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Adjusting to Globalization in Germany

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We study the impact of trade exposure on the job biographies of 2.4 million manufacturing workers in Germany. Rising export opportunities lead to two equally important sources of earnings gains: on the job and employer switches within the same industry. Highly skilled workers benefit the most. Import shocks mostly hurt low-skilled workers, especially when they possess lots of industry-specific human capital. They also destroy workers' rents when separating from high-wage plants, and they leave strongly scarring effects in the event of a mass layoff. We connect our results to the growing theoretical literature on the labor market effects of trade.

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I. Introduction

What are the distributional effects of globalization and trade? This is one of the classical questions in economics that dates back at least to the work by Stolper and Samuelson (1941). In the public and academic debate, there is a particular focus on the labor market. Does increased foreign competition lead to job losses at home? Which workers are the winners and losers of increased international trade—and are the gains and losses of economic significance? A recent and influential literature has indeed unmasked large discrepancies between local labor markets and a very unequal distribution in particular of the costs of trade. Examples of this literature include Autor, Dorn, and Hanson (2013) for the United States, Topalova (2010) for India, Dix-Carneiro and Kovak (2017) for Brazil, and Dauth, Findeisen, and Suedekum (2014) for Germany.[1] Another recent and theoretical literature has analyzed the effect of international trade in models with heterogeneous workers and firms and self-selection of the latter into exporting.[2] Examples of this literature include Helpman, Itskhoki, and Redding (2010) and Sampson (2014).[3] Models in this literature typically make predictions how new opportunities to export affect wage inequality and how exposed workers are expected to adjust to industry export shocks.

In this article, we investigate how workers in the labor market adjust to the substantial shocks in labor demand caused by trade. In contrast to most of the previous empirical literature, we analyze the reallocation process—how workers move across firms within and across industries and sectors—in response to both import and export shocks. It is important to understand empirically how individual workers adjust not only to foreign competition but also to positive labor demand shocks caused by the self-selection of domestic firms into exporting. Focusing on exports has the advantage that it connects the empirical to the growing theoretical literature on the interaction of trade and labor market adjustments in the presence of frictions.

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[1] Surveys of the literature are provided by Autor, Dorn, and Hanson (2016) and Muendler (2017).

[2] In the original Melitz (2003) model, which most papers build on, all workers are paid the same wage. Frictions or other deviations from a purely neoclassical labor market are needed to generate an effect of trade on inequality in this class of models.

[3] See Helpman (2016) for a survey.

Our paper focuses on the effect of exports and imports on the German labor market. Germany is regularly portrayed as a manufacturing powerhouse in the media.[4] In addition, it consistently ranks among the most open economies in the world and has held the unofficial title of the "export world champion," making it one of the most interesting countries to look at when searching for the labor market effects of export and import shocks. We consider two trade shock episodes that hit the German economy in the aftermath of important political events in the early 1990s. The first one is the fall of the Iron Curtain, which led to a rapid transformation of the former socialist countries in Eastern Europe, and the second one is the rise of China and its integration into the world economy. The pace of those changes was much faster than with any other trading partner in the world, making them the major globalization shocks that hit the German economy in those two decades.[5] We will use a big administrative data set, which covers a large part of all private sector employment in Germany and allows us to follow workers over time and across firms, industries, and regions to investigate the adjustment process in detail.

To preview our main results, we find that workers who were initially employed in industries with more export exposure see robust and lasting earning gains relative to less exposed workers. Those gains are mostly realized on two different margins with roughly equal importance: first, on the job with the original employer, and second, in a different firm within the original industry. This means that in order to profit from globalization many workers in Germany have adjusted by switching their employer and made full use of their accumulated industry-specific human capital. The firm-switching channel for individual workers to realize earnings gains is a key mechanism in many theoretical trade models, and our paper documents its empirical importance.

Our next contribution is to detect important heterogeneity in the export adjustment mechanisms. In line with the previous literature, we focus on workers' skills. We measure skill—flexibly and on a continuous scale—by preestimated (i.e., in a preceding period) two-way fixed effects models with worker and plant effects (Abowd, Kramarz, and Margolis 1999; Card, Heining, and Kline 2013), hereafter referred to as the AKM model. We show that the firm-switching channel is driven by the reallocation of the most highly skilled workers in Germany. Consequently, trade has increased skill demand in industries with greater trade exposure, and this led to a reallocation of high-skilled workers across firms to profit from exporting opportunities. This is consistent with the theoretical results from Sampson (2014).

[4] See among many other examples Steven Rattner, "The Secrets of Germany's Success," *Foreign Affairs*, July 2011; Richard Anderson, "German Economic Strength: The Secrets of Success," *BBC News*, August 2012; or Noah Smith, "Workers Made Germany into the World's Best Economy," *Bloomberg*, April 2017.

[5] Also see fig. 1.

Import competition, in contrast to export exposure, has only muted total effects on worker earnings in Germany. Moreover, we find that the negative consequences of import competition are concentrated on workers starting out in high-wage plants, when we again rank workers and firms by their fixed effects from preestimated models. Interestingly, import competition seems to mostly destroy workers' rents at the highest-paying companies. But at lower-paying firms, workers seem to be mostly sheltered from import competition.

Although the total effects of import competition are rather moderate, our findings suggest that job separations of exposed workers from their original employers are involuntary in import-competing industries. An influential literature, which is naturally related to our analysis on the effects of import competition, has focused on the long-run consequences of job loss, following the pioneering work by Jacobson, LaLonde, and Sullivan (1993). This literature focuses on mass layoff events, as they are arguably exogenous from the individual's perspective. We combine the two sources of variation—industry affiliation before the trade shocks and exploiting mass layoff events—to ask how globalization (in the form of import competition) affects the cost of job displacement. We find large heterogeneity in the strength of scarring effects. Being subject to a mass layoff in an import-competing industry is associated with a slower recovery in earnings and employment prospects, compared with being laid off in another industry. This is in line with recent evidence that the scarring effects of displacement in a mass layoff are more severe if the layoff happened during adverse macroeconomic conditions (Davis and von Wachter 2011).

Our article contributes to the literature on the labor market effects of international trade. A recent strand of studies at the worker level analyzes the consequences of trade using administrative data. Dix-Carneiro and Kovak (2019) analyze how workers respond to Brazil's trade liberalization in the early 1990s. They find that regions facing steeper tariff removals experience larger declines in labor demand and that transitions into the informal sector, a very salient feature in the Brazilian context, are an important margin of adjustment to the negative shock for workers.

Autor et al. (2014) exploit industry variation in the exposure to Chinese import competition for US workers. They find large and persistent negative effects on cumulative earnings, concentrated on low-wage workers who rank the lowest in the cohort-specific wage distribution. They do not study export shocks, however. Regarding the earnings losses from import competition, our study adds two main insights. First, the availability of employer-employee matched data allows us to also analyze heterogeneous effects from a firm's perspective. We rank firms using the AKM method and show that earnings losses from import competition are most pronounced for workers in high-wage plants. This is consistent with the interpretation that import shocks destroy rents for workers. Second, using person fixed effects

as obtained from the AKM model—arguably a better measure for the earnings potential of workers, since the AKM method filters out the plant-based wage component—we can complement the finding of Autor et al. (2014) that low-wage workers take the hardest hit.

For workers in the Danish textile sector, Utar (2018) presents compelling evidence how China's World Trade Organization accession harmed especially low-skilled workers. Her paper stresses the importance of human capital suitable for a successful transition into the service sector. Our paper also touches on the role of industry-specific human capital. We find that the positive labor demand shocks of exports are increasing in the specificity of human capital. For imports, on the other hand, consistent with Utar (2018), industry-specific human capital appears to be detrimental for the transition into other industries. In the bigger picture, while our paper is different in several respects from the literature on the worker-level impacts of import competition, the most important point of departure is the new and central focus on exports, which enables us to shed light on the positive labor demand effects of globalization from the perspective of workers in developed economies.

While the worker-level literature has mostly ignored adjustments to exporting opportunities, Verhoogen (2008) and Amiti and Davis (2012) study responses to export shocks from the firms' side. They show that wage inequality has increased between exporting and nonexporting firms in Mexico and Indonesia. Our longitudinal data set allows us to also introduce the workers' side and test another central theoretical prediction of most trade models, namely, the reallocation of workers within export industries. Krishna, Poole, and Senses (2014) argue that in Brazil, following liberalization, the (positive) sorting of workers to firms increases. We obtain consistent results, as we find stronger mobility responses by high-skilled workers in export industries.

Finally, in a previous paper we have documented that import competition from China and Eastern Europe had a negative effect on manufacturing employment across German local labor markets. This negative impact, however, is smaller than the positive effects from export opportunities (Dauth, Findeisen, and Suedekum 2014).[6] In the current study, we shift our focus to the adjustment process at the level of individual workers. This allows us to better understand the mechanisms how trade exposure affects labor markets. In particular, we can follow individual workers over a long period of time and observe how export and import exposure drive different margins of adjustments in their job biographies—including their mobility

[6] In a smaller companion study of job flows at the regional level, we show that a least a part of the aggregate effect stems from import competition diverting labor market entrants to take up their first job in the service sector instead of the manufacturing sector (Dauth, Findeisen, and Suedekum 2017).

across firms, industries, and sectors. Thereby we empirically investigate several mechanisms that are highlighted in the recent theoretical literature on how trade affects labor markets.

In section II we describe our data. Section III provides baseline estimates on the cumulative effects of export and import shocks on workers' careers over a 10-year horizon. Section IV analyzes the typical individual adjustment dynamics to trade shocks, while section V considers heterogeneity with respect to workers' skills and firm-specific wage premiums. In section VI we discuss how our empirical findings are related to the recent theoretical literature on trade and labor. Section VII shows how the scarring effects of layoffs are affected by import competition. Finally, section VIII concludes and discusses some policy implications for Germany and other developed countries.

II. Data and Measurement

A. Labor Market Data

Our main data source is the Integrated Labor Market Biographies (IEB V12.00.00-2015.05.15) from the German Institute for Employment Research. This data set stems from mandatory notifications to social security insurance, which essentially covers the universe of all individuals in the German labor market who were either employed in a job liable to contributions to social security or were unemployed and received benefits from unemployment insurance.[7] Our data set consists of all spells that belong to a 30% random sample of all individuals from the full data. This results in an individual-level spell data set that is highly accurate—even on a daily basis—as a result of its original purpose of calculating retirement pensions. In these administrative data, we can observe the location and industry of the workplace establishment along with individual characteristics, such as age, gender, nationality, educational attainment, and daily wage. This allows us to follow single workers over time and keep track of all of their on-the-job earnings changes, employer changes at the establishment level within and across industries and regions, and nonemployment spells.

Our observation period spans the time period from 1990 to 2010, which we split into two separate 10-year time windows. To construct our sample, we identify all individuals in either 1990 or 2000 who were between 22 and 54 years old, were employed full time in manufacturing with a tenure of at least 2 years, and had a mean daily wage above the marginal-job threshold on June 30 of the respective base year. This results in a data set that comprises the full employment biographies of more than 2.4 million individuals. For any given day during the observation period, we know whether a person held a job or was registered as unemployed. People may drop out of the

[7] See Oberschachtsiek et al. (2009) for an extensive introduction to this data set.

data set for several reasons. We can observe whether people died or emigrated to another country during the observation period while being employed or registered as unemployed, and we drop the full biographies of those people from our data. Other reasons for dropping out are retirement, withdrawal from the labor market, taking a job as a sworn civil servant, or transitioning into self-employment. Since we cannot observe these cases, we assume that all other people who drop out of the data set but neither died nor emigrated are nonemployed with zero earnings.[8] Below we conduct a robustness check on how this procedure affects our empirical results.

