Economic integration, industrial structure, and catch-up growth: Firm-level evidence from Poland*

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Abstract

We examine if and how deeper economic integration with high-income nations impacts industrial performance. We exploit Poland's accession to the European Union in 2004 as a source of variation in the degree of market integration with Germany. Using data on Polish manufacturing firms in the period 1995-2013, we find that EU accession was followed by significant within-firm growth in output and productivity, notably in industries in which Germany was more specialized at the moment of accession. Increased inflows of German investment to these sectors played an important role in shaping these effects. These results accord with models in which deeper integration stimulates the flow of capital and knowledge to the less advanced nation, and thereby narrows the productivity gap within industries.

Keywords: Economic integration, industrial structure, knowledge transfer, catch-up growth, firm performance.

JEL Classification: F11; F14; F15; F23; F63; L25; O47

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1 Introduction

Suppose that two nations with different levels of income per capita become more closely integrated. What are the implications for industrial performance in the less developed nation? In the standard Ricardian model of comparative advantage, both countries would gain from the reallocation of productive resources towards the industries in which they are relatively more efficient. In contrast, models of trade and growth emphasize performance gains caused by the flow of more advanced technologies, production processes, or organizational methods to the less developed economy, which contribute to narrow the efficiency gap within industries (Grossman and Helpman (1993); Coe and Helpman (1995); Coe et al. (1995); Goldberg et al. (2010)). If the transferable knowledge and technologies are industry-specific, the less developed country may plausibly observe stronger productivity and output growth in sectors in which the richer nation is relatively more advanced (Coe et al. (1995); Romer (2010)).

Despite the prominence of trade and growth models, we have surprisingly little evidence on the relevance of this hypothesis and the underlying microeconomic mechanisms. This paper sets out to investigate the extent to which this hypothesis played an important role in driving the patterns of catch-up growth observed in Poland following accession to the European Union in 2004—and the consequent deepening of market integration with Germany. Using detailed data on Polish manufacturing firms during 1995-2013 in a difference-in-differences strategy, we examine if and how the evolution of firm performance in Poland following EU accession was mediated by pre-determined measures of industrial specialization in Germany. If the scope for capital movements and knowledge transfers was higher in sectors in which Germany was relatively more efficient at the moment of accession, improvements in performance would be stronger among Polish firms operating in those sectors.

Poland's integration experience offers several interesting features for this analysis. Following the collapse of the Soviet Union in the late 1980s, a comprehensive reform program enabled the country to transform its socialist-style planned economy into a market economy. Like other post-communist nations, Poland experienced slumps in social and economic standards during this transition. But it became the first post-communist country to reach its pre-1989 income levels, which it achieved by 1995 following a period of strong economic growth. In the years preceding the accession in 2004, Poland observed a sharp increase in the degree of openness to international trade. A significant share of this rise was accounted for by the growth of trade flows with its higher-income neighbor, Germany—Europe's major center of high-tech industrial production. Following accession, Poland became also an important destination for Germany's FDI, and experienced a period of remarkable catch-up growth: GDP per capita (in current prices) increased from about 18% of Germany's in 2004 to about 29% in 2013.

The difference-in-differences estimates reveal that Polish manufacturing firms operating in sectors in which Germany was more specialized at the moment of accession experienced stronger output and productivity growth in the post-2004 period. These results remain qualitatively similar across different measures of comparative advantage, including output-based indicators of industrial specialization and measures of relative factor intensity in the sector. Reassuringly, placebo tests using similar measures of industrial specialization for Poland, Russia and other less developed non-EU neighbor countries—notably Ukraine and Lithuania—fail to identify systematic links with the evolution of firm performance in the post-2004 period.

Having established that within-firm productivity gains following EU integration were stronger in sectors in which Germany was more specialized at the moment of accession, we proceed by examining if trade and investment linkages appear to have played a role in shaping these differential within-firm responses across sectors. While we cannot rule out

some positive trade effects, increased inflows of German investment towards these sectors appears to have played a major role in shaping these effects. Event studies point to a sharp increase in German's acquisitions of Polish firms right after EU accession, and at a remarkable greater extent for sectors with higher export shares. While foreign acquisitions begin since 2001 in concomitance with the conclusions of the accession negotiations, it was only after joining the EU that FDI observed a sharp rise. Foreign acquisitions increased also from other EU countries, but to a much lower extent. Furthermore, results from a difference-in-differences matching estimator reveal a sizable positive effect of German acquisitions on employment growth. Taken together, our findings accord with models in which deeper integration stimulates the flow of capital and knowledge to the less advanced nation, and thereby narrows the productivity gap within industries.

In addition to the work cited above, this paper complements and extends several strands of literature. A number of cross-country studies have identified systematic empirical links between increased openness to trade, knowledge transfer and economic growth of less developed economies (Coe et al. (1995); Henry et al. (2009)). The current paper contributes to this literature by providing microeconomic evidence on these links, exploiting Poland's accession to the EU as a source of variation in the degree of integration with a high-income country. In doing so, this paper also relates to recent research using firm-level data to document effects of exports and foreign acquisitions on firm performance.[1] In contrast to this strand of literature, we emphasize the key role of specialization patterns in the advanced economy in driving the impacts of deeper integration on firm performance in the less developed countries.

The remainder of the paper proceeds as follows. Section 2 describes the institutional and economic background associated with Poland's accession to the European Union

[1]For example: Van Biesebroeck (2005), De Loecker (2007), Verhoogen (2008), Arnold and Javorcik (2009), Lileeva and Trefler (2010), Bustos (2011), Bloom et al. (2012), Guadalupe et al. (2012), Bastos et al. (2018), Atkin et al. (2017), Bastos et al. (2018).

in 2004. Section 3 outlines theoretical mechanisms and presents the empirical strategy. Section 4 describes the data and provides summary statistics. Section 5 reports the main econometric results and examines their robustness. Section 6 conducts placebo tests, while section 7 provides evidence on mechanisms driving the main results. Section 8 concludes the paper.

2 Background

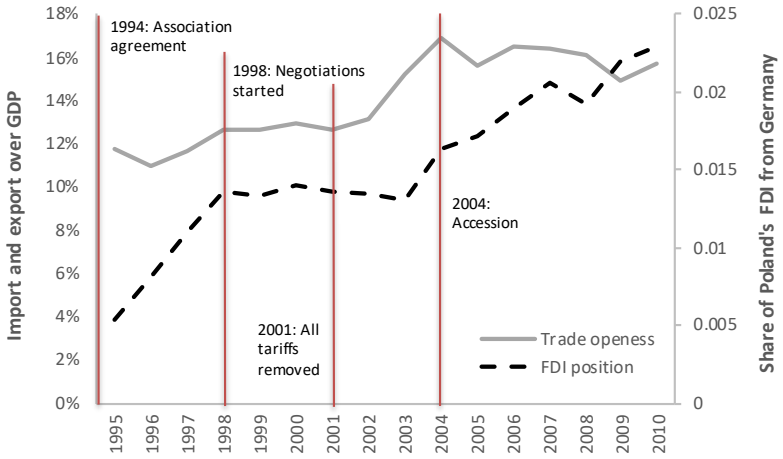
During the Revolutions of 1989, that led to the collapse of the Soviet Union, Poland transitioned from communism and adopted a new constitution establishing itself as a democracy. In the early 1990s, a comprehensive reform program enabled the country to transform its socialist-style planned economy into a market economy. Although Poland suffered slumps in social and economic standards during this transition, it became the first post-communist country to reach its pre-1989 GDP levels, which it achieved by 1995 following a period of strong economic growth.

Poland acceded to the European Union in May 2004. The negotiation process underlying accession began in 1989, when the *Poland and Hungary: Assistance for Restructuring their Economies (PHARE)* programme was launched to promote convergence with the European Union's extensive legislation and promote economic and social cohesion. To prepare for EU membership, Poland first signed the Europe (or association) Agreement in 1991. The agreement entered into force in February 1994, after the Polish Parliament had given its opinion and the ratification procedures had been completed. The Europe Agreement consolidated concessions previously granted and made provision for the progressive establishment of a free trade area over 10 years, and for the gradual abolition during the same period of customs duties between the EU and Poland.

In June 1993 at the European Council meeting the European Community leaders

explicitly endorsed the future accession of Poland conditional on the fulfillment of three conditions (known as the Copenhagen criteria, or membership criteria): (i) the achievement of stable institutions that guarantee democracy, legality, human rights and respect of minorities; (ii) a working market economy, and (iii) the acceptance of all the membership responsibilities, political, economic and monetary.

Figure 1: Poland's trade openness and inward FDI from Germany, 1995-2013



Notes: The grey line depicts the evolution of Poland's degree of trade openness relative to Germany (defined as the sum of bilateral exports and imports with Germany over GDP). The dashed line depicts the share of Poland in Germany's total outward foreign direct investment in the years 1995 to 2012. The sources of the data are UN COMTRADE and the World Development Indicators of the World Bank for trade opennes, and OECD for FDI position.

The EU supported Poland to adopt the Community's rules through a pre-accession strategy that covered all aspects of alignment with the European Union, such as progressive integration with the EU single market, the development of infrastructure in the context of the trans-European networks, the promotion of inter-regional cooperation and cooperation on environmental matters. The European Union also gave Poland financial assistance for developing its institutions, infrastructure and economy.

