Köln Z Soziol (2020) (Suppl 1) 72:535–560
https://doi.org/10.1007/s11577-020-00680-5

Kölner Zeitschrift für Soziologie und Sozialpsychologie

ABHANDLUNGEN
Berufe, Digitalisierung und Globalisierung

Trade and Wage Inequality: The Mediating Roles of Occupations in Germany

Malte Reichelt · Samreen Malik · Marvin Suesse

Published online: 17 June 2020

Abstract Recent evidence shows that rising wage inequality in industrialized countries can partially be attributed to trade integration. However, it is unclear what the mechanisms behind this relationship are. Previous explanations pointed toward the displacement of mid-wage manufacturing workers as a response to rising imports. However, for Germany it has been shown that rising exports likewise create manufacturing jobs, indicating that industry-based explanations fall short. We argue that focusing on changes of the occupational composition, as well as changes in the occupation-specific median and top wages, may help to explain the effects of trade on inequality. We draw on a task-based approach, theories of power relations between occupations, as well as self-selection by firms to arrive at predictions about the mediating role of occupations. We analyze German trade relations with China between 1994 and 2010 using social security data (BHP, IEB) and data on international trade flows (COMTRADE). Applying an instrumental variable approach, we find that, surprisingly, imports do not affect wage inequality. Instead, rising exports to China are responsible for the effects of trade integration on inequality as they increase wage dispersion within German labor market regions. Although increased

M. Reichelt (✉) · S. Malik
Social Science Division, New York University Abu Dhabi
Abu Dhabi, United Arab Emirates
E-Mail: malte.reichelt@nyu.edu

S. Malik
E-Mail: samreen.malik@nyu.edu

M. Reichelt
Institute for Employment Research (IAB)
Nuremberg, Germany

M. Suesse
Trinity College Dublin
Dublin, Ireland
E-Mail: marvin.suesse@tcd.ie

trade integration alters the occupational task composition, we find no evidence that these shifts mediate the effects of exports on wage inequality. Instead, exports increase the wages of some occupations, especially for top earners, highlighting the importance of focusing on within-occupation dynamics.

Keywords Globalisation · Labor markets · Job polarization · Tasks · Economic inequality

Internationaler Handel und Lohnungleichheit in Deutschland: Die Rolle des Berufs als Mediator

Zusammenfassung Neuere Erkenntnisse zeigen, dass sich die steigende Lohnungleichheit in industrialisierten Ländern partiell auf internationale Handelsverflechtungen zurückführen lässt. Noch ist jedoch unklar, welche Mechanismen hinter diesem Zusammenhang stehen. Bisherige Erklärungen stellen heraus, dass steigende Importe Arbeitsplätze im mittleren Lohnsegment des Produktionssektors vernichten. Für Deutschland hat sich jedoch gezeigt, dass Exporte in ähnlichem Maße neue Arbeitsplätze schaffen. Branchenbasierte Erklärungen scheinen also zu kurz zu greifen. Wir argumentieren, dass Veränderungen in der Berufsstruktur und in den berufsspezifischen Median- und Toplöhnen helfen können, den Zusammenhang zwischen Handelsbeziehungen und Lohnungleichheit zu erklären. Um Vorhersagen über die Rolle des Berufs zu treffen, greifen wir auf einen Task-Based-Approach sowie Theorien zu Machtverhältnissen zwischen Berufen und Selbstselektion von Firmen zurück. Wir analysieren die Handelsbeziehungen zwischen China und Deutschland für die Jahre 1994 bis 2010 und greifen dazu auf Sozialversicherungsdaten (Betriebs-BHP, IEB) sowie Daten zum internationalen Handelsverkehr (COMTRADE) zurück. Mithilfe von Instrumentenvariablenschätzern zeigen wir, dass Importe die Lohnungleichheit überraschenderweise nicht beeinflussen. Stattdessen sind steigende Exporte nach China für die wachsende Lohnstreuung in Arbeitsmarktregionen verantwortlich. Obwohl zunehmende Handelsverflechtungen die regionale Taskstruktur verändern, finden wir keine Anzeichen dafür, dass diese Veränderungen als Mediator für den Effekt von Exporten auf Lohnungleichheit dienen. Vielmehr scheinen Exporte die Löhne in einigen ausgewählten Berufen zu erhöhen, insbesondere für Spitzenverdiener. Die Ergebnisse unterstreichen die Bedeutung von innerberuflichen Dynamiken für die Erklärung sozialer Ungleichheit.

Schlüsselwörter Globalisierung · Arbeitsmärkte · Arbeitsmarktpolarisierung · Tasks · Wirtschaftliche Ungleichheit

1 Introduction

Most industrialized countries have experienced a striking increase in income and wage disparities over the past few decades (Neckerman and Torche 2007; Brady 2009; Piketty and Saez 2014). Although the United States has observed an unparalleled trend of rising inequality since the 1970s (DiPrete 2005), other European

countries, including Germany, have followed in the 1990s (Dustmann et al. 2009; Brady 2009; Tomaskovic-Devey et al. 2016). Over the same period, these countries have experienced increasing economic globalization (Brady et al. 2007). This has led social scientists to address the question to what degree globalization in general and rising trade openness in particular contribute to wage inequality. Although earlier studies cast doubt on a direct relationship between trade and wage dispersion (e.g., Bhagwati 1995) or only find small effects (e.g., Richardson 1995), more recent studies have reported that globalization, and in particular trade exposure, are partly responsible for the rising wage inequality (Brady 2009; Keller and Utar 2016).

To date, however, there is no consensus on how trade affects wage inequality. Many studies argue that imports are displacing domestic mid-wage manufacturing workers (Yuasa 2001; Rees and Hathcote 2004; Brady 2009; Autor et al. 2013; Dauth et al. 2014). Yet, for Germany, Dauth et al. (2014) show that exports are increasing employment to an even stronger degree. We thus argue that analyses of the effects of trade on wage inequality need to go beyond focusing on industrial change and mere changes in employment. Focusing on the dynamics within the manufacturing industry has the potential to uncover important and previously unknown mediators. Occupations, which vary within industries, and their characteristics have long been recognized as important drivers of wage inequality (Kim and Sakamoto 2008; Mouw and Kalleberg 2010; Liu and Grusky 2013; Williams and Bol 2018). We thus focus on occupational dynamics and propose three potential ways in which these can act as mediators of trade's effect on wage inequality.

First, trade may alter the composition of occupations. Drawing on a task-based approach, we argue that in times of economic globalization, high-wage countries import goods that are produced requiring routine and manual tasks. These tasks can be performed and monitored at lower costs in low-wage countries (Grossman and Rossi-Hansberg 2008). Exported goods will increasingly be produced requiring analytical or interactive tasks. We thus expect trade to affect the demand for occupations that are closely linked to these tasks. Occupations with routine manual tasks are usually found in the middle part of the wage distribution and occupations with mostly analytical tasks in the upper part of the wage distribution. The compositional changes should thus be accompanied by a rise in wage inequality, even if manufacturing employment as a whole were to remain constant.