As the wage information is subject to right censoring at the social security contribution ceiling, we apply the imputation procedure of Card, Heining, and Kline (2013). Moreover, we convert all earnings into constant 2010 euros using the consumer price index of the Bundesbank. Finally, we express annual incomes in multiples of the individual's earnings in the base year (1990 or 2000).[9] Panels A and B of table 1 report informative descriptive statistics for the outcome variables and individual and workplace characteristics.

B. Trade Exposure

Information on international manufacturing trade comes from the United Nations Commodity Trade Statistics Database (Comtrade). These data contain detailed annual trade statistics for more than 170 reporter countries broken down by industry. We convert trade flows into 2010 euros. To merge them with our labor market data, we harmonize industry classifications by a correspondence between 1031 Standard International Trade Classification revision 2/3 product codes and the employment data at the three-digit industry level (equivalent to NACE) as provided by the United Nations Statistics Division.[10] This yields information on international trade at the level of 93 three-digit manufacturing industries.

From the German perspective, the fall of the Iron Curtain and China's opening toward the world markets were important but virtually unanticipated

[8] As for self-employment, bear in mind that Germany ranks among the countries with the lowest entrepreneurship rates in the world (Global Entrepreneurship Monitor 2017). Even if someone becomes a so called "necessity entrepreneur" as an alternative to collecting unemployment insurance benefits, this kind of self-employment tends to be highly unstable and does not yield a substantial income (see Block and Wagner 2010).

[9] This is a standard approach in the labor economics literature to take into account ex ante earnings differences across workers. 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 (nonnormalized) log annual earnings. Instead of normalizing with base year earnings of a single year, we can also take an average over a few years. Results are very similar.

[10] Ambivalent cases were partitioned according to national employment shares in 1978.

Table 1
Descriptive Overview

	Mean (SD)	
	1990–2000	2000–2010
Observations	1,230,897	1,207,948
	A. Outcomes, Cumulated over 10 Years following the Base Year	
100 × earnings/base year earnings	873.6 (414.7)	906.2 (372.1)
Days employed	2,925 (1,032)	3,179 (881)
Average daily wage	121.6 (65.0)	124.3 (77.3)
	B. Control Variables, Measured in the Base Year	
Base year earnings	42,870 (24,442)	47,266 (44,449)
Dummy, 1 = female	.227 (.419)	.215 (.411)
Dummy, 1 = foreign national	.124 (.330)	.095 (.294)
Dummy, 1 = age ≤34 years	.372 (.483)	.310 (.463)
Dummy, 1 = age 35–44 years	.285 (.451)	.387 (.487)
Dummy, 1 = age ≥45 years	.333 (.471)	.287 (.452)
Dummy, 1 = unskilled	.215 (.411)	.139 (.346)
Dummy, 1 = vocational training	.710 (.454)	.759 (.428)
Dummy, 1 = college degree	.075 (.263)	.102 (.303)
Dummy, 1 = tenure 2–4 years	.248 (.432)	.276 (.447)
Dummy, 1 = tenure 5–9 years	.264 (.441)	.304 (.460)
Dummy, 1 = tenure ≥10 years	.444 (.497)	.364 (.481)
Dummy, 1 = plant size ≤9	.043 (.203)	.046 (.210)
Dummy, 1 = plant size 10–99	.181 (.385)	.245 (.430)
Dummy, 1 = plant size 100–499	.263 (.440)	.313 (.464)
Dummy, 1 = plant size 500–999	.125 (.330)	.118 (.323)
Dummy, 1 = plant size 1,000–9,999	.276 (.447)	.201 (.401)
Dummy, 1 = plant size ≥10,000	.112 (.315)	.074 (.262)
Dummy, 1 = food products	.074 (.261)	.089 (.285)
Dummy, 1 = consumer goods	.085 (.280)	.070 (.255)
Dummy, 1 = industrial goods	.369 (.482)	.391 (.488)
Dummy, 1 = capital goods	.472 (.499)	.450 (.497)
	C. Trade Exposure	
Δ export exposure	20.211 (16.874)	34.933 (28.079)
10th–90th percentile	3.479–44.136	5.436–68.933
25th–75th percentile	9.185–26.997	17.989–50.216
Δ import exposure	22.806 (26.198)	28.169 (54.724)
10th–90th percentile	1.867–47.600	1.878–68.323
25th–75th percentile	7.018–32.341	4.999–30.522

NOTE.—Import (export) exposure is the 10-year increase in imports (exports) from (to) China and Eastern Europe relative to the industry's total wage bill in the year before the base year.

shocks. Starting in the beginning of the 1990s, suddenly new export markets and new competitors emerged not only in Germany's direct eastern neighbors but also in Russia and the Far East. Because of this simultaneity, it is hard to disentangle the contribution of individual countries to the overall

effect. We therefore define "the East" as China and all 21 countries that were locked behind the Iron Curtain until 1991, which include the former USSR and all of its successor states as well as other Eastern European countries.[11] Figure 1 illustrates the evolution of German industry-level trade, with respect to both the East and the world as a whole. Trade volumes are depicted on a log scale and normalized to 1 in 1990, and the graphs capture the evolution across the industry distribution for the 25th, 50th, and 75th percentiles. The solid lines show that at the median of the distribution, German trade volumes with the East increased by a factor of 10 between 1990 and 2010, both on the import and on the export side. This substantially outpaces the growth of trade with the world as a whole, which only doubled over the same period. The rise of trade exposure from the East started in the late 1980s, while the trends were flat before. It was particularly strong in the years immediately after the fall of the Iron Curtain in 1990–91, flattened out over the 1990s, and then received another boost in 2001, which coincides with the entry of China into the World Trade Organization.

As those events were sudden and largely unexpected, we may suspect that much of this observed increase in German trade stems from developments that originate in those countries, namely, the vastly rising productivity and market access of China and the Eastern European countries as they were transformed into market economies (Autor, Dorn, and Hanson 2013; Pierce and Schott 2016). This rising trade exposure then constitutes the major globalization "shock" that hit the German labor market in that period. But it does not accrue only in the form of rising import penetration from labor-abundant countries with substantially lower wages. Importantly for the contribution of our paper, it also involves the surging export opportunities, which reflects the rising demand for German products from those areas.

Figure 1 highlights the strong differences in industry-level trade exposure. The dashed lines depict the evolution of the trade volumes of the industry at the upper and lower quartiles of the respective distribution of trade flows. With respect to the East, imports and exports have increased across the whole distribution relative to 1990 but with considerable variation across industries. In table A.1 (tables A.1–A.10 are available online), we report the industries with the highest export and import volumes in 2010 and the evolution of their trade over time. As can be seen, the automotive industry has by far the highest export volume (and also the strongest increase over time), followed by other German export sectors, such as special purpose machinery or chemicals. On the import side, the car industry

[11] Namely, these are Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, and the former USSR as well as its successor states, the Russian Federation, Belarus, Estonia, Latvia, Lithuania, Moldova, Ukraine, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. In sec. III, we separately examine trade with Eastern Europe and China and show that it is sensible to combine them because of the very similar patterns of German exports.

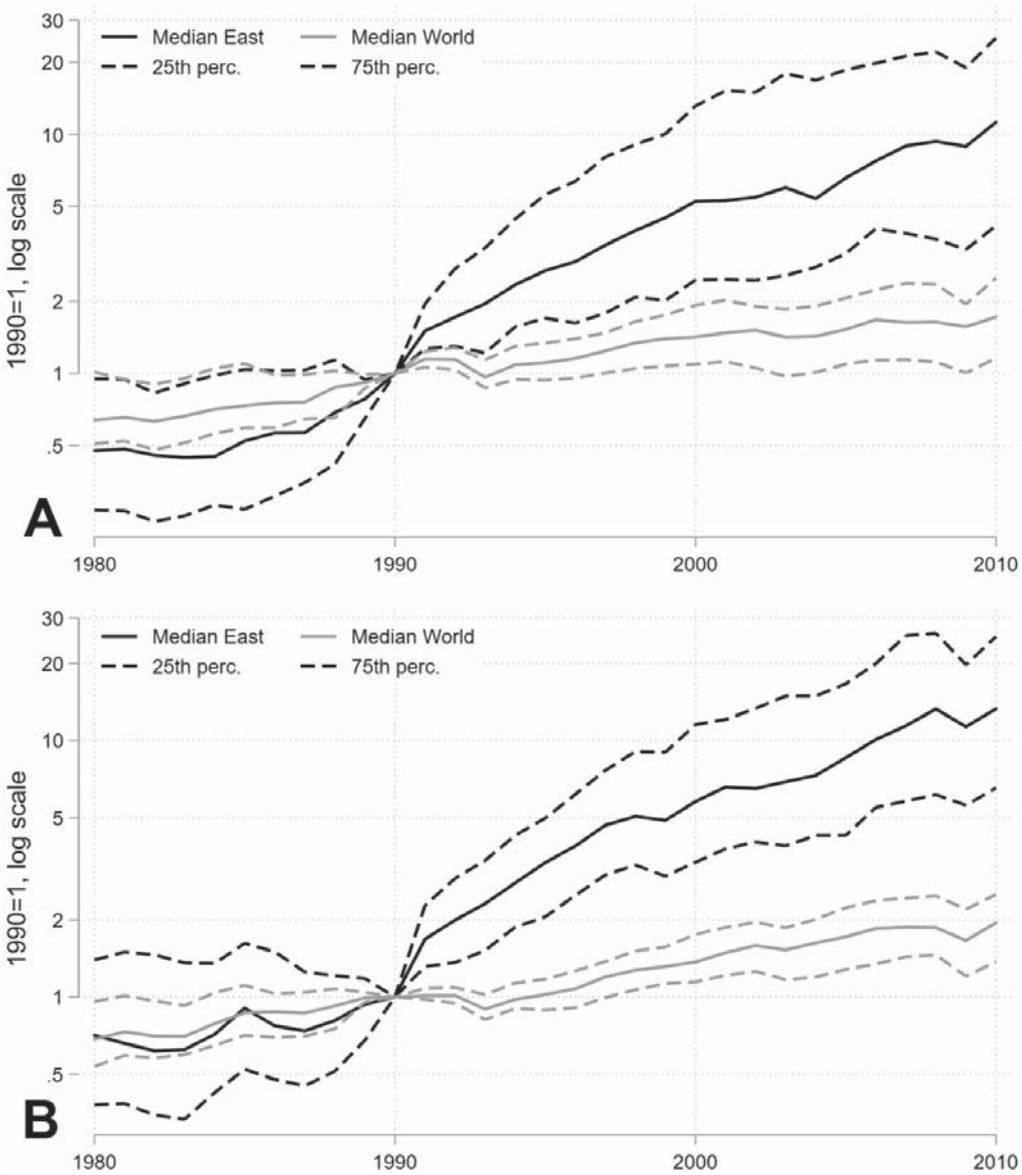

FIG. 1.—Rising German trade volumes. *A*, Imports. *B*, Exports. The graphs display quartiles of German industry-level import and export volumes, normalized to 1 in 1990 (log scale).

also shows up high on that list, as there is substantial intraindustry trade within that particular manufacturing branch. But we also see very different industries among those with the highest import penetration, in particular relatively labor-intensive industries like wearing apparel, furniture, and office machinery, where China and some Eastern European countries have developed a comparative advantage.

