is positive. As I expect, the exported value to Austria or Germany increased even more than average exports. The share of exporters to Germany is also significantly higher in the treated group after the Audi entry. As firm-level estimates show no significant effect on exports, new entrants exporting to Austria and Germany might move the industry-level estimates.

In order to look at the dynamics of the effect I use a more flexible specification including both a dummy and a trend for the period after the Audi entry. Table A15 and A16 of the Appendix show the results. The annual growth rate of total sales and total domestic sales increased by 8 and 6 percentage points. There is both a jump in the level and a shift in the trend for employment, increasing the annual growth rate by 4 percentage points. There is a large increase in exports, the annual growth rate of total exports to Germany

and Austria is 22 and 13 percentage points higher after the Audi entry. Results for the share of exporters to Germany suggest that new exporters arrived within a short period.

IV.D.2 Magnitude and composition of the total effect

Finally, I do some back of the envelope calculations to capture the magnitude of the total Audi effect. First I calculate the yearly contribution of Audi to total sales and total employment in the supplier industry. For the calculations I use the results from the industry-level estimations, and assume that the effect of Audi was homogeneous across years. As $E(log(y)) \neq log(E(y))$, I need to account for potential heteroskedasticity and make further adjustments to get the effect on the level of aggregate sales and employment. I follow the solution proposed by Silva and Tenreyro (2006) and I estimate the multiplicative model of the form $E(y_i|X_i) = e^{\beta X_i}$ using Poisson regressions, where y is either industry-level sales or employment and X includes supplier industry, close to Audi region and after Audi entry indicators, their interactions and the fixed effects as in Table 8. Then I calculate the yearly total effect of Audi in the following way:

$$TotalEffect_t = \sum_{j=1}^{n}(y_{jrt} - \frac{\hat{y_{jrt}}}{e^{\beta_4}})|_{Supplier_j=1, Near_r=1, After_t=1}, \tag{7}$$

where j is industry, r is region, t is year, y can be employment or sales, $\hat{y}$ is the predicted value from the Poisson regression and β_4 is the estimated coefficient on the triple interaction term. In the calculations I include only supplier industries located near Audi in the period after the Audi entry. Figure 5 shows the calculated yearly total effect of Audi on sales and employment with the 95% confidence interval calculated by bootstrap.

I also check the economic significance of my estimates, comparing the estimated effect and the direct

Figure 5: The estimated total amount of additional sales and employment due to Audi

(a) Sales

(b) Employment

contribution of Audi to the Hungarian GDP. For this calculation I use the industry-level estimates presented in Figure 5. I also consider that treated group firms might use inputs coming partly from control firms.

Using the input-output table, I calculate the share of inputs supplier industries import or purchase from supplier industries. This is about 65% in the treated firm group. I deduct this share from the estimated value of additional total sales due to Audi, and consider the remaining as the additional value added due to Audi. As a result I find, that in an average year the calculated additional value added of local firms due to Audi was 0.5% of the Hungarian GDP. As the direct contribution of Audi to the Hungarian GDP was around 1% in 2008 (Dusek et al., 2015), the total indirect contribution of Audi to the Hungarian GDP was about half of its direct contribution. Based on my estimates the number of additional workplaces due to Audi is about 14,500, which is four times higher than the number of people directly employed by Audi. The difference between the ratio of direct and indirect contribution to value added and employment is driven by the high value added per capita in Audi.

As a final exercise I calculate the relative importance of the intensive-margin effect on the incumbents and the effect on the size and growth of the new entrants within the total effect of Audi on sales and employment. I focus on the period 1996-2001, with the largest growth difference between supplier-industry firms located close to Audi and in the control region (see Figure 2). I do the following decomposition:

$$Y_t^w - Y_t^{wo} = \sum_{i \in BOTH} y_{i,t}^w + \sum_{i \in ONLY\_W} y_{i,t}^w - \sum_{i \in BOTH} y_{i,t}^{wo} - \sum_{i \in ONLY\_WO} y_{i,t}^{wo}, \tag{8}$$

where Y_t is total sales or employment in the treated firm group in year t and $y_{i,t}$ is a firm-level measure. w refers to the observed case with Audi and wo refers to the counterfactual situation without Audi. $BOTH$ refers to firms being present both with and without Audi, $ONLY\_W$ refers to firms which wouldn't have been present without Audi and $ONLY\_WO$ refers to firms which would have been there without Audi but exited or didn't enter with Audi. As I find no significant difference in the number of new entrants or exitors, I can neglect the second and the fourth term. I decompose the total effect further to the contribution of firms already existing before the Audi entry (OLD) and entering after Audi (NEW):

$$Y_t^w - Y_t^{wo} = \sum_{i \in BOTH} y_{i,t}^w - \sum_{i \in BOTH} y_{i,t}^{wo} = \sum_{i \in OLD} y_{i,t}^w + \sum_{i \in NEW} y_{i,t}^w - \sum_{i \in OLD} y_{i,t}^{wo} - \sum_{i \in NEW} y_{i,t}^{wo} \tag{9}$$

Then I decompose the contribution of new firms coming from their larger size at entry and the larger growth afterwards:

$$Y_t^w - Y_t^{wo} = \left(\sum_{i \in OLD} y_{i,t}^w - \sum_{i \in OLD} y_{i,t}^{wo} \right) + \sum_{i \in NEW} \left(y_{i,t_{i0}}^w - y_{i,t_{i0}}^{wo} \right) g_{i,t_{i0},t}^w + \sum_{i \in NEW} y_{i,t_{i0}}^{wo} \left(g_{i,t_{i0},t}^w - g_{i,t_{i0},t}^{wo} \right) \tag{10}$$

I write yearly sales and employment as the product of initial values at entry in $t_{i,0}$ and the growth afterwards, denoted by $g_{i,t_{i0},t} = y_{i,t}/y_{i,t_{i0}}$. The first term is the intensive-margin effect on the incumbent firms which were already present before the Audi entry. The second term is the part of the Audi effect coming from the size composition of new entrants, given the observed growth of firms. The third term is the effect on the growth of new entrants, conditional on no effect on their size at entry.

I calculate the first term with a firm-level Poisson regression where I constrain the sample to firms being already present before the entry of Audi. For ease of computation I do not include firm-fixed effects[9], but allow the effect to differ by size quartiles. For calculating the second term I use Poisson estimates for the size differences of new entrants in the second year after their entry. In this way I account for a potential transitory periods around the entry. Firm-level growth rates are observed in the data. I calculate the third term as a residual, taking the results from the industry-level Poisson regressions showed in Figure 5 as the total effect. I find that approximately 20% of the estimated total sales increase comes from the intensive margin effect on pre-existing firms, 20% is the contribution of the larger size of new entrants and the remaining 60% comes from the larger growth of new firms. The composition is very similar for employment: 22% comes from the pre-existing firms, 20% comes from the larger size of the entrants and 58% comes from the larger growth of the firms entering after Audi.