On 30 March 1998 the accession process was formally launched and the negotiations

started. The priorities and the specific support Poland required were defined in the accession partnerships adopted in 1998 and revised in 1999 and 2002. These documents were the basis for sector-by-sector evaluation to establish a roadmap that specified the legislation needed to be adopted or amended. Poland concluded the accession negotiations in December 2002 and the Copenhagen European Council was declared among the 10 candidate countries (others were: Cyprus, Estonia, Hungary, the Czech Republic, Slovenia, Latvia, Lithuania, Malta and Slovakia) that fulfilled the conditions necessary for joining the EU. Poland signed the Accession Treaty on 16 April 2003 in Athens and officially joined the EU on 1 May 2004 after the ratification procedures were completed.

In the years preceding EU accession, Poland observed a sharp rise in the degree of openness to trade. A significant proportion of this increase was accounted for by the growth of trade flows with Germany—Poland's high-income neighbor and main trade partner, and Europe's major center of high-tech industrial production (see Figure 1). Following accession, Poland further became a more important destination for German FDI (Figure 1). At the same time, the country experienced a remarkable period of catch-up growth: Poland's income per capita (in current prices) increased from about 18% of that of Germany in 2004 to about 29% in 2013. Similar patterns of catch-up growth were observed relative to the EU-15: GDP per capita in Poland was about 20% of that of the EU-15 in 2004 and it reached about 33% in 2013 (see Figure A.1).[2]

3 Theoretical motivation and empirical strategy

Models of trade and growth identify several channels by which deeper economic integration between countries with different levels of income per capita may influence produc-

[2]Prior the 2004 enlargement, the EU was composed of the following 15 member states: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

tivity growth in the less developed economy (Grossman and Helpman (1993); Coe et al. (1995); Goldberg et al. (2010)). First, international trade makes available to firms in the poorer country a larger variety of intermediate inputs and capital equipment. Second, trade and foreign direct investment offer channels of communication that stimulate the flow of better production and organizational methods, product design, and market conditions to the less developed country. Third, a broader set of international contacts make it possible for the less developed country to imitate technologies and adjust them to domestic use. Finally, deeper integration with a more advanced economy can lead to productivity gains in the development of new technologies or in the imitation of foreign technologies, thereby raising total factor productivity.

By integrating with a nation that is closer to the technology frontier, a less developed country stands to gain more—with regard to the products it can import and the direct knowledge it can acquire—than it would by integrating with a less advanced country. If the transferable inputs and knowledge are industry-specific, these gains would be stronger in sectors in which the stock of transferable knowledge of the advanced economy is relatively larger (Romer, 2010). To examine this hypothesis, we adopt the following econometric specification:

$$\log Y_{ijt} = \alpha Post_t + \beta Post_t * S_j + \gamma_i + \eta_t + \varepsilon_{ijt} \tag{1}$$

where Y_{ijt} is a measure of performance of firm i in sector j in year t; $Post_t$ is a dummy variable that takes value 1 for the post-accession period (i.e. from 2005 to 2014); and the variable S_j is a measure of Germany's specialization in sector j measured in the pre-accession period.

The main coefficient of interest is β which corresponds to the interaction between the post-accession dummy and the pre-determined sector-level measure of Germany's

comparative advantage. Equation (1) can be viewed as a difference-in-differences specification, in which all firms are treated after EU accession, but with a different intensity of treatment given by their industry's exposure to Germany's stock of knowledge. The standard errors are clustered at the sector level. For robustness, we will consider several alternative specifications.

4 Data and summary statistics

The empirical analysis draws on a survey of firms with more than 10 employees collected by the Central Statistical Office of Poland. This data set is available for the period 1995-2013 and contains information on a set of firm attributes, including employment, wages, capital stock, export and foreign ownership status, and industry affiliation. Unique firm identifiers make it possible to follow firms over time. As is customary in the empirical trade literature, the analysis excludes the "coke and refined petroleum" sector because of highly volatile data. The data set has an unbalanced structure and comprises information on 18,465 manufacturing firms with more than 10 employees. Data for the period 2000-2002 are available only for firms with more than 50 employees. To deal with this issue we exclude this time period from the main analysis but use it in robustness checks that consider only firms with more than 50 employees.

In the econometric analysis, we consider three different measures of firm performance: total factor productivity (TFP), revenues and employment. In our main specification, TFP is measured using the Levinsohn and Petrin (2003) methodology, in which total expenditure on material inputs is used as a proxy to unobservable productivity shocks. In order to allow for differences in technologies across sectors, different production functions were estimated for each 2-digit sector. As emphasized by De Loecker and Goldberg (2014), this is a commonly used measure of revenue-based TFP which also reflects changes

in markups, the product mix and product quality.[3] Yet, we also use alternative measures of productivity in a set of robustness checks.

Table 1: Summary statistics, estimation sample, 1995-2013

	1995-2013	1995-2004	2005-2013
TFP (log)	4.496	4.586	4.812
	(0.889)	(0.882)	(0.883)
Employment	169.452	218.992	147.329
	(381.65)	(468.696)	(333.21)
Revenues (in 000)	56.145	44.482	61.354
	(283.240)	(199.495)	(313.353)
Export participation	0.667	0.650	0.675
	(0.471)	(0.477)	(0.468)
Share of foreign owned	0.179	0.159	0.188
	(0.383)	(0.366)	(0.391)
N (obs.)	135,189	41,420	92,754
N (firms)	18,355	13,712	15,674

Notes: The table reports means and standard deviations (in parentheses) for the estimation sample of manufacturing firms with more than 10 employees over the period 1995-2013 (except 2000-2002). A firm is foreign owned if foreign investors hold at least 50% of capital. Monetary variables are in 2010 prices.

Table **??** reports summary statistics on each of these variables. The statistics in column (1) show that manufacturing firms in the estimation sample employed on average about 169 workers during the period 1995-2013. The statistics in columns (2) and (3) also show that average firm size declined in the post-accession period, from about 219 employees in 1995-2004 to 147 employees in 2005-2013. By contrast, TFP and revenues are higher, on average, in the post-2004 period. Column (1) further reveals that about 67% of firms were exporters during the sample period and 18% were owned by foreign investors. These proportions are moderately higher in the post-accession period (column 2 and 3).

Table 2 reports summary statistics on the same variables for each manufacturing sec-

[3]Applications of this method in an international trade context include Pavcnik (2002), Amiti and Konings (2007), Fernandes (2007) and Topalova and Khandelwal (2011), among many others.

Table 2: Summary statistics, estimation sample, 1995-2013

Sector	TFP	Employment	Revenues	Exporters	Foreign	N (obs.)	N (firms)
Food and beverages	3.865	151.866	64.439	0.466	0.105	25,841	3,592
	(0.847)	(287.204)	(205.281)	(0.499)	(0.307)		
Tobacco	2.743	829.116	1174.163	0.833	0.5	138	14
	(0.958)	(871.017)	(1391.239)	(0.374)	(0.502)		
Textile, wearing apparel, leather	3.974	157.637	16.212	0.764	0.188	13,782	1,867
	(0.922)	(235.768)	(42.777)	(0.424)	(0.391)		
Wood	3.626	127.085	29.272	0.785	0.152	7,150	1,034
	(0.691)	(195.2)	(110.173)	(0.411)	(0.359)		
Pulp, paper and printing	5.313	116.178	42.833	0.613	0.171	6,686	916
	(0.884)	(206.713)	(147.089)	(0.487)	(0.376)		
Chemicals	4.684	258.429	119.735	0.776	0.244	5,472	687
	(0.886)	(559.629)	(316.885)	(0.417)	(0.43)		
Rubber and plastic	4.066	122.512	38.165	0.778	0.231	11,774	1,622
	(0.708)	(266.831)	(130.317)	(0.416)	(0.421)		
Non-metallic mineral products	4.456	172.164	48.617	0.549	0.197	8,300	1,114
	(0.856)	(298.299)	(108.157)	(0.498)	(0.398)		
Basics and fabricated metals	4.64	141.681	43.103	0.717	0.187	21,419	3,000
	(0.78)	(374.529)	(264.849)	(0.45)	(0.39)		
Machinery and equipment	5.009	152.354	43.198	0.668	0.143	12,704	1,707
	(0.791)	(326.021)	(256.078)	(0.471)	(0.35)		
Electrical, comm., medical	5.227	202.276	71.201	0.709	0.231	9,619	1,262
	(0.949)	(424.024)	(379.659)	(0.454)	(0.421)		
Motor vehicles, other transport	5.419	354	152.26	0.783	0.288	8,348	1,056
	(0.989)	(806.788)	(728.611)	(0.412)	(0.453)		
Other	4.612	202.387	39.12	0.83	0.196	8,004	1,150
	(0.874)	(442.729)	(153.547)	(0.376)	(0.397)		

Notes: The table reports means and standard deviations (in parentheses) for the estimation sample of manufacturing firms with more than 10 employees over the period 1995-2013 (except 2000-2002). A firm is foreign-owned if foreign investors hold at least 50% of capital. Monetary variables are in 2010 prices. The Tobacco industry has a small number of firms. To preserve their confidentiality, summary statistics for this industry are not reported.

tor over the period 1995-2013. The statistics in this table show that the measures of firm performance vary substantially across manufacturing industries. Firm-level TFP tends to be higher, on average, in the sectors "Motor vehicles, other transport", "Electrical, communications, medical", and "Pulp, paper and printing". The former two sectors are also characterized by a relatively high average firm size, both in terms of employment and revenue. They are also sectors with a relatively high share of exporters and, especially, foreign-owned firms.