Rising exposure to trade from the East, hence, affects workers very differently, depending on industry affiliation. To reflect this variation, we construct our main exposure measures for import penetration and export opportunities in industry j as follows:

$$ImE_{jt} = \frac{IM_{jt}^{EAST \to D}}{\bar{w}_{j(t-1)} L_{j(t-1)}} \quad \text{and} \quad ExE_{jt} = \frac{EX_{jt}^{D \to EAST}}{\bar{w}_{j(t-1)} L_{j(t-1)}}, \tag{1}$$

where $IM_{jt}^{EAST \to D}$ and $EX_{jt}^{EAST \to D}$ are aggregate national import/export volumes with the East in industry j and year t. We normalize them with a measure for sector j's overall size in the German economy, more specifically with the total domestic wage bill lagged by 1 year.[12] Panel C of table 1 reports descriptive statistics for the individual trade exposure measures. There we report the changes of ImE_{jt} and ExE_{jt} over 10 years and find a notable heterogeneity across workers. For example, during the first decade, the worker at the 75th percentile experienced an almost five times stronger increase in import penetration than the worker at the 25th percentile and a six times stronger increase during the second decade. Similarly, for exports we also find that rising opportunities in the East affected some workers much stronger than others.[13]

III. The Overall Effects of Export and Import Exposure on Worker Careers

We begin by studying the effects of trade on the earnings trajectories of German manufacturing workers. Our estimates identify relative effects between industries. In essence, we compare the labor-market trajectories of—ex ante—observationally similar workers who differ in their initial industry of employment at the onset of the trade shocks. In our baseline model, for each worker i starting out in a manufacturing industry j, we add up all labor earnings over the next 10 years, irrespective of where they accrued, and divide them by the respective base year labor income. We use data from the two decades t = 1990–2000 and t = 2000–2010. For the first decade, we construct the dependent variable as $Y_{ijt} = \Sigma_{k=1991}^{2000} E_{ijk}/E_{ij1990}$, where i is the worker index, j is a worker's initial industry at the beginning of the decade t, and E is yearly earnings in k. For the second decade 2000–2010, the dependent variable is constructed analogously. This approach—normalizing cumulative earnings by a pretreatment base year[14]—allows us to decompose the total effects of export and imports into different channels of adjustment

[12] 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 available only from surveys of larger firms and at a different level of aggregation.

[13] At this point, we drop the comparatively small industry of manufacture of knitted and crocheted articles that comprises only 0.04% of the national wage bill in 1990 but is an extreme outlier with an increase in import exposure of 1,860% of the industry's initial wage bill.

[14] Our results are robust to using more pretreatment years to construct the denominator. That is, if we normalize cumulative earnings by 3- or 5-year averages, our estimates of interest are almost unaffected.

(Autor et al. 2014) because it permits the inclusion of all observations even when a worker's earnings from a source are equal to zero.

We regress the (normalized) cumulated individual earnings Y_{ijt} on the increases in import and export exposure of the worker's original three-digit industry j during the respective time period:

$$Y_{ijt} = \boldsymbol{\alpha} \cdot \mathbf{x}'_{ijt} + \beta_1 \cdot \Delta ImE_j + \beta_2 \cdot \Delta ExE_j + \phi_{REG(i)} + \phi_{J(j)} + \phi_t + \epsilon_{ijt}. \quad (2)$$

In the vector x_{ij} we include a rich set of worker-level variables and firm size, with dummies for gender, foreign nationality, three skill categories, three tenure categories, three age groups, and six plant size groups. We add dummies for 141 commuting zones denoted by $\Phi_{REG(i)}$. This means we identify effects within local labor markets. This is potentially important because of the German reunification shock—but as we show more directly below, the inclusion or exclusion of East Germany does not affect our estimates.

We include dummy variables for four broad manufacturing industry groups $\phi_{J(j)}$.[15] The term ϕ_t is a time dummy to differentiate the two cross sections (1990–2000 and 2000–2010).

The two main coefficients, β_1 and β_2, capture causal effects when there are no parallel unobservable shocks that simultaneously affect trade and labor market outcomes. To address this concern, we follow common practice and instrument the exposure variables with trade flows of other countries vis-à-vis the East.[16]

In panel A of table 2, we estimate model (2) by ordinary least squares (OLS). In all columns, there are statistically significant relationships between the change in trade exposure and cumulative earnings. Standard errors are clustered by industry × commuting zone × base year. Working in an industry with higher export (import) growth to Eastern Europe and China is associated with higher (lower) total earnings. Columns 1 and 2 control for worker demographics. Adding plant size indicators in column 3 reduces the export coefficient by about a third. This suggests that larger plants offer steeper wage trajectories and self-select more into exporting.

Panel B shows the second-stage results of the instrumental variable estimation. We again find statistically significant relationships in all models. Across all columns, compared with the OLS estimates, the import and

[15] These are food products, consumer goods, industrial goods, and capital goods.

[16] This instrumental variable approach has been developed by Autor, Dorn, and Hanson (2013) and applied to the German case by Dauth, Findeisen, and Suedekum (2014). We follow their approach and use the trade flows of Australia, New Zealand, Japan, Singapore, Canada, Sweden, Norway, and the United Kingdom to construct the instrument by replacing the numerators of ImE_{jt} and ExE_{jt}. 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
Trade Exposure and Individual Employment Outcomes

	(1)	(2)	(3)	(4)
	A. Ordinary Least Squares			
Export exposure	.9058***	1.0301***	.6988***	.4880***
	(.057)	(.061)	(.056)	(.047)
Import exposure	−.0940***	−.1310***	−.1540***	−.0550**
	(.031)	(.033)	(.029)	(.027)
R^2	.085	.109	.119	.126
	B. Two-Stage Least Squares			
Export exposure	1.2215***	1.3328***	.9515***	.5245***
	(.092)	(.098)	(.087)	(.084)
Import exposure	−.2234***	−.3052***	−.2677***	−.1038**
	(.046)	(.047)	(.042)	(.043)
R^2	.085	.108	.118	.126
Kleibergen-Paap weak ID *F*-statistic	32.8	32.5	31.8	44.0
	C. First Stage: Import Exposure			
Export exposure	.1565***	.1566***	.1520***	.1477***
	(.026)	(.026)	(.027)	(.023)
Import exposure	.2487***	.2488***	.2491***	.2365***
	(.018)	(.018)	(.018)	(.020)
R^2	.473	.473	.476	.501
F-statistic of excluded instruments	120.423	120.013	118.254	115.465
	D. First Stage: Export Exposure			
Export exposure	.2265***	.2239***	.2172***	.2114***
	(.018)	(.018)	(.018)	(.014)
Import exposure	.0113*	.0116*	.0121**	.0107**
	(.006)	(.006)	(.006)	(.005)
R^2	.372	.379	.397	.436
F-statistic of excluded instruments	141.193	140.585	136.269	198.303
Age, gender, nationality dummies	Yes	Yes	Yes	Yes
Education and tenure dummies	No	Yes	Yes	Yes
ln(base year earnings)	No	Yes	Yes	Yes
Plant size dummies	No	No	Yes	Yes
Broad industry dummies	No	No	No	Yes
Commuting zone dummies	No	No	No	Yes

NOTE.—Results are based on 2,438,845 workers. The outcome variable is 100 × earnings normalized by earnings in the base year cumulated over the 10 years following the base year. Import (export) exposure is the 10-year increase in imports (exports) from (to) China and Eastern Europe relative to the industry's total wage bill in the year before the base year. In panel B, this is instrumented by analogous measures constructed from trade flows of other high-income countries. Age groups are ≤34 (reference), 35–44, and ≥45 years of age in the base year. Tenure groups are <2 (reference), 2–4, 5–9, and ≥10 years. Plant size groups are ≤9 (reference), 10–99, 100–499, 500–999, 1,000–9,999, and ≥10,000 workers. Broad industries are food products (reference), consumer goods, industrial goods, and capital goods. Standard errors, clustered by industry × commuting zone × base year, are in parentheses.

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

export coefficients increase in absolute terms. This implies a negative correlation between industry export demand shocks from China/Eastern Europe for German goods and German industry labor demand shocks and a positive correlation between import demand shocks and German industry labor demand shocks. Going from column 2 to column 3, one can again observe that the export coefficient is reduced by the inclusion of plant size dummies.

Industries that face greater import competition may also be on a general downward trend that is confounded with negative trade shocks. Similarly, industries that face greater export opportunities may be on a general upward trend, correlated with the positive trade shock. That is why we include dummies for four different manufacturing industry groups in column 4, the most demanding model. The same holds true for local shocks and motivates the inclusion of 141 commuting zone dummies. Effectively, we thus compare workers across different subindustries within the same manufacturing sector/commuting zone. Controlling for confounding shocks is indeed important and reduces the effects from column 3 to column 4 for exports and imports.

To convert these estimates into economically meaningful magnitudes, consider two workers in 1990 who experience a rise in import exposure at the 75th percentile ($\Delta ImE_j = 32.34$) and at the 25th percentile ($\Delta ImE_j = 7.02$) over the following 10-year period. Our estimates from column 4 of panel B in table 2 (-0.10 for import exposure and 0.52 for export exposure) imply that, cumulated over those 10 years, the former worker's earnings will have declined by $-0.10 \times (32.34 - 7.02) = 2.5$ percentage points more relative to their respective earnings in the base year. If both workers had earned the average annual income in the base year 1990 (42,870€; see table 1), then this difference would amount to −1,085€, which equals $1,411 using the average 2010 euro to US dollar exchange rate (which is equal to 1.3.) For the second decade, the percentage point difference is also 2.5 percentage points, which amounts to a difference of −1,206€ (=$1,568). At the local labor market level, an earlier paper of ours (Dauth, Findeisen, and Suedekum 2014) documented stronger negative import effects at the regional level. The effect on local labor markets, by contrast, can work not only via incumbent workers but also includes reduced demand for labor market entrants or potential job switchers from other sectors, as shown in Dauth, Findeisen, and Suedekum (2017). Consistent with the relatively strong employment protection laws and unions present in Germany, the results imply that incumbent workers are partly shielded from the negative consequences of import competition.

For export exposure, performing an analogous benchmarking or interquartile comparison, we find a difference of $0.52 \times (27.00 - 9.19) = 9.3$ percentage points relative to the base year earnings in the first decade and of 16.8 percentage points in the second decade. This amounts to an absolute difference of +3,990€ (=$5,187) in the first decade and +7,865€ (=$10,224)

in the second decade if both workers had earned the average base year earnings.

Panels C and D show that our instruments have sufficient power. The respective *F*-statistics in column 4—our preferred model—are 115 and 198. There is strong predictive power of trade growth in other high-income countries for German trade growth with the former Eastern Bloc and China. Figure 2 shows the first-stage relationships.