V Conclusion

In this study I estimate the effect of Audi, a large FDI entering Hungary in 1993, on the local firms operating in supplier industries. I focus on two potential channels: the demand effect increasing sales and employment, and the knowledge spillovers increasing productivity and promoting exports. I identify supplier firms based on their industry and location. I use a triple difference-in-differences approach, where I compare the outcomes of firms in supplier and control industries, located close to Audi and in a control region, before and after the entry of Audi. I use the second best potential location choice of Audi as a control region. My results support the hypothesis that Audi had a demand effect on closely located firms operating in the supplier industries. I find a positive effect on average firm-level sales and employment, but I don't find a positive effect on productivity. The estimated effect is not immediate and also differs by firm characteristics. Firms with domestic owners could not benefit from the presence of Audi, and demand effect estimates are higher for more productive firms. As firms with domestic owners had a lower initial productivity than firms with foreign owners, it seems that domestic firms could not learn from Audi due to the productivity gap. At the same time, firms with foreign owners might have had less room to learn from Audi. I do industry-level estimates to incorporate additional effects coming from new entrants, finding a positive effect on sales, employment and exports. Supplier-industry firms entering the treated region after the Audi entry are significantly larger and also grow faster. Simple calculations show that the indirect effect of Audi through the supplier industry is approximately half of its direct contribution to the Hungarian GDP. For a deeper analysis of the Audi effect it would be necessary to have data on business links, which were not available for the current study. A systematic identification of the firms supplying Audi could shed even more light on the precise mechanism and timing of the Audi effect.

[9]OLS estimates give similar results with or without firm-fixed effects when I include only those firms in the estimation which already existed before the Audi entry.

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Appendix

Figure A1: The yearly sales of Audi, Opel and Suzuki over time

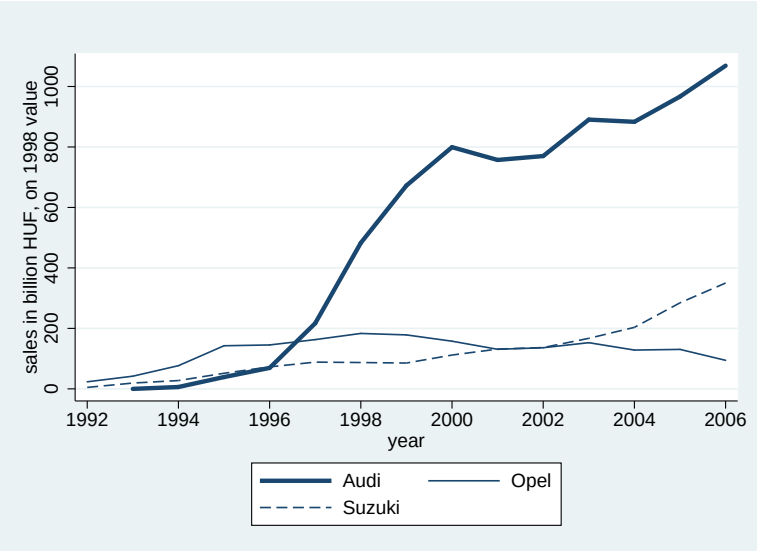


Figure A2: The location of the known suppliers of Audi in Hungary

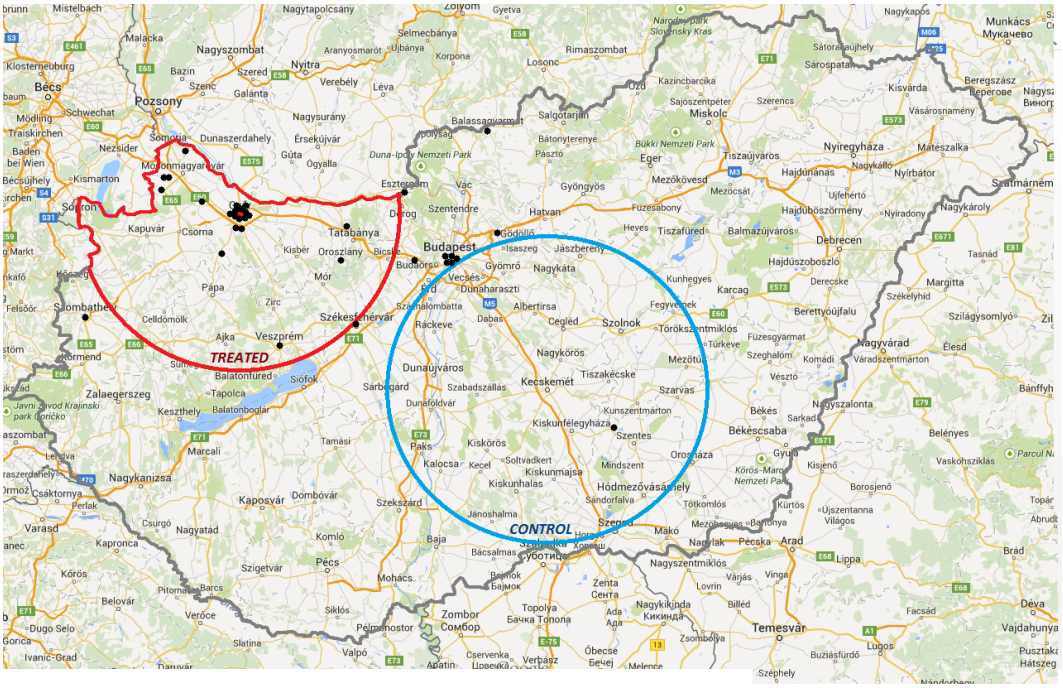
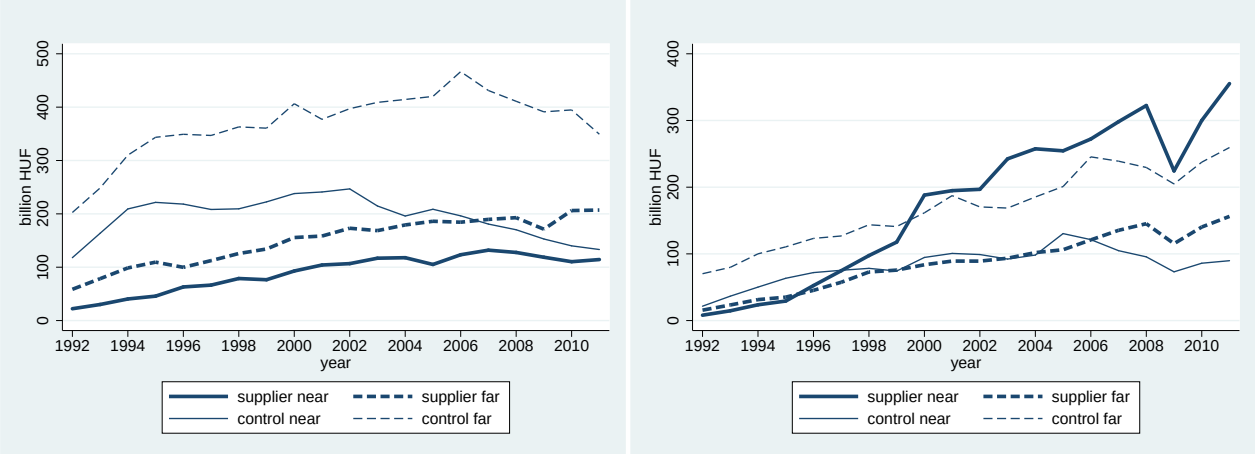