To implement equation (1), we consider different measures of Germany's comparative advantage. In the main analysis, we consider two different output-based measures of industrial specialization: (i) the share of each industry in total exports; and (ii) the share of each industry in total manufacturing output. In the context of the neoclassical trade model, these measures have the advantage of allowing for both differing technologies and differing factor supplies as drivers of international specialization (Harrigan (1996); Redding (2002)). For robustness, we further consider input-based measures of relative factor intensity in each sector, notably average wages, capital stock, and capital stock per worker. Since Germany has relatively large supplies of skilled labor and capital, it would be expected to have a comparative advantage in the sectors that use these factors more intensively (Levchenko (2007); Debaere (2014)). Industries that are intensive in skilled labor and capital would also be expected to have larger stocks of knowledge, which could be shared with Polish firms through trade and investment linkages. To mitigate concerns about endogeneity, all these measures are constructed using data for Poland's pre-accession period. For example, data on Germany's pre-accession exports and output by sector refer to the averages over the period 1994-2004. To conduct placebo tests, we further collected data on output-based measures for Poland itself, Russia and other neighbor countries, notably Ukraine and Lithuania. Data on the various measures of comparative advantage are obtained from Eurostat, OECD and UNIDO. The Appendix

reports summary statistics on the main measures (Table A.1 and A.2).

In order to investigate possible underlying mechanisms we employ an additional dataset obtained from the Orbis database of Bureau Van Dijk. The Orbis dataset provides retrospective information on company ownership and reports the country of origin of each foreign shareholder, although the share value is often unknown. It also provides information on employment and turnover. We extracted data on foreign ownership on all manufacturing firms (an annual average of 73,000 companies) for the period 1997 to 2013. The data covers about 58% of Polish firms as reported by Eurostat and coverage varies significantly across regions (Farole et al., 2017).

5 Main Results

Table 3 reports the point estimates yielded by estimating equation (1), using Germany's initial export and output shares in the sector during 1994-2004 as measures of industrial specialization. The specifications in columns (1) and (2) consider the effects of accession on TFP. Those reported in columns (3) and (4) consider effects on revenue. Finally, the estimates in columns (5) and (6) estimate effects on employment. The point estimates reveal that Polish manufacturing firms operating in sectors where Germany was more specialized at the moment of accession experienced significantly higher TFP and revenue growth in the post-2004 period. The point estimates on employment are also positive, but imprecisely estimated when using the export share as a measure of initial industrial specialization in Germany.

6 Robustness

We proceed by assessing the robustness of the main results to alternative sub-samples and econometric specifications. In Table A.3, we use the industry's export share to measure

Table 3: Baseline estimates

Dep. variable:	log TFP		log revenue		log employment	
	(1)	(2)	(3)	(4)	(5)	(6)
Post*Germany's export share (log)	0.048***		0.082**		0.029	
	(0.017)		(0.032)		(0.023)	
Post*Germany's output share (log)		0.041**		0.091**		0.062**
		(0.018)		(0.041)		(0.026)
N (obs.)	134,174	134,174	134,176	134,176	134,178	134,178
N (firms)	18,355	18,355	18,357	18,357	18,359	18,359
R-squared	0.105	0.105	0.110	0.111	0.105	0.105

Notes: All regressions include firm and year fixed effects. Germany's exports and output shares are measured in the period 1994-2004. The standard errors in parentheses are clustered at industry level. *10% level, **5% level, and ***1% level.

Germany's industrial specialization at the moment of accession. Since EU accession was pre-announced, some of its impacts might be expected to start materializing before 2004. To account for this possibility, in column (1) we exclude from the sample the years 2000-2004, thereby examining the differential evolution of firm performance across sectors between 1995-1999 and 2004-2013. Reassuringly, the point estimates for TFP and revenue remain very similar to those reported in Table 3 (slightly larger). In Table A.4 we provide estimates using an alternative method to estimate TFP based on Ackerberg et al. (2015). Results are very much aligned with those from our baseline specification.

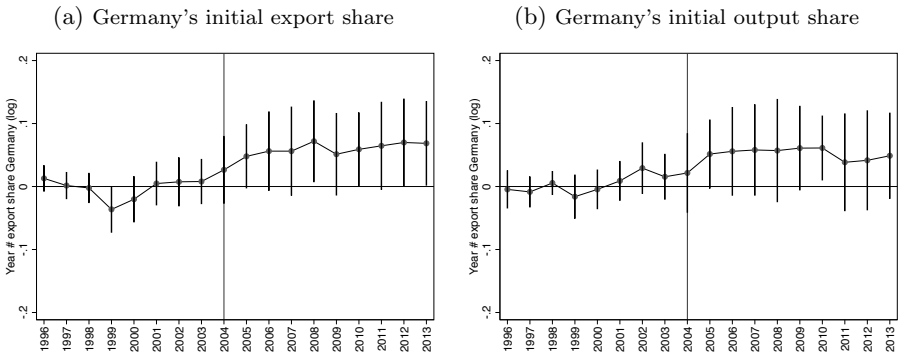
As noted above, for the years 2000 to 2002 the data include only firms with more than 50 employees. For this reason, data for these years were excluded from the main estimation sample. For robustness, the estimation sample used in column (2) of Table A.3 includes these three years, but considers only firms with more than 50 employees. Reassuringly, the estimates remain qualitatively and quantitatively very similar to those in Table 3. Using this restricted sample, we can interact Germany's indices of industrial specialization with year dummies to track the effects over times. The results are shown in Figure 2, which provides further evidence on how the evolution of firm TFP was mediated by Germany's industrial specialization pattern at the moment of accession. The diagram

in Panel A plots the coefficient of the interaction term between Germany's export share and a full set of year fixed effects. In turn, the diagram in Panel B plots the coefficient of the interaction term between Germany's output share and these year effects. One advantage of this approach is that it does not impose any specific treatment period. Yet, the sharp increase in the estimated effects coincide with EU accession. Hence, the visual evidence points to a positive relationship between each measure of industrial specialization in Germany and the evolution of firm TFP in Poland in each year of the the post-accession period. It also suggests that the estimates in Table 3 are not driven by pre-trends.[4] Hence, based on the weaker assumption, with respect to the parallel trends assumption, that these pre-trends are a reasonable proxy counterfactual trends, our baseline estimates can be interpreted casually. In addition, the lack of pre-trends suggest that, possible anticipatory effects are not driving our estimates. In Figure A.2 we show similar results when using a binary measure of Germany specializion. To draw a parallel with the standard difference in differences literature, in this specification treated sectors are those with an above median output or export share.

The baseline estimates are based on an unbalanced panel including all firms above 10 employees, irrespective of the year in which they were first observed in the data set. The baseline results might therefore partially reflect differential patterns of entry and exit of firms across sectors, as opposed to improvements in the size and efficiency of firms that were already operating prior to EU accession. To account for this possibility, the estimates in column (3) of Table A.3 excludes from the estimation sample firms that are only observed in the post-2004 period, while those in column (4) exclude firms that switched sector over the sample period. Once again, the point estimates remain very similar when imposing these restrictions.

[4] As noted above, the sample used in these regressions includes only firms with more than 50 employees, thereby allowing us to cover all years in the sample period.

Figure 2: Event study: the effects of Germany's specialization over time



Notes: The plots are created by regressing firm-level TFP on a full set of time indicators interacted with Germany's initial export share (Panel A) and output share (Panel B) controlling for firm and year fixed effects. Estimates are based on the sample of firms with more than 50 employees.

In the baseline analysis, Germany's pre-determined export shares were measured in the period 1994-2004. If Germany's specialization patterns changed considerably over this period, one may worry about the extent to which they are an appropriate measure of industrial specialization at the moment of accession. To account for this concern, the estimates in column (5) of of Table A.3 use Germany's export shares measured in the period 2000-2004. Reassuringly, the baseline estimates remain robust when considering this alternative specification.

During the period of analysis, the Polish food and chemicals industries were subject to significant changes in the regulatory environment, which might have direct effects on firm performance. In column (6) of of Table A.3, we examine the extent to which the baseline results are sensitive to the exclusion of firms operating in these sectors. In column (7) we account for tariff changes, which might also be expected to have direct effects on firm performance. Finally, in column (8) we exclude firms from the food and chemicals sector and control for tariffs. Once again the results show that the baseline estimates are robust across these various sub-samples and econometric specifications.

In Table A.5 we conduct similar robustness checks, but now using output shares instead of export shares to measure the extent of industrial specialization in Germany in the pre-accession period. Reassuringly, the baseline estimates for TFP and revenue remain robust across these various specifications. The effects on employment, which were positive and statistically significant in column (6) of Table 3, remain positive but are not statistically significantly different from zero.