Second, workers who leave occupations that are negatively affected by trade may create an oversupply of labor for other occupations, reducing their wages. Likewise, rising exports may increase the demand for some occupations, increasing wages for these occupations. These dynamics should be particularly important in labor markets that are highly structured by occupations as in Germany. Career trajectories are organized along occupational lines (Blossfeld and Mayer 1988; Damelang et al. 2015), standardization and occupation-specific credentials determine access to occupations (Solga and Konietzka 1999) and legal and administrative regulations may limit options for occupational mobility (Reichelt and Abraham 2017). Leaving a declining occupation may thus require entering another occupation mismatched or overqualified, which may lead to lower wages (Kracke et al. 2018). Supply to the increased demand for rising occupations may also not be met immediately. Moreover, Sklair (2002) argues that the effects of trade are mediated by power relations:

globalization shifts power to managers and capital owners, which may undermine the class capacity of workers. Consequentially, revenues of exporting firms are not distributed equally among the workforce (see also Grant and Wallace 1994; Brady and Wallace 2000). The consequence is that some occupations disproportionately benefit from trade (e.g., managers), increasing inequality between occupations.

Lastly, productive higher-paying firms may self-select into profitable exports, resulting in wage disparities between firms (Helpman et al. 2017). In this case, we would expect wages of top earners to rise in those occupations associated with the exported goods. Increased intra-occupation wage heterogeneity would then contribute to overall wage inequality.

So far, research on the effects of trade on inequality has potentially missed important explanatory factors, as previous studies have mainly focused on the reduction or creation of manufacturing jobs (Autor et al. 2013; Dauth et al. 2014) or only focused on imports (Keller and Utar 2016). To address these shortcomings and to analyze the mediating role of occupations in the relationship between trade and wage inequality, we use complete aggregate social security data from Germany (Betriebshistorik-Panel, BHP), individual-level data including information on occupation from the Integrated Employment Biographies (IEB), and product-level trade data (COMTRADE) from the International Trade Statistics Database for the time period 1994 to 2010.

First, we analyze to what degree Germany's trade exposure to China affects the occupational task composition in German labor market regions. We expect regions with large increases in trade exposure to experience greater shifts in their occupational task composition. Second, we study the effect of trade exposure on regional wage inequality. Third, we disentangle whether these effects are mediated by changes in the occupational task composition and the occupational composition more generally. We distinguish between changes in median occupational wages and rising wages for top earners within occupations. This allows us to identify which of the theoretical arguments most convincingly explain how trade affects wage inequality.

To circumvent potential endogeneity, resulting from trade being a response to the changing occupational composition, we employ an instrumental variable approach that has been widely used in the economics trade literature before.

We speak to various strands of literature. We contribute to scholarship on the effects of globalization in general (Brady et al. 2007; Spilerman 2008; Hällsten et al. 2010; Wallace et al. 2011) and trade exposure in particular (Autor 2013; Keller and Utar 2016). On a more general level, we contribute to literature on the causes of rising inequality (Blau and Kahn 2002; Neckerman and Torche 2007). Lastly, a core interest of economic sociology is how general changes in labor market structures and the dynamics of globalization affect economic inequality (Morris and Western 1999). We contribute to this literature by elaborating on the role of occupations and occupational change as a mediator between globalization and rising wage inequality.

2 Trade and Wage Inequality: Trends and Theory

2.1 Trends for Germany

Over the past decades, many societies have experienced a remarkable increase in economic globalization. Since the 1960s, international economic exchange, foreign direct investment, the flow of goods, services, labor, and capital have vastly increased for most industrialized countries (Brady et al. 2007; Brady 2009). It is thus not surprising that the emergence and consequences of economic globalization constitute one of the most topical debates in sociology and economics alike (see for example Blossfeld et al. 2006; Spilerman 2008; Autor et al. 2013; Wallace et al. 2011). Research pertaining to the labor market effects of international trade—the import and export of manufactured goods—has occupied a central role. In part, this is due to the remarkable increase in trade volumes over the past few decades, but also because theories about consequences for workers, inequalities, and labor market structures have traditionally been controversial.

We focus on Germany as the largest European economy and fourth largest in the world, which has more recently witnessed a higher degree of trade integration with China. This case is particularly interesting as Germany is constantly ranked among the most open economies. Over the past decades and together with the USA and China, it exhibits the largest export volumes. Moreover, China entered the global stage relatively late, providing a good case to study the effects of trade shocks—especially between high- and low-wage countries.[1]

As Fig. 1 shows, over the last two decades, Germany's exposure to trade with China has dramatically risen. Although Germany generally has a trade deficit with China, both imports and export volumes have grown substantially by more than 1,000% since the early 1990s. Imports mostly encompass textiles, toys, or office and computer equipment. At the same time, new export opportunities have arisen for automobiles, specialized machinery, and electronic and medical equipment (Dauth et al. 2014). The increasing trade volumes reflect economic globalization, productivity gains in China, but also increased market access after joining the World Trade Organization (WTO) in 2001.

Despite being known for its relatively strong employment protection, collective bargaining institutions, and traditionally relatively modest wage inequality (DiPrete and McManus Patricia 1996), the more recent trend in Germany reveals an increase in wage dispersion. Bartels (2019) finds that the income share accruing to the top 10% of the income distribution has been increasing since the 1970s. By this measure, inequality surpassed pre-World War I levels in 2010. Focusing more closely on wage inequality, Dustmann et al. (2009) show that wage inequality in Germany has been

[1] As Dauth et al. (2014) show, trade with Eastern Europe has risen to an even higher degree and has had a more severe impact on employment in Germany. In this study, we focus solely on China, as trade with Eastern Europe mostly depicts intra-industry trade. The theoretical predictions regarding changes in the occupational composition are thus not as clear-cut and likely differ. We thus emphasize that our results should not be generalized to all forms of trade relations.

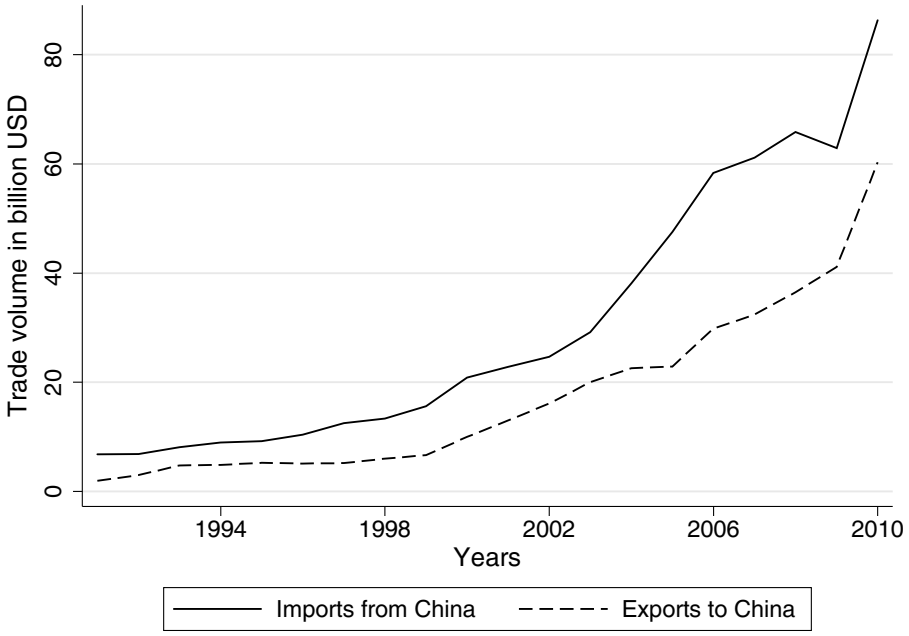

Fig. 1 Trade volumes between Germany and China over time. Note: own calculations, based on COMTRADE data

increasing since the 1980s, broadly mirroring patterns observed in the USA and UK (also see Brady 2009; Tomaskovic-Devey et al. 2016).

