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Adjusting to Globalization – Evidence from Worker-Establishment Matches in Germany *

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Abstract

This paper addresses the impact of rising international trade exposure on individual earnings profiles in heterogeneous worker-establishment matches. We exploit rich panel data on job biographies of manufacturing workers in Germany, and apply a high-dimensional fixed effects approach to analyze endogenous mobility between plants, industries, and regions in response to trade shocks. Rising import penetration reduces earnings within job spells, and it induces workers to leave the exposed industries. Intra-industry mobility to other firms or regions are far less common adjustments. This induced industry mobility mitigates the adverse impacts of import shocks in the workers' subsequent careers, but their cumulated earnings over a longer time horizon are still negatively affected. By contrast, we find much less evidence for sorting into export-oriented industries, but the earnings gains mostly arise within job spells. These results point at an asymmetry in the individual labour market response to trade shocks: Import shocks trigger substantial "push effects", whereas the "pull effects" of export shocks are weaker.

JEL-Classification: F16, J31, R11
Keywords: International trade, Individual labour market responses, work biographies, endogenous worker mobility, Germany

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1 Introduction

What are the labour market effects of "globalization"? Although a classical question in the economics literature that dates back, at least, to the seminal work by Stolper and Samuelson (1941), relatively little is known about the micro-level impacts of trade shocks on the job biographies of heterogeneous individuals. How are different workers affected, depending on their initial sectoral affiliation, location, and personal characteristics? Do they systematically adjust to globalization by moving across industries, regions, or plants to mitigate import shocks or to benefit from export opportunities? Does this endogenous mobility occur smoothly, or does it involve disruptive unemployment spells? And what are the cumulated long-run effects of trade shocks?

In this paper, we use detailed German data on worker-establishment matches to shed light on those questions, which appear to be a central concern for policy-makers who worry about the distributional consequences of trade liberalizations. Our data allow us to follow single individuals over a long time period (1990-2010), and we study how they were affected by, and responded to, the rising German trade exposure during that period. More specifically, we study the fall of the iron curtain and the transformation of the former socialist countries in Eastern Europe, and the rise of China and its integration into the world economy. These events, which happened quickly and unexpectedly for Germany, led to massive increases in imports from, as well as to surging exports to those markets. The pace was much faster than with respect to any other trading partner in the world (see Figure 1 below), making it the major globalization shock that hit the German economy in those two decades.[1]

International trade theory suggests that such liberalizations reinforce the countries' specialization patterns according to their comparative advantage, and indeed, we find this pattern in the structure of German trade flows: there are rising exports in relatively skill- and technology-intensive manufacturing industries, and rising imports of goods from relatively labour-intensive sectors. Turning to the implications for the domestic labour market, traditional models with homogeneous workers and firms (e.g. Helpman and Krugman; 1985) predict cross-industry worker flows out of the declining import-competing and into the expanding export-oriented industries. Newer approaches along the lines of Melitz (2003) or Bernard et al. (2007) highlight intra-industry reallocations towards more productive firms, and corresponding worker flows within industries, as an additional channel. These baseline models do not feature any wage dispersion or a differential impact of trade across equivalent workers. Those features arise, however, once labour market frictions are introduced, as for example in Egger and Kreickemeier (2009), Helpman et al. (2010), Davis and Harrigan (2011), Felbermayr et al. (2011), or Amiti and Davis (2012) . In particular, recent models fea-

[1] The consequences of the rise of China for US local labour market have been studied in an influential article by Autor et al. (2013). A similar analysis for German regions has been conducted by Dauth et al. (2014). This paper looks at the same globalization shock, but shifts focus and studies the micro-level impacts on the earnings profiles of single workers and their individual labour market responses.

ture assortative matching of heterogeneous firms and workers within industries, see Yeaple (2005), Monte (2011), Helpman et al. (2012), Sampson (2014), or Davidson et al. (2014), or sorting of workers across sectors given their industry-specific productivity realizations (Caliendo et al. (2015), Galle et al. (2015), Fan (2015), Dix-Carneiro (2014)).

A common theme of these recent structural models is that globalization affects different worker-establishment matches differently. Moreover, it induces workers to adjust to the exogenous shocks by moving across industries, local labour markets, or plants. Empirical evidence on these differential effects, and especially about individual mobility responses to trade shocks is rare, however.

With our empirical approach, we trace the impacts of the continuous rise in trade on the earnings profiles of German manufacturing workers. We set up a short-run panel model and investigate how contemporaneous changes in import and export exposure affect their yearly earnings, and we also study the cumulated effects over a longer time horizon in a complementary cross-sectional analysis. Different estimation techniques are considered to address confounding industry-specific shocks, in particular an instrumental variable approach close in spirit to Autor et al. (2013) using third-country trade flows. Moreover, in our short-run model we include interacted individual-level fixed effects to capture unobserved heterogeneity, and to restrain the variation that identifies our central coefficients. We start from an encompassing approach with dummies for every worker, and successively move to more demanding specifications with worker $\times$ region, worker $\times$ (local) industry, or even worker $\times$ plant-fixed effects. When we only exploit the variation *within* worker-establishment spells, we eliminate all earnings effects stemming from sorting based on time-invariant characteristics and come as close as we can to the *direct* effects of trade. A comparison to the results with only individual-fixed effects, which exploits the workers' total earnings variations and thereby captures also indirect compositional effects, then allows us to gauge how important endogenous worker mobility is in the adjustment to trade shocks. Furthermore, by identifying effects within industries or regions, but across plants, we shed light on the relative importance of different types of adjustment.

Our main results can be summarized as follows: First, with respect to the overall impact of trade on earnings, we find that rising import penetration of the respective industry of employment has an adverse effect, while rising export opportunities work in the opposite direction. The latter channel is quantitatively more important on balance, which suggests that rising trade exposure was beneficial for German manufacturing workers at large. There are winners and losers, however, and for workers starting out in import-competing industries we find substantial subsequent earnings losses. This globalization shock has therefore contributed to rising inequality within Germany.

Turning to the individual labour market adjustments, we find much stronger negative earnings effects of import shocks *within* than *across* industry-job spells. Import shocks, thus, seem to generate substantial endogenous mobility ("push effects") out of the exposed sectors, while intra-industry adjustments across regions or plants are of

minor importance. For positive export shocks, on the other hand, we find that most of the benefits accrue within worker-establishment matches, but there is little evidence for additional "pull effects" into export-oriented sectors. This general notion, that individuals respond *asymmetrically* to negative and positive shocks, seems to be well known from other contexts.[2] Yet, we believe that this paper is the first to establish such an empirical finding for the responses to trade shocks in a frictional labour market.

Digging deeper into the induced mobility responses, we then investigate in more detail *who* leaves the import-competing industries, and how the movers perform relative to the stayers in their subsequent careers. It turns out (see Figure 3 below) that the group of movers is negatively selected, and that they experience a sharp earnings decline before the move, supposedly because of their inferior industry-specific unobserved ability. After moving to less import-exposed industries, which are often in the service sector and only to a lesser extend in export-oriented manufacturing, their earnings stabilize and do not decrease further. But the movers are left with a medium-run decline, also relative to the stayers, because they never make up for the initial drop. Overall, these results are suggestive that trade shocks do not trigger much "voluntary" sorting, but the patterns we observe in the data (namely little mobility towards expanding export sectors, and medium-run losses of movers) seem to be better consistent with mobility that is "forced" by job displacement and unemployment.

Finally, turning to the heterogeneity of the effects, we construct various sub-samples and investigate how different types of workers react to trade shocks. Our results show that younger and less-skilled individuals are hit harder by import shocks, but also benefit more from export opportunities. Women and men are affected similarly from import penetration, but men seem to materialize the benefits of rising export exposure better than women. Moreover, based on the decomposition approach by Card et al. (2013), we can distinguish workers and plants according to their preceding unobserved productivity levels, and find that "good" workers are largely insulated from trade shocks. "Bad" workers and employees of "bad" establishments, by contrast, suffer the most from import shocks.

Our study is related to a recent line of research that investigates the causal effects of trade liberalization on the work biographies of domestic workers. In particular, Autor et al. (2014) find strongly negative effects of the rise of China on the cumulative earnings and other labour market outcomes of American manufacturing workers. In this paper, we first follow their approach as a benchmark for the medium-run effects of trade. Comparing our results for Germany with their results for the US, we consistently find that rising import penetration per se adversely affects cumulated individual earnings. Yet, unlike in the US case, this is more than offset by a positive causal effect of rising export opportunities. This overall picture, that this globalization episode was

[2] In the labour economics literature, for example, Hunt (2006) and Mayda (2010) find asymmetric push and pull effects for migrant flows. Taylor (1991) is the seminal reference from the psychology literature which argues that individuals react stronger to negative than to positive shocks.

beneficial to German manufacturing workers overall, is thus consistent with the basic message by Dauth et al. (2014) for aggregate regional labour markets in Germany in comparison with the findings by Autor et al. (2013) for the US.

We then complement this cross-sectional analysis with a short-run estimation approach that fully exploits the panel structure of our data. This allows us to tightly control for unobserved heterogeneity across individuals, and to address the important issue of endogenous worker mobility with our high-dimensional fixed effects models which restrain the identifying variation. The short-run analysis is related to some recent studies that investigate the impact of trade shocks within worker-job spells. Krishna et al. (2014) exploit linked employer-employee data from Brazil and argue that the entire exporter wage premium is due to unobserved differences in workforce compositions, but they find no on-the-job earnings premium for more export exposed workers. Ashournia et al. (2014), on the other hand, find a negative causal effect of Chinese import penetration on wages of Danish workers in a given job. In our study, we investigate import and export shocks separately and find an asymmetry in the individual response to the two types. Moreover, we find causal effects of trade within job spells in addition to endogenous worker mobility that is triggered by trade shocks.

The rest of this paper is organized as follows. Section 2 describes the data and gives a descriptive overview. Section 3 addresses the overall impact of trade shocks in the medium- and short-run, while Section 4 analyzes individual adjustments. Section 5 is devoted to the analysis of heterogeneous effects of trade. Section 6 concludes.

2 Data and descriptive overview

We use the Sample of Integrated Labour Market Biographies (SIAB) from the German Institute for Employment Research (IAB). This data stems from all German social security notifications, and a random two percent sample has been drawn from all persons who have either been employed or officially registered as job-seekers. This results in an individual-level spell data set that is highly accurate even on a daily basis due to its original purpose of calculating retirement pensions. With this data, we can follow single workers over time, and keep track of all on-the-job earnings changes as well as of all employer changes within and across industries, regions, and plants.

As the wage information is subject to right-censoring at the social security contribution ceiling, we apply the imputation procedure by Card et al. (2013). Moreover, we deflate wages with the consumer price index by the German *Bundesbank* and normalize earnings and trade volumes to 2010-Euros.