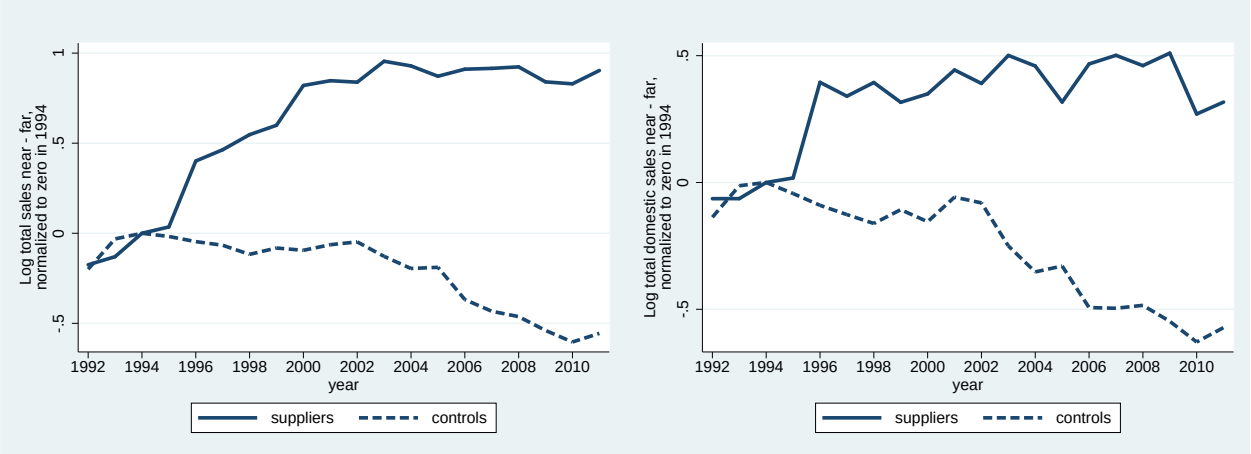
Figure A3: The evolution of total domestic sales and export sales in the different firm groups



(a) Domestic sales

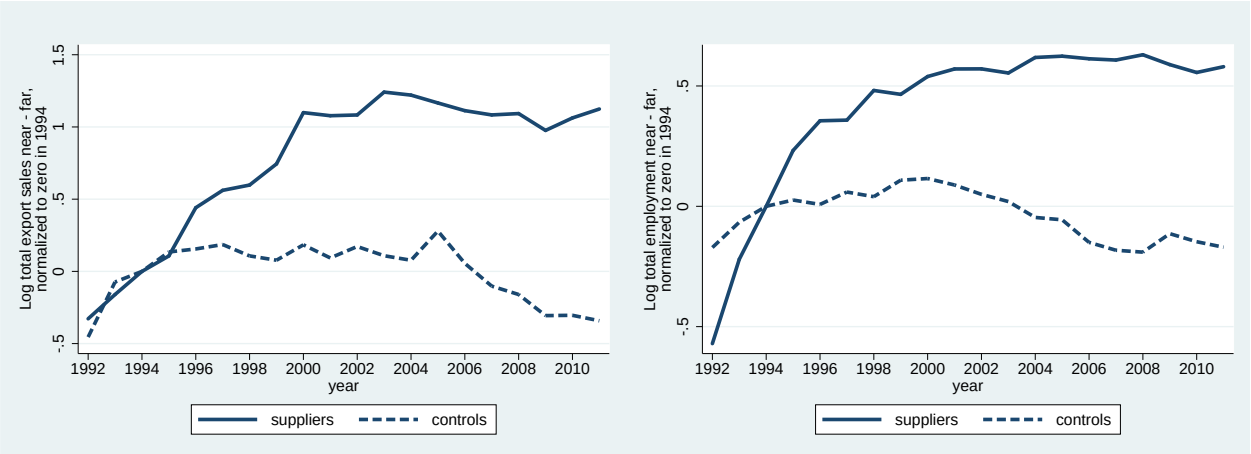
(b) Export sales

Figure A4: The difference in the log of total sales, domestic sales, export sales and employment between the treated and control region



(a) Sales

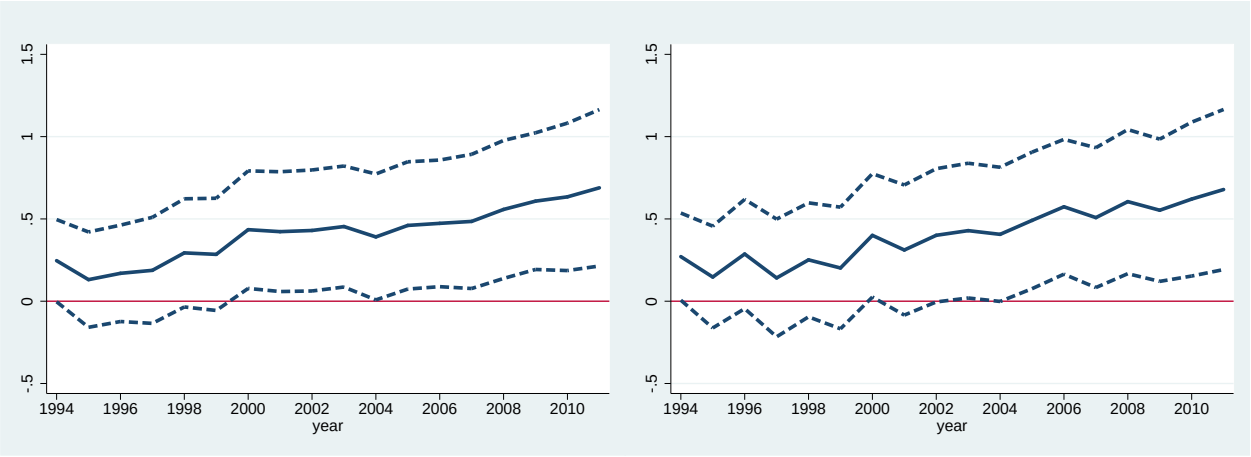
(b) Domestic sales



(c) Export sales

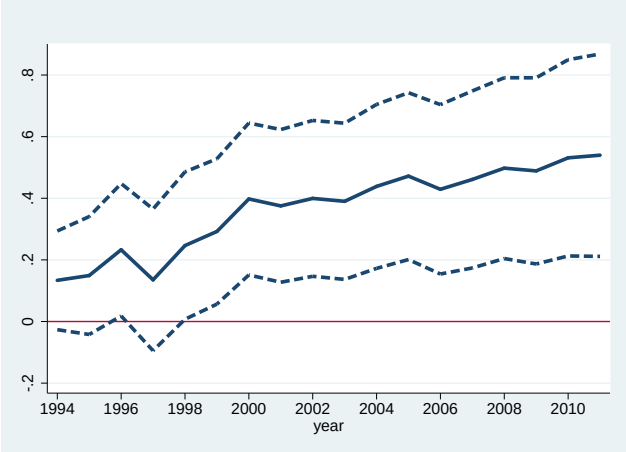
(d) Employment

Figure A5: The estimated coefficients of the triple interaction terms with year dummies and their 90% confidence interval using the flexible specification of equation 3