As a further robustness check, in Table 4 we consider pre-determined input-based measures of comparative advantage in Germany. In particular, we consider measures of relative factor intensity in each sector, notably average wages, capital stock, and capital stock per worker. Since Germany has relatively large supplies of skilled labor and capital, it would be expected to have a comparative advantage in the sectors that use these factors more intensively (Levchenko (2007); De Loecker and Goldberg (2014)). The results in Table 4 reveal that our main findings are generally robust across these various alternative measures. In particular, they provide evidence that TFP and revenue growth among Polish firms following EU accession was significantly stronger in German sectors characterized by higher average wages and capital stock at the moment of accession. We also find positive and significant effects on employment when using these alternative measures.

6.1 Placebo tests

In the analysis so far, we have examined the extent to which the evolution of firm performance in Poland following EU accession was mediated by pre-determined measures of comparative advantage in Germany. If these time-invariant measures are systematically correlated with other drivers of firms performance in Poland, our interpretation of the econometric results might be challenged. In particular, we worry that the differential evolution of firm performance across sectors following EU accession reflects, at least in

Table 4: Robustness, input-based measures of Germany's comparative advantage

A. Dep. variable: log TFP	(1)	(2)	(3)
Post*Germany's initial average wages (log)	0.052***		
	(0.013)		
Post*Germany's initial capital per worker (log)		0.038	
		(0.046)	
Post*Germany's initial capital stock (log)			0.036***
			(0.013)
N (obs.)	134174	134174	134174
N (firms)	18355	18355	18355
R-squared	0.106	0.104	0.105
B. Dep. variable: log revenue			
Post*Germany's initial average wages (log)	0.116***		
	(0.027)		
Post*Germany's initial capital per worker (log)		0.149*	
		(0.081)	
Post*Germany's initial capital stock (log)			0.091***
			(0.026)
N (obs.)	134174	134174	134174
N (firms)	18355	18355	18355
R-squared	0.114	0.110	0.114
C. Dep. variable: log employment			
Post*Germany's initial average wages (log)	0.065**		
	(0.028)		
Post*Germany's initial capital per worker (log)		0.121**	
		(0.049)	
Post*Germany's initial capital stock (log)			0.062***
			(0.017)
N (obs.)	134174	134174	134174
N (firms)	18355	18355	18355
R-squared	0.077	0.076	0.078

Notes: All regressions include firm and year fixed effects. Explanatory variables are calculated over the period 1994-2004.. Standard errors in parentheses clustered at industry level. *10% level, **5% level, and ***1% level.

part, Poland's comparative advantage (as opposed to Germany's). To explore this possibility, in columns (1) and (2) of Table 5, we examine the extent to which the evolution of firm performance in the post-2004 period was mediated by Poland's initial export shares across sectors. Reassuringly, the results in column (1) do not show a significant relationship between Poland's export shares and firm performance in the post-accession period. In column (2), we include simultaneously the pre-determined export shares for Poland and Germany. The results reveal that Germany's initial export share in the sector is a significant predictor or the evolution of firm TFP and revenue in the post-2004 period, while that of Poland is not.

In columns (3)-(8), we further assess the validity of our interpretation of the econometric results by conducting a set of placebo tests for Russia and two other neighboring countries: Lithuania and Ukraine. Since EU accession did not entail deeper integration with Russia and Ukraine, we would not expect to observe systematic positive effects on firm performance. Lithuania also joined the EU in 2004, but unlike Germany did not have significantly higher levels of income per capita. The econometric results suggest that the export shares for these countries do not have a systematic positive effect on the dynamics of firm performance in Poland after accession to the EU. In Table A.6 of the Appendix we conduct a similar set of placebo tests using initial output shares, instead of export shares. The results are qualitatively similar. We interpret this evidence as providing further support to the hypothesis that deeper integration with Germany following EU accession was an important driver of firm performance in the post-accession period. Taken together, these results reported above are consistent with theories of trade-induced knowledge transfer.

Table 5: Placebo test: initial export share for Russia, Ukraine, Lithuania and Poland

	Poland		Russia		Ukraine		Lithuania	
A. Dep. variable: log TFP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post*country's export share (log)	0.002	-0.042*	-0.004	-0.035**	0.012	-0.022	-0.020	-0.034**
	(0.028)	(0.021)	(0.013)	(0.013)	(0.027)	(0.025)	(0.017)	(0.016)
Post*Germany's export share (log)		0.062***		0.071***		0.060***		0.056***
		(0.019)		(0.015)		(0.013)		(0.013)
N (obs.)	134174	134174	134174	134174	134174	134174	134174	134174
N (firms)	18355	18355	18355	18355	18355	18355	18355	18355
R-squared	0.104	0.106	0.106	0.107	0.104	0.106	0.104	0.106
B. Dep. Variable: log revenue								
Post*country's export share (log)	0.014	-0.058	-0.006	-0.059***	0.046	-0.002	-0.059	-0.086**
	(0.046)	(0.043)	(0.020)	(0.019)	(0.049)	(0.041)	(0.036)	(0.031)
Post*Germany's export share (log)		0.102**		0.120***		0.083***		0.102***
		(0.039)		(0.034)		(0.021)		(0.030)
N (obs.)	134174	134174	134174	134174	134174	134174	134174	134174
N (firms)	18355	18355	18355	18355	18355	18355	18355	18355
R-squared	0.106	0.111	0.106	0.113	0.107	0.110	0.108	0.114
C. Dep. variable: log employment								
Post*country's export share (log)	0.021	0.001	-0.002	-0.021	0.028	0.017	-0.023	-0.032
	(0.023)	(0.034)	(0.017)	(0.024)	(0.035)	(0.038)	(0.028)	(0.031)
Post*Germany's export share (log)		0.029		0.043		0.020		0.037
		(0.031)		(0.029)		(0.022)		(0.027)
N (obs.)	134174	134174	134174	134174	134174	134174	134174	134174
N (firms)	18355	18355	18355	18355	18355	18355	18355	18355
R-squared	0.073	0.074	0.073	0.074	0.073	0.074	0.073	0.074
D. Dep. variable: TFP (ACF)								
Post*country's export share (log)	-0.015	-0.058***	-0.010	-0.039***	0.014	-0.014	-0.033**	-0.046***
	(0.025)	(0.020)	(0.014)	(0.013)	(0.026)	(0.026)	(0.015)	(0.013)
Post*Germany's export share (log)		0.061***		0.067***		0.049***		0.052***
		(0.020)		(0.019)		(0.017)		(0.014)
N (obs.)	134174	134174	134174	134174	134174	134174	134174	134174
N (firms)	18355	18355	18355	18355	18355	18355	18355	18355
R-squared	0.114	0.116	0.115	0.117	0.115	0.116	0.115	0.117

Notes: All regressions include firm and year fixed effects. Export shares are measured in the period 1994-2004. Standard errors in parentheses clustered at industry level. *10% level, **5% level, and ***1% level.

7 Mechanisms

As discussed above, models of trade and growth suggest that foreign trade and investment provide important channels of communication by which inputs and knowledge can be transferred between nations. If the transferable inputs and knowledge are industry-specific, these gains would be stronger in sectors in which the stock of transferable knowledge of the advanced economy is relatively larger. Although the data available to us do not make it possible to examine empirically the full set of mechanisms emphasized by these models, we aim at providing some suggestive evidence on two main channels: foreign ownership and trade.

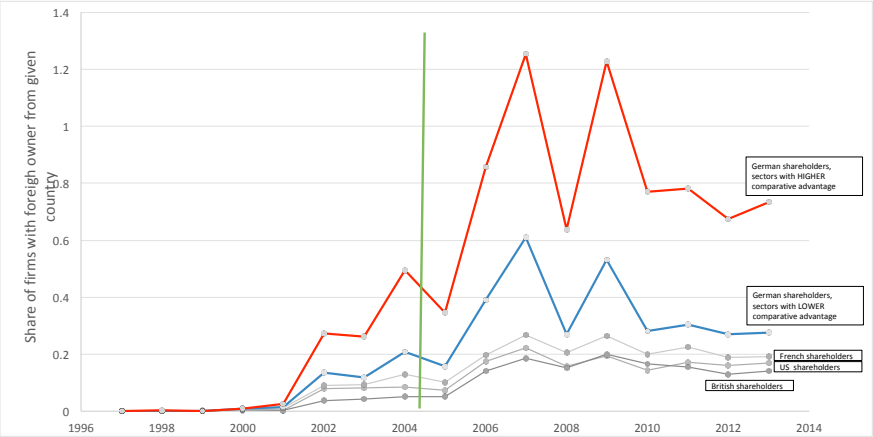
7.1 Performance gains from foreign ownership

The first mechanism we explore is the role of foreign investment. Figure 3 shows the evolution of the percentage of companies with at least one foreign shareholder from either Germany, French, USA or the United Kingdom. In the case of German shareholders, sectors are divided into those with the highest pre-determined export share (top quartile, red line) and those with lower level of specialization (bottom quartile, blue line). The figure confirms the sharp increase in German's acquisitions of Polish firms (anticipated in Figure 1) right after EU accession, and at a remarkable greater extent for sectors with higher export shares. The percentage of German owned companies peaked in 2007 and 2009 at about 1.8% overall, corresponding to about 18% of total employment (according to our sample). While foreign acquisitions begin since 2001 in concomitance with the conclusions of the accession negotiations, it was only after joining the EU that FDI observed a sharp rise. Foreign acquisitions increased also from other EU countries, such as France and the United Kingdom, and non-EU major trade partners, such as the US, but to a much lower extent. This suggests that German foreign investment played an

important role.