The co-occurrence of both trends led social scientists to address the question to what degree globalization contributes to wage inequality. Recent studies evaluating the relationship between trade exposure and wage inequality have indeed found positive effects (Brady 2009; Keller and Utar 2016).[2]

2.2 Theoretical Explanations for the Relationship Between Trade and Inequality

Why should trade exposure positively affect wage inequality? Although theoretically, at an aggregate level, international trade improves welfare, the costs and benefits of trade are not distributed uniformly. Welfare gains or losses may depend on the industry of employment, geographical location, consumption patterns, and education, among many other factors (Autor et al. 2013; Fajgelbaum and Amit 2016; Dauth et al. 2014). In general, an exogenous increase in trade exposure may lead to the expansion of some types of employment and the decline of others. With an increase in demand for imported products, the domestic demand for jobs producing the same good may reduce. In the same vein, an increase in demand of exports increases the demand for the jobs required to produce these goods.

[2] For Germany, Bartels (2019) observes that although trade exposure has not been associated with increasing inequality for most of German economic history, such an association, however, may have existed since the 1990s.

Previous studies primarily focused on the decline in manufacturing employment, which in response to trade increases wage inequality (e.g., Autor et al. (2013); Dauth et al. (2014)). In contrast, we argue that shifts in the occupational composition (within the manufacturing industry) may contribute to rising inequality—especially as Dauth et al. (2014) have shown that the negative effect of imports on manufacturing employment is more than offset by the positive effect of rising exports. However, these contributions do not consider the role of occupations, which vary within industries and have long been recognized as one of the main drivers of wage inequality (Kim and Sakamoto 2008; Mouw and Kalleberg 2010; Liu and Grusky 2013; Williams and Bol 2018). In the following sections, we describe three potential ways in which occupations and their characteristics function as mediators of trade on wage inequality.

2.2.1 Changing the Occupational Composition

A large proportion of wage inequality lies between occupations (Mouw and Kalleberg 2010; Bol and Weeden 2015; Williams and Bol 2018). Therefore, a shift in the occupational composition likely changes the wage structure. But why and how should the occupational composition change in response to trade? The production of goods that are imported or exported naturally requires different skill-sets and different tasks to be performed. A task can be understood as a unit of work activity that produces output, such as goods and services (Acemoglu and Autor 2010). As occupations reflect bundles of tasks (Autor et al. 2013), a change in skill demands (e.g., as a response to trade) likely alters the occupational composition—some occupations become redundant whereas others experience an increased labor demand.

Which tasks will be affected by increased trade with low-wage countries? Following Autor et al. (2003), researchers have often distinguished between three groups of tasks: routine (cognitive or manual) tasks, which are codifiable because they are repetitive, abstract analytical tasks that require creativity or problem-solving skills, and non-routine manual tasks, which require skills such as visual recognition or physical flexibility (Autor et al. 2013). More nuanced task distinctions differentiate between analytical (e.g., evaluating, planning), interactive (e.g., coordinating, selling), and manual (repairing, accommodating guests) non-routine tasks as well as cognitive (e.g., calculating, measuring) and manual (e.g., operating machines) routine tasks (Spitz-Oener 2006; Matthes et al. 2014; Dengler et al. 2014).

The extended neoclassical Heckscher–Ohlin framework implies that trade has a differential impact on segments of the population by virtue of the skill-levels of workers (Feenstra and Taylor 2017). The reward from a factor after opening up to trade is proportional to its relative abundance in a trading country (Mahutga et al. 2017). Thus, countries with an abundance of cheap labor, such as China (Li et al. 2012), have a relative surplus of labor with manual skills compared to Germany (Feenstra and Taylor 2017). This implies that Germany would export goods that employ non-manual labor more intensively and import goods that use manual labor (see Fig. 3 for descriptive evidence on the occupational tasks associated with imported and exported goods). We can thus assume that import exposure reduces

local demand for manual tasks whereas export demand should increase the need for non-manual tasks (e.g., cognitive, interactive, and analytical).

Moreover, from the literature on offshoring, we know that routine jobs are easier to monitor, and can easily be moved to a low wage location (Grossman and Rossi-Hansberg 2008), especially if they can be summarized in deductive rules (Levy and Murnane 2004). Consequentially, measures of routineness and offshorability are positively associated (Goos et al. 2014). This stands in contrast to tasks that are inherently non-routine, and that are therefore closely tied to a particular location, as they require careful and subtle supervision. In such tasks, high-wage locations can be said to have a relative advantage, which is reflected in the growth of non-routine tasks as a response to imports (Kemeny and Rigby 2012). Germany imports goods whose production consists of routine tasks, whereas those goods with non-routine content are exported.

Combining the two arguments, the effect on the task structure would have important distributive effects. We expect demand in occupations that are marked by both manual and routine tasks to decline because of import exposure. These compositional shifts should be accompanied by an overall decrease in manufacturing employment, as the production of certain products is reduced. The opposite should hold true for occupations with both non-manual and non-routine tasks (analytical and interactive). As a response to increasing exports, one would assume employment in occupations with these tasks to rise.[3] However, one could also assume trade to affect the occupational composition without increasing the number of manufacturing jobs. Firms tend to invest higher revenues from trade in technological advancements (Bustos 2011) and technology substitutes routine and manual tasks while complementing non-routine ones (Autor et al. 2003). As technological advancements moreover increase a firm's productivity and thus require less labor for exported goods (Bartel et al. 2007), one would predict the same shifts in the occupational composition, without expecting manufacturing employment to grow.

Relative to other tasks, manual routine tasks lie in the middle of the wage distribution whereas analytical tasks on average have the highest remuneration (Goos and Manning 2007). Table 1 ranks the task categories according to the average wages paid in those occupations.[4] The final column sums up our prediction from the pre-

Table 1 Trade shocks (rising import exposure and demand for exports) and hypothesized effect on German wage distribution

Task category	Observations	Mean wage	Prediction on employment
Analytic non-routine	437,660	85.61	+
Cognitive routine	860,168	66.01	∼
Manual routine	356,762	62.34	–
Interactive non-routine	251,477	57.51	+
Manual non-routine	752,151	55.02	∼

[3] The prediction for occupations marked by a mixture of routine and cognitive tasks, as well as those with mixed manual and nonroutine content is ambivalent.

[4] Data source: see the section "Data". Wages refer to mean daily wages in 1994. Task categories refer to the tasks that are predominant in a three-digit occupation.

ceding discussion regarding the impact of trade shocks (rising import exposure and demand for exports) on employment in occupations with the main occupational task. From this ranking, it is clear that occupations at the top and bottom of the wage distribution are likely to see a relative increase as a result of trade shocks. This is due to Germany's international specialization in non-manual, non-routine tasks. The occupations in the middle of the wage distribution (manual routine tasks), however, which are marked by high tradability and relative productivity disadvantages will likely decline. Increased trade should therefore translate to rising wage inequality.

2.2.2 Changing Between-Occupation Wages

Shifts in the occupational composition may impact wage inequality because the demand for certain workers with certain skill-sets is changing. However, these dynamics may also lead to changes in wages of some occupations, e.g., if the demand for employees is rising more quickly than the supply, or if employees leaving declining occupations need to enter other occupations (Gu et al. 2020).