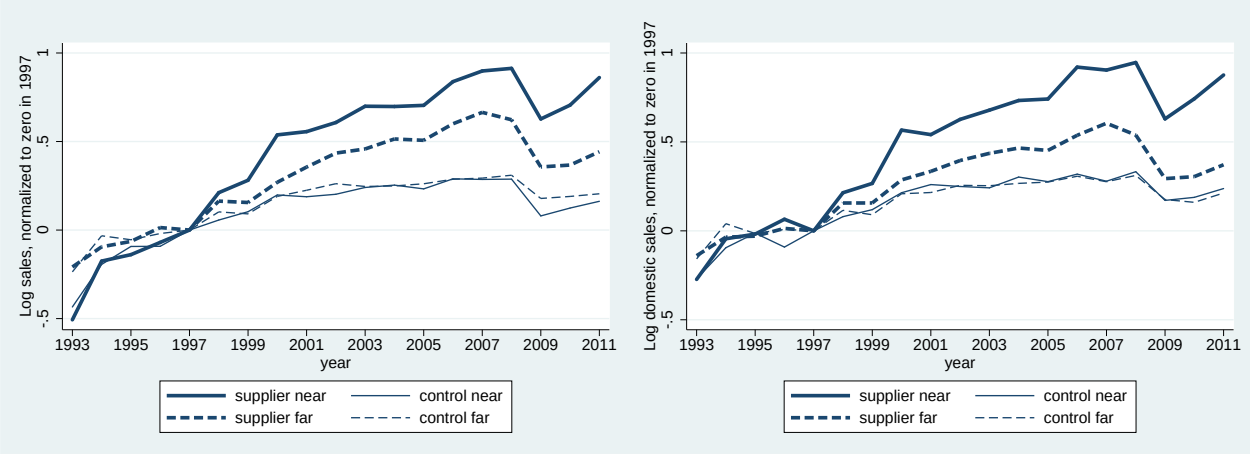
(a) Sales

(b) Domestic sales



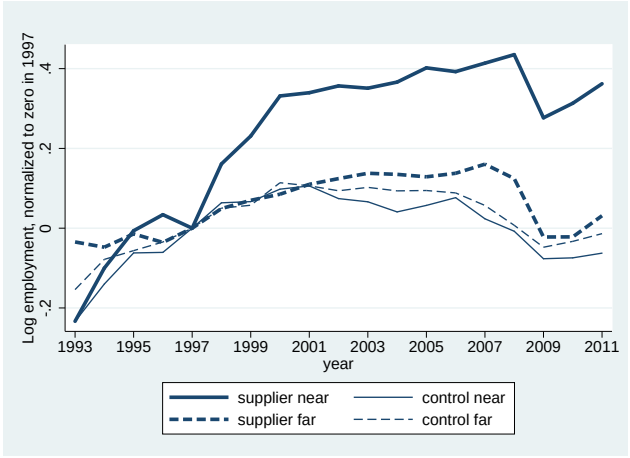
(c) Employment

Figure A6: The evolution of average log sales, log domestic sales and log employment in the different firm groups, normalized to zero for all groups in 1997



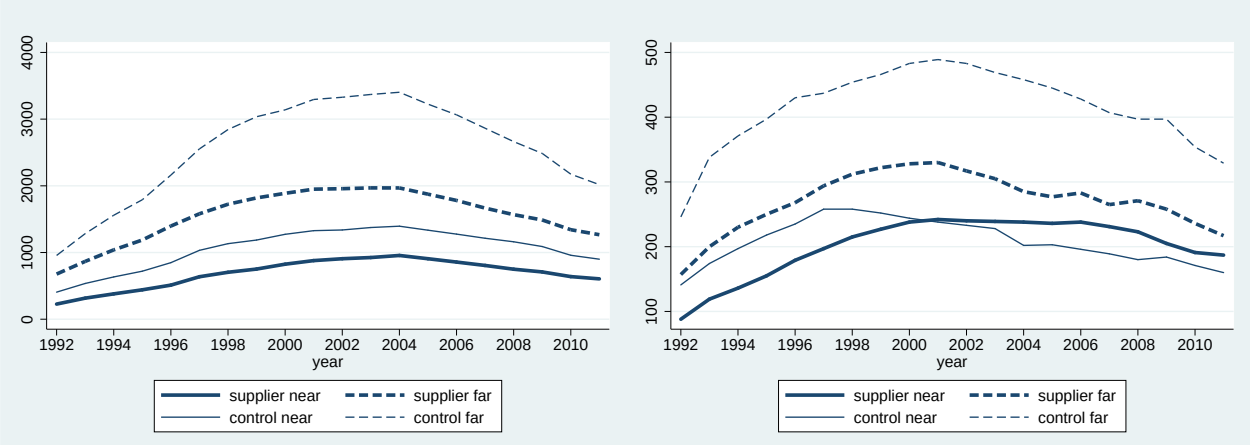
(a) Sales

(b) Domestic sales



(c) Employment

Figure A7: The number of firms by ownership



(a) Domestic firms

(b) Foreign firms

Table A1: The estimated coefficients of the Cobb-Douglas production function by 2-digit industry

Dep. var: sales										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NACE-2	nace 15	nace 17	nace 18	nace 19	nace 20	nace 21	nace 22	nace 24	nace 25	nace 26
employment	0.443***	0.363***	0.453***	0.463***	0.348***	0.312***	0.627***	0.399***	0.343***	0.304***
	(0.012)	(0.014)	(0.013)	(0.021)	(0.013)	(0.033)	(0.018)	(0.035)	(0.015)	(0.016)
capital	0,023	0.088***	0.189***	0.253***	0.079***	0.040	0.168***	0.141***	0.086***	0.232***
	(0.020)	(0.028)	(0.020)	(0.049)	(0.026)	(0.039)	(0.020)	(0.055)	(0.029)	(0.055)
material	0.483***	0.279***	0.200***	0.086	0.496***	0.456***	0.293***	0.567***	0.498***	0.374***
	(0.034)	(0.050)	(0.026)	(0.083)	(0.038)	(0.068)	(0.048)	(0.055)	(0.037)	(0.082)
Observations	51,226	13,410	23,798	6,294	26,488	5,724	45,649	9,319	23,305	16,593
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
NACE-2	nace 27	nace 28	nace 29	nace 30	nace 31	nace 32	nace 33	nace 34	nace 35	nace 36
employment	0.318***	0.401***	0.386***	0.602***	0.332***	0.370***	0.374***	0.353***	0.381***	0.441***
	(0.042)	(0.010)	(0.014)	(0.049)	(0.018)	(0.022)	(0.017)	(0.030)	(0.062)	(0.018)
capital	0,073	0.091***	0.136***	0	0.113***	0,051	0.072***	0,013	0.256***	0.226***
	(0.060)	(0.019)	(0.014)	(0.062)	(0.033)	(0.041)	(0.025)	(0.048)	(0.069)	(0.017)
material	0.436***	0.466***	0.432***	0,059	0.360***	0.306***	0.335***	0.464***	0.282***	0.203***
	(0.087)	(0.026)	(0.025)	(0.045)	(0.046)	(0.055)	(0.059)	(0.062)	(0.107)	(0.030)
Observations	4,057	62,930	40,001	2,861	12,589	9,866	17,858	4,479	2,374	27,545