It is worth noting that the sharp increase in foreign acquisitions was not likely driven by the lift of restrictions on FDI. OECD data on FDI restrictiveness for Poland show that screening and legal restrictions on FDI in manufacturing sectors had already been greatly removed by the time of accession. Hence, the observed increase in FDI could be attributed to the removal of the uncertainty regarding the future relationship with EU members and the progressive alignment of regulations associated with EU membership.

Figure 3: Share of foreign owned firms by origin of shareholder and level of industrial specialization (for Germany only)

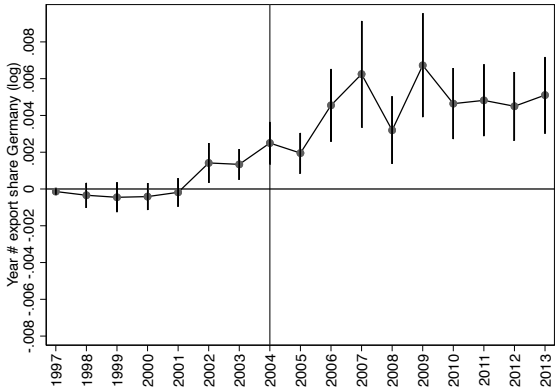


Author's calculation based on the Orbis database. The red line shows the shares of firms with a German shareholder in sectors where Germany show greater industrial specialisation. etc. Sectors with higher comparative advantage include: motor vehicle, machinery, chemicals, pharmaceutical, metals, communication and specialised equipment.

The above pattern is confirmed in an event study setting where a binary variable indicating the presence of at least one German shareholder is regressed on our pre-determined measure of comparative advantage, controlling for firm and year fixed effects. The results are shown in Figure 4 and include only firms that were established prior to 2004 to ensure comparability. The focus on incumbents allows us to restrict the findings to the effect of foreign acquisition of existing firms. We do not find evidence

of border regions receiving more FDI from German (Figure A.3 of the Appendix). As a placebo experiment, we employ the same specification on similar data for Romanian firms, also from the Orbis database. Since Romania acceded the EU in 2007, we would not expect to observe a significant effect in this case. Results in Figure A.4 of the Appendix show indeed no effect of our measure of pre-determined German specialization on the German acquisition of Romania firms. The estimates show only a negligible increase in the probability of being acquired by a German shareholder after 2007, which is also not statistically significance. Hence, these estimates argue against the possibility of Germany investing abroad more heavily after 2004 independently of EU membership. The small increase after 2007 also reflects weaker economic ties between Germany and Romania.

Figure 4: Event study: the effect of pre-determined measure of German comparative advantage on the acquisition of Polish firms.



Author's calculation based on the Orbis database. The plot is created by regressing a dummy variable indicating German ownership on a full set of event time indicators interacted with the pre-determined measure of German comparative advantage and controlling for firm and year fixed effects. The vertical line indicates 95% confidence interval. Results include only firms established before 2004. Germany's comparative advantages are measured by average sector-level export shares over the period 1994-2004.

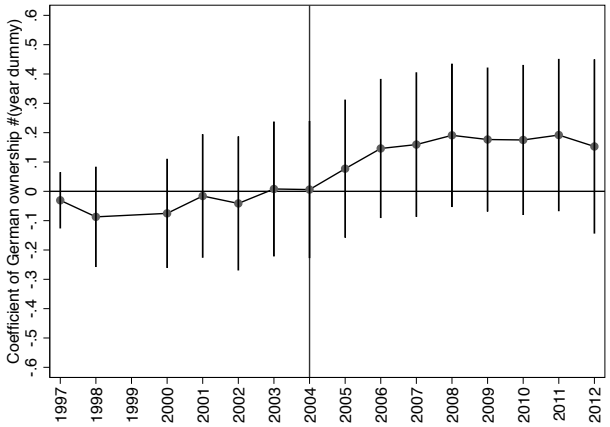
In the next step, we estimate the effect of German acquisitions on firm performance. We do so in two ways. First we compare the performance of domestic firms with that of

those acquired by a German shareholder. We consider employment growth as a measure of firm performance as constructing measures of productivity, including labor productivity, with the Orbis database entails loosing a large number of observations. We implement a difference in differences analysis where firm-level employment is regressed on a treatment variable that takes value one if a firm is acquired by a German owner. Figure 5 show the event-study results where the treatment dummy is interacted with time dummies, and firm and year fixed effects are included. In this specification we consider only firms established before 2004 and consider equally treated all firms acquired after 2004, i.e. independently of the year of acquisition. This specification has the advantage of ensuring comparability across firms and mitigating potential endogeneity related to the timing of foreign acquisition. For example, a foreign takeover could happen strategically (and systematically) after a firm experienced a decline in employment. However, in the earlier years after 2004, the treatment group includes also firms that have not been yet acquired, the effect, is therefore, likely to be underestimated. This specification also offer a visual test for the absence of pre-trends in foreign acquisitions. Before 2004 there is no discernible difference in employment growth between domestic and to-be-acquired firms. However, after 2004 we observe a positive effect of foreign acquisition on employment growth that persist throughout the period of analysis[5].

A second approach follows the literature on the effects of foreign acquisitions (see, e.g., Arnold and Javorcik (2009), Guadalupe et al. (2012), Bastos et al. (2018)) and

[5]This hypothesis is further supported by anecdotal evidence that we gathered through interviews to foreign and domestic firms from the automotive sector in the region of Gliwice. The region is currently a cluster for the automotive sector, in which GM Opel operates and where domestic suppliers are located. In the auto sector–in which Germany's firms are world leaders–increased trade and investment linkages with Poland were reported to have facilitated knowledge transfers and induced growth of domestic firms. When GM Opel first start operating in Gliwice's special economic zone it created a reaction through the whole supply chain. The zone has now about 80 plants, many of which are supplying to GM Opel, but also to other carmakers in Poland and abroad. Becoming accredited suppliers of GM Opel benefitted domestic firms in two ways. First, they received training and supervision by GM Opel. Second, they acquired the reputation of supplying high-quality products which improved their prospects with other clients as well.

Figure 5: Event study: the effect of German acquisition on firm-level employment.



Author's calculation based on the Orbis database. The plot is created by regressing a the log of employment on a full set of event time indicators interacted with the a dummy variable indicating whether a firm was acquired by a German shareholder after 2004 and controlling for firm and year fixed effects. The vertical line indicates 95% confidence interval. Results include only firms established before 2004. Germany's comparative advantages are measured by average sector-level export shares over the period 1994-2004.

involves estimating the effect of German acquisition on employment by combining a difference-in-differences approach with propensity score matching (DD-PSM). In particular, a propensity score is estimated as a function of firm attributes observed one year before the treatment occurs. We estimate a single model for the propensity score including all years and industries. We use lagged employment (log) and employment growth as explanatory variables in addition to industry and year fixed-effects. We matched treated firms by year and industry using one-to-one nearest-neighbor matching without replacement and imposing common support. By doing so we consider only firms that had similar observable attributes and trends in the year prior to the acquisition. Table A.7 of the Appendix show the results of the propensity score estimation[6] while Table A.8 of

[6]Because the variable turnover has many missing values, we show the results when matching on employment variable only. In the Appendix, however, we also show the results of the propensity score matching (Table A.7, column 2) and the DD-PSM estimates when matching on lagged employment and turnover, and employment and turnover growth (Table A.9).

the Appendix reports summary statistics for the unmatched and matched samples. This latter table shows that the matching procedure was successful at removing observable differences between domestic and acquired firms in the year prior to acquisition. The difference-in-differences results are presented in Table 6 and shows a positive effect of German acquisition on employment growth. German acquisition increases employment growth by about 20%. We also conduct the event study analysis above considering only the matched sample. The results are reported in Figure A.6 of the Appendix and confirm previous findings. It is worth noting that our previous results on TFP are not driven by foreign firms only. Indeed the effect persists when excluding foreign acquired firms, suggesting substantial spillover effects.

Table 6: The effect of German acquisition on employment

Dep. Var.: employment (log)	FE (1)	DD-PSM (2)	DD-PSM (3)
German owned	0.215***	0.219***	0.213***
	(0.024)	(0.034)	(0.033)
Sector time trends	No	No	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N (obs.)	413054	11921	11921
N (firms)	97863	1038	1038

Standard errors clustered at sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. DD-PSM indicates difference in differences estimation with matching based on column 1 of Table A.7.

7.2 Trade-induced performance gains

An alternative possible channel stems from the increase in foreign competition, especially in sectors where Germany had a comparative advantage. While plausible, it is likely that these effects would have already manifested well before 2004. Indeed, the EU had already reduced to zero all tariffs on manufacturing imports from Poland since 1995. Another possible argument is that deeper integration could have further promoted

exports after 2004. However, descriptive statistics show that Polish exports peaked in 2004 (Figure 1, while the share of exporters has remained constant throughout the entire period of analysis (Table 1). In addition, the absence of pre-trends in our estimates (Figure 2) suggests that, while international competition could have possibly promoted productivity growth before accession, this was not correlated with the degree of industrial specialisation in Germany. Hence, competition for the export market is unlikely to explain the heterogeneity in TFP gains observed in the post-2004 period.