A. Eastern Europe versus China

Throughout our main analysis, we aggregate imports and exports from/to China and Eastern Europe. We do this because their rising importance on the world markets happened roughly at the same time. For a country like Germany, which has close trade linkages with both, it is therefore difficult to analyze one independently of the other. Nevertheless, it is interesting to analyze which trading partner is mainly driving our results. In table A.2, we report results of several different variants.[17] First, we repeat the baseline specification in column 1. In columns 2 and 3, import and export exposure are constructed only from trade with either Eastern Europe or China. We find very similar coefficients for export exposure, which are about twice the size as the original coefficient for "the East." This is because both are strongly correlated, causing an upward bias in the coefficient when only one is included.

The effect of Chinese import penetration appears to be virtually zero, while the coefficient for imports from Eastern Europe is significantly negative and even larger than the baseline coefficient. This is in line with the more detailed analysis in Dauth, Findeisen, and Suedekum (2014). There we argued that this is because of the greater similarities in industry structures between Germany and Eastern Europe, which suggests that imports from there imply more direct competition for German industries and workers.

To analyze the effects of Eastern Europe and China jointly, we construct two measures for the net export exposure to each trading partner of industry *j*, which is the difference of the respective terms for export and import exposure from equation (1).[18] For reference, we first report in column 4 the result when using the net exposure instead of import and export exposure separately. That exercise yields very similar quantitative predictions as before. Including net export exposure with both trading partners jointly in column 5 again yields a similar result, where the original coefficient of aggregate net exports is in between the coefficients of the separate variables.

[17] Summary statistics of the modified measures for trade exposure are reported in table A.3.

[18] The instrument is constructed analogously.

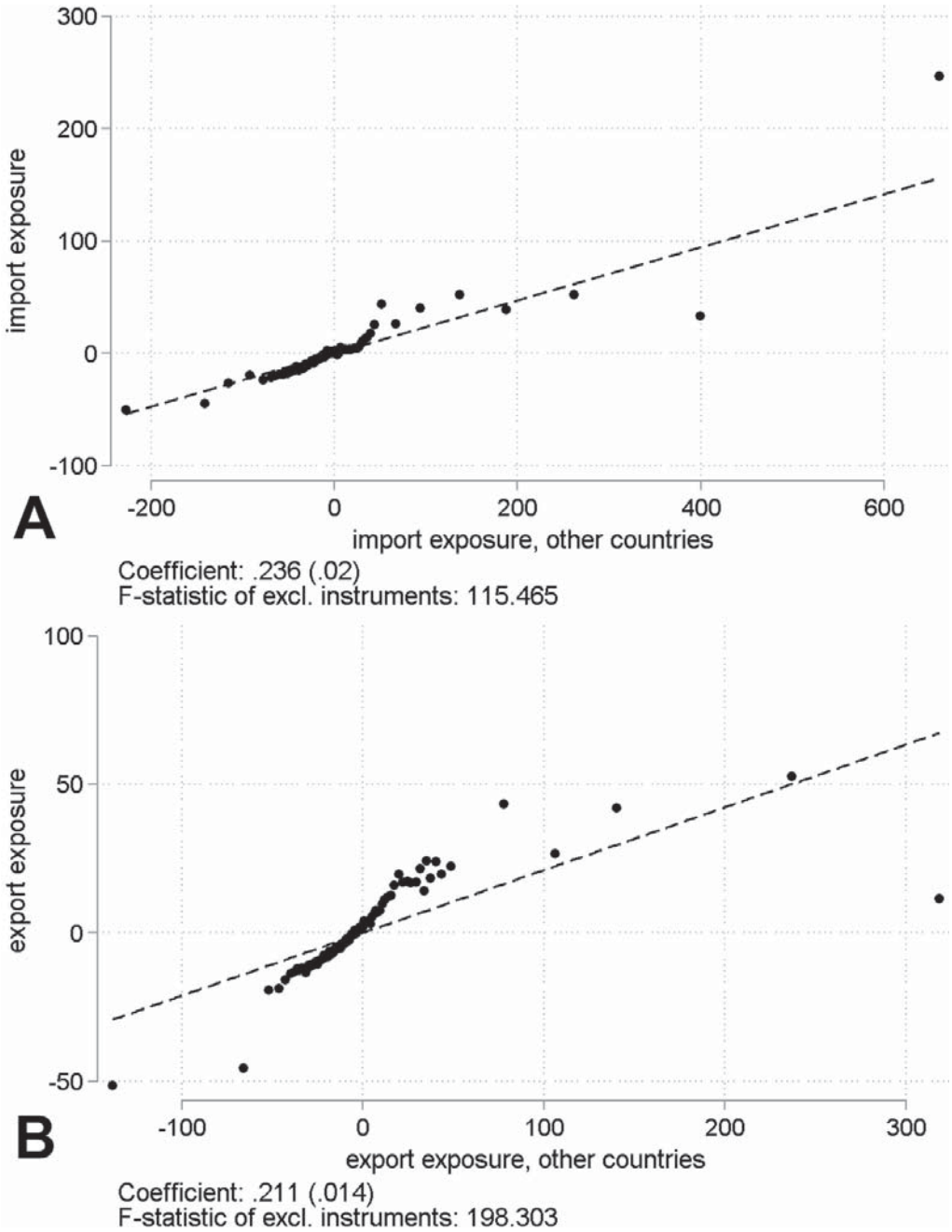

FIG. 2.—First stages, based on 2,438,845 workers. *A*, Import exposure. *B*, Export exposure. The graphs visualize the correlations of our trade exposure measures and the respective instruments. Import (export) exposure is the 10-year increase in imports (exports) from (to) China and Eastern Europe relative to the industry's total wage bill in the year before the base year. The instruments are analogously constructed from trade flows of other high-income countries. First, both variables are residualized from the other instrument relating to the other trade flow and all control variables from column 4 of table 2. Then the residuals of the instrument are classified into 100 percentiles. The points represent the average values of both residualized variables for each of the 100 bins.

B. Robustness Checks

Returning to our baseline approach, in table A.4 we check the robustness of our results along several additional margins. The German social security data, unfortunately, does not cover self-employed individuals or civil servants (*Beamte*), who cannot be laid off and have their own pension system. Lacking further information on the specific reasons why people disappear from the data other than death or emigration, we assumed so far that all other workers who drop out of the data during the observation period are nonemployed with labor earnings set to zero. However, our results on import competition would be too pessimistic if those workers become public servants or self-employed rather than dropping out of the labor force. To check whether this affects our results, we change our outcome variable to be unaffected by the times an individual is not observed in the data. We redefine employment as the percentage of days an individual is registered as employed relative to the total number of days this person is observed in the data. This variation now comes purely from times that a person is registered either as employed or as receiving benefits from unemployment insurance. In column 1, we see that an increase of import exposure by 1 percentage point reduces the employment time by 0.9 percentage points. To compare this coefficient to the results for earnings, one must divide it by 10 since this outcome is normalized by the total duration over 10 years and not just the base year. The results of this exercise are therefore in the same ballpark as our baseline findings.

Next, we scrutinize the decision to drop the industry "manufacture of knitted and crocheted articles" (see n. 13). This is a very small industry, but its import exposure is around three times as large as the second most exposed industry. However, given its small size, omitting this industry does not substantially affect our results.

Another concern is that our approach picks up the specific developments in East Germany, which is included in the second time period starting in 2000. Since East German manufacturing was mostly not competitive, this sector declined strongly after the reunification. The employment share of the manufacturing sector is substantially lower in East than in West Germany, and hence only around 5% of all observations started in an East German plant. While controlling for region dummies should further mitigate this concern, we also drop all workers from Berlin or one of the East German states but find very similar results as in column 3.

Our measure for trade exposure might be too narrow, since trade shocks could be transmitted along the value chain. We follow Acemoglu et al. (2016) and augment the measures of import and export exposure for each industry j with the weighted exposure of all downstream industries.[19] When

[19] The intuition is that the steel industry, e.g., not only is directly affected by import shocks but also is indirectly affected, as other negatively affected sectors may

using those comprehensive measures, we estimate similar coefficients as in our baseline. This suggests that our results remain robust when taking input-output linkages into account.

Next, we consider an alternative estimation strategy where net trade exposure is constructed from the residuals of a preceding gravity estimation (see app. C; apps. A–D are available online). For reference, we again report in column 5 the coefficient for the net trade exposure constructed as the difference of the terms in equation (1). The coefficient in column 6 is also highly significant, and multiplied with the observed changes in the gravity measure implies consistent (although somewhat more conservative) magnitudes.[20]

Finally, we are concerned that our results may pick up industry-specific pretrends. To explore this possibility, we run a placebo regression to analyze whether there is a correlation between past earnings trends and the future rise of trade exposure. Specifically, we regress cumulated earnings 1981–90 of manufacturing workers in 1980 on the increase of net export exposure over the period 1990–2010, controlling for the same variables as in the baseline and using analogous instruments. We obtain an insignificant and small estimate in column 7, which reassures that our results capture not industry trajectories but causal effects of rising trade exposure.

IV. Individual Adjustments to Export and Import Shocks

This section presents our first set of main results regarding how individual workers adjust to import and export shocks. We will exploit the granularity of our data, which allows us to measure employment with daily precision and thus to reconstruct the complete labor force history of all workers in our sample highly accurately. In this section we describe our empirical approach and the main results. In section V we investigate heterogeneous effects for different workers, and in section VI we will connect our empirical results to the large and growing theoretical literature on trade and labor markets.

So far we have studied total cumulative earnings over 10 years, irrespective of where they accrued. To proceed, we now decompose Y_{ij} into different parts and add up all earnings or days of employment that worker i has collected during the respective decade in the original establishment, in different establishments within the same two-digit manufacturing industry, in different manufacturing industries, or outside of manufacturing.[21] The results are in table 3. In column 1, we repeat our estimation from column 4

demand less raw steel. Similarly, the car parts industry benefits directly not only from more export opportunities but also via its most important downstream customer, the automotive industry. See app. B for more details.

[20] Comparing a worker at the first and third quartile of the increase of net export exposure, our traditional approach suggests a difference of $(21.12 - (-5.47)) \times 0.17 = 4.57$ percent of base year earnings, and the gravity approach suggests a difference of $(2.33 - (-0.58)) \times 0.62 = 1.80$ percent of base year earnings.

[21] The results are robust to using the same three-digit industry.

Table 3
Adjustment

	All Employers	Same Sector			Other Sector
	(1)	(2)	(3)	(4)	(5)
	A. Earnings				
Same two-digit industry		Yes	Yes	No	No
Same employer		Yes	No	No	No
Export exposure	.5245***	.3528*	.3017**	.0344	−.1644*
	(.084)	(.213)	(.149)	(.062)	(.092)
Import exposure	−.1038**	−.5469***	−.1159**	.1141***	.4449***
	(.043)	(.111)	(.055)	(.023)	(.063)
	B. Employment				
Same two-digit industry		Yes	Yes	No	No
Same employer		Yes	No	No	No
Export exposure	.7078***	.5393	.9181*	−.0080	−.7416**
	(.188)	(.713)	(.504)	(.200)	(.299)
Import exposure	−.5798***	−1.9069***	−.3852**	.3468***	1.3656***
	(.112)	(.374)	(.187)	(.076)	(.182)

NOTE.—Results are based on 2,438,845 workers. The outcome variables are 100 × earnings normalized by earnings in the base year (panel A) and cumulated days of employment (panel B), both cumulated over the 10 years following the base year. For col. 1, the outcomes are cumulated over all employment spells in the 10 years following the base year. For col. 2, the outcomes are cumulated only when they occurred at the original workplace. For the other columns, the outcomes are cumulated only when they occurred at a different plant in the same industry (col. 3), at a plant in a different manufacturing industry (col. 4), and outside the manufacturing sector (col. 5). Import (export) exposure is the 10-year increase in imports (exports) from (to) China and Eastern Europe relative to the industry's total wage bill in the year before the base year. Both are instrumented by analogous measures constructed from trade flows of other high-income countries. All regressions include the same control variables as in col. 4 of table 2. Standard errors, clustered by industry × commuting zone × base year, are in parentheses.