Construction of the samples. We identify all individuals in either 1990 or 2000, who were between 22 and 54 years old and held their main job in the manufacturing sector. We then construct a balanced 11-year panel for each of these workers that captures their employment biographies and earnings profile. We eliminate those who died or

emigrated to a different country during the 10-year period. For all other cases, where workers drop out of the data or have holes in their job biographies, this constitutes long-term unemployed, early retirement, or labour market exit. As these are all endogenous labour market outcomes, we keep those person-year spells in the data as observations with zero labour earnings and employment.

For the short-run analysis, we add up daily earnings during the respective year and construct as our main variable of interest the annual earnings of an individual relative to his or her earnings in the base year (1990 or 2000).[3] Table 1 below reports some descriptive statistics. As can be seen there, over the whole observation period from 1990 to 2010, the median worker exactly retained annual earnings equal to his or her base year earnings, while the average German manufacturing worker actually experienced a decline in real earnings to about 98.9% of the base year level. This real earnings decline was stronger in the second decade of our observation period. Moreover, Table 1 shows a marked increase in inequality, since the worker at the first quartile saw a decline of annual earnings to only 64% of the initial level, while the worker at the third quartile experienced a real earnings increase to about 108%. Our study investigates if globalization had its role in explaining those divergent trends.

In the medium-run analysis, we closely follow the approach by Autor et al. (2014) and transform our panel to two staggered cross-sections for the years 1990 and 2000. All covariates stem from these base years and the dependent variables are the cumulative earnings over the following ten years relative to the earnings in the base year. Some descriptives for this sample are reported in Appendix Table A.1, which shows comparable trends in real earnings inequality for the two decades.

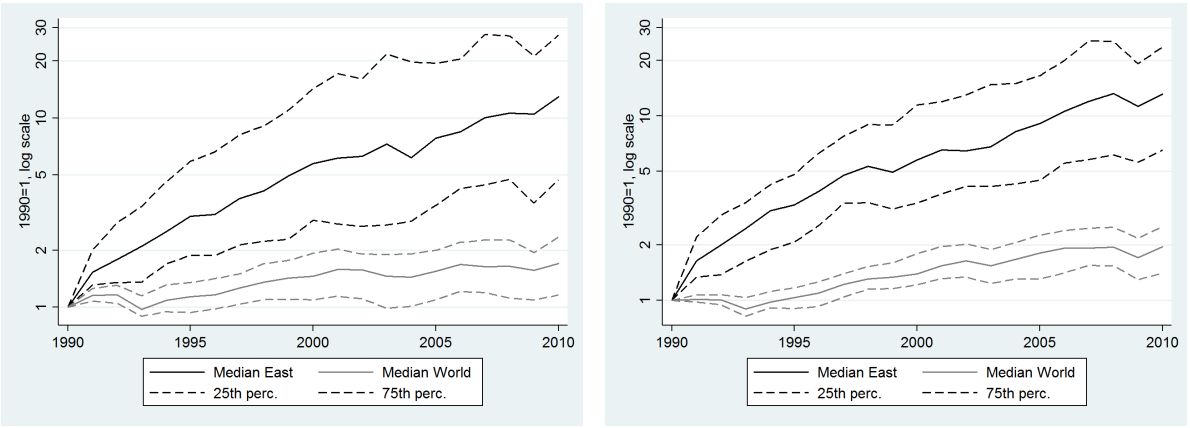
Trade data. Information on international manufacturing trade comes from the United Nations Commodity Trade Statistics Database (Comtrade). This data contains annual international trade statistics of over 170 reporter countries detailed by commodities and partner countries. Trade flows are converted into Euros of 2010 using exchange rates supplied by the German *Bundesbank*. We merge these two data sources by harmonizing industry and product classifications. A correspondence between 1031 SITC rev. 2/3 product codes and the employment data at the 3-digit industry level (equivalent to NACE) is provided by the UN Statistics Division. Ambivalent cases were partitioned into industries according to national employment shares in 1978. This yields information on international trade for 93 3-digit industries.

Our main exposure measures for import penetration and export opportunities in industry j are constructed as follows:

$$ImE_{jt}^{EAST\to D} = 100 \times \frac{IM_{jt}^{EAST\to D}}{IM_{jt}^{World\to D}} \qquad \text{and} \qquad ExE_{jt}^{EAST\to D} = 100 \times \frac{EX_{jt}^{D\to EAST}}{EX_{jt}^{D\to World}}, \quad (1)$$

[3]Notice that this normalized earnings approach is robust to observations with zero earnings in a year, which would not be the case if we had used (non-normalized) log annual earnings as the outcome variable. Moreover, with the normalization we can already partly take into account ex-ante earnings differences across individuals that could, for example, stem from unobserved ability.

where $ImE_{jt}^{EAST \to D}$ and $ExE_{jt}^{EAST \to D}$ are trade volumes in 1000 Euros. Here, the East is composed of China and 21 Eastern European countries that were transformed into market economies in the early 1990s.[4] We normalize those trade volumes by total German trade with the rest of the world in the respective industry, which accounts for the relative increase of the East as a trading partner for Germany.



(a) Imports (b) Exports

Figure 1: Rising German trade volumes

Figure 1 illustrates this rising importance. There we display the evolution of the median and the upper and lower quartiles of German industry-level trade, both with respect to the East and the world as a whole (the numerator and the denominator of eq.(1)). As can be seen, both the increase and the variation are much larger for the former, whereas the latter rise more evenly. In other words, it seems to be the sudden and unexpected rise of China and Eastern Europe which constituted the major globalization shock that hit the German labour market during the time period from 1990–2010, and our measures for import and export exposure reflect this major impact. This involves rising import penetration, which consist by and large of labour-abundant countries with substantially lower wages than in Germany, but also the surging German exports to that area which became vastly more important as an export destination.[5]

We have also experimented with alternative trade exposure measures. In particular, instead of (1), we have normalized industry-level trade volumes vis-a-vis the East with a measure for sector j's overall size in the German economy, more specifically the total domestic wage bill $w_j \times L_j$.[6] It turns out, however, that the correlation with total German imports and exports in j is substantial ($\rho = 0.67$ and 0.83, respectively). This alternative normalization, thus, exploits a similar variation as our benchmark ap-

[4]These are Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, and the former USSR or its succession states Russian Federation, Belarus, Estonia, Latvia, Lithuania, Moldova, Ukraine, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.

[5]In Appendix Table A.2 we report the industries with the strongest increases of the ImE_j and ExE_j.

[6]This approach follows Autor et al. (2014), who normalize trade flows with total domestic consumption. Directly replicating their normalization is not feasible in our context, because the required data for Germany are only available from surveys of larger firms and at a different level of aggregation.

proach and leads to very similar estimation results to those reported below.

Table 1 reports descriptive statistics for the individual trade exposure variables (1), which are by construction identical for all workers in the same industry j and in the same year t. Since our main specification uses time-variation to identify our coefficients, we there report the trade exposures in first differences. Over the whole observation period, the median worker experienced an annual increase of Eastern relative to total exports by 0.63%, while the median annual rise in import exposure was 0.58%. The rise in import exposure was a bit faster during the first decade, while exports kicked in a bit later and their increase then outpaced imports during the time window 2000-2010. The comparable figures for the medium-run approach are shown in Appendix Table A.1 and reveal a similar pattern.

Table 1: Descriptive Statistics - Panel Approach

	mean	sd	1st quartile	median	3rd quartile
1990-2010					
100 × rel. Earnings	98.91	420.00	64.00	100.00	108.86
avg. prev. Earnings / yr	44537	46429	26695	35220	45221
Δ ImE	0.66	4.71	0.00	0.58	1.70
Δ ExE	0.49	3.31	0.00	0.63	1.52
Δ ImE_{+down}	0.87	4.98	0.10	0.82	1.98
Δ ExE_{+down}	0.66	3.49	0.00	0.85	1.84
1990-2000					
100 × rel. Earnings	100.43	483.77	51.79	100.00	109.60
avg. prev. Earnings / yr	45552	49477	27074	34987	44601
Δ ImE	0.95	3.29	0.00	0.71	1.69
Δ ExE	0.57	2.83	0.00	0.58	1.51
Δ ImE_{+down}	1.20	3.46	0.28	1.02	1.98
Δ ExE_{+down}	0.73	2.96	0.00	0.73	1.84
2000-2010					
100 × rel. Earnings	97.37	343.85	73.74	100.00	108.10
avg. prev. Earnings / yr	43522	43145	26209	35481	45862
Δ ImE	0.37	5.77	-0.02	0.41	1.77
Δ ExE	0.42	3.72	0.00	0.68	1.56
Δ ImE_{+down}	0.68	6.02	0.01	0.73	2.18
Δ ExE_{+down}	0.61	3.87	0.01	0.92	1.82

Table 1 also illustrates the strong heterogeneity in individual trade exposure, which is driven by the industry affiliation of the respective workers. In fact, some industries did not exhibit a notable increase in relative trade with the East, while that trend was very strong for others (e.g., in the games and toys or the office machinery industry). Hence, we may expect that the careers of individual workers were affected unevenly, depending on initial and contemporaneous industry affiliations.

3 The overall impacts of import and export shocks

We consider two empirical approaches to investigate the impact of the rise of the East on individual earnings of manufacturing workers in Germany. We first analyze the cumulative effect of trade over a ten year time horizon. This analysis closely follows Autor et al. (2014) and allows us to compare their results for the United States with our findings for Germany. Afterwards we turn to our novel panel analysis and study the short-run impacts of trade on annual individual earnings.

3.1 Medium-run analysis

For the medium-run analysis, we split the overall observation period into two ten-year time intervals (1990-2000 and 2000-2010). We observe all workers i active in a manufacturing industry j in the respective starting year (1990 or 2000), and then add up their cumulated earnings over the subsequent decade, irrespective of where (in which firm, industry or region) these earnings accrue. Using these two staggered cross-sections, we then regress the cumulated individual earnings Y_{ij} (normalized by the base-year value) on the corresponding increases in import and export exposure of the worker's original 3-digit industry during the respective time period:

$$Y_{ij} = \boldsymbol{\alpha} \cdot \mathbf{x}'_{ij} + \beta_1 \cdot \Delta ImE_j^{EAST \to D} + \beta_2 \cdot \Delta ExE_j^{D \to EAST} + \phi_{REG(i)} + \phi_{J(j)} + \phi_{1990-2000} + \epsilon_{ij}$$

In the vector $\mathbf{x}_{ij}$ we include standard worker-level controls. Moreover, we add Federal State and broad manufacturing industry-group fixed effects (10 categories), as well as a time period dummy to differentiate the two cross-sections.