On the import side, the elimination of import tariffs in Poland began in 1992 and was completed in 2001, when all tariffs on manufacturing products, excluding food products, had been reduced to zero. Goh and Javorcik (2007) analyse the effect of this trade liberatization process for the entire period 1992-2001. Sectors experiencing the largest reduction in import tariffs were those with a higher proportion of unskilled workers. The authors found positive effects on wages through increased productivity. As for exports, we expect possible competitive effects to have occurred before accession. Moreover, we do not observe any significant correlation between the observed decrease in tariffs and our pre-determined measure of Germany comparative advantage (the correlation is actually negative, -13%). Similarly, the pattern of imports of intermediates from Germany was also not correlated with our measure of comparative advantage (see Figure A.7 of the Appendix). Since we focus on within-firm productivity, the possible exit of less productive firms due to increased competition is unlikely to be a key driver of our estimates. However, it could be argued that EU accession brought greater stability and certainty and led Polish firms to improve their absorptive capacity (mainly through investment) and enabled them to assimilate the knowledge embedded into imported goods. Yet this is likely to be a generalized effect, hence not heterogenous across sectors. Finally, it is worth noting that while our results are unlikely to be explained by direct trade effects, trade openness was certainly a prerequisite for higher foreign investment.

8 Concluding remarks

The belief that deeper integration with high-income markets can help firms in less developed countries to reduce efficiency gaps is a key argument for pursuing deeper international economic integration. Prominent models of trade and growth emphasize performance gains caused by the flow of more advanced technologies, production processes, or organizational methods to the less developed economy, which contribute to narrow the productivity gap within industries. If the transferable knowledge and technologies are industry-specific, the less developed country may plausibly observe stronger productivity and output growth in sectors in which the richer nation is relatively more advanced.

Despite the prominence of trade and growth models, there is still surprisingly little evidence on the relevance of this hypothesis and the underlying microeconomic mechanisms. In this paper we have exploited Poland's accession to the European Union in 2004 as a source of variation in the degree of market integration with Germany–Poland's high-income neighbor and Europe's major center of high-tech industrial production. We have used firm-level panel data in a difference-in-differences strategy to examine whether and how the evolution firm performance in Poland following EU accession was mediated by measures of industrial specialization in Germany in the pre-accession period.

The econometric results provide evidence that EU accession was followed by significant within-firm growth in scale and efficiency, especially in industries in which Germany was more specialized at the moment of accession. While we cannot rule out some positive trade effects, the deepening of foreign investment linkages appears to have played a major role in shaping these effects.

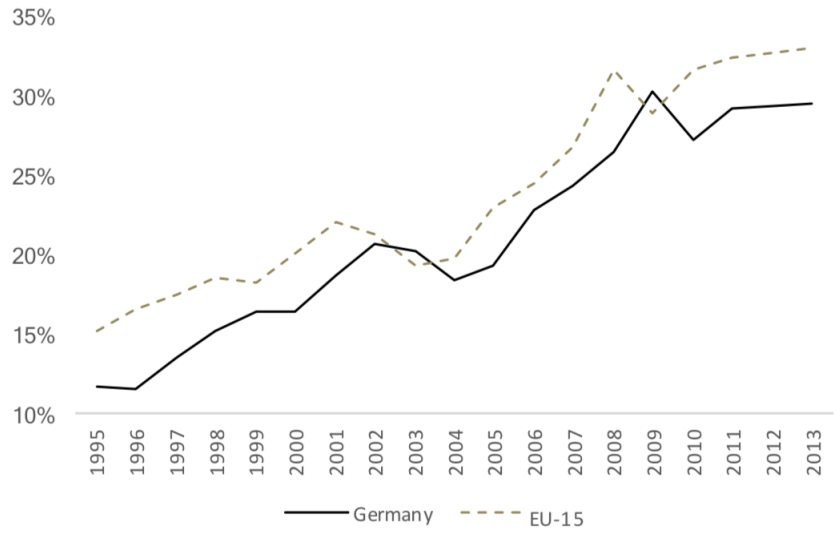
This points the attention towards the benefits of deeper economic integration. Despite Poland and EU both having eliminated all tariffs ahead of 2004, it was only with the full membership of the European Union that Poland began to enjoy the benefit of economic

integration through FDI-induced productivity gains.

Appendix

A. Additional tables and figures

Figure A.1: Poland's GDP per capita relative to Germany and the EU-15



Notes: The figure depicts the evolution of Poland's GDP per capita (in current prices) as a share of that of Germany and the EU-15. The source of the data is the EU AMECO database.

Table A.1: Export shares by country, 1994-2004

Sector	Description	Germany	Russia	Ukraine	Lithuania	Poland
15	Food products, Beverages	3.97	2.58	10.25	11.84	8.28
16	Tobacco	0.30	0.09	0.32	0.55	0.17
17	Textile	2.42	0.77	0.85	7.18	2.96
18	Leather	1.26	0.52	2.82	9.73	6.24
19	Footwear	0.50	0.24	1.04	0.99	1.34
20	Wood and Products of Wood and Cork	0.62	2.68	1.07	4.92	3.58
21	Paper	2.32	2.94	1.30	1.15	2.88
22	Printing and publishing	1.05	0.95	0.20	0.43	0.69
23	Coke, Refined Petroleum Products and Nuclear Fuel	1.26	22.15	5.81	18.33	2.31
24	Chemicals and Chemical Products	13.43	11.74	11.56	9.41	6.91
25	Rubber and Plastics Products	3.52	0.84	1.55	2.40	3.90
26	Other Non-Metallic Mineral Products	1.49	0.76	1.39	1.50	2.76
27	Basic Metals	4.88	33.52	41.64	1.57	8.07
28	Fabricated Metal Products	3.37	2.05	2.51	1.95	6.04
29	Machinery and Equipment, not elsewhere classified	16.36	4.11	6.59	4.30	7.22
30	Office, Accounting and Computing Machinery	2.82	0.16	0.23	0.60	0.28
31	Electrical Machinery and Apparatus, not elsewhere classified	5.42	1.44	2.69	2.78	5.85
32	Radio, Television and Communication Equipment	4.92	0.68	0.67	4.50	3.80
33	Medical, Precision and Optical Instruments	4.12	1.55	1.22	1.15	0.79
34	Motor Vehicles, Trailers and Semi-Trailers	20.14	2.35	1.37	5.93	12.23
35	Other Transport Equipment	3.94	5.10	4.42	4.78	5.72
36/37	Manufacturing not elsewhere classified; Recycling	1.89	2.77	0.51	4.03	7.98

Notes: Table reports export shares by sector over the period 1994-2004 for sectors are classified according to NACE Rev. 1 (2-digit) classification.

Table A.2: Output shares by country, 1994-2004

Sector code	Description	Germany	Russia	Ukraine	Lithuania	Poland
15	Food products, Beverages	10.46	20.30	22.63	25.01	22.01
16	Tobacco	1.23	1.05	1.23	1.31	2.18
17	Textile	1.20	1.53	1.04	5.59	2.34
18	Leather	0.92	1.20	1.10	5.39	2.12
19	Footwear	0.32	0.45	0.66	0.88	0.87
20	Wood and Products of Wood and Cork	1.54	1.81	0.90	5.12	3.31
21	Paper	2.35	2.39	1.18	1.32	2.36
22	Printing and publishing	3.68	1.03	1.29	2.90	3.36
23	Coke, Refined Petroleum Products and Nuclear Fuel	5.50	9.17	7.61	20.78	6.86
24	Chemicals and Chemical Products	9.81	9.51	6.94	5.96	7.29
25	Rubber and Plastics Products	4.09	2.20	1.97	3.17	4.42
26	Other Non-Metallic Mineral Products	3.09	5.44	4.58	3.37	4.76
27	Basic Metals	4.61	18.18	25.08	0.37	5.83
28	Fabricated Metal Products	6.55	2.41	3.53	2.39	5.58
29	Machinery and Equipment, not elsewhere classified	12.29	7.80	6.13	2.97	5.88
30	Office, Accounting and Computing Machinery	1.16	0.31	0.33	0.12	0.29
31	Electrical Machinery and Apparatus, not elsewhere classified	6.14	2.25	2.36	2.21	3.36
32	Radio, Television and Communication Equipment	2.26	n.a.	0.81	3.56	2.26
33	Medical, Precision and Optical Instruments	2.59	0.96	0.67	1.04	1.10
34	Motor Vehicles, Trailers and Semi-Trailers	15.68	7.65	2.91	0.25	7.00
35	Other Transport Equipment	1.95	1.31	4.29	2.11	2.45
36	Manufacturing not elsewhere classified	2.41	2.13	0.92	3.64	3.99
37	Recycling	0.18	0.92	1.87	0.56	0.38

Notes: Table reports export shares by sector over the period 1994-2004 for sectors are classified according to NACE Rev. 1 (2-digit) classification.