Coefficients of Levinson-Petrin production function estimates, separately for each 2-digit NACE industry. Variables are measured in logs.

Table A2: The list of 4-digit supplier industries, using NACE Rev 1.1.

Supplier industries			
NACE		NACE	
1711	Preparation and spinning of cotton-type fibres	2722	Manufacture of steel tubes
1712	Preparation and spinning of woollen-type fibres	2734	Wire drawing
1713	Preparation and spinning of worsted-type fibres	2741	Precious metals production
1714	Preparation and spinning of flax-type fibres	2742	Aluminium production
1721	Cotton-type weaving	2743	Lead, zinc and tin production
1722	Woollen-type weaving	2744	Copper production
1725	Other textile weaving	2745	Other non-ferrous metal production
1730	Finishing of textiles	2751	Casting of iron
1752	Manufacture of cordage, rope, twine and netting	2752	Casting of steel
1754	Manufacture of other textiles n.e.c.	2753	Casting of light metals
1910	Tanning and dressing of leather	2811	Manufacture of metal structures and parts of structures
2412	Manufacture of dyes and pigments	2840	Forging, pressing, stamping and roll forming of metal; powder metallurgy
2414	Manufacture of other organic basic chemicals	2851	Treatment and coating of metals
2416	Manufacture of plastics in primary forms	2852	General mechanical engineering
2430	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	2863	Manufacture of locks and hinges
2463	Manufacture of essential oils	2873	Manufacture of wire products
2466	Manufacture of other chemical products n.e.c.	2874	Manufacture of fasteners, screw machine products, chain and springs
2511	Manufacture of rubber tyres and tubes	2875	Manufacture of other fabricated metal products n.e.c.
2512	Retreading and rebuilding of rubber tyres	2911	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
2513	Manufacture of other rubber products	2912	Manufacture of pumps and compressors
2521	Manufacture of plastic plates, sheets, tubes and profiles	2913	Manufacture of taps and valves
2522	Manufacture of plastic packing goods	2914	Manufacture of bearings, gears, gearing and driving elements
2523	Manufacture of builders' ware of plastic	2924	Manufacture of other general purpose machinery n.e.c.
2524	Manufacture of other plastic products	2943	Manufacture of other machine tools n.e.c.
2611	Manufacture of flat glass	3110	Manufacture of electric motors, generators and transformers
2612	Shaping and processing of flat glass	3120	Manufacture of electricity distribution and control apparatus
2613	Manufacture of hollow glass	3130	Manufacture of insulated wire and cable
2614	Manufacture of glass fibres	3140	Manufacture of accumulators, primary cells and primary batteries
2615	Manufacture and processing of other glass, including technical glassware	3161	Manufacture of electrical equipment for engines and vehicles n.e.c.
2682	Manufacture of other non-metallic mineral products n.e.c.	3210	Manufacture of electronic valves and tubes and other electronic components
2710	Manufacture of basic iron and steel and of ferro-alloys	3430	Manufacture of parts and accessories for motor vehicles and their engines
2721	Manufacture of cast iron tubes	3663	Other manufacturing n.e.c.

Table A3: The list of 4-digit control industries, using NACE Rev 1.1

Control industries			
NACE		NACE	
1511	Production and preserving of meat	1600	Manufacture of tobacco products
1512	Production and preserving of poultrymeat	1751	Manufacture of carpets and rugs
1513	Production of meat and poultrymeat products	1771	Manufacture of knitted and crocheted hosiery
1520	Processing and preserving of fish and fish products	1772	Manufacture of knitted and crocheted pullovers, cardigans and similar articles
1531	Processing and preserving of potatoes	1810	Manufacture of leather clothes
1532	Manufacture of fruit and vegetable juice	1821	Manufacture of workwear
1533	Processing and preserving of fruit and vegetables n.e.c.	1822	Manufacture of other outerwear
1541	Manufacture of crude oils and fats	1823	Manufacture of underwear
1542	Manufacture of refined oils and fats	1824	Manufacture of other wearing apparel and accessories n.e.c.
1543	Manufacture of margarine and similar edible fats	1830	Dressing and dyeing of fur; manufacture of articles of fur
1551	Operation of dairies and cheese making	1920	Manufacture of luggage, handbags and the like, saddlery and harness
1552	Manufacture of ice cream	1930	Manufacture of footwear
1561	Manufacture of grain mill products	2010	Sawmilling and planing of wood; impregnation of wood
1562	Manufacture of starches and starch products	2020	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards
1571	Manufacture of prepared feeds for farm animals	2040	Manufacture of wooden containers
1572	Manufacture of prepared pet foods	2122	Manufacture of household and sanitary goods and of toilet requisites
1581	Manufacture of bread; manufacture of fresh pastry goods and cakes	2124	Manufacture of wallpaper
1582	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	2211	Publishing of books
1583	Manufacture of sugar	2212	Publishing of newspapers
1584	Manufacture of cocoa; chocolate and sugar confectionery	2213	Publishing of journals and periodicals
1585	Manufacture of macaroni, noodles, couscous and similar farinaceous products	2214	Publishing of sound recordings
1586	Processing of tea and coffee	2215	Other publishing
1587	Manufacture of condiments and seasonings	2221	Printing of newspapers
1588	Manufacture of homogenized food preparations and dietetic food	2222	Printing n.e.c.
1589	Manufacture of other food products n.e.c.	2223	Bookbinding
1591	Manufacture of distilled potable alcoholic beverages	2224	Pre-press activities
1592	Production of ethyl alcohol from fermented materials	2225	Ancillary activities related to printing
1593	Manufacture of wines	2231	Reproduction of sound recording
1594	Manufacture of cider and other fruit wines	2232	Reproduction of video recording
1595	Manufacture of other non-distilled fermented beverages	2233	Reproduction of computer media
1596	Manufacture of beer	2310	Manufacture of coke oven products
1597	Manufacture of malt	2320	Manufacture of refined petroleum products
1598	Production of mineral waters and soft drinks	2415	Manufacture of fertilizers and nitrogen compounds

Table A4: The list of 4-digit control industries, using NACE Rev 1.1 (cont.)