Especially in labor markets that are highly structured by occupations, as in Germany, career trajectories are organized along occupational lines (Damelang et al. 2015; Blossfeld and Mayer 1988). Standardization and occupation-specific credentials determine which occupations can be entered (Solga and Konietzka 1999) and legal and administrative regulations may limit options for occupational mobility (Reichelt and Abraham 2017), reflected in overall lower occupational mobility compared to other countries (DiPrete 2002). Because human capital is mostly industry and occupation specific (Kambourov and Manovskii 2009), leaving a declining occupation may thus require workers to enter other occupations where these workers are mismatched or overqualified (Kracke et al. 2018). The supply of workers for occupations with lower entry barriers (e.g., requiring lower formal degrees) would thus increase, potentially lowering wages in these occupations. Likewise, rising occupations may pay particularly high wages as the demand is often larger than the supply—thus creating wage inequality between occupations.

Even if the occupational composition would not change, wages between occupations might diverge as a response to trade. Exports have been shown to alter power relations in firms (Sklair 2002). Bargaining power is shifted from employees to employers. Globalization lowers the negotiation power of labor, and enhances it for employers, who may search or threaten to search for cheaper labor elsewhere. Decision makers, such as managers or top engineers, can use their decision-making power to appropriate a larger share of the surplus. Rising revenues from exports may then not be distributed equally among the workforce, leading to wage dispersion within firms and thus between occupations (Sklair 2002; Brady and Wallace 2000; Grant and Wallace 1994). Wage inequality may also increase within occupations if not all firms participate in trade and top-earners in exporting firms benefit the most.

2.2.3 *Changing Within-Occupation Wages*

A third potential mechanism is that more productive firms are able to benefit from export opportunities to a greater degree, and consequentially pay higher wages. Only a fraction of firms are productive enough to export their output (Helpman et al. 2017). Firms are thus differentially exposed to profitable exports, and firms that are most exposed pay higher wages (Felbermayr et al. 2018).[5] These dynamics imply that wage dispersion within occupations is rising as a response to increasing export demand, because top earners within occupations are disproportionally benefiting from lucrative trade.

Although all these theoretical explanations are plausible, their differential predictions allow us to empirically distinguish between their importance. In the following, we will empirically test the role of changing occupational composition vis-à-vis explanations based on changes in occupation-specific wages.

3 Analytical Strategy

3.1 Empirical Specification

To test each of the mechanisms, we investigate the effect of import and export shocks on labor market outcomes at a regional level.[6] To do so, we broadly follow the approach of Dauth et al. (2014), which builds on Autor et al. (2013), and consider regional variation in import and export exposure, changes in the occupational composition, mean occupational wages, and top wages per occupation in Germany over the time periods 1994–2002 and 2002–2010. We divide our observational period, because in 2002, China officially joined the WTO.

We use regional demarcations that are based on commuting patterns and reduce the 402 counties in Germany to 258 labor market regions i (assessed by the Joint Task Force on the "Improvement of the Regional Economic Structure" (Schwengler and Binder 2007; RWI 2018)). As opposed to purely administrative regions, these local labor markets should be able to better capture effects on employment or occupational composition that go beyond the firms producing the imported or exported goods. More importantly, regional labor markets reduce the observed mobility across regions, which facilitates the interpretation of estimates.

Variations in trade exposure stem from initial differences in the industrial composition of labor market regions. For each three-digit industry, we map the volumes of goods imported and exported and use the volumes as proxies for how much each

[5] It is important to note that, like the first mechanism, this theory relies on the assumption of imperfect labor mobility (between firms in this case), because firms pay similar workers different wages. Furthermore, note that the effects of imports in the second and third mechanisms are ambiguous, as increased competition can eliminate unproductive low-paying firms (hence raising average wages), but also decrease the capacity of the remaining relatively unproductive firms in the market to pay higher wages.

[6] Replication files can be found at *malte-reichelt.com*. Note that the data are only available via remote access at the Research Data Centre (FDZ) of the Federal Employment Agency at the Institute for Employment Research (IAB).

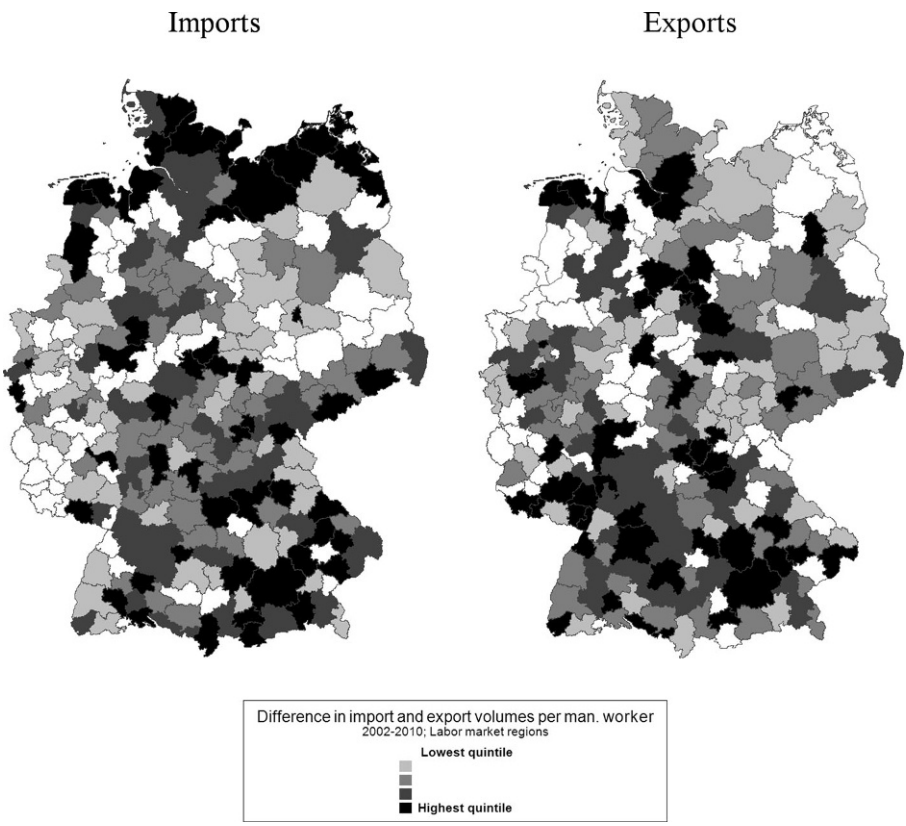

Fig. 2 Change in import and export volumes at labor market region level: 2002–2010

labor market region is affected by trade. As Fig. 2 shows, because the types of manufacturing work are not distributed equally across Germany, workers have not been exposed to import competition and export demand to the same degree. A typical manufacturing worker in West Germany—for example—experienced a stronger increase in imports in his/her industry than a typical worker in East Germany. Likewise, a typical manufacturing worker in Southern Germany faced increased demand for exports in his/her industry—which can be attributed to the prevalence of car manufacturing.