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

of panel B in table 2. In columns 2–5, we then investigate how trade shocks to the initial industry *j* have affected the different additive components of total cumulative earnings. Notice that the coefficients in columns 2–5 add up to the coefficient in column 1 by construction.[22]

A. Exports: Workers Switching across Firms

We start by discussing the results for exports and earnings in panel A of table 3. In column 2, the point estimate of 0.35 shows that the earnings increases within the original firm are the largest contributor to the total effect. In column 3, however, we see that an economically and statistically significant part of the total earnings effects comes from higher earnings at other firms within the same industry. The size of the effect—0.30—is in fact very close to the value in column 2. It shows that exports cause wage gains on the job but also cause workers to change workplaces within industries and that both adjustment mechanisms are of similar economic magnitude.

[22] Autor et al. (2014) introduce this decomposition.

Earnings are the product of employment and wages. We can look directly at employment by exploiting that we observe every worker on a daily level. We replace the dependent variable in equation (2) by the (cumulated) days of employment in panel B. As expected from the earnings results, export exposure stabilizes employment, as seen in column 1. The most important finding here, however, is that the coefficient in column 3 with a value of 0.92 is larger—and almost twice the size of the coefficient in column 2. An exogenous rise in export exposure causes turnover or the reallocation of workers across firms, in line with the prediction of expanding employment at the most productive firms in heterogeneous firm models. The economic size of this effect is considerable. Comparing again workers at the 75th percentile to the 25th percentile of the export exposure distribution, we calculate that in the industry with higher export exposure, days worked at a different firm within the same industry increase by 10%.

Column 4 shows relatively precise zero effects of export exposure on earnings and employment in other industries within manufacturing. Labor reallocations happen within industry, suggesting that firms that expand do so by poaching workers from other competing firms in the same industry. This is consistent with the importance of industry-specific human capital that we will investigate in more detail below. Finally, column 5 shows there is an offsetting force to the increase in employment in a worker's original industry. Earnings and employment in the service sector are reduced.

B. Imports: Manufacturing Exits

The import estimates strikingly show the importance of labor market adjustments in Germany. While the total response in column 1 of table 3 is relatively modest—remember from the last section that comparing workers at the 75th percentile to those at the 25th percentile in import exposure, we find that the former earn 1,206€ ($1,568) less over 10 years—this hides large effects on earnings and time spent with the original employer. In column 2, one sees that earnings losses at a worker's original firm are more than five times as large compared with the overall response in column 1. For days employed, the effect in column 2 is still about three times larger compared with column 1.

How do workers adjust, then, to import pressure? The answer is by transitioning to the service sector. For earnings, the coefficient in column 5 is 81% of the size of the own-firm response in column 2. For employment, the value is 72%. Interestingly, changes in the transition rates within the manufacturing sector roughly cancel each other out. From columns 3 and 4 in both panels, we get the result that transitions within the original industry decrease, but this is offset by an increase of similar proportion for earnings/employment in other manufacturing industries.

In summary, laid-off workers in import-competing industries make up only a very small part of their total losses in other manufacturing industries.

Instead, they are moving out of manufacturing. In the bigger picture, this may be a surprising finding, considering that in the trade integration episodes we study (the collapse of the Iron Curtain and the opening of China) and also in general, Germany is running a trade surplus. Our findings suggest that workers affected by import competition are only partially absorbed by the expanding export industries.

C. Industry-Specific Human Capital

Our results so far have shown that mobility within an industry is an important margin for workers to adjust to an export shock. At the same time, workers who move out of their original industry recover most—but not all—of their losses at their original plant due to an import chock. This suggests that a crucial determinant of successful adjustment is specific human capital. Workers who possess a lot of industry-specific human capital might be particularly attractive for other firms in expanding industries but might also find it more difficult to adjust to a negative shock and transition to different industries. In this subsection, we analyze this in more detail.

We measure the importance of industry-specific human capital according to the index proposed by Utar (2018). She argues that some occupations require only general human capital, which allows workers to easily move between industries. An example is janitors. Other occupations—such as tailors, for example—are so specific that workers are "locked" into their original industry. She measures an occupation's industry specificity IndSpec_{oj} as the ratio of workers of occupation o in industry j relative to the total number of workers in occupation o. Workers with an occupation with a high value of IndSpec_{oj} possess human capital that is very industry specific and therefore difficult to transfer to different industries. The advantage of this measure is that it also varies within and not only between industries.[23] We compute this index for all combinations of 89 two-digit occupations and 22 two-digit manufacturing industries observed in the respective base year, normalize it to have a standard deviation of 1, and interact it with our original measures for export and import exposure. The results are reported in table A.5.

The isolated coefficients of export and import exposure in column 1 are similar to the original results for total earnings. The coefficients of the interaction term of import exposure and industry specificity in columns 1 and 2 are relatively small and insignificant. Workers in very specific occupations have no additional losses in terms of own-industry earnings. However,

[23] Neal (1995) and Parent (2000) analyze the rewards to industry-specific experience as opposed to plant tenure. In principle, one could modify their approach and allow this measure to vary over industries. However, adapting this for the present context is not straightforward, as one would have to deal with endogeneity concerns discussed in the original studies and make strong assumptions about the functional form to obtain a single measure.

while mobility between manufacturing industries allows compensation for some of the initial losses in general according to column 3, this adjustment channel is at least partly obstructed by specificity of human capital. This is consistent with Utar (2018), who also finds that Danish workers with high industry-specific human capital are less likely to move to a different industry in response to an import shock.

By contrast, the positive effects of exports are magnified for workers with higher industry-specific human capital. Since investment in specific human capital is costly, these workers are more attractive for firms that expand because of the export shock, and therefore they are able to reap more of the benefits from exports.

V. Heterogeneity of Workers and Firms: AKM Effects

We now consider heterogeneous effects of export and import shocks for workers with different skills and for workers employed at firms of different quality.

A. Measurement

We measure skill for workers and firm characteristics by using preestimated two-way fixed effects models. The methodology was introduced by Abowd, Kramarz, and Margolis (1999) and has since been widely applied, prominently by Card, Heining, and Kline (2013) for Germany. In particular, their wage regression is $\ln(\text{wage}_{it}) = \alpha_i + \psi_{p(it)} + x'_{it} + r_{it}$, where observable worker characteristics x'_{it} are education-specific age profiles. The person effects α_i can therefore be interpreted as unobservable worker skills that are rewarded equally across different employers. Similarly, the establishment fixed effects $\psi_{p(it)}$ are proportional pay premiums (or discounts) by plant p to all its employees. They may stem, for example, from rent sharing or efficiency wage considerations and serve as a proxy for workplace quality.

To implement this approach, we use the fixed effects estimates from Card, Heining, and Kline (2013), which are based on the universe of social security records in Germany and can be merged to our 30% sample via unique person and establishment identifiers. It is important to note that those fixed effects are identified from time windows that precede the start of our two decades, since they would otherwise be endogenous to the later trade exposure trends.[24] We define three dummy variables that indicate the

[24] For the first decade of our analysis we use their estimated fixed effects from the 1985–91 time interval, and for the second decade we use their estimates for the 1996–2002 period. Estimation of the fixed effects requires all firms to be connected by worker mobility. Firms or workers who were not part of this connected set have no fixed effects and hence cannot be used in our analysis in this section. This reduces the number of observations by around 6.6%. We thank Joerg Heining for making these estimates available to us.

terciles of the person and the establishment fixed effects distributions, in the latter case pertaining to the observed worker-plant matching in the respective base year, which we interact with our measures for trade exposure.

We then repeat our empirical estimations and let the coefficients of import and export exposure vary with the tercile of the person and the establishment fixed effects distributions. Essentially, these are triple difference estimates and, since we normalize cumulative earnings by preperiod earnings, the effects can again be interpreted on a proportional scale, similar to looking at percentage changes.

B. Results

Table 4 contains results for the worker skill rankings, and table 5 contains those for the firm "quality" rankings. We start our discussion with the worker skill results.

Column 1 in table 4 shows that export exposure has a strong effect on the returns to skill. The most skilled workers from the top tercile of the skill distribution in export-exposed industries see large earnings gains relative to

Table 4
Earnings Adjustment by Worker Quality

	All Employers	Same Sector			Other Sector
	(1)	(2)	(3)	(4)	(5)
Same two-digit industry		Yes	Yes	No	No
Same employer		Yes	No	No	No
ExE bottom tercile	−.8571***	−.4721**	.0662	−.1570***	−.2942***
	(.118)	(.189)	(.158)	(.046)	(.057)
ExE middle tercile	.3202***	.4885**	.1612	−.0416	−.2879***
	(.083)	(.197)	(.124)	(.048)	(.075)
ExE top tercile	1.9012***	.8281***	.5501***	.3132***	.2098
	(.138)	(.243)	(.181)	(.092)	(.132)
ImE bottom tercile	−.5063***	−.5608***	−.1883***	.0833***	.1595***
	(.067)	(.104)	(.064)	(.022)	(.033)
ImE middle tercile	−.1865***	−.5535***	−.0574	.1013***	.3231***
	(.049)	(.111)	(.055)	(.023)	(.049)
ImE top tercile	.2584***	−.5745***	−.1041	.1491***	.7878***
	(.083)	(.155)	(.075)	(.037)	(.108)

NOTE.—Shown are two-stage least squares results, based on 2,277,914 workers. The outcome variables are 100 × earnings normalized by earnings in the base year cumulated over the 10 years following the base year. For col. 1, the outcomes are cumulated over all employment spells in the 20 years following the base year. For col. 2, the outcomes are cumulated only when they occurred at the original workplace. For the other columns, the outcomes are cumulated only when they occurred at a different plant in the same industry (col. 3), at a plant in a different manufacturing industry (col. 4), and outside the manufacturing sector (col. 5). This table reports coefficients of interactions of import (export) exposure (*ImE* and *ExE*) with dummies indicating the tercile of a worker's individual fixed effect from Card, Heining, and Kline (2013). Import (export) exposure is the 10-year increase in imports (exports) from (to) China and Eastern Europe relative to the industry's total wage bill in the year before the base year. All trade exposure variables are instrumented by analogous measures constructed from trade flows of other high-income countries. All regressions include the same control variables as in col. 4 of table 2. Standard errors, clustered by industry × commuting zone × base year, are in parentheses.