Control industries			
NACE		NACE	
2420	Manufacture of pesticides and other agro-chemical products	2953	Manufacture of machinery for food, beverage and tobacco processing
2441	Manufacture of basic pharmaceutical products	2954	Manufacture of machinery for textile, apparel and leather production
2442	Manufacture of pharmaceutical preparations	2955	Manufacture of machinery for paper and paperboard production
2451	Manufacture of soap and detergents, cleaning and polishing preparations	2960	Manufacture of weapons and ammunition
2452	Manufacture of perfumes and toilet preparations	2971	Manufacture of electric domestic appliances
2465	Manufacture of prepared unrecorded media	2972	Manufacture of non-electric domestic appliances
2621	Manufacture of ceramic household and ornamental articles	3001	Manufacture of office machinery
2622	Manufacture of ceramic sanitary fixtures	3002	Manufacture of computers and other information processing equipment
2624	Manufacture of other technical ceramic products	3220	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
2625	Manufacture of other ceramic products	3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
2626	Manufacture of refractory ceramic products	3310	Manufacture of medical and surgical equipment and orthopaedic appliances
2630	Manufacture of ceramic tiles and flags	3320	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
2640	Manufacture of bricks, tiles and construction products, in baked clay	3330	Manufacture of industrial process control equipment
2651	Manufacture of cement	3350	Manufacture of watches and clocks
2661	Manufacture of concrete products for construction purposes	3511	Building and repairing of ships
2662	Manufacture of plaster products for construction purposes	3512	Building and repairing of pleasure and sporting boats
2663	Manufacture of ready-mixed concrete	3520	Manufacture of railway and tramway locomotives and rolling stock
2664	Manufacture of mortars	3530	Manufacture of aircraft and spacecraft
2665	Manufacture of fibre cement	3541	Manufacture of motorcycles
2666	Manufacture of other articles of concrete, plaster and cement	3542	Manufacture of bicycles
2670	Cutting, shaping and finishing of ornamental and building stone	3550	Manufacture of other transport equipment n.e.c.
2731	Cold drawing	3611	Manufacture of chairs and seats
2732	Cold rolling of narrow strip	3612	Manufacture of other office and shop furniture
2733	Cold forming or folding	3613	Manufacture of other kitchen furniture
2754	Casting of other non-ferrous metals	3614	Manufacture of other furniture
2812	Manufacture of builders' carpentry and joinery of metal	3615	Manufacture of mattresses
2822	Manufacture of central heating radiators and boilers	3621	Striking of coins
2861	Manufacture of cutlery	3622	Manufacture of jewellery and related articles n.e.c.
2931	Manufacture of agricultural tractors	3630	Manufacture of musical instruments
2932	Manufacture of other agricultural and forestry machinery	3640	Manufacture of sports goods
2941	Manufacture of portable hand held power tools	3650	Manufacture of games and toys
2951	Manufacture of machinery for metallurgy	3661	Manufacture of imitation jewellery
2952	Manufacture of machinery for mining, quarrying and construction	3662	Manufacture of brooms and brushes

Table A5: The number of firms by 2-digit industry, and industry composition by region in the pre-entry period

NACE2	near		far		total number
	control	supplier	control	supplier	of firms
15	13.1%	0.0%	15.1%	0.0%	1036
17	2.7%	1.7%	2.5%	1.4%	133
18	6.3%	0.0%	7.2%	0.0%	455
19	1.6%	0.3%	1.6%	0.1%	112
20	6.2%	0.0%	4.8%	0.0%	181
21	1.3%	0.0%	1.7%	0.0%	8
22	6.0%	0.0%	6.8%	0.0%	242
23	0.1%	0.0%	0.2%	0.0%	9
24	2.2%	1.6%	1.4%	1.1%	124
25	0.0%	5.9%	0.0%	6.5%	411
26	3.2%	0.7%	2.5%	0.6%	239
27	0.4%	1.0%	0.2%	1.1%	84
28	3.4%	12.2%	3.2%	12.4%	1088
29	6.7%	5.3%	6.7%	6.0%	435
30	1.0%	0.0%	0.6%	0.0%	18
31	1.2%	1.4%	1.6%	2.1%	111
32	1.5%	0.7%	1.4%	1.0%	124
33	3.2%	0.0%	3.5%	0.0%	143
34	0.1%	0.8%	0.2%	0.9%	54
35	0.5%	0.0%	0.4%	0.0%	26
36	6.5%	1.1%	4.2%	1.0%	415

Columns 1-4 show the composition of industry-region groups before the Audi entry, by 2-digit NACE categories, as a percentage of the total number of firms in a group. Column 5 shows the total number of firms in the given industry group which were included in the analysis in either the pre- or the post-entry period.

Table A6: Comparing the short- and long-run effect of Audi by dividing the post-entry period into four sub-periods: sales, employment and productivity

Dep. var.:		log sales	log domestic sales	log employment	labor productivity	total factor productivity
		(1)	(2)	(3)	(4)	(5)
Triple interaction term with after entry periods	1994-1997	0.187	0.212	0.163*	-0.118	-0.101*
		(0.129)	(0.141)	(0.091)	(0.083)	(0.061)
	1998-2001	0.362**	0.296*	0.326***	-0.061	-0.109
		(0.168)	(0.176)	(0.117)	(0.099)	(0.070)
	2002-2006	0.440**	0.461**	0.419***	-0.114	-0.165**
		(0.183)	(0.197)	(0.127)	(0.105)	(0.073)
	2007-2011	0.586***	0.585***	0.494***	-0.017	-0.102
		(0.209)	(0.216)	(0.148)	(0.110)	(0.080)
Double interaction terms		YES	YES	YES	YES	YES
After entry period dummies		YES	YES	YES	YES	YES
Year-industry-fixed effects		YES	YES	YES	YES	YES
Firm-fixed effects		YES	YES	YES	YES	YES
Observations		54,017	51,857	53,394	51,663	50,341

Triple interaction term: time dummies for after Audi entry periods, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry period dummies interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs. Year-industry fixed effects use 2-digit industry classifications.

Table A7: Comparing the short- and long-run effect of Audi by dividing the post-entry period into four sub-periods: trade

Dep. var.:		log exported value			probability of starting to export			log imported value
		to all destinations	to Germany	to Austria	to all destinations	to Germany	to Austria	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Triple interaction term with after entry periods	1994-1997	0.199	0.122	1.073**	0.077*	0.056	0.002	-0.328
		(0.304)	(0.400)	(0.461)	(0.040)	(0.037)	(0.026)	(0.268)
	1998-2001	0.252	0.383	1.369**	0.029	0.027	-0.029	-0.210
		(0.360)	(0.464)	(0.558)	(0.040)	(0.034)	(0.027)	(0.326)
	2002-2006	0.204	0.559	0.966	0.044	0.022	-0.005	-0.315
		(0.383)	(0.505)	(0.614)	(0.041)	(0.035)	(0.027)	(0.338)
Double interaction terms		YES	YES	YES	YES	YES	YES	YES
After entry period dummies		YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects		YES	YES	YES	YES	YES	YES	YES
Firm-fixed effects		YES	YES	YES	YES	YES	YES	YES
Observations		12,681	6,944	4,472	21,862	21,862	21,862	13,798

Triple interaction term: time dummies for after Audi entry periods, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry period dummies interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Year-industry fixed effects use 2-digit industry classifications.