The import exposure per region i during time period t (*1994–2002* and *2002–2010*) can be written as:

$$\Delta(import\,exp.)_{it}^{\text{China}} = \sum_{j} \frac{E_{ijt}}{E_{jt}} \frac{\Delta \text{Imp}_{jt}^{D \leftarrow Ch}}{E_{it}^{\text{Man}}} \tag{1}$$

where $\Delta \text{Imp}_{jt}^{D \leftarrow Ch}$ is the total change in imports from China to Germany in industry j over time period t. The change in trade volume is weighted by region i's share of employment in industry j at the beginning of the period $\frac{E_{ijt}}{E_{jt}}$ to arrive at each region's trade exposure. The term is divided by the region's total manufacturing employment

$E_{it}^{\text{Man}}$and summed across all j industries to calculate the average change in trade exposure per manufacturing worker in region i. In a similar manner, we construct the average change in export exposure per manufacturing worker in region i over the period t:

$$\Delta(export\,exp.)_{it}^{\text{China}} = \sum_{j} \frac{E_{ijt}}{E_{jt}} \frac{\Delta \text{Exp}_{jt}^{D \to Ch}}{E_{it}^{\text{Man}}} \tag{2}$$

This measure captures the region i's potential for export of manufacturing products given its initial sectoral employment. In our regression analyses, we are aiming to identify the causal effect of both import and export exposure on a range of regional-level variables that also change during the time period t. More specifically, we are interested in the change in region i's share in manufacturing employment, regional task and occupational compositions, and lastly the wage distribution. For the latter variable, we measure the change in wages at the 85–15 percentiles.[7] We regress these dependent variables ΔY_{it} on the above described changes in import and export exposure and a range of start-of-period control variables:

$$\Delta Y_{it} = \beta_0 + \beta_1 \Delta(import\,exp.)_{it}^{\text{China}} + \beta_2 \Delta(export\,exp.)_{it}^{\text{China}} + X_{it}^{'} + \epsilon_{it} \tag{3}$$

$X_{it}^{'}$ is a vector comprising regional level control variables similar to those included in Dauth et al. (2014) (share of highly skilled workers, share of female workers, and share of foreign nationals) as well as period dummies. We added the control variables at the regional level because such labor is prevalent in the service industries and can be negatively related to manufacturing employment growth. The differential demographic composition may therefore be an additional confounding factor, which we control for. Errors are clustered at the regional labor market level.

3.2 Instrumentation

One concern when estimating the effects of local import and export exposure on regional level variables is that imports from China may correlate with industry-specific import demand shocks and exports to China may correlate with industry export supply shocks. In this case, the OLS estimates of the relationship between increased imports and exports from China and changes in Germany's employment structure may be biased, as both employment and trade exposure may positively correlate with unobserved product supply and demand shocks in Germany. For example, rising employment in the automotive industry (and thus in certain regions) may be accompanied by an increased demand for imported technical car parts, biasing the effects of China's supply shock on employment in Germany.

To identify the causal effect of rising Chinese import and export exposure on local labor market outcomes, we employ an instrumental variables strategy. Following Autor et al. (2013), we concentrate on shocks emanating from China. The reasoning

[7] Since wages are censored above the social security contributions limits, we use the differences in wages at the 85th and the 15th percentiles instead of the lowest and highest wages.

behind this choice is firstly that China was rapidly increasing in importance, both as a source of imports and as a destination for exports. Crucially, the presence of China in world markets was not primarily driven by demand from Germany, but by domestic supply-side reforms in the wake of transitions from a system of socialist planning to a market economy. These factors are largely exogenous to German domestic conditions. To instrument the regional import exposure from China, we construct the following variable for every German region i:

$$\Delta(import\,exp._{\text{Inst}})_{it}^{\text{China}} = \sum_j \frac{E_{ijt-1}}{E_{jt-1}} \frac{\Delta \text{Imp}_{jt}^{\text{Other} \leftarrow Ch}}{E_{it-1}^{\text{Man}}} \tag{4}$$

This measure identifies the supply-driven component of Chinese imports as $\Delta \text{Imp}_{jt}^{\text{Other} \leftarrow Ch}$ are import flows from China to eight other high-income developed countries (Australia, Canada, Japan, Norway, New Zealand, Sweden, Singapore, and the UK). These flows should affect Germany's labor market outcomes only through imports to Germany rather than the changes in the domestic economy in Germany. Unobserved regional shocks should, however, not affect other countries' imports from China. We use employment levels from 8 years before the period starts $(t-1)$ because employment might be affected by anticipated trade.[8]

Like the instrument constructed for the import exposure above, we construct the following instrumental variable that uses changes in exports of other countries to China:

$$\Delta(export\,exp._{\text{Inst}})_{it}^{\text{China}} = \sum_j \frac{E_{ijt-1}}{E_{jt-1}} \frac{\Delta \text{Exp}_{jt}^{\text{Other} \rightarrow Ch}}{E_{it-1}^{\text{Man}}} \tag{5}$$

The instrument for export exposure relies on the idea that as China becomes more important in the world economy, it also becomes an export destination not only for German products but for products that are produced in other countries as well. Again, using the instrument, we circumvent the problem of regional export shocks in Germany driving the correlations between changes in exports and local labor market structures.[9]

4 Data

For the analysis at the regional level, we combine three data sources. Our first data set consists of complete social security data from the Betriebshistorik-Panel of the Institute for Employment Research (IAB) in Germany. The BHP provides

[8] While Autor et al. (2013) use a 10-year lag for employment levels, this is not a feasible choice for our analysis of the sub-period 1994–2002 owing to the German reunification in 1990, and moreover, our accessible employer–employee data start from 1988.

[9] Additionally, previous research has shown that trade shocks, when instrumented with this procedure, tend to operate largely independently of technology shocks, which could otherwise present a confounder (Autor et al. 2015).

data aggregated at the establishment level, which we further aggregate to regional levels. To obtain measures on occupational structures (which are not included in the BHP), we sample 10% of all employment spells on 30 June of each year between 1994 and 2010 using regionally (258 labor market regions) stratified samples of employment spells of the Integrated Employment Biographies . Both data sets consist of mandatory notifications regarding social security contributions. The data are thus produced and collected for administrative purposes. On the one hand, the data are thus restricted to information relevant to social security, such as age, sex, nationality, qualification, occupation, industry, or wage of the employees in the workforce. On the other hand, they provide a highly reliable data source for our analyses.

Based on the cross-sections, we construct a data set that includes the two time periods 1994–2002 and 2002–2010. We thus begin our observational period at the time when trade with China started to increase. We split the period into two equal parts for our analyses and aggregate information for the time periods 1994–2002 and 2002–2010. We have data on 203 labor market regions for the first period and 256 for the second period. We only use data on West Germany for the first period to establish comparability with previous studies (e.g., Dauth et al. 2014) and because data on East Germany are partly not available for the beginning of the 1990s or are unreliable. Using these time periods also allows us to use lagged employment for our instrument.

Trade data are taken from the COMTRADE dataset. We convert all values for trade volumes in US Dollars to Euros using the exchange rate normalized to 2005 values. As COMTRADE is a product-based trade database (with Standard International Trade Classification [SITC] classification) it requires us to indicate the industry to which each product belongs. To merge industries, we are using a concordance table between SITC and industry classifications (Statistical Classification of Economic Activities in the European Community [NACE] rev. 1 or International Standard Industrial Classification of All Economic Activities). The European Statistical Office provides these concordance tables, which are merged with our trade dataset. We aggregate industries on a three-digit NACE level to be able to merge it with the administrative data.

In the IAB data, the industry classification changes twice during our time-period (2003 and 2008). We therefore use correlation tables to construct a consistent industry classification for the whole period (Eberle et al. 2014). In computing trade volumes for other developed economies, we aggregate the COMTRADE data from a product level to an industry level to mirror German industry classifications for each country.