The two main coefficients of interest, β_1 and β_2, only capture the causal effects of rising trade exposure if there are no parallel confounding unobservable shocks that simultaneously affect trade and labour market outcomes over the respective decade. To address this concern, we instrument the exposure variables with trade flows of other countries vis-a-vis the East.[7] The results are reported in Table 2.

Results. In column 1 in the upper panel, we first estimate the model with simple ordinary least squares (OLS), while columns 2 and 3 refer to the first stage results when German trade exposure is regressed on the trade flows of the instrument countries. As can be seen, the instrument appears to be strong and all coefficients have the expected sign. In particular, both import and export exposure are predominantly predicted by their respective instrument counterparts. Our main result is then in column 4, which refers to the second-stage results of the instrumental variable estimation.

[7]This instrumental variable approach has been developed by Autor et al. (2013) and applied to the German case by Dauth et al. (2014). We follow their approach, and use the trade flows of Australia, New Zealand, Japan, Singapore, Canada, Sweden, Norway, and the UK to construct the instrument by replacing the numerators of ImE_{jt} and ExE_{jt}, respectively. The rationale is that demand shocks in those "instrument countries" are largely uncorrelated with German ones, and have little direct effects on German workers. On the other hand, those countries are similarly affected by the rise of the East.

Table 2: Medium-run analysis

	Dependent variable: 100 x cumulated earnings relative to earnings in base year			
	OLS	1st Stage ImE	1st Stage ExE	2SLS
import exposure (Δ ImE)	-0.5362**	0.6359***	0.0165	-1.8111***
	(0.255)	(0.036)	(0.019)	(0.463)
export exposure (Δ ExE)	1.2993***	0.1155*	0.7585***	2.1998***
	(0.408)	(0.069)	(0.058)	(0.728)
Individual base year earnings	YES	YES	YES	YES
Worker-level controls	YES	YES	YES	YES
Industry-group dummies	YES	YES	YES	YES
Region and decade dummies	YES	YES	YES	YES
R^2	0.131	0.483	0.311	0.130
1st Stage F		162.672	86.435	
	2SLS	OLS	Gravity	Placebo
import exposure (Δ ImE_{+Down})	-1.8509***			-0.3957
	(0.471)			(0.288)
export exposure (Δ ExE_{+Down})	2.0661***			1.4777**
	(0.661)			(0.584)
net trade exposure		0.2630*	0.0438***	
		(0.152)	(0.010)	
Individual base year earnings	YES	YES	YES	YES
Worker-level controls	YES	YES	YES	YES
Industry-group dummies	YES	YES	YES	YES
Region and decade dummies	YES	YES	YES	YES
R^2	0.130	0.131	0.131	0.155

Notes: 216,838 observations. Further controls include indicators for gender, foreign nationality, 3 skill categories, 3 tenure categories, 7 age groups, 5 plant size groups, 10 manuf. industry groups, and federal states. Standard errors, clustered by industry x base year in parentheses

We find that an increase of import exposure by one percentage point reduces normalized cumulative earnings over ten years by about 1.8 percentage points, while rising exports lead to an increase by about 2.2 percentage points.[8] Benchmarking those effects with the observed median increases in individual trade exposure as reported in Appendix Table A.1, this implies that import penetration has caused a cumulated earnings loss of $-1.8 \times 9.9 = -17.82$ percentage points for the median worker. The effect of rising export exposure is $2.2 \times 8.8 = +19.36$. We therefore conclude that the rise of the East has led to an overall earnings gain for the median German manufacturing worker. This result is qualitatively different from the key message of Autor et al. (2014), who find considerable earnings losses in the US manufacturing sector. It is consistent with the aggregate analysis by Dauth et al. (2014) for German local labour markets,

[8]The coefficients for the other control variables all have the expected signs and are precisely estimated. They are available upon request from the authors.

however, who argue that Germany seems to be positively affected on balance by this globalization episode, due to its better export performance in the East.

Robustness checks. The bottom panel of Table 2 considers several robustness checks. First, while our baseline measures only consider the rising trade exposure of the respective industry j itself, we augment them by the weighted trade exposure in downstream industries in column 5. To construct weights, we follow Acemoglu et al. (2015) and use German input-output tables from the Federal Statistical Office to calculate the importance of each industry as a buyer of industry j's products. The intuition is that globalization shocks may also be transmitted along the whole value chain. For example, the steel industry is not only directly affected by import shocks, but also indirectly as downstream industries such as machinery suffer themselves from import penetration and consequently demand less raw steel. Similarly, the car parts industry not only benefits directly from more export opportunities, but also via its most important downstream customer, the automotive industry. When using those comprehensive measures, we estimate roughly similar coefficients as in column 4. This suggests that our approach is robust to taking input-output linkages into account.[9]

Next, we consider an alternative estimation strategy and measure the trade exposure of industry j by residuals from a preceding estimation of a gravity equation. Those gravity residuals structurally capture the increase in competitiveness of the East relative to Germany, and its rising attractiveness as an export market relative to other destinations. Thereby we neutralize possible confounding demand and supply shocks that could jeopardize identification, without having to rely on an instrumental variable. Conceptually, this gravity approach relates to the *net* export exposure of an industry, as the residuals include relative changes of the East's market size, productivity, and accessibility (see Autor et al. (2014) for more details). To reflect this, we first report in column 6 a simple OLS estimation where we consolidate the previous import and export exposures into a single measure. Consistent with column 1, we find a positive impact of this composite net export exposure on cumulated earnings. In column 7, we then implement the gravity approach, and find that employees of industries with a higher gravity residual experience significant earnings gains over the subsequent decade.[10] In other words, if the rise of the East mostly implies a gain in demand and market access for a particular German industry j, this will benefit the workers originally affiliated with that industry in the medium run. The effect on cumulated earnings is negative, however, for German workers of industries where rising Eastern competitiveness mostly leads to displacement effects and decreasing market shares.

Finally, we are concerned with the possibility that our results may pick up pretrends rather than causal effects of trade shocks. In particular, some industries may

[9] See Appendix A for details on these comprehensive measures.

[10] The estimated coefficient in column 7 is substantially smaller than in column 6, but this is due to the different unit of measurement of the gravity residuals.

have been on a long-term declining (growing) trend well before the 1990s. When China and Eastern Europe entered the stage, this may not have causally affected earnings profiles, but the rising imports (exports) to those areas could also be symptoms of the previous industry-specific trajectories. To explore this possibility, we run a placebo estimation where we regress cumulated earnings of manufacturing workers between 2000 and 2010 on the rise in trade exposure lagged by twenty years (1980-1990). As can be seen in column 8, for imports we estimate an effect close to zero. For exports we cannot entirely rule out pre-trends, but we obtain a coefficient that is substantially smaller and much less precisely estimated than in column 4.

3.2 Short-run panel approach

The medium-run analysis has allowed us to quantify the *overall* impact of the rise of the East on the cumulated earnings of German manufacturing workers over a full decade. Given that the fall of the iron curtain in the early 1990s and the rise of China after its WTO accession in 2001 occurred quickly and unexpectedly, we may think of the workers' original industry affiliations in the two starting years as being orthogonal to these two major globalization shocks. The effects identified in the previous subsection then encompass first-round impacts of those shocks on individual wages and employment, but also possible second-round adjustments or induced general equilibrium repercussions and how they affect individual earnings over a longer time horizon. In this section, we develop a complementary analysis that aims to sort out the short-run effects of trade. Specifically, in contrast to Autor et al. (2014) and Dauth et al. (2014) we now exploit the full panel structure of the data and follow single workers on an annual basis, investigating how contemporaneous changes in trade exposure affect yearly earnings.

For our short-run analysis, we again split the observation period into two time intervals (1990-2000 and 2000-2010) and observe all workers active in a manufacturing industry in the respective starting year (1990 or 2000). We then follow those workers on an annual basis over the next ten years by running a panel estimation of this form:

$$Y_{ipjrt} = \mathbf{x}'_{it}\boldsymbol{\alpha} + \beta_1 \cdot ImE_{jt}^{EAST \to D} + \beta_2 \cdot ExE_{jt}^{D \to EAST} + \phi_{t,J(j)} + \phi_{t,REG(r)} + \gamma_i + \epsilon_{ipjrt}$$

Here, Y_{ipjrt} are annual earnings of individual i, working in establishment p, 3-digit industry j, and local labour market r in year t. For ease of interpretation, we again normalize annual earnings by the worker's earnings in the respective starting year. The industry-level trade exposures now refer to the contemporaneous industry affiliation of worker i in year t.[11] They are included in levels, so that the coefficients β_1 and β_2 indicate how short-run *changes* in $ImE_{jt}^{EAST \to D}$ and $ExE_{jt}^{D \to EAST}$ from one year to the next affect annual individual earnings of worker i. As before, we instrument these

[11] In case of industry switches, we use the industry j where worker i had the longest employment spell in days during the respective year t. Moreover, during unemployment spells we use the exposure of the worker's last industry j thus supposing some short-term industry attachment.

variables with third country trade flows in the respective year t to address confounding demand shocks. Moreover, to control for broad sectoral and regional trends, we include 1-digit industry $\times$ year and Federal State $\times$ year fixed effects.

The most important difference to the medium-run analysis is that we control for various unobservable characteristics with individual-level fixed effects. In our baseline specification of the short-run model, we introduce a dummy γ_i for every individual worker.[12] That approach, thus, exploits the overall variation of annual individual earnings relative to the respective person-mean in the respective decade. In the next section, we then replace γ_i with higher-order interacted fixed effects and only use the variation of individual earnings within particular industries, locations, or plants.

Table 3: Baseline short-run results

	Main Dependent variable: 100 x annual earnings normalized by earnings in base year			
	(1) OLS	(2) 1st-Stage ImE	(3) 1st-Stage ExE	(4) 2SLS
import exposure (ImE_{jt})	-0.1562**			-0.3226***
	(0.0606)			(0.0936)
export exposure (ExE_{jt})	0.1915***			0.3921***
	(0.0549)			(0.1039)
$\text{ImE}_{inst.}$		0.7980***	0.0827***	
		(0.0197)	(0.0103)	
$\text{ExE}_{inst.}$		0.0872***	0.7938***	
		(0.0338)	(0.0298)	
worker-fixed effect γ_i	YES	–	–	YES
R^2	0.747	0.938	0.927	0.747
1st Stage F		818.299	367.558	
Weak ID sta.			369.397	

Notes: 2,378,332 observations of 216,212 workers. Standard errors, clustered by industry x year in parentheses.

The estimation results for our baseline short-run approach are summarized in Table 3. In column 1 we report OLS results, while columns 2 and 3 show the relevance of our instrument in this context. Our main result is again in column 4, which refers to the second-stage results of the instrumental variable estimation.[13]

We find that an increase of export exposure by 1,000 Euro raises normalized annual earnings by 0.39 percentage points, while a corresponding increase in import exposure lowers earning by about 0.32 percentage points. Qualitatively, those findings are consistent with the medium-run results from Table 2. In particular, the marginal effect of rising export seems to outweigh the negative marginal effect of rising import exposure.