Table A.3: Robustness across sub-samples and set of controls, export share

	excl. 2000-2004 (1)	only firms with empl. above 50 (2)	only firms born before 2004 (3)	export share for 2000-2004 (4)	excl. food and chemicals (5)	excl. switch sector (6)	tariffs (7)	excl. food chemicals plus tariffs (8)
A. Dep.var: TFP								
Post*export share	0.065**	0.052**	0.048***	0.049***	0.062***	0.050**	0.046**	0.060***
	(0.023)	(0.021)	(0.017)	(0.017)	(0.010)	(0.019)	(0.017)	(0.009)
Tariffs							-0.003	0.050***
							(0.006)	(0.014)
N (obs.)	111050	100888	111478	134174	102736	127020	131450	100679
N (firms)	16,647	11,669	13,720	18,355	14,131	17,663	18,355	14,130
R-squared	0.110	0.138	0.117	0.105	0.113	0.105	0.094	0.102
B. Dep.var: rev.								
Post* export share	0.090*	0.085**	0.082**	0.086**	0.099***	0.083**	0.082**	0.097***
	(0.050)	(0.037)	(0.032)	(0.032)	(0.032)	(0.034)	(0.031)	(0.030)
Tariffs							0.011	0.144***
							(0.013)	(0.038)
N (obs.)	111050	100888	111478	134174	102736	127020	131450	100679
N (firms)	16,647	11,669	13,720	18,355	14,131	17,663	18,355	14,130
R-squared	0.106	0.216	0.113	0.111	0.119	0.106	0.106	0.117
C. Dep.var: empl								
Post*export share	0.016	0.018	0.029	0.032	0.029	0.032	0.030	0.031
	(0.040)	(0.028)	(0.023)	(0.024)	(0.023)	(0.024)	(0.022)	(0.022)
Tariffs							-0.026**	0.082**
							(0.011)	(0.039)
N (obs.)	111050	100888	111478	134174	102736	127020	131450	100679
N (firms)	16,647	11,669	13,720	18,355	14,131	17,663	18,355	14,130
R-squared	0.072	0.053	0.082	0.074	0.084	0.074	0.067	0.075

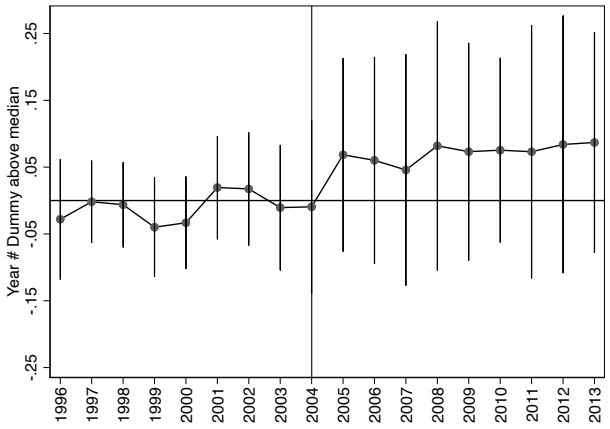
Notes: All regressions include firm and year fixed effects. Germany's output shares are measured in the period 1994-2004. Standard errors in parentheses clustered at industry level. Dependent variables and Germany initial export shares are in log. *10% level, **5% level, and ***1% level.

Table A.4: Robustness: alternative measure of TFP

A. Dep. variable: log TFP (ACF)	(1)	(2)	(3)	(4)	(5)
Post # Exports share (log)	0.041**				
	(0.018)				
Post # Output share (log)		0.022			
		(0.025)			
Post # initial capital stock (log)			0.022		
			(0.020)		
Post # initial capital per worker (log)				0.024	
				(0.054)	
Post # initial average wages (log)					0.041**
					(0.019)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N (obs.)	134174	134174	134174	134174	134174
N (firms)	18355	18355	18355	18355	18355
R-squared	0.115	0.114	0.114	0.114	0.115

Notes: All regressions include firm and year fixed effects. Germany's output shares are measured in the period 1994-2004. Standard errors in parentheses clustered at industry level. Dependent variables and explanatory variables are in log. *10% level, **5% level, and ***1% level. TFP is estimated using the method proposed in Ackerberg et al. (2015)

Figure A.2: Event study: effects based on binary measure of Germany's specialization.



Notes: The plot is created by regressing the firm-level TFP on a full set of time indicators interacted with a binary measure of Germany's specialization that assigned 1 to sectors that have above median levels of output share or export share and controlling for firm and year fixed effects. Estimates are based on sample of firms with more than 50 employees.

Table A.5: Robustness across sub-samples and set of controls, output share

	excl. 2000-2004	only firms with empl. above 50	only firms born before 2004	export share for 2000-2004	excl. food and chemicals	excl. switch sector	tariffs	excl. food chemicals plus tariffs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Dep.var: TFP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post*output share	0.056**	0.032	0.041**	0.041**	0.064***	0.044**	0.041**	0.062***
	(0.024)	(0.023)	(0.018)	(0.016)	(0.012)	(0.019)	(0.018)	(0.012)
Tariffs							0.004	0.040***
							(0.008)	(0.014)
N (obs.)	111050	100888	111478	134174	102736	127020	131450	100679
N (firms)	16,647	11,669	13,720	18,355	14,131	17,663	18,355	14,130
R-squared	0.110	0.137	0.116	0.105	0.113	0.104	0.093	0.101
B. Dep.var: revenue								
Post*output share	0.078*	0.054*	0.063**	0.060**	0.070**	0.068**	0.058**	0.071**
	(0.041)	(0.029)	(0.026)	(0.025)	(0.032)	(0.025)	(0.028)	(0.031)
Tariffs							-0.015	0.067*
							(0.011)	(0.037)
N (obs.)	111050	100888	111478	134174	102736	127020	131450	100679
N (firms)	16,647	11,669	13,720	18,355	14,131	17,663	18,355	14,130
R-squared	0.075	0.057	0.085	0.076	0.087	0.077	0.069	0.078
C. Dep. var: empl								
Post*output share	0.122**	0.096**	0.092**	0.091**	0.141***	0.093**	0.098**	0.137***
	(0.054)	(0.045)	(0.041)	(0.038)	(0.033)	(0.041)	(0.037)	(0.031)
Tariffs							0.030**	0.118***
							(0.012)	(0.030)
N (obs.)	111050	100888	111478	134174	102736	127020	131450	100679
N (firms)	16,647	11,669	13,720	18,355	14,131	17,663	18,355	14,130
R-squared	0.109	0.218	0.114	0.112	0.124	0.107	0.108	0.121

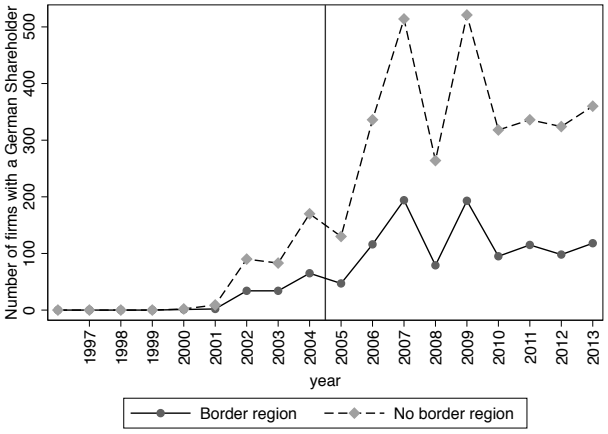
Notes: All regressions include firm and year fixed effects. Germany's output shares are measured in the period 1994-2004. Standard errors in parentheses clustered at industry level. Dependent variables and Germany initial output shares are in log. *10% level, **5% level, and ***1% level.

Table A.6: Placebo test: initial output share for Russia, Ukraine, Lithuania and Poland

Poland		Russia		Ukraine		Lithuania		
A. Dep. variable: log TFP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post*country's output share (log)	0.002	-0.079***	0.009	-0.047**	0.012	-0.022	0.005	-0.044***
	(0.018)	(0.021)	(0.016)	(0.018)	(0.027)	(0.025)	(0.013)	(0.014)
Post*Germany's output share (log)		0.098***		0.086***		0.060***		0.085***
		(0.019)		(0.023)		(0.013)		(0.022)
N (obs.)	134174	134174	132709	132709	134174	134174	134174	134174
N (firms)	18355	18355	18161	18161	18355	18355	18355	18355
R-squared	0.104	0.107	0.104	0.106	0.104	0.106	0.104	0.106
B. Dep. variable: log revenue								
Post*country's output share (log)	0.021	-0.136***	0.015	-0.089***	0.022	-0.098***	-0.042**	-0.063***
	(0.048)	(0.024)	(0.030)	(0.024)	(0.037)	(0.031)	(0.020)	(0.018)
Post*Germany's output share (log)		0.189***		0.182***		0.185***		0.110***
		(0.043)		(0.045)		(0.047)		(0.030)
N (obs.)	134174	134174	134174	134174	132709	132709	134174	134174
N (firms)	18355	18355	18355	18355	18355	18355	18355	18355
R-squared	0.106	0.115	0.106	0.115	0.107	0.116	0.108	0.115
C. Dep. variable: log employment								
Post*country's output share (log)	0.047*	-0.012	0.019	-0.040*	0.026	-0.035*	0.001	-0.012
	(0.026)	(0.025)	(0.018)	(0.020)	(0.021)	(0.020)	(0.014)	(0.012)
Post*Germany's output share (log)		0.071*		0.103**		0.095**		0.066**
		(0.040)		(0.037)		(0.038)		(0.028)
N (obs.)	134174	134174	134174	134174	132709	132709	134174	134174
N (firms)	18355	18355	18355	18355	18355	18355	18355	18355
R-squared	0.075	0.076	0.073	0.077	0.073	0.076	0.073	0.077
D. Dep. variable: TFP (acf)								
Post*country's output share (log)	-0.024	-0.103***	-0.007	-0.046**	-0.007	-0.060***	-0.033***	-0.039***
	(0.019)	(0.020)	(0.015)	(0.018)	(0.018)	(0.018)	(0.009)	(0.011)
Post*Germany's output share (log)		0.096***		0.068**		0.082***		0.033*
		(0.023)		(0.031)		(0.027)		(0.019)
N (obs.)	134174	134174	134174	134174	132709	132709	134174	134174
N (firms)	18355	18355	18355	18355	18355	18355	18355	18355
R-squared	0.115	0.117	0.114	0.116	0.112	0.114	0.116	0.116