** Significant at 5%.

*** Significant at 1%.

Table 5
Earnings Adjustment by Plant Quality

	All Employers	Same Sector			Other Sector
	(1)	(2)	(3)	(4)	(5)
Same two-digit industry		Yes	Yes	No	No
Same employer		Yes	No	No	No
ExE bottom tercile	.1302	−.0199	−.0761	.1937***	.0325
	(.092)	(.202)	(.134)	(.052)	(.081)
ExE middle tercile	.5644***	.1675	.4940**	.0387	−.1358
	(.101)	(.285)	(.210)	(.081)	(.101)
ExE top tercile	.8215***	.9797***	.3650*	−.1316	−.3915**
	(.128)	(.330)	(.209)	(.104)	(.164)
ImE bottom tercile	−.0689	−.2571**	−.0754	.0473**	.2163***
	(.043)	(.111)	(.069)	(.021)	(.041)
ImE middle tercile	−.0610	−.5029***	−.1545**	.1575***	.4389***
	(.074)	(.142)	(.073)	(.039)	(.089)
ImE top tercile	−.2252**	−1.3495***	−.0982	.1607***	1.0617***
	(.097)	(.310)	(.139)	(.060)	(.200)

NOTE.—Shown are two-stage least squares results, based on 2,279,638 workers. The outcome variables are 100 × earnings normalized by earnings in the base year cumulated over the 10 years following the base year. For col. 1, the outcomes are cumulated over all employment spells in the 20 years following the base year. For col. 2, the outcomes are cumulated only when they occurred at the original workplace. For the other columns, the outcomes are cumulated only when they occurred at a different plant in the same industry (col. 3), at a plant in a different manufacturing industry (col. 4), and outside the manufacturing sector (col. 5). This table reports coefficients of interactions of import (export) exposure (*ImE* and *ExE*) with dummies indicating the tercile of a worker's workplace fixed effect from Card, Heining, and Kline (2013). Import (export) exposure is the 10-year increase in imports (exports) from (to) China and Eastern Europe relative to the industry's total wage bill in the year before the base year. All trade exposure variables are instrumented by analogous measures constructed from trade flows of other high-income countries. All regressions include the same control variables as in col. 4 of table 2. Standard errors, clustered by industry × commuting zone × base year, are in parentheses.

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

highly skilled workers in industries that are not exposed to trade. To put the effect into quantitative perspective, note that its magnitude of 1.90 is almost four times the size of the benchmark coefficient of 0.52 (table 3, panel A, col. 1). Second, low- and medium-skilled workers from the bottom and middle tercile, respectively, experience small or even negative effects of export exposure. Taken together, in highly export-exposed industries, the most skilled German workers—as measured by their AKM person effect—received large earnings gains compared with lower-skilled workers in the same industries. Skilled workers profited the most from trade globalization in Germany.

Next, when focusing on columns 2 and 3, we see that a significant part of these gains for high-skilled workers stems from firm mobility within the original industry of employment. As with column 1, the majority of the average effect of earnings gains from intraindustry firm mobility from column 3 in panel A of table 3 is driven by the highest-skilled workers in Germany. This is consistent with increased labor demand for skills within the

export industries driven by firms that self-select into new markets. In table A.6, we can confirm these mobility patterns across skill groups by directly looking at employment instead of earnings. In more export-exposed industries, highly skilled workers actually see a decrease in their employment in their original firm, but this decrease is dominated by an increase in the days employed at competitor firms within the same original industry.

The import results in table 4 reveal that the negative consequences are mostly borne by low-skilled workers. A key finding here is that the result is driven by the differential ability to adjust by skill group. Column 2 shows remarkably similar effects for earnings with the original employer. Columns 4 and 5 reveal that more highly skilled workers can soften or even overcompensate the initial loss by transitions to the service sector and other manufacturing industries.

Table 5 displays the two-stage least squares (2SLS) coefficients when we let the effects of export exposure and import exposure vary with the rank of a worker's initial employer in the firm effects distribution. Remember that the firm effects measure a (proportional) pay premium of the plant (controlling for the skill of the workforce). One expects a positive correlation of the firm effects with the productivity level of the firm, but it has been widely discussed in the literature that the estimated effects should not be literally interpreted as productivity (Card et al. 2018).

Turning to the results in table 5, we observe in column 1 that the coefficient for workers from firms in the top tercile is significantly larger than that for the other two terciles. All effects are precisely estimated. Second, in column 2 we reassuringly observe that for workers from firms in the top tercile the earnings gains indeed happen with the original employer. For workers starting out with a firm in the lower two terciles, in contrast, we cannot find statistically significant gains on the job. Interestingly, workers starting out in firms in the middle of the distribution see sizable gains in different firms but within the same industry (col. 3). Presumably, industry export exposure increased labor demand by exporting firms and allowed these workers to move up in the establishment ladder.

For the import results, we see in column 1 that the negative effects are driven by workers starting out in the plants that—before the trade shocks materialized—paid the largest wage premiums to all of its workers. Column 2 shows clearly—with a strongly negative coefficient of −1.35—that this stems from earnings losses with the original firm. In table A.7, we can narrow down the channel further by looking at employment directly. There we find that workers in importing competing industries starting out at high-wage plants see a very large reduction in employment at their original firm. Taken together, the negative labor market consequences of import competition are borne by workers at high-paying plants that lay off workers. Subsequently, these workers lose their workplace-specific rent they enjoyed at the original firm.

C. Trade and the Quality of Worker-Firm Matching

One of the main insights of this paper is that exports induce mobility of high-skilled workers to high-paying plants. A complementary question is where in the wage distribution of their new workplaces those movers end up.

To answer this question, we modify our empirical approach. For each year in the observation periods 1991–2000 and 2001–10, we identify those from the 2,438,845 individuals who have either stayed continuously with their original employer (incumbents) or have moved from their original employer to a new plant in the same industry (movers).[25] We then regress the log daily wage on a dummy indicating a mover and a number of control variables. To analyze whether those wage differences vary with respect to the exposure to international trade, we interact this dummy with our measures for export and import exposure. We run this regression separately for movers and stayers observed either 2 or 5 years after the start of the respective period.

A simple comparison of all movers and stayers might be problematic in several ways. Even if movers receive random job offers, they are likely to chose to move only if the new job is more lucrative. We therefore control for how well a plant pays their workers in general by including the plant effect from Card, Heining, and Kline (2013), estimated in the period that ends at the beginning of the respective observation window. Since movers are also likely a positive selection of the workforce in their old plant, we furthermore control for the preestimated worker effect, age, and labor market experience. To account for structural differences across industries, we also include three-digit industry fixed effects. This means that the isolated export and import exposure variables are perfectly collinear to the industry effects but their interactions with the mover dummy are still identified. In a final specification, we also account for the fact that incumbents have accumulated firm-specific human capital by including a linear term for tenure, which is zero for movers.

The results in table A.8 indicate that early movers receive around 3% higher wages compared with incumbent workers. Since this holds even when observed and unobserved characteristics of the two groups are accounted for, the only explanation is that those movers are better matches to their new firms compared with their incumbent coworkers. The difference between movers and stayers increases when we account for the fact that movers start with no firm-specific human capital. For people who move 5 years after the beginning of the period, we observe a higher wage only if their lack of tenure is accounted for. While import exposure neither increases

[25] Because our data offer only information on daily wages, we drop all observations of part-time employment, since their daily wages are not comparable to those of full-time workers.

nor decreases this relation, the wage difference between movers and incumbents is bigger in industries with a strong export exposure. Apparently, the matching of movers and their new firms improves because of exports. In addition to the increased assortative matching we found in this section, the quality of the new matches themselves seems to be better than for the incumbent workers. This finding is in line with Krishna, Poole, and Senses (2014), who find that trade liberalization leads to an increase in worker ability in Brazilian-exporting firms and an increase in the quality of worker-firm matches. The paper by Gibbons et al. (2005) considers the case where different sectors value skills differently. Learning about workers' comparative advantages over time leads to dynamic sorting across sectors. Empirically, their model in addition implies that the returns to skills are higher in high-wage sectors. One could imagine an extension of this mechanism that operates across employers within an industry. It is also very plausible that trade and exports amplify differences in the returns to skills, increasing them more in some firms than in others. This would mean that movers in sectors treated by export shocks should have larger gains, consistent with our results.

VI. Relationship to Theory

In this section we will connect our empirical findings with the growing theoretical literature integrating heterogeneous firms in the spirit of Melitz (2003) with various labor market imperfections.

The central building block is the self-selection of the most productive firms in an industry into export markets, which leads to an increased labor demand at these firms. Since we focus on the workers' perspective in this paper, we should observe that a substantial part of the earnings gains from exports for manufacturing workers are realized in different firms than the original employer. If parts of workers' human capital is industry specific, those effects should show up in earnings gains in different plants within the same industry. In section IV, we found evidence in table 3 that is precisely in line with this key channel of the theoretical literature. Moreover, we found that the quantitative importance of this reallocation channel is substantial and is indeed as important for individual workers as on-the-job earnings gains from exporting.

The baseline Melitz model assumes identical workers and competitive labor markets. Thus, the baseline model makes no predictions for the effect of trade for earnings inequality, since wages are homogeneous across all workers and firms. A next generation of papers, including Sampson (2014), Egger and Kreickemeier (2012), Amiti and Davis (2012), and Helpman, Itskhoki, and Redding (2010), studies the interaction of labor market frictions or worker heterogeneity with trade. Those models make a richer set of interesting predictions for the labor market effects of trade, and our empirical results also speak to this theoretical literature.

In Sampson (2014), workers are ex ante heterogeneous with regard to their skill level. Matching is positive assortative by (strict) log supermodularity between worker skills and firm productivities. Because skilled workers are more likely to work in firms that self-select into exporting (by positive assortative matching), one should expect an increase in earnings inequality between workers of different skills in exposed industries. Our empirical results confirm this prediction. Moreover, since more productive firms also increase their demand for skilled labor, one expects that in particular highly skilled workers realize earnings gains by switching firms. This is in line with our findings in table 4. Such reallocations in response to rising export opportunities may take place within but also between industries. But consistent with the notion of industry-specific human capital, analyzed in table A.5, we have empirically found a stronger effect on within-industry reallocations.

A different approach is taken in the models of Egger and Kreickemeier (2012) and Amiti and Davis (2012). Firms share the rents from increased revenues with their workers. Firms also select into export markets on the basis of their productivity, since they must cover a fixed exporting cost, so more productive firms also pay higher wages. We should, therefore, expect that in export-exposed industries, earnings for workers employed in more productive firms should increase more than those in their less productive counterparts. Unfortunately, direct measures of productivity are not available in our empirical analysis. However, when ranking firms according to their establishment fixed effects from the AKM model, as discussed in section V, we indeed find strong evidence in table 5 that earnings are increased the most for workers in highly ranked firms.

In an influential paper, Helpman, Itskhoki, and Redding (2010) have developed a theory of trade and wages that relies on search and matching in the labor market with homogenous workers, but the productivity of workers in a specific job is a random draw. Firms can screen workers and learn something about the fit of a worker to the firm, but this is costly. Selection into exporting provides productive firms with the strongest incentives to screen, which further increases productivity differences. Since part of the productivity increases are passed on to workers in the wage-bargaining process, export exposure will have an effect on earnings inequality between firms within industries.[26] In particular, trade should also improve the quality of worker-firm matching, which is consistent with the results we report in table A.8.

[26] In detail, in their model trade liberalization has nonmonotonic effects on income inequality within industries. Starting from autarky, inequality will rise. However, inequality peaks when the fraction of exporters is less than 1. When trade costs become so small that all firms decide to export, inequality will fall again to autarky levels. In Sampson (2014), inequality will unambiguously increase in percentage/log terms (and therefore also in absolute terms) because of log supermodularity of the production function. This is consistent with our results. In the fair wage

In sum, our empirical analysis reveals results that are firmly in line with existing theories on how trade liberalization affects the labor market in the presence of worker heterogeneity. In particular, (relative) earnings gains in export-exposed industries are firstly driven by high-skilled workers who profit on the job. In other words, when employed at a plant that is highly ranked, there is no need for workers to switch firms to profit from export opportunities, but the earnings gains for these workers materialize to a large extent at the original employer. Additionally, there are earnings gains from switching to different firms within the same industry in all models, and we indeed find empirical evidence for both channels.