Table A8: Comparing the short- and long-run effect of Audi: 1st, 2nd, 3rd and 5th difference estimations

Dep. var.:	log sales	log domestic sales	log employment
	(1)	(2)	(3)
First differencing			
Triple interaction term	0.164	0.210*	0.131**
	(0.109)	(0.110)	(0.065)
Observations	48,416	45,284	47,833
Second differencing			
Triple interaction term	0.249**	0.295**	0.183**
	(0.111)	(0.115)	(0.080)
Observations	43,295	40,267	42,638
Third differencing			
Triple interaction term	0.234*	0.286**	0.247***
	(0.131)	(0.138)	(0.091)
Observations	38,585	35,696	37,942
Fifth differencing			
Triple interaction term	0.321**	0.373**	0.263**
	(0.152)	(0.150)	(0.110)
Observations	30,303	28,003	29,713
Double interaction terms	YES	YES	YES
After entry dummy	YES	YES	YES

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Industry-year fixed effects are included. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét.

Table A9: The effect of Audi on firms with foreign owners by how much the German trust in the owner's country

Dep. var.	log sales (1)	log employment (2)	log sales (3)	log employment (4)	log sales (5)	log employment (6)
Triple interaction term	0.901**	0.902***	0.185	0.456	0.185	0.456
	(0.356)	(0.225)	(0.833)	(0.579)	(0.833)	(0.579)
Triple interaction term X Trust in units			0.839	0.543		
			(0.958)	(0.656)		
Triple interaction term X Trust in st.dev.					0.232	0.150
					(0.265)	(0.182)
Double interaction terms and after entry dummy, also interacted with the trust measure	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES	YES	YES
Observations	7,799	7,758	7,799	7,758	7,799	7,758
Number of firms	681	681	681	681	681	681

The sample is all firms with an owner from EU15 or from Norway. Owners in 1993 or in the first available year are regarded. When owners are from multiple countries, the firm is assigned to the country the most trusted by the German. Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Trust uses Eurobarometer survey data from 1995, aggregated by Guiso et al. (2009, p. 1102, Table I), measuring the difference of trust in the given country compared to the lowest level of trust (in Italians) by the German. The original question was "How much trust you have in people from various countries?" with answer options lot of trust (4), some trust (3), not very much trust (2) or no trust at all (1). Trust in units uses the simple difference in the aggregate trust measure. Trust in st.dev. expresses the difference in standard deviation of the trust measure across countries. In columns (3) - (6) the baseline category is firms with Italian owners. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Year-industry fixed effects use 2-digit industry classifications.

Table A10: The effect of Audi by firm size

Dep. var.:		log sales (1)	log domestic sales (2)	log employment (3)	labor productivity (4)	total factor productivity (5)	log exported value (6)	log imported value (7)
Triple interaction term X size tertiles	1st tertile	0.367	0.261	0.384**	-0.064	-0.047	0.347	-0.330
		(0.229)	(0.233)	(0.164)	(0.178)	(0.140)	(0.778)	(0.577)
	2nd tertile	0.396	0.282	0.363**	0.013	-0.073	0.033	-1.068*
		(0.254)	(0.275)	(0.179)	(0.136)	(0.099)	(0.610)	(0.571)
	3rd tertile	0.038	0.349	0.137	-0.190	-0.178*	0.238	0.025
		(0.270)	(0.311)	(0.170)	(0.146)	(0.097)	(0.423)	(0.377)
Double interaction terms		YES	YES	YES	YES	YES	YES	YES
After entry period dummy		YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects		YES	YES	YES	YES	YES	YES	YES
Firm-fixed effects		YES	YES	YES	YES	YES	YES	YES
Observations		22,871	22,102	22,645	22,032	21,478	7,375	7,942

Triple interaction term: time dummy for after Audi entry, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs. Size tertiles determined based on before Audi value. Year-industry fixed effects use 2-digit industry classification.

Table A11: The effect of Audi by ownership, size and productivity

Sample: firms present in 1993 Dep. var:	log sales			log employment		
	overall	by size groups	by productivity groups	overall	by size groups	by productivity groups
	(1)	(2)	(3)	(4)	(5)	(6)
Triple interaction term	0.095			0.053		
	(0.180)			(0.122)		
Triple interaction term x foreign	0.805**			0.845***		
	(0.368)			(0.253)		
Triple interaction term x 1st tertile		0.179	-0.149		0.204	-0.074
		(0.231)	(0.333)		(0.177)	(0.214)
Triple interaction term x 2nd tertile		0.104	0.429*		0.058	0.215
		(0.281)	(0.259)		(0.186)	(0.181)
Triple interaction term x 3rd tertile		-0.106	0.037		-0.076	0.128
		(0.294)	(0.262)		(0.180)	(0.252)
Triple interaction term x 1st tertile x foreign		0.698	0.938		0.615	1.078**
		(0.663)	(0.759)		(0.432)	(0.426)
Triple interaction term x 2nd tertile x foreign		0.865	0.394		0.932**	0.762*
		(0.601)	(0.539)		(0.404)	(0.394)
Triple interaction term x 3rd tertile x foreign		0.572	1.098**		0.624*	0.616
		(0.495)	(0.497)		(0.340)	(0.435)
Double interaction terms	YES	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES	YES	YES
Observations	24,309	22,379	20,996	23,928	22,157	20,746
Number of firms	1,957	1,724	1,599	1,959	1,725	1,599

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. All these also interacted with foreign dummy being one if in at least one year the firm had more than 20% foreign ownership share. Size tertile indicators are also included in columns (2) and (5), and productivity tertile indicators in columns (3) and (6), interacted with all other indicators and interaction terms. Size and productivity tertiles are determined based on before Audi value. Productivity tertiles are determined separately for each 2-digit industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs. Only domestic (always 100%) and foreign (minimum 20% foreign ownership at some point) owned firms included. Year-industry fixed effects use 2-digit industry classifications.