To merge task measures to occupations (Klassifikation der Berufe 1988, KldB88), we use a classification proposed by Dengler et al. (2014), which differentiates between non-routine manual, interactive, routine manual, cognitive routine, and analytical tasks, based on an expert database (BERUFENET of the German Federal Employment Agency). We assign the main task that is required in each three-digit occupation. Although tasks associated with occupations may change over time (Becker and Muendler 2015), the task measure we utilize only captures the task content for the years 2011–2013. However, as Akçomak et al. (2016) show, although technological improvements may have an impact on within-occupation task change, offshoring

Table 2 Summary statistics full sample

	Observed	Mean	Standard Deviation	Minimum	Maximum
Δ Import exposure in 1000 USD	459	1.83	2.08	0.06	16.85
Δ Export exposure in 1000 USD	459	1.20	1.38	–0.37	14.79
Δ Share of manual employment in % points	459	–2.28	2.81	–14.96	7.80
Δ Total manual employment	459	–2975.82	7210.58	–71043.00	7079.00
Δ Manual non-routine occupations in % points	459	–0.55	1.65	–6.27	5.84
Δ Interactive occupations in % points	459	0.67	0.80	–1.57	4.22
Δ Manual routine occupations in % points	459	–1.32	1.65	–7.32	11.38
Δ Cognitive routine occupations in % points	459	–0.07	1.39	–6.31	6.90
Δ Analytical occupations in % points	459	0.59	1.24	–3.98	6.19
Δ 85–15 percentile wages over 8 years	459	14.49	5.57	2.69	32.82
% Women	459	54.24	9.93	31.79	73.66
% Foreign	459	7.13	4.31	0.30	19.92
% Highly skilled	459	8.95	4.08	2.85	24.46

The sample comprises all employees in manufacturing at time t_0 or over period t_0–t_1
Δ signifies changes in variables from beginning to end of the 8 year periods

does not. We would thus not expect trade to have an effect on the regional task composition through within-occupation task changes, which would potentially bias our results. Moreover, we use the main tasks as opposed to task shares per occupation, as these are less likely to change over time.

Table 2 shows the summary statistics for all variables employed. Highly skilled employees are operationalized as employees holding an academic degree and foreign employees comprise all workers of non-German nationality.

5 Main Results

The main goal of this study is to analyze whether trade shocks affect wage inequality through changes in the occupational task composition, the occupational composition more generally, and through changes in occupational wages. Because we derived explicit hypotheses about how the occupational task composition may change in response to trade and thus affect wage inequality, we analyze the compositional shifts first.

As compositional changes may occur either through increasing or decreasing employment in manufacturing or through changes within the manufacturing industry, it is first helpful to assess whether and to what degree regional manufacturing employment is affected and to uncover what occupational main tasks are associated with the production of imported and exported goods. We then proceed by analyzing the effects of trade on the occupational task composition and the regional wage inequality.

Lastly, we analyze whether the effects of trade are mediated by the compositional changes and changes in occupational wages.

5.1 Trade and Its Effects on the Occupational Task Composition

In Table 3 we analyze the causal effects of import and export exposure on changes in the share of manufacturing employment separately, while including a battery of controls. Our results show that import competition reduces the share of manufacturing employment. This finding is not surprising given that the import shocks, which emit from China, are a direct source of competition for manufacturing jobs in the German local labor markets. These results point in the similar direction as those found by Autor et al. (2013) for the USA. However, we find no association or causal

Table 3 Imports from and exports to China and change in (manufacturing) employment in labor market regions, 1994–2002 and 2002–2010: ordinary least squares (OLS) and two-stage least Squares (2SLS) Estimates

	Changes in share of manufacturing employment in % points	
	OLS	2SLS
Δ Import exposure	–0.175**	–0.372***
	(0.07)	(0.11)
Δ Export exposure	–0.131	–0.632
	(0.18)	(0.39)
% Women	–0.003	–0.083
	(0.05)	(0.08)
% Foreign	–0.280***	–0.235***
	(0.03)	(0.05)
% Highly skilled	0.040	–0.012
	(0.03)	(0.06)
Region-year dummies	Yes	Yes
First-stage		
Imp: Δ Import exposure	–	0.217***
		(0.019)
Imp: Δ Export exposure	–	–0.021
		(0.055)
Exp: Δ Import exposure	–	–0.008
		(0.010)
Exp: Δ Export exposure	–	0.215***
		(0.050)
F-test first-stage import	–	144.77
F-test first-stage export	–	19.18
Number of observations	459	459

$N = 459$ (256 labor market regions in East and West Germany for period 2002–2010; 203 labor market regions in West Germany for period 1994–2002). Labor market regions Göttingen and Osterode am Harz are excluded owing to insufficient data. All regressions include a constant and period dummy variables. First-stage estimates and F statistics also include the control variables that are indicated in the corresponding columns of the second-stage results. Robust standard errors in parentheses are clustered on labor market region level.
Significance levels: *10%, **5%, ***1%

effect of export demand shocks on the share of manufacturing employment. One explanation may be that firms invest revenues from exports in technology, shifting the occupational composition, but not increasing overall employment. The results are qualitatively comparable and qualitatively similar to those estimated by Dauth et al. (2014).[10]

Given these employment effects, a look at what occupational tasks are associated with the production of the traded goods allows for a first prediction of the change in the occupational task structure. Figure 3 includes three graphs showing task distributions at three different time points, because the associated tasks may change over time (1994, 2002, and 2010).[11]

The graph on the left-hand side shows the distribution of occupational main tasks in Germany. The two graphs on the right-hand side depict the distribution of occupational main tasks that are associated with the production of an average imported and an average exported good. Comparing these occupational task distributions with the overall distribution in the labor market, one can see that imported products at the beginning of the period heavily rely on manual routine tasks. Because the overall share of occupations with manual routine tasks in the labor market is much lower and since—as seen above—imports reduce manufacturing employment, one would assume a decline in the share of occupations with routine manual tasks. For later points in time, the predictions are not as clear-cut.

The previous analysis also showed that manufacturing employment is not increasing in response to export demand from China. Thus, changes in regional task distributions may only result from changes in tasks within the manufacturing industry. Over time, the share of occupations with cognitive routine tasks that are associated with the production of exported goods is declining and the share of occupations with analytical tasks is increasing. One would thus assume regional task distributions to change in exactly this way in response to rising export demand.

To causally assess whether the occupational task structure is indeed changing in these directions as a response to increased trade, we again use our instrumental variable approach and regress regional shares of occupational tasks on imports and exports. We present these results in Table 4. In this table, we order tasks by initial mean wage level, as we did in Table 1.

Supporting the hypotheses and the descriptive evidence, the results indicate that imports lead to a decrease in occupations with manual routine tasks and thus a relative expansion of occupations marked by tasks at the lower and upper ends of the wage distribution. Given that manufacturing employment declines as a response to rising imports, the shifts in the occupational task structure are mainly the result of jobs with routine manual tasks being made redundant.

[10] Dauth et al. (2014) also find no statistically significant effects on manufacturing employment when examining export potential to China specifically. They do, however, find export potential overall to significantly increase employment prospects.

[11] As we cannot precisely measure which occupations were truly responsible for the production of a good, we arrive at the distribution of main occupational tasks per average imported or exported product by first calculating the share each three-digit industry holds of the total imported or exported goods and then weighting these shares by the number of jobs for each occupational main task in each industry.