VII. Trade and the Costs of Job Displacement

We have so far estimated the labor market impacts of trade by comparing workers across their start-of-period industry affiliation. Our findings suggest that workers in increasingly import-competing industries are more likely to leave their original employer. Some are then absorbed by the expanding export industries, but the majority take jobs in the service sector. Since this is related to a drop in wages, we conjecture that those separations are involuntary.

A related and influential literature has focused on the long-run consequences of job loss, following the pioneering work by Jacobson, LaLonde, and Sullivan (1993). This literature focuses on job losses that result from mass layoff events, as they are arguably exogenous from the individual's perspective. The methodology used in the mass layoff literature employs an event-study design to relate the discrete shock of a worker's layoff to counterfactual labor market outcomes.[27] Davis and von Wachter (2011) and, more recently, Schmieder, von Wachter, and Heining (2018) show that the long-term costs of job loss vary with the macroeconomic situation at the time of the layoff. Being laid off during a recession leaves a deeper scar in a worker's earnings biography compared with being laid off during a boom. Following this logic, we now investigate whether exposure to international trade induces a similar heterogeneity. The adjustment paths of workers from different industries may be systematically linked to import competition. If human capital that has been accumulated in one industry is difficult to apply in other industries, laid-off workers in import-competing industries are

model of Amiti and Davis (2012), there is no unambiguous prediction for percentage changes. In their empirical application using firm-level data on wages from Indonesia, Amiti and Davis (2012) find evidence that inequality increases in log terms, mirroring our results with worker-level data. The model of Helpman, Itskhoki, and Redding (2010) is structurally estimated in Helpman et al. (2017). Their results imply that trade liberalization in Brazil increased log wage inequality, in line with what we find for Germany.

[27] See Couch and Placzek (2010) and Huttunen, Møen, and Salvanes (2018) for more recent works employing the same identification strategy.

likely hit particularly severely, as they might find it more difficult to find a new job in their own industry.

In this section, we combine the two sources of variation—industry affiliation before the trade shocks and exploiting mass layoff events—to ask how import competition affects the cost of job displacement. This complements our analysis from the previous section, because now we focus on workers who experience a (mass) layoff. In our analysis, we will investigate differences in the scarring effects of this layoff and how it is influenced by globalization. In other words, we are interested in the question whether and how increasing import exposure in Germany affects workers' ability to adjust after layoffs.

A. Estimation: The Costs of Job Loss

Like almost all recent studies of this topic, we follow the procedure of Davis and von Wachter (2011) to estimate the cost of an involuntary job loss. The first step is to identify plants that have plausibly undergone a mass layoff somewhere between 1990 and 2009. For this task, we use the Establishment History Panel (BHP) of the Institute for Employment Research (IAB). The BHP is a plant-level aggregation of all social security notifications that cover June 30 of a given year, pertaining to the universe of all employees in the German labor market subject to social security.[28] We trace the evolution of the size of all German plants and only consider manufacturing plants with at least 50 employees and a stable workforce in the preceding 2 years. We then define a potential mass layoff event in year t^* if there is a permanent drop in employment of at least 30% within 1 year. In addition, we require that less than 25% of the leaving workers move to the same new plant, because otherwise we suspect that this might be due to restructuring within a firm rather than a layoff.

To estimate the individual cost of job loss, we obtain the full employment biographies of all employees who had been holding their main job at one of those plants for at least 3 years prior to the mass layoff event. We then identify an equal-sized control group of workers in our 30% random sample of all individuals described in section II.A. We use propensity score matching with a caliper of 0.005 to search for individuals of the same gender within the same broad manufacturing industry group (food, consumer goods, production goods, capital goods) and the same year with similar characteristics in terms of employment and earnings histories, age, nationality, education, and plant size. We ensure that each individual enters either the treatment or control group only once. The employment biographies consist of all spells of employment or recipience of benefits from the unemployment insurance and include the start and end dates of each spell. We aggregate this information to calendar years and define k as the number of years before/after the layoff. The preparation of the mass layoff data is explained in detail in

[28] A detailed description can be found in Spengler (2008).

appendix D.[29] The outcome y_{it} is the log labor earnings per calendar year. Our model is

$$y_{it} = \beta_0 + \sum_{k=-3}^{5} [\delta_k I(t = t^* + k) I(\text{layoff}) + \gamma_k I(t = t^* + k) I(\text{control})] + \alpha_{tc} + \varepsilon_{it}. \quad (3)$$

The term α_{tc} indicates fixed effects for interactions of calendar year t and birth year c of the respective individuals, and ε_{it} is a normally distributed error term that may be correlated across workers laid off in the same year. The event dummies $I(t = t^* + k)I(\text{layoff})$ and $I(t = t^* + k)I(\text{control})$ indicate the years before/after the event, separately for people actually laid off and the control group. The term $I(t = t^* - 1)I(\text{control})$ is omitted as the reference category. We run this regression separately for each three-digit industry. This means that the workers in the treatment group were laid off from a plant in the respective industry, while their matches in the control group must be employed in a different plant in the same broad industry group but not necessarily in the same industry.[30]

Figure 3 visualizes the coefficients of the time-to-layoff dummies from two separate event studies of two exemplary industries. We see that the earnings of workers in both the treatment group and the control group are very similar prior to the layoff. Starting in the year of the event, earnings decline markedly for laid-off workers, while earnings remain much more stable for the control group. There are clear and significant differences how workers from both industries recover. Former employees in TV and radio manufacturing have declining incomes until the second year after the mass layoff. They recover to some extent, but their annual earnings remain substantially below the earnings of comparable workers who were not laid off. By contrast, the average workers in manufacturing of special-purpose machines start to recover already in the second year after the mass layoff. At any point in time their earnings loss relative to the control group is less severe compared with their counterparts in TV and radio manufacturing. Five years after the layoff, their earnings do not differ significantly from those of the control group.

B. Scarring Effects and Import Competition

One major difference between manufacturing of TVs and radios and manufacturing of special-purpose machines is that the former is heavily

[29] We thank Silvina Copestake at IAB's Data and IT Management (DIM) department for handling the full sample data for us.

[30] In this exercise, we aim to study the effect of a layoff on individual earnings. Since import competition increases the probability of being laid off irrespective of whether it happens during a mass layoff or as an isolated case, drawing the control group from the same three-digit industry would not yield a valid counterfactual.

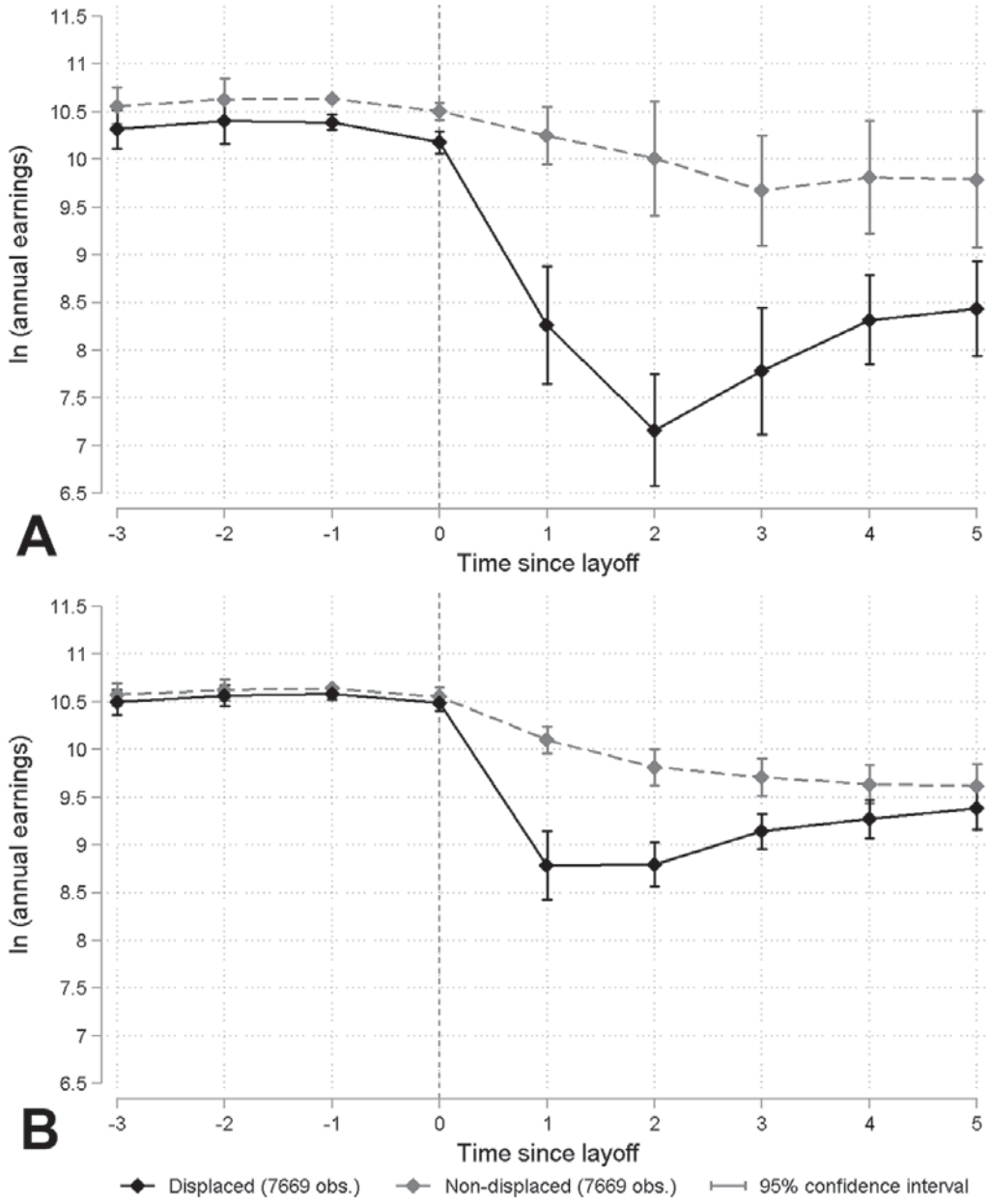

FIG. 3.—Event study results. *A*, TV and radio receivers. *B*, Special purpose machines. The graphs plot the coefficients of dummies indicating the time before and after a mass layoff from two event study regressions for two exemplary sectors.

exposed to increasing trade competition from Eastern Europe and China while the later is not. We may thus presume that the adjustment paths of workers from those different industries are systematically linked to import competition.

We follow Schmieder, von Wachter, and Heining (2018) and use the time structure of our data and the matched twins to construct double differences for each laid-off individual:

$$\Delta_{dd}\bar{y}_{ij,t} = \left(\bar{y}_{ij,\text{post}} - \bar{y}_{ij,\text{pre}}\right) - \left(\bar{y}_{i',\text{post}} - \bar{y}_{i',\text{pre}}\right), \tag{4}$$

where $\bar{y}_{i,\text{pre}}$ is the average log earnings in $t = t^* - 3, t^* - 2, t^* - 1$ of either worker i from industry j who is displaced in a mass layoff in year t^* or of her or his statistical twin i'. The variable $\bar{y}_{i,\text{post}}$ is the average of the same variable in $t = t^* + 1, t^* + 2, t^* + 3, t^* + 4, t^* + 5$. This double difference represents the log earnings a worker loses in the medium run because of the layoff.