[12] In the vector x_{it} we then have the squared and cubic term of the worker's age, since all other standard characteristics (such as gender, skill, etc.) are absorbed by the various fixed effects and trends.

[13] We have also conducted all robustness checks that were presented in the bottom panel of Table 2 above, but for brevity we focus here on the IV results.

Quantitative bechmarking and comparison to medium-run approach. To translate this into economically meaningful magnitudes, we multiply the coefficients from column 4 of Table 3 with the observed median yearly increases in individual trade exposure as reported in Table 1. This calculation yields an annual effect for the median worker equivalent to $0.58 \times -0.32 = -0.19$ percentage points of normalized annual earnings due to rising import penetration, and $0.63 \times 0.39 = 0.25$ percentage points because of rising export opportunities. Cumulated over ten years, this means that a hypothetical worker who received the median import and export shock in every year, would experience an earnings reduction by $-0.19\,(1 + 2 + ... + 10) \approx -10.45$ percentage points due to imports, while exports raise total earnings by 13.75 percentage points.

Since no worker exhibits such an exposure profile in the data, we can also adopt a more realistic approach to estimate how trade has affected earnings in German manufacturing. Specifically, we first compute the overall trade exposure for every worker i by keeping track of his or her industry affiliations over time, and by multiplying the coefficients from column 4 of Table 3 with the respective values of ImE_{jt} and ExE_{jt} in every year. Taking the median of the resulting distribution, we find that rising import penetration has led to an earnings decline of -11.25 percentage points over ten years, while rising export opportunities have raised earnings by 17.14 percentage points.

Those numbers suggest somewhat more pronounced trade effects than the naive benchmarking exercise, because most industries and workers experienced more severe trade schocks early in the respective periods, which had longer lasting effects. They are slightly smaller, however, than the corresponding values from the medium-run analysis (-17.82 and $+19.36$, respectively), where it should be kept in mind that this approach exploited different types of variation. Overall, we conclude that the medium- and the short-run analysis yield consistent quantitative predictions, which provide a corridor how the rise of the East has affected individual earnings profiles in the German manufacturing sector.

4 Individual adjustments to trade shocks

Trade shocks can trigger endogenous worker mobility. One possible adjustment behaviour for workers – emphasized already in traditional neoclassical models of international trade – is to systematically move out of highly import-exposed and into export-oriented industries. New trade theory also highlights other patterns, such as intra-industry reallocations of workers towards more productive plants that expand after trade liberalization (Melitz (2003), Bernard et al. (2007)), or towards regions with a favourable industry mix (Galle et al. (2015), Caliendo et al. (2015)).

When it comes to individual mobility responses, the labour economics literature has broadly distinguished "pull effects" and "push effects". In the former case, workers sort into expanding segments in order to benefit from the rising opportunities there, while in the latter case mobility of the respective individual is induced by the inferior

conditions in the current job, displacement risk, unemployment, and so on. In this section we address the relative importance of different possible mobility responses across industries, regions, and firms, and their effects on the workers' careers. Given that we observe a mobility response, our administrative data do – of course – not allow us to uncover the precise individual motives behind this particular job switch. Yet, by following movers and stayers over time, we also shed some light on whether mobility patterns are shaped more by "push" or by "pull effects".

4.1 High-dimensional fixed effects models

The baseline specification of the short-run model from the previous sections includes all sorts of individual mobility responses, since the coefficients in column 4 of Table 3 are identified from any variation of worker i's earnings and trade exposure over time. This variation may come from several sources, however. The worker can experience an increase in import or export exposure in his or her original job or industry, but in the wake of the trade shocks the person may also change exposure by moving to another industry or region with a potentially different match-specific productivity. The baseline model with fixed effect γ_i yields an estimate for the short-run causal impacts of trade *including* the indirect compositional effects from this individual sorting.

In this subsection, we augment the previous short-run panel model and replace the worker-fixed effect γ_i with different high-dimensional interacted fixed effects $\gamma_{i,u}$. More specifically, we estimate a set of models of the following form:

$$Y_{ipjrt} = \mathbf{x}'_{it}\boldsymbol{\alpha} + \beta_1 \cdot ImE_{jt}^{EAST \to D} + \beta_2 \cdot ExE_{jt}^{D \to EAST} + \phi_{t,J(j)} + \phi_{t,REG(r)} + \gamma_{i,u} + \epsilon_{ipjrt},$$

where $u = \{p, jr, j, r\}$. That is, we consider interacted worker $\times$ plant, worker $\times$ local industry, worker $\times$ industry, or worker $\times$ location fixed effects.[14] Table 4 presents the estimation results. Column 5 repeats our baseline approach with worker-fixed effects, while we limit the exploited variation in the data as we move from right to left.[15]

The most demanding specification is in column 1, where we introduce worker $\times$ plant-fixed effects $\gamma_{i,p}$. In this scenario, the coefficients β_1 and β_2 are tightly identified only from the variation within worker-establishment matches. To understand its meaning, consider the following thought experiment of an exemplary job biography: Suppose a person works in plant 1 for three years, then switches to plant 2 (which operates in a different industry and thus exhibits different trade exposures) during the fourth year, and then works for six years until the end of the decade in that plant. The coefficient in column 1 picks up the earnings profile during the first three and the last six years, but not the (upward or downward) change in earnings when the worker

[14] Our notation is directly borrowed from Foged and Peri (2015), who have recently employed a similar estimation strategy to characterize the dynamics of natives' labour market outcomes after a labour supply shocks caused by the arrival of immigrants in Denmark.

[15] Notice that the Kleinbergen Papp-statistics indicate no weak instrument problem in any of the different specifications, and furthermore all coefficients are precisely estimated.

Table 4: High-dimensional fixed effect models

2SLS	Dependent variable: 100 x annual earnings normalized by base year earnings				
	(1)	(2)	(3)	(4)	(5)
ImE	-0.6525***	-0.7188***	-0.7275***	-0.3164***	-0.3226***
	(0.1046)	(0.1097)	(0.1094)	(0.0934)	(0.0936)
ExE	0.2743**	0.3716***	0.3833***	0.2367**	0.3921***
	(0.1366)	(0.1436)	(0.1459)	(0.1012)	(0.1039)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	315721	299150	289894	258200	216212
R^2	0.873	0.872	0.868	0.846	0.747
KP	116.227	114.620	114.340	275.364	369.397

Notes: 2,378,332 observations of 216,212 workers. Further controls include three age polynomials, 1-digit industry x year and federal state x year interactions. Standard errors, clustered by industry $\times$ year in parentheses.

switches plants; this is in contrast to the γ_i-model in column 5 which captures the worker's entire earnings profile. The $\gamma_{i,p}$-model in column 1 therefore purges indirect sorting effects and yields the *direct* effect of trade shocks on short-run individual earnings if match-specific productivity levels for worker i and plant p are time-invariant. As discussed at length in Krishna et al. (2014), this assumption is satisfied in recent theoretical models of international trade such as Helpman et al. (2010) where workers draw match-specific ability levels for particular firms. It may not be satisfied in general, for example, if worker i's productivity in plant p is itself a time-varying function of the establishment's trade exposure.[16] However, the $\gamma_{i,p}$-model is much closer to the direct wage effect of trade, and a comparison to the γ_i-model from column 5 yields insights about the quantitative importance of endogenous worker mobility.

The models in columns 2–4 range in between the two extremes. Here we only exploit the variation within locations, industries, or local industries and thereby purge the coefficients of particular types of adjustments, while still allowing others to influence our estimates. For example, the $\gamma_{i,jr}$- and $\gamma_{i,j}$-models in column 2 and 3 capture worker sorting across plants within particular local industries in response to trade shocks, or respectively within industries in general. The comparison of the different coefficients then allows us to address which adjustment channels are relatively more important for workers to respond to import- and export-shocks.

We now discuss our estimation results for the different models in Table 4, and we start with the negative trade shocks from rising import penetration. Afterwards, we discuss the effects of positive export shocks.

Imports. Column 1 shows that an increase of import competition by one percentage point leads to a reduction of normalized earnings by -0.653 percentage points within

[16] Also see the more general discussion in Abowd et al. (2015) from the labour economics literature about wage determination with endogenous worker mobility.

worker-plant matches. This effect is about twice as large as the coefficient of -0.323 in column 5, which is identified from the within-variation of particular workers across all their different job spells, i.e., with all mobility adjustments taken into account. This means that import shocks have indeed triggered substantial endogenous mobility, and that workers were able to mitigate the partial impact of import shocks on earnings by about 50% with that mobility. As will become clearer in the next subsection, however, that does *not* mean that movers were able to cushion the total impact of import shocks, or that movers outperformed stayers in their subsequent earnings profiles.

Which type of mobility change the effects of import shocks? Columns 2 and 3 show the impact on annual earnings within (local) industries. The two coefficients are almost identical, and more than twice as large in absolute terms as the baseline coefficient from column 5. This shows that workers respond to negative import shocks – which are by construction industry-specific in our empirical approach – mostly by moving to other, less import-exposed industries. It does not seem to be important whether this adjustment takes place locally within the same region, or in a different region. In other words, industry mobility seems to be the key adjustment channel, whereas regional mobility per se (within the same industry) is not. This conclusion is also supported in column 4, where we identify the effects within regions but across industries. This model yields basically the same coefficient as the full adjustment-model in column 5, which suggests that mobility across regions plays a minor role in the response to import shocks.

Finally, notice that the within-industry coefficients from columns 2 and 3 are slightly (but not significantly) larger in absolute terms than the within-plant effect from column 1. This pattern is consistent with a moderate negative selection of within-industry plant switchers in response to an import shock. Faced with stiffer import penetration, firms might try to retain their best workers with the highest match-specific productivity, while relatively less productive matches are laid off. Those workers with low match-specific but high industry-specific productivity might stay within the same sector, but when switching plants they are likely to suffer an earnings loss which is picked up by the $\gamma_{i,j}$ and the $\gamma_{i,jr}$-models but not by the $\gamma_{i,p}$-models.

Exports. Turning to the effects of rising export opportunities, we observe some differences across specifications in Table 4, but overall these differences are much smaller and statistically not significant. In other words, most of the positive effects of export shocks accrue *within* worker-establishment matches for incumbent workers who are initially affiliated with the right industries. This is in line with the existence of a causal exporter wage premium in Germany (Baumgarten (2013), Schank et al. (2007)). However, there is only weak evidence that export shocks induce additional mobility, i.e., that workers sort into those industries.