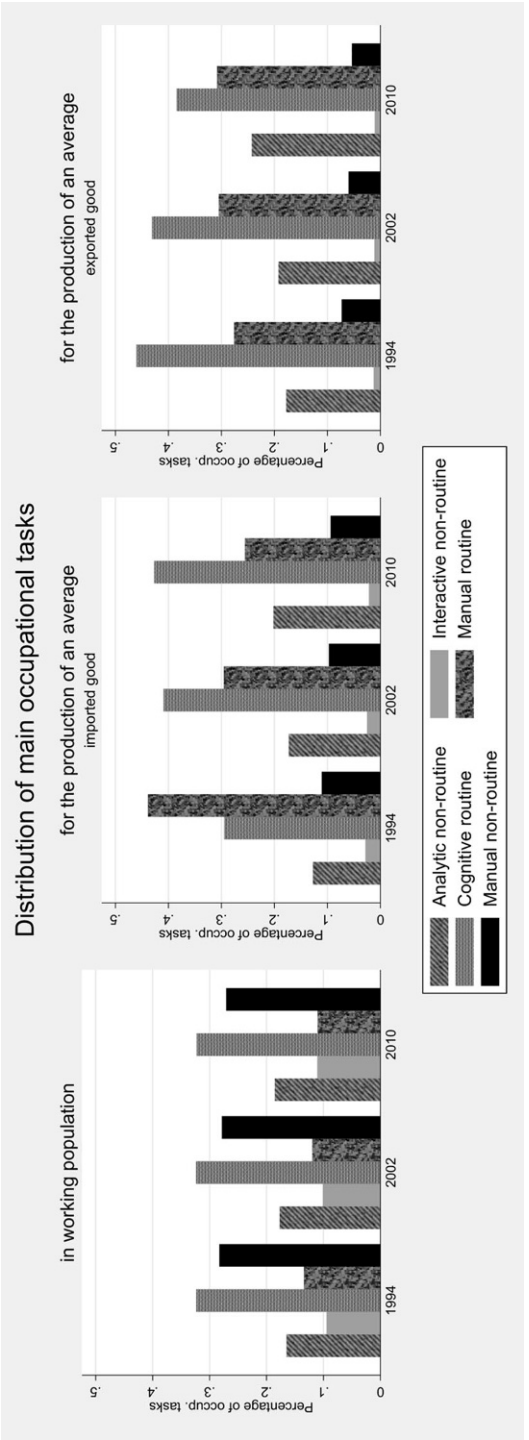

Fig. 3 Distribution of occupational tasks over time. Note: own calculations, based on COMTRADE and BHP data

Table 4 Imports from and exports to China and change in main task types in labor market regions, 1994–2002 and 2002–2010: 2SLS estimates

	Changes in share of occupations with main task in % points				
	Manual non-routine	Interactive	Manual routine	Cognitive routine	Analytical
Δ Import exposure	–0.083	0.039	–0.181*	0.155	0.028
	(0.07)	(0.04)	(0.09)	(0.10)	(0.05)
Δ Export exposure	–0.099	–0.031	–0.052	–0.244*	0.256**
	(0.13)	(0.11)	(0.16)	(0.13)	(0.11)
% Women	0.015	0.020	–0.038	–0.024	0.019
	(0.03)	(0.02)	(0.04)	(0.03)	(0.02)
% Foreign	0.005	0.005	–0.091***	–0.009	0.091***
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)
% Highly-skilled	0.041**	–0.000	0.052*	–0.106***	–0.010
	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)
Region-year dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	459	459	459	459	459

$N = 459$ (256 labor market regions in East and West Germany for the period 2002–2010; 203 labor market regions in West Germany for the period 1994–2002). Labor market regions Göttingen and Osterode am Harz are excluded owing to insufficient data. All regressions include a constant and period dummy variables. Robust standard errors in parentheses are clustered on labor market region level.
Significance levels: *10%, **5%, ***1%

As described above, exports to China do not lead to an increase in manufacturing employment. Changes in the occupational task composition should therefore rather result from changes in occupational demands within the manufacturing sector. As Fig. 3 showed, over time, exported goods increasingly rely on analytical tasks and less on cognitive routine tasks. Indeed, increasing export demand from China points toward task-based job polarization, in which the share of occupations with cognitive routine tasks is declining in favor of occupations with mainly analytical tasks.

As hypothesized, some adjustment in the labor market evidently occurs at the task level instead of at the employment level. Both the changes in the task composition induced by imports and exports are reflective of task-based job-polarization, although the underlying dynamics seem to differ. The fact that increased export demand leads to the described occupational restructuring within the manufacturing industry, rather than to increased manufacturing employment, speaks in favor of exporting firms becoming more productive, potentially because of trade-induced technological change. The rising revenues should consequentially be distributed more unequally—either between occupations or between firms within occupations. In the next section, we test if trade does indeed induce wage inequality and if compositional changes or shifts in occupational wages are the underlying mechanisms.

5.2 Testing the Mechanisms Behind the Effect of Trade on Wage Inequality

As a first step, we estimate the direct effect of trade shocks on wage inequality conditional only on our standard vector of control variables. As the first column of Table 5 shows, surprisingly, we find that import shocks do not affect the difference

Table 5 Imports from and exports to China and change in wage polarization in labor market regions, 1994–2002 and 2002–2010: 2SLS estimates

	Difference in 85–15 percentile wages over 8 years				
	Base model	Δ Task composition	Δ Occupation composition	Δ Occupation median wage	Δ Occupation top wage
Δ Import exposure	–0.149	–0.176	–0.120	–0.343	–0.026
	(0.12)	(0.14)	(0.14)	(0.10)	(0.09)
Δ Export exposure	2.007***	1.973**	2.039***	1.300**	0.680**
	(0.40)	(0.64)	(0.64)	(0.044)	(0.30)
Δ Manual non-routine occ. in % points	–	–0.009	0.540*	–0.016	0.008
	–	(0.20)	(0.33)	(0.18)	(0.13)
Δ Interactive occupation in % pts	–	–0.338	0.447	–0.426**	–0.110
	–	(0.30)	(0.56)	(0.22)	(0.18)
Δ Manual routine occupation in % pts	–	0.270	0.833*	0.097	0.070
	–	(0.19)	(0.44)	(0.18)	(0.14)
Δ Cognitive routine occupation in % pts	–	0.458*	1.380**	0.160	0.167
	–	(0.25)	(0.62)	(0.18)	(0.13)
Δ Analytical occupation in % pts	–	0.667**	1.27**	0.667	0.716
	–	(0.27)	(0.59)	(0.22)	(0.13)
% Women	0.010	0.026	0.055	0.027	0.013
	(0.06)	(0.09)	(0.09)	(0.06)	(0.05)
% Foreign	0.198***	0.168**	0.138**	0.026	0.046
	(0.07)	(0.05)	(0.05)	(0.04)	(0.03)
% Highly skilled	0.007***	0.007***	0.007***	0.005***	0.002***
	(0.05)	(0.07)	(0.09)	(0.05)	(0.05)
Period dummies	Yes	Yes	Yes	Yes	Yes
Δ *2-digit occupation in % points*	–	–	Yes	–	–
Δ *Median wage per occupation*	–	–	–	Yes	Yes
Δ *85th percentile wage per occupation*	–	–	–	–	Yes
Number of observations	459	459	459	459	459

$N = 459$ (256 labor market regions in East and West Germany for the period 2002–2010; 203 labor market regions in West Germany for the period 1994–2002). Labor market regions Göttingen and Osterode am Harz are excluded owing to insufficient data. All regressions include constant and period dummy variables. Robust standard errors in parentheses are clustered at the labor market region level.
Significance levels: *10%, **5%, ***1%

between the 85th and 15th wage percentiles in regional labor markets. This implies that—even if imports decrease manufacturing employment and increase task-based job polarization—rising imports from China do not lead to increased wage inequality.