We then regress these losses on measures for the exposure to imports and exports at the level of the industry j, constructed analogously to equation (1) with the difference that we measure trade as the increase in imports (exports) from (to) China and Eastern Europe over the period from 3 years before the layoff to 5 years after relative to the industry's total wage bill 3 years before the mass layoff. The regression model is

$$\Delta_{dd}\bar{y}_{ij,t} = \beta_1 \cdot \Delta ImE_j + \beta_2 \cdot \Delta ExE_j + \beta_3 \text{plantsize}_i + \phi_{J(j)} + \phi_t + \epsilon_{ijt}. \tag{5}$$

As in section III, we again control for broad industry group ($\phi_{J(j)}$) and calendar year fixed effects (ϕ_t). In the 2SLS model, we also use instruments constructed from increases of trade flows of other high-wage countries with the East relative to the industry's total wage bill 10 years before the mass layoff.

The credibility of this approach hinges on two assumptions. First, the matched control group should provide a valid counterfactual to the earnings of the displaced workers if the mass layoff had never occurred. In table A.9 we report summary statistics for the observable characteristics of both groups. Indeed, the matching appears to have worked reasonably well. There are some scattered statistically significant differences between the displacement and control groups, but none of those differences are large in economic terms. The second assumption is that displaced workers do not differ across industries in a way that is related to trade exposure. The final column of table A.9 reports the shares of the between-industry variance relative to the variable's total variation among the displaced workers. For all but one variable the largest share of variation is within rather than between three-digit industries. However, there are substantial differences in plant sizes across industries. Since this might be correlated to trade exposure, we control for the number of employees in the plant from which worker i was fired.

In column 1 of table 6, we at first do not find any relationship between the costs of mass layoffs and exposure to international trade. However, this result is entirely driven by the industry "manufacturing of office machinery and computers." This industry is strongly exposed to imports from China and has a comparatively large number of workers who experienced a mass layoff. Yet being laid off apparently has not harmed the workers in this industry. Figure A.2 (figs. A.1, A.2 are available online) shows that the earnings of

Table 6
Trade Exposure and Earnings Losses from Mass Layoffs

	Dependent Variable: Δ_{dd} Log Earnings		
	(1)	(2)	(3)
	A. Ordinary Least Squares		
Export exposure	−.1430	−.1590	−.1879*
	(.104)	(.104)	(.106)
Import exposure	−.0617	.2464***	−.2490***
	(.067)	(.068)	(.074)
R^2	.004	.004	.005
	B. Two-Stage Least Squares		
Export exposure	−.5467	−.3435	−.3588
	(.379)	(.296)	(.288)
Import exposure	−.0667	−.2923***	−.3079***
	(.098)	(.0984)	(.107)
Log plant size	Yes	Yes	Yes
Layoff year dummies	Yes	Yes	Yes
Broad industry dummies	No	No	Yes
Drop manufacturing of computers	No	Yes	Yes

NOTE.—This table shows how the individual long-term losses of a mass layoff vary with the trade exposure of the industry from where a worker is laid off, based on 151,711 (col. 1) and 147,517 (cols. 2, 3) laid-off workers. The outcome variable is earnings loss during the 5 years after the layoff, constructed as the double difference (before vs. after layoff and laid-off vs. matched control group) of log earnings. Import (export) exposure is the increase in imports (exports) from (to) China and Eastern Europe over the period from 3 years before the layoff to 5 years after relative to the industry's total wage bill 3 years before the mass layoff. In panel B, this is instrumented by similar measures constructed from trade flows of other high-income countries. Standard errors, clustered by industry × layoff year, are in parentheses.

* Significant at 10%.

*** Significant at 1%.

those workers have never significantly fallen below the earnings of the matched control group, neither during the initial drop nor during the subsequent recovery. It seems plausible that the computer industry is a somewhat special case. Workers laid off from this industry have special skills that are also valuable outside their original industry. This certainly does not apply to the majority of industries exposed to competition from China and Eastern Europe. Once we omit the computer industry, we find a clear pattern of higher losses in more exposed industries. In the most conservative model, we find that each percentage point of import exposure costs displaced workers an additional 0.25%–0.31% of earnings per year. According to the summary statistics reported in table A.10, a worker at the 75th percentile of import exposure is exposed by around 19.8 percentage points more strongly than is a worker at the 25th percentile. This means that the former experienced an earnings loss that is on average 5–6 percentage points stronger in each of the 5 years after the layoff.

Interestingly, the coefficient of export exposure is also negative but very imprecisely estimated. In fact, it is not clear ex ante what happens to workers

in plants that experience a mass layoff even though their industry's market is expanding. One possibility could be that those plants were comparatively unproductive and were displaced from the market from firms that expand because of increased export opportunities, as in the model by Melitz (2003). If there is assortative matching, as suggested by Sampson (2014), then the workers at those firms are also the least productive. But according to our findings in section V, firm switchers who benefit from switching within industries are positively selected. Expanding exporting firms apparently are reluctant to hire unproductive workers displaced from unproductive firms. By contrast, successfully exporting firms offer high firm-specific rents because of rent sharing and fair wage considerations (Egger and Kreickemeier 2012). If a mass layoff happened because of bad management decisions or other reasons unrelated to productivity, then the laid-off workers' loss of firm-specific rents are particularly high.

C. Import Competition and the Incidence of Mass Layoffs

Workers in industries that face increasing competition from abroad find it more difficult to recover from losing their job in a mass layoff event. It is also possible that the probability of a mass layoff event itself might be related to increasing trade with the East. It is plausible that an increase in import competition increases the probability of a plant to be in distress and fire a substantial share of its workforce, whereas new opportunities to export should reduce this probability. To examine this possibility, we use a cross section of all manufacturing plants that meet the first two criteria of identifying mass layoffs laid out in section VII.A, namely, a minimum size of 50 employees and a stable workforce in the proceeding 2 years anytime during the period 1990–2009. Among those 32,131 plants, 10.0% also fulfill the other criteria, a permanent drop in employment of at least 30% within 1 year and less than 25% of the leaving workers moving to the same new plant.

We regress a dummy indicating a mass layoff on the increase in import and export exposure at the industry level during the period 1990–2010. The results are reported in table 7. We find some weak and barely significant evidence that plants that operate in industries that benefit from access to new markets in the East are less likely to lay off a large share of their workforce. By contrast, there is no opposing effect of imports. While we do find that individual workers face a higher probability of leaving their original workplace if they work in industries with higher import competition, there is no such effect on the probability that firms fire a large share of their employees or even close. Note, however, that this might also be due to the way we identify mass layoffs. Our heuristic minimizes the risk that we falsely identify mass layoff events that are actually related to restructuring. This means that we cannot rule out false negatives, that is, that we do not detect all events that happened in our observation period. This procedure is therefore better

Table 7
Trade Exposure and the Incidence of Mass Layoffs

	Dependent Variable: Dummy, 1 = Plant Experienced a Mass Layoff		
	(1)	(2)	(3)
	A. Ordinary Least Squares		
Import exposure	.0197*	.0220*	.0057
	(.011)	(.012)	(.006)
Export exposure	−.0187*	−.0193*	−.0090*
	(.010)	(.011)	(.005)
R^2	.011	.012	.021
	B. Two-Stage Least Squares		
Import exposure	.0335	.0444	.0103
	(.025)	(.035)	(.021)
Export exposure	−.0845	−.1005	−.0275
	(.065)	(.084)	(.046)
Log plant size	Yes	Yes	Yes
Founding year dummies	Yes	Yes	Yes
Broad industry dummies	No	No	Yes
Drop manufacturing of computers	No	Yes	Yes

NOTE.—This table shows the relationship between plants experiencing a mass layoff and trade exposure, based on a cross section of 32,131 (col. 1) and 31,885 (cols. 2, 3) manufacturing plants with at least 50 employees and a stable workforce in the proceeding 2 years anytime in 1990–2010. The outcome variable is a dummy variable that indicates a plant that experienced a mass layoff. Import (export) exposure is the increase in imports (exports) from (to) China and Eastern Europe over the period 1990–2010 relative to the industry's total wage bill in 1990. In panel B, this is instrumented by similar measures constructed from trade flows of other high-income countries. Standard errors, clustered by industry, are in parentheses.

* Significant at 10%.

suited to analyze the effects of mass layoffs on individuals rather than their incidence itself.

VIII. Conclusion

A growing and recent empirical literature has unmarked how trade and in particular import competition can disrupt (local) labor markets (Autor, Dorn, and Hanson 2016). In this article, we have studied how workers in Germany have adjusted to trade shocks. For Germany, globalization led to a strong rise in exports. This gives us the opportunity to investigate how the workers adjusted to increasing export opportunities. This focus on exports makes it easier to bridge the empirical literature to an equally influential theoretical literature (see the survey by Helpman 2016), which studies the effect of trade on labor when firms self-select into export markets and the labor market is characterized by frictions. Consistent with the theoretical literature, we find that German workers in export-exposed industries realize earnings gains partly on the job and partly by switching employers within industries. For imports, our results suggest relatively small losses for affected workers. But if incumbent workers are laid off nonetheless, their losses are driven by workers who start out in high-paying firms and subsequently lose

these rents as they are forced to switch into the service sector. Finally, our paper presents novel evidence how the scarring effects of a layoff are more severe in import-competing industries. In this way, we connect to a large literature in labor economics that has focused on the cost of job loss.

How representative are our results for other high-income countries? First, with respect to trade, Germany is regularly considered a manufacturing powerhouse and exhibits a record-high trade surplus. This surplus, however, is mostly with other high-income countries, while trade has been roughly balanced vis-à-vis "the East" on which we focus in this paper. In that respect, Germany is a more typical case than the United States, which has built up a massive trade deficit with China since the mid 1990s. This special constellation is also a strong driver of the "China shock" in America, which has seen very little positive labor market effects from rising exports to the newly emerging markets. We believe that our paper therefore adds an important perspective by showing that this globalization episode has not only been about rising import penetration.

On the labor market, Germany also has some special features that differ notably from other countries. Nowadays, unemployment rates are very low, but this has not always been the case during the observation period. Quite the opposite—during the 1990s and early 2000s, Germany was often referred to as the "sick man of Europe" and exhibited very rigid labor market institutions and high unemployment. Our empirical analysis therefore refers to a case that, on average, is not very different from other high-income countries but should reveal representative patterns.

What policy lessons can be learned from our empirical analysis? The most important one seems to be that low-skilled workers with lots of industry-specific human capital in import-competing industries seem to be hurt the most from adverse trade shocks, since they have a harder time adjusting than medium- or high-skilled workers. If educational systems—and labor market institutions more broadly—are tailored such that this mobility could be enhanced, it would benefit those workers who currently lose the most from trade liberalization. Which particular reforms are most conducive to those goals—for example, more generous trade assistance programs, as recently analyzed by Hyman (2018), or an expansion of the apprenticeship system that provides some general skills to non-college-educated workers and thus facilitates their occupational mobility later on—is an important topic for future research.

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