At face value, the coefficients in column 1 and 5 imply that the impact of export exposure within establishments accounts for $100 \times \frac{0.274}{0.392} \approx 70\%$ of the total effect in the last column. The remaining 30% then come from within-industry sorting across

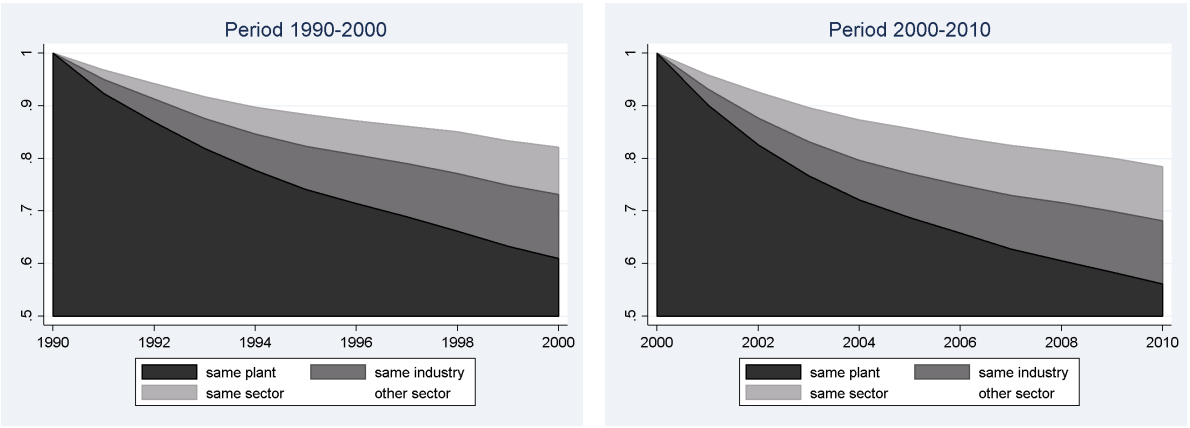
plants. This follows from the coefficients in columns 2 and 3, which add the variation of plant switchers but industry stayers to the identification. Workers thus seem to respond to rising export opportunities, in particular by moving towards plants with a higher (match-specific) productivity within the same industry. This is consistent with trade models along the lines of Melitz (2003), which take the assignment of heterogeneous workers and firms into account (e.g. Helpman et al. (2010)). It is also consistent with the findings by Davidson et al. (2014) that trade improves firm-worker matching, and with the findings by Krishna et al. (2014) that it leads to endogenous worker mobility. In contrast to the latter paper, however, we still find substantial *direct* effects of trade shocks in our data. Rising export opportunities seem to raise worker earnings on the job, and this in fact accounts for the majority (70 %) of the overall effect. The indirect positive effects of better matching and sorting then come on top of that and are responsible for 30 % of the total effect.

The asymmetric response to import and export shocks. Taken together, we find a notable asymmetry in the individual response to trade shocks. The total marginal effects of rising import and export exposure across job spells is roughly similar, as can be seen in column 5 of Table 4. However, while import shocks trigger substantial worker mobility out of the exposed industries, we find much weaker evidence that export shocks also induce such adjustments in the opposite direction.

One potential problem with this conclusion is that our sample only consists of workers who started out in manufacturing. While we follow those individuals if they leave for a job in the service sector, we do – by construction – not take into account initial service employees who later sorted into an export-oriented manufacturing job. To investigate this possible bias, we change our sample in the Appendix and also include service workers who moved into manufacturing at some point during the respective decade. While still in the service sector, we either assign them with zero trade exposure (see Table A.4), or as an additional robustness check we define trade exposure more comprehensively to include also downstream linkages (see Tables A.3 and A.5) which then leads to positive import and export exposures also for service industries. In both cases, we find that the effect of rising export exposure on annual earnings is roughly the same, regardless of whether we identify coefficients within ($\gamma_{i,j}$) or across industries (γ_i). For rising import exposure, however, the negative impact is much larger in the $\gamma_{i,j}$- than in the γ_i-model, thus pointing at substantial induced mobility.

Summing up, our novel findings suggest that rising import competition triggers substantial "push effects" out of the exposed industries. However, the corresponding "pull" effects of rising export opportunities appear much weaker in comparison. Other types of induced mobility, such as intra-industry adjustments across regions or plants, appear to play a weaker role in the response to trade shocks. To further investigate this latter conclusion, we graphically illustrate the mobility patterns of the workers in our samples in Figure 2. The dark areas show that, over both decades, around 60%

of the workers have not switched their employer, i.e., they work for the same plant at the beginning and the end of the decade (or became unemployed and never took up another job). Roughly 40% of the individuals had *some* job switch, and the figure decomposes different types of mobility. As can be seen, less than 10% of the workers switched jobs within their original manufacturing industry (see the grey area), which includes intra-industry plant switches in the same and in different regions. More than 30% changed the industry when switching their employer, however, which can mean taking up a job in another manufacturing industry (light grey area) or moving to the service industry (white area). That is, conditional on switching, more than 75% of this mobility occurs *across*, and less than 25% is *within* the same manufacturing industry.



(a) 1990-2000 (b) 2000-2010

Figure 2: Different types of labour mobility

Figure 2 is, of course, only descriptive and we do not claim that the mobility patterns shown there are caused by trade shocks. However, the stylized fact that most job switches also involve an industry switch is consistent with the causal evidence from Table 4 that we have discussed in this subsection. Finally, as a further consistency check, we also conduct some simple aggregate regressions across our 93 industries. Specifically, when regressing employment changes over ten years on our measures of import and export exposure, we find that a 1%-point increase of the former decreases industry employment by 352.4^{**} full-time jobs (std. error 145.0), but we find no significant effect of the latter (521.4, with std. error 393.6).

This suggests that more import-competing sectors shrink in terms of overall employment, but more export-oriented sectors do not robustly grow faster, which is in line with our conclusion that only negative trade shocks induce mobility responses. The large white areas in Figure 2 then suggest that employees who leave the import-competing manufacturing industries often move towards the service sector, while mobility towards export-oriented manufacturing seems to happen only to a lesser extent.

4.2 Push effects of import shocks

We have found that rising import exposure pushes workers out of the exposed industries. Moreover, columns 3 and 5 of Table 4 show that workers can mitigate the marginal effect of import shocks on their earnings with this industry mobility. In other words, by moving to less import-exposed sectors (either in manufacturing or in services), workers can achieve that their earnings are subsequently less affected by import shocks. This immediately raises two questions that we try to answer in this subsection: a) who moves out of the import-competing industries, i.e., how do movers compare to stayers ex ante?, and b) how do movers subsequently perform relative to the stayers, i.e., can they absorb the negative import shocks with their mobility ex post?

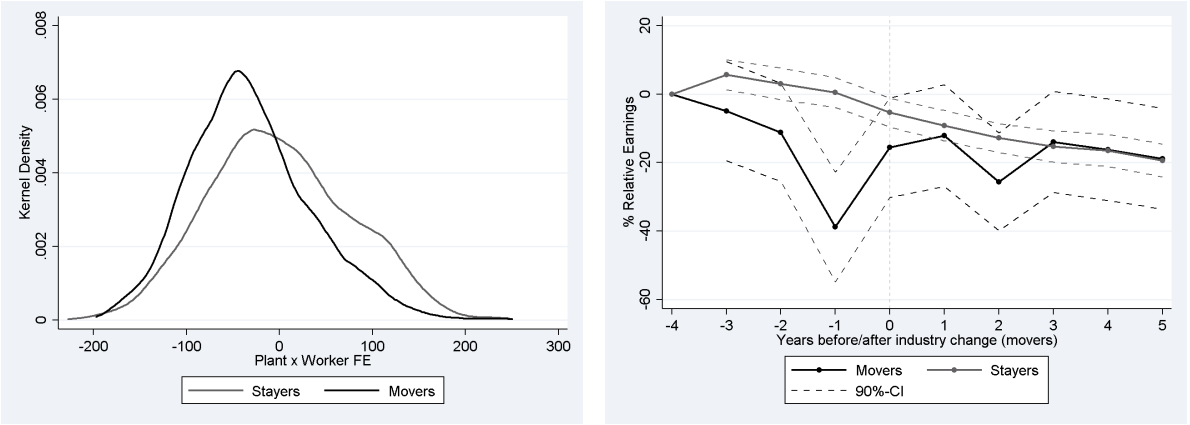
The left panel of Figure 3 addresses the first question. There we focus only on workers from the upper quartile of net import exposure, and distinguish those who stayed within their original industry and those who eventually switched at some point during the respective decade. We then plot the distribution of their unobserved match-specific ability levels, namely the estimated coefficients of the dummies $\gamma_{i,p}$ from the original job, separately for the movers and the stayers.[17] As can be seen, the $\gamma_{i,p}$-distribution for the stayers first-order stochastically dominates the one for the movers, i.e., the industry stayers tend to have higher match- and also industry-specific ability levels than the movers. Put differently, the movers tend to be *negatively* selected among all workers starting out in highly import-exposed industries. This is a first indication that the mobility induced by import shocks does not fit the image of voluntary (re-)sorting across industries in the wake of rising trade exposure, because we would then probably expect that movers were positively selected and escape the exposed industries first. The evidence rather suggests that the mobility is "forced", in the sense that firms in the declining industries try to retain their relatively most able workers and push out the less able ones.

The right panel of Figure 3 turns to the second question and compares the highly import-exposed movers and stayers from a different perspective. There we follow an event study design, and define the industry switch as the respective "event" in the employment biography, which occurs at time 0 for every mover. We then estimate dummies for every year before and after the event, in order to trace the representative profile for earnings normalized by the individual's base year value.[18]

Figure 3 shows that, both, movers and stayers experience earnings declines prior to time 0, which reflects their affiliation in highly import-exposed sectors. The decline in the pre-event period is much sharper for the later movers, however, which is consistent with our previous finding that movers tend to be negatively selected. When the

[17] This figure looks similar for the distributions of the industry-specific fixed effects $\gamma_{i,j}$, but we prefer the $\gamma_{i,p}$ fixed effects in order to capture also within-industry sorting of workers towards the plant where they exhibit the highest match-specific productivity.

[18] For the stayers, we simply define the year in the middle of the decade as the respective "event", in order to estimate all time dummies before and after. See the Appendix B for further details.