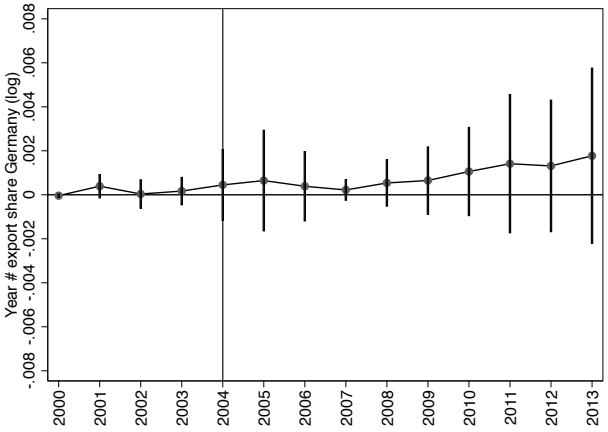
Notes: All regressions include firm and year fixed effects. Output shares are measured in the period 1994-2004. Standard errors in parentheses clustered at industry level. *10% level, **5% level, and ***1% level. TFP (ACF) is estimated using the method proposed in Ackerberg et al. (2015).

Figure A.3: Share of firms acquired by German shareholder by location



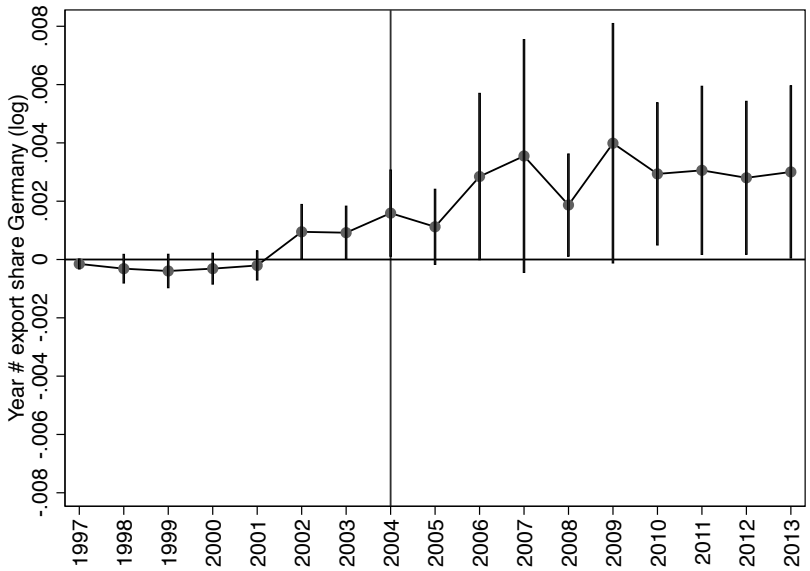
Author's calculation based on the Orbis database.

Figure A.4: Event study: the effect of pre-determined measure of German comparative advantage on the acquisition of Romanian firms.



Author's calculation based on the Orbis database. The sample includes only Romanian firms. The plot is created by regressing a dummy variable indicating German ownership on a full set of event time indicators interacted with the pre-determined measure of German comparative advantage and controlling for firm and year fixed effects. The vertical line indicates 95% confidence interval. Results include only firms established before 2004. Germany's comparative advantages are measured by average sector-level export shares over the period 1994-2004.

Figure A.5: Average firm size by foreign ownership



Author's calculation based on the Orbis database. The plot is obtained by averaging firm-level employment for domestic firms and for firm acquired by a German shareholder after 2004 over time.

Table A.7: Propensity score estimates

Dep. variable: foreign ownership	(1)	(2)
Lagged employment (log)	0.930***	-0.449***
	(0.025)	(0.054)
Employment growth	0.017***	-0.039*
	(0.002)	(0.021)
Lagged turnover (log)		0.843***
		(0.057)
Turnover growth		0.000***
		(0.000)
Sector FE	Yes	Yes
Year FE	Yes	Yes
Observations	375867	36270

Standard errors clustered at sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The table reports the estimates of a logit model. Growth of employment and turnover is calculated between the year prior to acquisition and the acquisition year.

Table A.8: Propensity score estimates

Variables	Unmatched sample Always domestic	Acquired by German investors	Difference	Matched sample Always domestic	Acquired by German investors	Difference
Employment	2.27	4.53	-2.25 ***	4.49	4.48	0.00
Employment growth	0.06	0.14	-0.08	0.04	0.14	-0.10**
Turnover	8.25	9.14	-0.90***	8.64	9.09	-0.45
Turnover growth	4.25	0.53	3.72***	0.15	0.53	-0.39

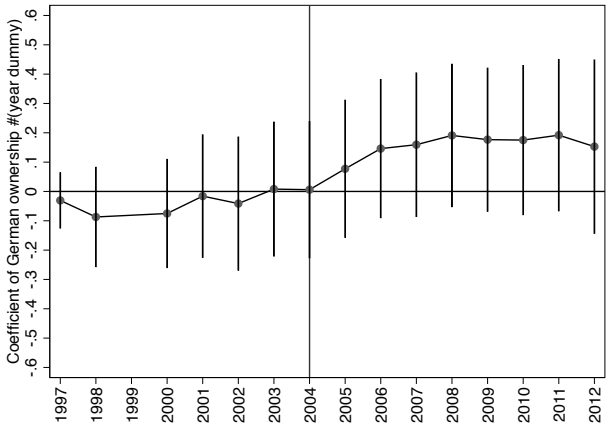
The table reports sample means. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Variables in levels are in log and measured in the year prior to acquisition.

Table A.9: The effect of German acquisition on employment, and productivity

	FE	DD-PSM	DD-PSM
German owned	0.215***	0.255***	0.251***
	(0.024)	(0.027)	(0.028)
Sector time trends	No	No	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N (obs.)	413054	12385	14361
N (firms)	97863	1070	1312
Dep. Var.: turnover (log)			
German owned	0.275***	0.279***	0.276***
	(0.029)	(0.037)	(0.037)
Sector time trends	No	No	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N (obs.)	113312	14018	14018
N (firms)	16898	1123	1123

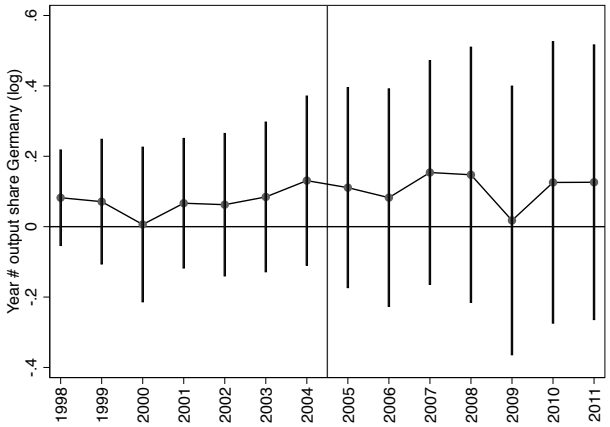
Standard errors clustered at sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. DD-PSM indicates difference in differences estimation with matching. In this specification, matching is based on lagged employment and turnover, and employment and turnover growth (column 2 of table A.7).

Figure A.6: Event study: the effect of German acquisition on firm-level employment.



Author's calculation based on the Orbis database. The plot is created by regressing a the log of employment on a full set of event time indicators interacted with the a dummy variable indicating whether a firm was acquired by a German shareholder after 2004 and controlling for firm and year fixed effects. The vertical line indicates 95% confidence interval. Results include only firms established before 2004. Germany's comparative advantages are measured by average sector-level export shares over the period 1994-2004. The control group include only matched firms based on the one- to-one nearest-neighbor matching procedure explained above.

Figure A.7: Event study: the effect of pre-determined measure of German comparative advantage on the import of intermediate goods from Germany.



Author's calculation based on the COMTRADE database. The plot is created by regressing a the log of imports of intermediate from Germany on a full set of event time indicators interacted with our pre-determined measure of comparative advantage and controlling for sector and year fixed effects. The vertical line indicates 95% confidence interval. Germany's comparative advantages are measured by average sector-level export shares over the period 1994-2004.

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