Table A12: The effect of Audi by firm size and productivity

Sample: firms present in 1993 Dep. var:			log sales (1)	log employment (2)
Triple interaction term X firm groups	Small	Low-productivity	0.697 (0.451)	0.394 (0.257)
		Medium-productivity	0.490 (0.346)	0.444 (0.295)
		High-productivity	0.174 (0.372)	0.385 (0.284)
	Medium-size	Low-productivity	-0.062 (0.420)	0.129 (0.304)
		Medium-productivity	1.054*** (0.403)	0.655** (0.272)
		High-productivity	0.649 (0.396)	0.537* (0.304)
	Large	Low-productivity	-0.525 (0.470)	0.000 (0.266)
		Medium-productivity	-0.037 (0.408)	0.223 (0.282)
		High-productivity	0.827* (0.439)	0.262 (0.278)
Double interaction terms			YES	YES
After entry dummy			YES	YES
Year-industry-fixed effects			YES	YES
Firm-fixed effects			YES	YES
Observations			21,456	21,203
Number of firms			1,621	1,621

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. All these also interacted with size tertile and productivity tertile indicators, and their interactions. Size and productivity tertiles are determined based on before Audi value. Productivity tertiles are determined separately for each 2-digit industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs. Year-industry fixed effects use 2-digit industry classifications.

Table A13: Robustness checks of the demand effect for selective entry and different age composition across firm groups

Sample:	Firms already existing in 1992			All firms		
Dep. var.:	log sales (1)	log domestic sales (2)	log employment (3)	log sales (4)	log domestic sales (5)	log employment (6)
Triple interaction term with after dummy	0.329** (0.151)	0.400** (0.173)	0.304*** (0.112)	0.370** (0.150)	0.368** (0.158)	0.307*** (0.105)
Double interaction terms	YES	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	NO	NO	NO
After entry trend	NO	NO	NO	YES	YES	YES
Firm age	NO	NO	NO	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES	YES	YES
Observations	19,583	18,966	19,265	54,017	51,857	53,394
Number of firms	1,576	1,574	1,577	5,427	5,410	5,434

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry period interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Year-industry fixed effects use 2-digit industry classifications.

Table A14: The baseline sales and employment regressions, comparing different specifications

Control region:	80 km around Kecskemét						Pest & Budapest	
Sample:	All firms				Firms present in 1993		All firms	
Dep. var.:	log sales	log employm.	log sales	log employm.	log sales	log employm.	log sales	log employm.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Triple interaction term	0.347**	0.309***	0.288*	0.271**	0.426**	0.279**	0.395***	0.304***
	(0.151)	(0.105)	(0.161)	(0.110)	(0.168)	(0.127)	(0.141)	(0.095)
Double interaction terms	YES	YES	YES	YES	YES	YES	YES	YES
After entry dummy	YES	YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	NO	NO	YES	YES	YES	YES
Firm-fixed effects	YES	YES	YES	YES	NO	NO	YES	YES
Observations	54,017	53,394	54,017	53,394	24,607	24,226	77,828	76,708
Number of firms	5,427	5,434	5,427	5,434			7,798	7,804

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry dummy interacted with close to Audi location and supplier industry. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Year-industry fixed effects use 2-digit industry classifications.

Table A15: The effect of Audi across 4-digit industries, allowing for separate effects on levels and trends: sales, employment and productivity

Unit of obs.: NACE 4 industry					
Dep. var.:	log sales	log domestic sales	log employment	labor productivity	total factor productivity
	(1)	(2)	(3)	(4)	(5)
Triple interaction term	0.199	0.406	0.384**	-0.230	-0.054
with after dummy	(0.280)	(0.329)	(0.160)	(0.214)	(0.088)
Triple interaction term	0.083***	0.059**	0.038**	0.006	0.001
with after trend	(0.023)	(0.025)	(0.016)	(0.011)	(0.010)
Double interaction terms	YES	YES	YES	YES	YES
After entry trend	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES
Observations	6,387	6,322	6,283	6,212	6,109

Triple interaction term: time dummy or time trend for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry trend interacted with close to Audi location and supplier industry. Control region: 80 km around Kecskemét. Labor productivity and total factor productivity are calculated as yearly 4-digit industry averages. Year-industry fixed effects use 2-digit industry classification. Weighted regressions, using total employment by NACE4 in 1993 as weights. Standard errors are clustered by 2-digit industry-supplier group-region.

Table A16: The effect of Audi across 4-digit industries, allowing for separate effects on levels and trends: trade

Unit of obs.: NACE 4 industry Dep. var.:	log exported value			export probability if not exported before			log imported value
	to all destinations	to Germany	to Austria	to all destinations	to Germany	to Austria	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Triple interaction term	1.020*	0.274	0.741	-0.002	0.095***	0.011	0.278
with after dummy	(0.578)	(0.463)	(0.716)	(0.040)	(0.026)	(0.027)	(0.458)
Triple interaction term	0.000	0.217***	0.128**	-0.000	-0.009***	0.001	0.028
with after trend	(0.049)	(0.064)	(0.048)	(0.005)	(0.003)	(0.003)	(0.046)
Double interaction terms	YES	YES	YES	YES	YES	YES	YES
After entry trend	YES	YES	YES	YES	YES	YES	YES
Year-industry-fixed effects	YES	YES	YES	YES	YES		
Observations	3,068	2,300	1,984	3,882	3,882	3,882	3,200

Triple interaction term: time dummy or time trend for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Double interaction terms: after Audi entry trend interacted with close to Audi location and supplier industry. Control region: 80 km around Kecskemét. Export probability is calculated as yearly share of exporters within a 4-digit industry. Year-industry fixed effects use 2-digit industry classification. Weighted regressions, using total employment by NACE4 in 1993 as weights. Standard errors are clustered by 2-digit industry-supplier group-region.

Table A17: Comparing the exit probability of firms in the different firm groups

Dep. var.: Exit probability	(1)	(2)
Triple interaction term	0.009	0.002
	(0.015)	(0.014)
Firm characteristics	YES	YES
After entry dummy	YES	NO
Supplier dummy	YES	NO
NACE 2 industry FE	NO	YES
Year FE	NO	YES
Year-industry-fixed effects	YES	YES
Observations	31,768	31,768

Triple interaction term: time dummy for after Audi entry years, region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Time-varying firm characteristics: employment, total factor productivity, age. Time-invariant firm characteristics: firm ever exporter, region dummy, also interacted with supplier industry dummy. Year-industry fixed effects use 2-digit industry classifications. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét.

Table A18: Comparing the characteristics of exiting firms in the different firm groups

Dep. var.:	log sales (1)	log domestic sales (2)	log employment (3)	labor productivity (4)	total factor productivity (5)	log exported value (6)	log imported value (7)
Interaction term	0.039	-0.146	0.032	-0.113	-0.136	-0.704	-1.115*
	(0.197)	(0.215)	(0.125)	(0.141)	(0.150)	(0.487)	(0.593)
Industry and region dummies	YES	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES	YES
Observations	2,069	1,913	2,052	1,935	1,825	529	515

Sample: firms exiting after the Audi entry one year before their exit. Interaction term: region dummy for locations close to Audi and industry dummy for the supplier industries interacted. Standard errors in parentheses are clustered by 4-digit NACE industry - county groups. Only firms with at least 5 employees considered. Control region: 80 km around Kecskemét. Labor productivity is value added per capita, total factor productivity is estimated from a Cobb-Douglas production function with coefficients varying by 2-digit industries. Both are measured in logs.