(a) Selection into mobility

(b) Prior and subsequent careers: Event study

Figure 3: Movers versus stayers

event occurs, we see that movers experience an upward earnings jump from period -1 to period 0. This jump is likely driven by workers who were unemployed in -1 but were employed in 0 by definition.[19] More importantly, for movers we find that their earnings profile becomes flat in the years after the event, while for the stayers the decline continues. This flattening of the earnings decline for the movers can be related to our estimation results from Table 4. There we have found that workers can mitigate the marginal impact of import shocks by industry mobility, which followed from the comparison of the respective coefficients of the $\gamma_{i,j}$- and the γ_i-model. Figure 3 illustrates what this mitigation means: after the move, the respective worker is now less import-exposed, and therefore does not experience further earnings declines. This is different for the stayers, for whom the high import exposure and the earnings decline go on. However, the representative mover is *not* able to make up for the cumulated earnings losses from the pre-event period by the relatively better performance in the post-event period. Eventually, the movers even seem to catch up to the stayers, but over the full decade the movers realize lower total earnings than the stayers.

In other words, those who started out in highly import-exposed industries are, on average, left with earnings losses over the subsequent decade. This is consistent with our findings from the medium-run analysis from Section 3.1., and it turns out to be true both for stayers and for movers. The movers being negatively selected, they perform worse than the stayers over a longer time horizon, which is a further indication that their mobility can be thought of as "forced" rather than voluntary sorting. But unlike the stayers, we find that the movers are at least able to stop the earnings drain that was caused by rising import penetration through their industry mobility.

[19] Recall that we define displaced workers to be still affiliated with their original industry until they take up another job elsewhere (which happens at time 0 for the movers).

4.3 Smooth versus bumpy job careers

How do the short-run impacts of trade shocks come about? The results for total annual earnings from Table 4 include wage and employment adjustments on the same job, uninterrupted job-to-job transitions, as well as transitions into and out of unemployment. This latter channel is of particular interest, since unemployment is still considered an issue of top priority for policy-makers in Germany. Our aim in this subsection is, therefore, to gain insights about how much of the overall earnings effect is driven by disruptions in individual work biographies. Moreover, we investigate if the strong push effects that we found for import shocks only come from job displacements and forced industry switches after an unemployment spell, or if the asymmetry between push and pull effects also arises when we only consider smooth job-to-job transitions.

Table 5: Drop workers with employment < 11 x 365 days

2SLS	Dependent variable: 100 x earnings relative to avg. earnings in pre-period				
	(1)	(2)	(3)	(4)	(5)
ImE	-0.3672***	-0.3969***	-0.4067***	-0.2788***	-0.2300***
	(0.0900)	(0.0967)	(0.0966)	(0.0607)	(0.0529)
ExE	0.2973**	0.3393***	0.3568***	0.2678***	0.2474***
	(0.1238)	(0.1288)	(0.1311)	(0.0903)	(0.0848)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	100866	94540	91618	86071	77939
R^2	0.505	0.497	0.490	0.484	0.461
KP	97.846	96.683	96.613	163.210	196.576

Notes: 857,329 observations of 77,939 workers. Further controls include three age polynomials, 1-digit industry x year and federal state x year interactions. Standard errors, clustered by industry × year in parentheses.

To do so, we repeat in Table 5 all specification from before but now focus on a subsample of individuals with extremely stable job biographies. In particular, we only keep such individuals who were constantly employed on each day of the respective decade. Earnings changes for those individuals can, thus, only arise on-the-job or by smooth job switches, but they do not involve even very short unemployment spells (not even a single day). This leads to a notable reduction in the number of observations: Before our estimations were for 216,212 workers, and now we have only 77,939 workers left. Those workers with very high labour force attachment are, of course, not a random but supposedly a positively selected sample. Yet, by comparing the earnings effects for this group to the overall results from Table 4, we gain insights how much of the burden of negative import shocks falls on workers with bumpy job careers, and respectively, how much of the blessings from rising export opportunities.

As can be seen in Table 5, we find that all coefficients for export exposure are quite similar across the different specifications and also in the same ballpark as in Table 4. If anything, we find some evidence for within-industry sorting towards better plants,

which can be seen by the slightly larger positive coefficient in column 3 compared to column 1. By and large, however, we find that the positive effect of export shocks mainly accrue for incumbent workers who started out in the right industries, and as before we find little evidence for additional pull effects. Moreover, it turns out that this subgroup of workers with very stable biographies is affected by rising export opportunities similarly as the entirety of German manufacturing workers.

Turning to the negative import shocks, notice at first that the coefficients in columns 1, 2 and 3 are almost equal and about twice as large as the one in column 5. This pattern in Table 5 is the same as in Table 4, which shows that import shocks also induce mobility among those workers with very stable careers. The push effects of import shocks, therefore, do not necessarily involve unemployment spells, but they can also arise smoothly via uninterrupted job-to-job transitions.

The key difference between Tables 4 and 5 is that the coefficients for import shocks are now substantially smaller in absolute terms than before. Comparing the results for the $\gamma_{i,p}$ models from column 1, they are -0.6525 and -0.3672, respectively. The group of highly attached workers, thus, suffers much less from import shocks in a given worker-establishment match than German workers at large. In fact, their earnings losses are only around half of what we observe among all workers, supposedly because these workers are positively selected and exhibit higher unobserved ability levels. Similarly, comparing the results for the γ_i models from column 5 (which are -0.3226 and -0.2300, respectively) we consistently find below-average total earnings losses for the subgroup of stable workers when taking all sorts of adjustment and mobility into account.

This suggests that workers with bumpier job careers are affected more severely by import shocks, and that unemployment spells play an important role for the overall effect of those shocks on individual earnings profiles. However, our previous results on the asymmetric push and pull effects of trade shocks remain robust also when considering only workers with extremely stable work biographies.

5 The impact on heterogeneous workers and plants

The distributional aspects of globalization are a central question in the academic literature, as well as in the policy debate, and identifying the winners and losers can potentially help to mitigate any negative impacts by targeted policies.[20] We add to this literature by exploring the impacts of rising trade exposure on the job biographies of workers with varying characteristics. More specifically, we analyze the heterogeneous effects on different worker groups in Germany, using the same set of high-dimensional fixed effects models as in the previous section. This also allows us to investigate differential mobility responses across groups, in addition to the differential average impacts.

[20]Recent theoretical and empirical works on the unequal effects of trade on welfare and labour-market outcomes include, for example, Costinot and Vogel (2010), Krishna et al. (2012), or Fajgelbaum and Khandelwal (2015).

First, we split the sample along formal education levels. Second, we explore the impacts among workers and establishments with different unobservable characteristics. Finally, we explore differences across age and gender groups.

5.1 Education and skills

Table 6 presents the results for two skill groups. We classify all individuals with only lower secondary schooling or less (no vocational training) as low skilled. High-skilled individuals, by contrast, have a certificate of completion of advanced level high school (Abitur), completed vocational training, or a university degree.

Comparing the total impact of import shocks across all job spells (i.e., the model with individual-fixed effects γ_i in column 5), we find that the negative effects are almost three times larger for unskilled than for skilled workers (-0.569 versus -0.198). This difference is, to a large extent, driven by differences in worker mobility rates i.e., by the differential ability of skilled and unskilled workers to adjust. Comparing the effects within given job spells (the $\gamma_{i,p}$-model from column 1), the difference between the skill groups is significantly smaller (-0.733 versus -0.581). A similar picture emerges in columns 2 and 3 where effects are identified within (local) industries only. That is, high-skilled workers seem more able than low-skilled workers to cushion adverse import shocks by moving across industries.

The results for exports are again somewhat different. Within the same job, low-skilled and high-skilled workers reap very similar earnings gains from rising export exposure (0.299 versus 0.261). Yet, we see that low-skilled workers experience larger gains across job spells (0.539 versus 0.323), again mostly driven by variation across industries. In other words, there seems to be more induced mobility (pull effects) for low-skilled than for high-skilled workers. This result may reflect that high-skilled workers have, of course, higher absolute earnings and are therefore somewhat less responsive to positive shocks in export opportunities. That interpretation is in line with the literature on the exporter wage premium in Germany, which finds that wages of blue collar workers are more sensitive to the firm's export status (see Schank et al.; 2007).

Overall, import shocks tend to increase earnings differences between the two skill groups, whereas exports tend to decrease between-group inequality. Moreover, we obtain a more nuanced picture for the asymmetric individual response to trade shocks. For high-skilled workers, we find the same pattern as in the overall sample from Table 4. For low-skilled workers, however, we find that industry mobility allows them to dampen negative import effects only to a small extent. Yet, for them we find stronger pull effects into export oriented industries, which in turn allows them to reap a higher relative exporter earnings premium.

Table 6: Effects by Educational Attainment

2SLS	Dependent variable: 100 x earnings relative to avg. earnings in pre-period				
	(1)	(2)	(3)	(4)	(5)
Unskilled (N=688,556)					
ImE	-0.7327***	-0.8144***	-0.8165***	-0.4265***	-0.5688***
	(0.1127)	(0.1189)	(0.1214)	(0.0891)	(0.2008)
ExE	0.2999*	0.5187***	0.5120***	0.3560***	0.5393***
	(0.1640)	(0.1902)	(0.1962)	(0.1318)	(0.1692)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	88192	83613	81562	72099	61366
R^2	0.822	0.823	0.815	0.810	0.559
KP	133.374	129.784	129.666	345.940	451.170
Skilled (N=1,719,916)					
ImE	-0.5814***	-0.6372***	-0.6511***	-0.2465**	-0.1982**
	(0.1205)	(0.1252)	(0.1229)	(0.1248)	(0.0953)
ExE	0.2618*	0.3050**	0.3277**	0.1878	0.3230***
	(0.1498)	(0.1546)	(0.1566)	(0.1224)	(0.1201)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	227529	215537	208332	186101	154846
R^2	0.898	0.895	0.893	0.862	0.836
KP	103.792	102.635	102.434	238.325	326.163

5.2 Unobservable skills and productivities

Following the methodology of Abowd et al. (1999), the recent contribution by Card et al. (2013) decompose changes in the German wage structure over the last 30 years. They find the main drivers of increasing inequality are unobservable factors: an increasing variance of unobserved person effects and establishment effects, and a rise in assortative matching along those two dimensions. Motivated by the growing importance of unobserved factors in shaping the wage distribution, we now study heterogeneous effects of trade exposure along the distribution of unobservables, measured by pre-estimated worker and plant fixed-effects.

Heterogeneous workers. We split our sample along the terciles of the worker and plant fixed-effects distributions estimated by Card et al. (2013). We take the estimates from Card et al. (2013) for the years *before* our analysis starts.[21] It is important to note

[21] Card et al. (2013) implement AKM models (Abowd et al. (1999)) using the universe of social security records for Germany for different sub–periods. The estimates we use to split our sample come from regressions of the form:

$$Y_{ipt} = \mathbf{x}'_{it}\boldsymbol{\alpha} + \gamma_i + \lambda_p + \epsilon_{it},$$

where γ_i and λ_p are individual and establishment fixed-effects. For the first decade 1990-2000 of our analysis, we use the estimated fixed effects from 1985-1991 from their analysis. For second decade 2000-2010 of our analysis, we assign the person and establishment fixed effects estimated on the 1996-2002

Table 7: Unobserved skills and productivities

	Dependent variable: 100 x earnings relative to avg. earnings in pre-period					
	(1)	(2)	(3)	(1′)	(2′)	(3′)
	33% good workers (N=802,362)			33% good plants(N=794,585)		
ImE	-0.3218**	-0.4214***	-0.0854	-0.0604	-0.1155	-0.3967*
	(0.1635)	(0.1570)	(0.2328)	(0.1284)	(0.1245)	(0.2290)
ExE	-0.1287	0.1291	0.2901*	0.0507	0.0437	0.1068
	(0.2012)	(0.2140)	(0.1649)	(0.2593)	(0.2523)	(0.3059)
Fixed effects	i x p	i x j	i	i x p	i x j	i
Groups	106788	97588	71972	100691	92473	71898
R^2	0.869	0.866	0.735	0.852	0.851	0.676
KP	101.502	95.989	340.827	58.220	56.762	158.880
	34% medium workers (N=711,260)			34% medium plants (N=721,556)		
ImE	-0.5892***	-0.6036***	-0.3755***	-0.3451**	-0.3361**	-0.1510
	(0.1264)	(0.1319)	(0.0970)	(0.1686)	(0.1645)	(0.2094)
ExE	0.2979*	0.3171*	0.2640	0.2024	0.2570	0.4670**
	(0.1627)	(0.1690)	(0.2018)	(0.1827)	(0.1855)	(0.2043)
Fixed effects	i x p	i x j	i	i x p	i x j	i
Groups	91538	83778	64274	95722	87792	65100
R^2	0.884	0.877	0.789	0.908	0.901	0.828
KP	99.575	97.605	284.321	114.314	111.112	378.732
	33% bad workers (N=656,942)			33% bad plants (N=651,904)		
ImE	-0.8250***	-0.9271***	-0.4255***	-0.6796***	-0.8138***	-0.1760*
	(0.1131)	(0.1185)	(0.0785)	(0.1541)	(0.1559)	(0.1006)
ExE	0.2581*	0.2902*	0.4419***	0.2078	0.4145**	0.4392***
	(0.1491)	(0.1517)	(0.1226)	(0.1338)	(0.1726)	(0.1148)
Fixed effects	i x p	i x j	i	i x p	i x j	i
Groups	86707	80438	59223	88301	81248	58243
R^2	0.890	0.872	0.756	0.851	0.835	0.768
KP	150.221	153.202	463.056	142.662	123.920	544.542

that these effects are estimated on a time period before the start of our two periods, as otherwise we would split the sample along an endogenous dimension. One can interpret the worker fixed effects as a combination of different unobservable factors that are rewarded equally across employers and are transferable across jobs. In the discussion of the results, we refer to those person effects as unobservable skills. The results are reported in the left half of Table 7 where the sample is split according to the terciles of the "CHK person effects", merged to our sample. To save space, we only present the results for the $\gamma_{i,p}$-, the $\gamma_{i,j}$-, and the γ_i-model at this point.

Column 1 shows the within-match effects. Import competition hits good workers less than bad workers. For the same increase in import exposure, earnings of workers

period from their paper. We thank Joerg Heining for making their estimates available to us.

with unobservable skills in the lowest tercile decrease by two and half times more than for workers in the highest tercile; the coefficient is -0.82 for the former and -0.32 for the latter. As a result, import competition increases inequality between these groups.

Column 3 shows the within-worker estimates. For all three groups, increasing import competition has again a smaller impact when endogenous mobility is taken into account. The coefficient for the highest skilled group is around zero, implying that after taking into account induced mobility those workers are large insulated from import shocks. The industry-worker estimates in column 2 are close to the match-specific ones in column 1, which means that for all groups the important adjustment margin is a change of industry or sector.

Increasing export exposure on the other hand, raises earnings of bad and intermediate workers more than of good workers. The latter two groups see similar gains within job spells (column 1) with a coefficients between 0.25 and 0.30. The effect for good workers, by contrast, is not statistically different from zero. This suggests that firms are willing to raise earnings of their workers with low-to-medium ability, but not of their most able workers – export shocks therefore tend to decrease between-group inequality. Strikingly, while the good workers do not seem to reap gains from rising export exposure within their jobs, because of mobility they are still able to profit as the coefficient in column 3 increases to 0.29.

Heterogeneous establishments We now estimate trade effects on workers' earnings across different establishment types. We split the sample into terciles depending on the firm fixed effects from the pre-period. The firm fixed effect should be interpreted as proportional pay premiums (or discount) paid by an establishment to all its workers, independent of workers' observables or unobservables.

The right half of Table 7 shows the results. First, the imports effects within worker-establishment matches ($i \times p$) are most severe for employees of bad plants with low fixed effects, they are reduced in the middle tercile, and almost vanish in the top tercile. Apparently workers are shielded from the hazards of import competition if they work in highly productive plants. However, it is still possible for workers who start out in the bottom tercile to mitigate the negative effects of imports by moving to different industries. Remarkably, just switching plants within industries is not enough. Since CHK estimate the plant and workers effects while not controlling for industries, it is possible that these effects and the industrial affiliation are correlated. In fact, we do find that plants in the bottom tercile are more likely to be in import-competing manufacturing industries, such as manufacture of toys, textiles, furniture or consumer electronics. When switching within such an industry, workers thus might end up in another plant which is suffering from import competition as well.

The adjustment to import shocks is very different when workers start out in good plants. For the top tercile, we see that plant switchers, and in particular those simultaneously switching industry, lose earnings relative to co-workers who stay with the original establishment. This suggests that, if workers leave those high-wage firms, they

can only do worse and likely move to plants with lower pay premiums.

5.3 Age and gender

Finally, we investigate differential effects of trade shocks on workers in different age and gender groups.

Effects by Age. The upper part of Table 8 reports the results when we split the sample along the median age in our sample at the start of the period (38 years). Strikingly, the estimates show that the incidence of trade is to a very large degree borne by young workers. Within employer-employee spells, older workers experience a much smaller relative earnings loss of around -0.183, compared to -1.186 for young workers.

Our results suggest a hierarchy within firms, under which young workers see their wages and employment cut first in response to rising import penetration. Industry mobility helps those younger and more negatively affected workers to mitigate more than half of the shock, as can be seen by the difference between column 1 and 3. Consistent with the import results, old workers are also insulated from increased export opportunities. In sum, this suggests that firms react to trade shocks by changing their labour demand for young workers, both in the positive and in the negative sense.

Gender. The lower part of Table 8, we split our sample by sex. The most remarkable finding here is that the gains from positive export shocks seem to be exclusively realized by men. In the subsample for women, we find no significant effects of export exposure at all, while for men we find the same pattern as in Table 4 with significantly positive and similar coefficients across specifications.

The fact that all positive effects from exports stem from men supports the notion that men perform different tasks within the manufacturing sector than women, and that those tasks are likely more prone to yield an exporter wage premium. Relatedly, Card et al. (2015) find in recent work for Portugal that changes in revenue of firms disproportionally benefit men, contributing to the gender wage gap. Our results point into the same direction, as women do not benefit from export shocks within plant spells.

Women are able to close part of the gap by switching firms within their original industry: the coefficient increases from around zero to 0.17 in columns 2 and 3. But after taking into account that many women leave their manufacturing industry towards the service sector, it turns out that women, on average, do not benefit from export shocks: the coefficient in column 5 is estimated around zero. Interestingly, these results are in line with findings from Boler et al. (2015) who document that exporting firms have higher gender wage gaps than non-exporters. Our results suggest that this seems to happen also within firms over time. As export exposure increases, the gender wage gap widens, at least for those matches which are not broken off.

Turning to negative import shocks, we find that adverse earnings effects are about the same for both sexes within worker-job spells (-0.5381 versus -0.5898). Also the

Table 8: Effects by age and gender

2SLS	Dependent variable: 100 x earnings relative to avg. earnings in pre-period				
	(1)	(2)	(3)	(4)	(5)
Younger than median of cohort (approx. 38yrs, N=1,256,647)					
ImE	-1.1863***	-1.2876***	-1.2781***	-0.4248***	-0.4459***
	(0.1855)	(0.1893)	(0.1864)	(0.1636)	(0.1553)
ExE	0.6338***	0.8470***	0.8474***	0.3602**	0.5760***
	(0.2215)	(0.2343)	(0.2359)	(0.1656)	(0.1703)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	172960	164124	158676	139524	112382
R^2	0.878	0.877	0.873	0.851	0.751
KP	115.389	112.473	111.795	313.156	427.233
Older than median of cohort (approx. 38yrs, N=1,233,349)					
ImE	-0.1835**	-0.2115***	-0.2318***	-0.1589***	-0.0965
	(0.0762)	(0.0781)	(0.0788)	(0.0573)	(0.0589)
ExE	-0.0678	-0.0666	-0.0534	0.0405	0.0819
	(0.1178)	(0.1199)	(0.1207)	(0.0800)	(0.0748)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	151494	143571	139647	126727	111195
R^2	0.605	0.600	0.597	0.552	0.514
KP	112.235	111.168	110.948	240.577	314.900
Male (N=1,739,837)					
ImE	-0.5381***	-0.5967***	-0.5988***	-0.2631*	-0.3528***
	(0.1314)	(0.1388)	(0.1409)	(0.1360)	(0.1009)
ExE	0.4278***	0.4787***	0.4970***	0.2929**	0.5264***
	(0.1492)	(0.1552)	(0.1583)	(0.1194)	(0.1187)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	228858	216712	209675	188743	157439
R^2	0.892	0.893	0.887	0.858	0.825
KP	113.401	112.707	112.625	261.088	345.205
Female (N=668,635)					
ImE	-0.5898***	-0.6877***	-0.7151***	-0.2764***	-0.1471
	(0.1137)	(0.1114)	(0.1098)	(0.0815)	(0.1777)
ExE	-0.0693	0.1738	0.1682	0.1518	0.0300
	(0.1741)	(0.1891)	(0.1917)	(0.1325)	(0.1383)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	86863	82438	80219	69457	58773
R^2	0.841	0.836	0.835	0.825	0.616
KP	99.046	94.365	93.546	269.445	356.876

coefficients in columns 2–4 are roughly similar, pointing at comparable effects for men and women within the same industry or local labour market. What stands out, how-

ever, is the difference in column 5 (-0.3528 versus -0.1471). For women, the coefficient is not precisely estimated, but at face value we find that the effect is much smaller for women than for men, both in absolute terms and also relative to column 1. This probably indicates that women respond more easily to import shocks by moving out of the manufacturing sector altogether. Stated differently, it appears to be easier for men to find a suitable job within manufacturing, while women do better at cushioning import shocks by changing to the service sector.

6 Conclusions

In this work, we shed light on how manufacturing workers in Germany were affected by, and adjusted to, rising trade exposure between 1990 and 2010. We use detailed spell data which allow us to follow single workers over time.

Our panel approach exploits rich variation within workers and worker-industry, worker-region and worker-establishment matches. By restricting the identifying variation to within variation models, we complement previous estimation approaches to the labor effects of globalization, which use mostly cross-industry or regional variation in exposure. The advantage of our approach is that we can tightly control for unobserved heterogeneity.

Our key insights are that German manufacturing workers benefited at large from this particular globalization episode. Yet, there have been winners and losers, and for workers of strongly import-competing sectors, we find substantial earnings losses in the short- and in the medium-term. Moreover, we find an *asymmetry* in the individual response to negative import and positive export shocks. While export shocks do not seem to trigger many "pull effects" into the respective industries, we find much more important "push effects" out of the sectors with high import penetration.

Our study is complementary to a recently growing theoretical literature that explores the impact of external trade shocks on the adjustments of heterogeneous workers across industries, regions, and firms. Some of these papers even consider the rise of China (which is part of the East in our study) as the specific trade shock whose quantitative consequences in general equilibrium are then explored in counterfactual analyses. See, in particular, the recent studies by Caliendo et al. (2015), Galle et al. (2015) and Fan (2015)). The empirical results reported in our study may be informative for those papers, in particular our findings that industry sorting seems much more effective than other forms of adjustment when it comes to absorbing trade shocks, and our novel finding about the asymmetric response to positive and negative shocks.

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Appendix

A Extending trade measures by exposure of downstream industries

In our main specifications, we only consider how workers are affected by imports and exports of their own industry's imports and exports. However, if an industry suffers from import competition, it might also reduce demand from its domestic suppliers, whereas it might increase this demand when it exports more. We thus expand our trade measure to account for these linkages.

We use the 1995 input-output table from the German Statistical Office to calculate what share of its output an industry sells to each other industry. This table contains information on linkages between 2-digit industries. We can expand this matrix to our 221 3-digit industries under the assumption that each industry causes linkages that are proportional to its size.

Multiplying this matrix W by the vector of trade exposures ImE or ExE would yield the additional exposure an industry receives from its direct buyers. We follow Acemoglu et al. (2015) and compute the Leontief inverse of the input-output matrix to account for the additional exposure of the whole value chain. Our augmented measures for trade exposure are then defined as $ImE_{+down} = ((I - W)^{-1})' \times ImE$ and $EmE_{+down} = ((I - W)^{-1})' \times ExE$. These capture both the direct effects of the own industry's exposure as well as the weighted indirect effects of all downstream industries.

B Event Study

In section 4.2, we ask how workers who switch between industries perform relative to stayers, both before and after their move. To answer this question, we employ an event study in the spirit of Jacobson et al. (1993). We observe each worker over at least one eleven year period $y = 1990, 1991, \ldots, 2000$ or $y = 2000, 2001, \ldots, 2010$ (workers who are observed in both periods are treated as two individual workers). If a worker i who starts out in industry j starts to work in a different industry $s \neq j$ in year y_m, we define the variable $k = y - y_m$ that indicates the number of years relative to the move. For workers who never move, we define $k = y - 1994$ for the first and $k = y - 2004$ for the second period. We then run a regression of the form:

$$y_{ik} = \alpha_i + \sum_{k=\underline{C}}^{\overline{C}} \delta_k^S S_i^k + \sum_{k=\underline{C}}^{\overline{C}} \delta_k^M M_i^k + u_{ik} \tag{A.2}$$

y_{ik} is the same outcome as in our short-run panel regressions, namely annual earnings relative to start of period earnings. M_i^k and S_i^k are event dummies, that take the value of one if the worker is observed at time k and is either an industry mover (M_i) or stayer

(S_i). We set $\underline{C} = -3$ and $\overline{C} = 5$. All observations more than four years before and five years after the layoff, are represented by four further dummies. The dummies for $k = -4$ are omitted as the reference category. Normally, one would include calendar time fixed effects. These would make little sense here, since the timing is fixed for stayers. The $\delta_k^M M_i$ and $\delta_k^S S_i$ report how the outcomes of movers and stayers evolve over time, relative to the period of $k = -4$.

C Appendix Tables

Table A.1: Descriptive Statistics - Long-run Approach

	mean	sd	1st quartile	median	3rd quartile
1990-2010					
100 × rel. Earnings	1014.698	713.465	642.013	1002.482	1197.380
avg. prev. Earnings / yr	42152	41706	23830	32933	42712
Δ ImE	11.640	8.972	4.423	9.904	17.807
Δ ExE	8.581	5.167	4.903	8.841	11.391
1990-2000					
100 × rel. Earnings	1024.565	759.621	609.688	1009.023	1218.366
avg. prev. Earnings / yr	38357	30150	23301	32094	41286
Δ ImE	13.003	8.834	6.016	12.263	18.017
Δ ExE	8.341	5.645	4.566	6.879	11.737
2000-2010					
100 × rel. Earnings	1004.328	661.343	678.043	997.249	1175.938
avg. prev. Earnings / yr	46139	50804	24472	33876	44236
Δ ImE	10.208	8.893	4.012	7.780	14.469
Δ ExE	8.833	4.597	5.558	9.825	11.038

Table A.2: The most affected industries

Rising Export Opportunities in the East		Rising Import Competition to the East	
Industry	%-point increase	Industry	%-point increase
191 tanning and dressing of leather	37.1	231 coke oven products	77.6
313 insulated wire and cable	31.0	365 games and toys	72.8
264 bricks, tiles and construction products, in baked clay	30.9	204 wooden containers	72.2
263 ceramic tiles and flags	30.9	342 bodies (coachwork) for motor vehicles	57.8
176 knitted and crocheted fabrics	30.4	192 luggage, handbags and the like	57.0
343 parts and accessories for motor vehicles and their engines	29.9	205 other products of wood and cork	56.2
172 textile weaving	26.7	361 furniture	56.1
171 preparation and spinning of textile fibres	26.5	315 lighting equipment and electric lamps	55.6
342 bodies (coachwork) for motor vehicles	26.5	364 sports goods	55.4
312 electricity distribution and control apparatus	25.4	313 insulated wire and cable	54.7
287 other fabricated metal products	25.2	300 office machinery and computers	54.7
294 machine-tools	23.6	366 miscellaneous manufacturing n.e.c.	48.5
322 television and radio transmitters	23.5	297 domestic appliances n.e.c.	48.2
293 agricultural and forestry machinery	23.2	322 television and radio transmitters	48.0
333 industrial process control equipment	22.0	323 television and radio receivers	47.1
323 television and radio receivers, sound or video recorders	22.0	355 other transport equipment n.e.c.	47.0
202 veneer sheets; plywood, laminboard, part	21.9	182 other wearing apparel and accessories	44.1
252 plastic products	21.9	174 made-up textile articles, except apparel	43.6
311 electric motors, generators and transformers	21.9	281 structural metal products	42.3
316 electrical equipment n.e.c.	21.7	262 non-refractory ceramic goods other than for constructio	41.3
251 rubber products	21.6	283 steam generators, except central heating hot water boil	41.2
321 electronic valves and tubes, other electronic components	21.5	183 Dressing and dyeing of fur; articles of fur	41.1
175 other textiles	21.4	267 Cutting, shaping and finishing of stone	39.3
282 tanks, reservoirs and containers of metal;	20.8	321 electronic valves and tubes, other electronic components	38.7
295 other special purpose machinery	20.7	316 electrical equipment n.e.c.	36.3

Note: Increase of Eastern trade volumes relative to World imports/exports per sector, 1990-2010

Table A.3: High-dimensional fixed effect models, account for trade exposure of downstream industries

2SLS	Dependent variable: 100 x annual earnings normalized by base year earnings				
	(1)	(2)	(3)	(4)	(5)
ImE_{+down}	-0.6379***	-0.7046***	-0.7078***	-0.2786***	-0.2947***
	(0.1020)	(0.1070)	(0.1065)	(0.0901)	(0.0914)
ExE_{+down}	0.2205*	0.2799**	0.3048**	0.2188**	0.3812***
	(0.1239)	(0.1288)	(0.1309)	(0.0909)	(0.1022)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	315721	299150	289894	258200	216212
R^2	0.873	0.872	0.868	0.846	0.747
KP	118.990	116.947	117.445	304.512	419.545

Notes: 2,378,332 observations of 216,212 workers. ImE_{+down} and ExE_{+down} include weighted trade exposure of downstream industries. Further controls include three age polynomials, 1-digit industry x year and federal state x year interactions. Standard errors, clustered by industry $\times$ year in parentheses.

Table A.4: High-dimensional fixed effect models, including workers who changed into the manufacturing sector but startet elsewhere

2SLS	Dependent variable: 100 x annual earnings normalized by base year earnings				
	(1)	(2)	(3)	(4)	(5)
ImE	-0.6824***	-0.7471***	-0.7514***	-0.4063***	-0.4396***
	(0.1164)	(0.1235)	(0.1224)	(0.0913)	(0.0865)
ExE	0.2369	0.3030*	0.3179*	0.1163	0.3873***
	(0.1634)	(0.1686)	(0.1693)	(0.1423)	(0.1285)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	394798	376359	364645	316045	250596
R^2	0.886	0.886	0.883	0.831	0.748
KP	114.074	113.159	113.240	317.201	425.763

Notes: 2,756,556 observations of 250,596 workers. Further controls include three age polynomials, 1-digit industry x year and federal state x year interactions. Standard errors, clustered by industry $\times$ year in parentheses.

Table A.5: High-dimensional fixed effect models, including workers who changed into the manufacturing sector but startet elsewhere, account for trade exposure of downstream industries

2SLS	Dependent variable: 100 x annual earnings normalized by base year earnings				
	(1)	(2)	(3)	(4)	(5)
ImE_{+down}	-0.6471***	-0.7341***	-0.7202***	-0.3435***	-0.3807***
	(0.1133)	(0.1215)	(0.1198)	(0.0898)	(0.0852)
ExE_{+down}	0.2137	0.2293	0.2693*	0.1754	0.4345***
	(0.1374)	(0.1428)	(0.1429)	(0.1238)	(0.1153)
Fixed effects	i x p	i x j x r	i x j	i x r	i
Groups	394798	376359	364645	316045	250596
R^2	0.886	0.886	0.883	0.831	0.748
KP	118.642	117.842	119.304	387.995	555.534

Notes: 2,756,556 observations of 250,596 workers. ImE_{+down} and ExE_{+down} include weighted trade exposure of downstream industries. Further controls include three age polynomials, 1-digit industry x year and federal state x year interactions. Standard errors, clustered by industry $\times$ year in parentheses.

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