Why does import-induced job polarization not lead to wage inequality? One explanation is that existing wage differences between task categories are not uniform. As shown in Table 1, the average wage differences between tasks at the lower end of the wage distribution in Germany are relatively small. Changes in the employment

composition between tasks in this segment may therefore not have a large aggregate effect on wage inequality. This will be the case especially if the number of workers changing occupations owing to trade shocks is quantitatively small. According to Table 1 the largest wage premium is attached to analytical non-routine tasks; thus, a change in the weight of this category would have a greater effect on wage inequality. Yet for this category we found only a minor effect of imports in Table 4. Another explanation may be that individuals move across occupations without taking a substantial cut in wages. For example, in response to an import shock, some workers in manual routine occupations may move to manual non-routine occupations, where they become relatively highly paid workers. In this case, wage inequality would increase within occupations, but not necessarily along the wage distribution.[12]

We do, however, find that wage inequality in German labor market regions increases in response to export demand arising from China. We further investigate in the second column whether this estimated effect of export exposure is reduced when we account for changes in the occupational task structure. The coefficients for the task categories pick up the positive effect of the expanding share of occupations with analytical tasks on wage inequality. However, the estimated effect of export exposure on wage inequality remains unchanged. Although exports alter the task composition, this change does not seem to be the driver of the effect on wage inequality. The effects on wage inequality must therefore occur within task categories.

To assess whether changes in the occupational composition are mediating the effect of trade on inequality at all, we account for the changes in more fine-grained two-digit level occupations in column 3. Again, the effect of export exposure remains unchanged and statistically significant.

A reason why changes in the occupational composition are not mediating the effect of exports on wage inequality could be that the wage difference between the declining occupations with cognitive routine tasks and the increasing occupations with analytical tasks is marginal. Exports must thus either affect wage inequality because average wages of some occupations increase or because top earners in exporting firms are able to disproportionately benefit from trade. We hypothesized that some occupations (e.g., engineering) would experience increasing wages because of a shortage of labor supply because power relations in firms shift as a response to rising exports. Moreover, exporting firms may disproportionately increase their revenues, putting top earners (within occupations) into advantageous positions.

Columns 4 and 5 add the changes in median wages per two-digit occupation and the changes in the 85th percentile wages per occupation. As the reduction of the effect of export exposure shows, both explanations seem to hold true. The difference in coefficients is significant when adding both changes in occupational wages. We thus conclude that although trade affects the occupational composition, the true mediators behind the impact of exports on wage inequality are changes in average and top wages of some occupations.

[12] We also estimated regressions with the median wage at the regional labor market level as the dependent variable. The results show that there is indeed no statistically significant reaction of wages to import shocks. One reason for constant wages may be that workers move occupations within the same firm, as wage cuts are relatively rare in Germany.

The results reported in Tables 3, 4, and 5 are also robust to the other definitions of regions in Germany. In particular, the results are qualitatively similar when instead of labor market regions, we use counties (*Kreise*) (as used in Dauth et al. (2014)) as the unit of regional analysis. Moreover, using the share of tasks in an occupation instead of the main task does not substantially change the results.

6 Discussion and Conclusion

Most industrialized countries have experienced a simultaneous rise in wage inequality and trade integration, which led social scientists to address the question to what degree globalization and wage inequality are related. Although studies have reported that trade exposure is positively associated with rising wage inequality, it is yet unclear what the mechanisms behind this relationship are. Although many studies point towards the reduction of manufacturing employment, we argued that—at least for Germany—these explanations fall short because exports increase the number of jobs in manufacturing to the same degree.

In this article, we put occupations and tasks at the center of the explanation and proposed that trade could theoretically contribute to wage inequality via three channels: (1) through changes in the composition of occupational tasks and of occupations more generally, (2) through changes in average wages of certain occupations, and (3) through disproportionate wage increases for top earners.

Drawing on a task-based approach, we argued that high-wage countries import goods that are produced requiring routine and manual tasks, as these can be performed and monitored at lower costs in low-wage countries. Exported goods are increasingly produced, requiring analytical or interactive tasks. Because of the differential returns to occupational tasks, we assumed the compositional changes to be accompanied by a rise in wage inequality, even if manufacturing employment as a whole were to remain constant.

Moreover, we argued that occupations may affect inequality because the average wage of occupations may change in response to trade. Workers leaving negatively impacted occupations create an oversupply of labor for other occupations, reducing their wages, whereas rising exports may increase the demand for some occupations, increasing their wages. We assumed these dynamics to be particularly important in labor markets that are highly structured by occupations—as in Germany. As exports may also shift power dynamics within firms, increasing revenues of exporting firms may not be distributed equally among the workforce, putting some occupations in advantageous positions, thus affecting their wages.

Last, we assumed that productive higher-paying firms may self-select into profitable exports, resulting in a rise in top earners' wages in those occupations associated with the exported goods. To test these hypotheses we used social security data for Germany (BHP and IEB) and data on international trade flows between Germany and China (COMTRADE). Drawing on an instrumental variable approach we found that import exposure reduces manufacturing employment and in particular the share of manual routine jobs in regional labor markets. Increased export demand does not alter the number of jobs in manufacturing. However, exports increase the share of

occupations with analytical tasks while reducing those with cognitive routine tasks. One explanation potentially lies in technological advances in firms that benefit from trade. These could shift the occupational composition more toward analytical tasks.

Although the occupational task composition thus changes in response to both imports and exports, we did not find evidence for increasing wage inequality in response to imports. Even though exports are a source of rising regional wage inequality, the compositional changes in occupational tasks or even more fine-grained occupational categories cannot explain this effect either. Trade-induced shifts in the occupational composition are thus not associated with changes in the wage structure—average wages in declining and rising occupations seem to be fairly similar.

Instead, we found that changes in occupational mean wages and wages of top earners in some occupations explain a large share of the effect of trade on inequality. The findings offer support for theories positing that the effect of exports on wage inequality should come from an increase in the wage differences between exporting and non-exporting firms, under-supply of labor for rising occupations, and theories stating that globalization shifts power relations between occupations, placing decision-makers in advantageous positions.

Distinguishing between these different theories about why average wages rise in some occupations and top-earners disproportionally benefit from rising globalization goes beyond the scope of this article. However, our results emphasize the importance of going beyond employment changes and even changes in the occupational composition to understand the consequences of globalization. Occupations are central in explaining the effect of rising trade on inequality. Differences in average occupational wages grow and top-earners in some occupations seem to benefit the most. An important avenue for future research on the consequences of economic globalization will thus be the focus on dynamics both within and between occupations.

Although our results are robust to various specifications of local labor markets and task operationalizations, there are clear limitations to our study. First, we would like to stress the point that the results hold for the trade relations between Germany and China and should not be generalized, especially not to trade relations with non-low-wage countries. Even though, for example, trade with Eastern Europe has risen to an even larger degree, the trade mostly occurs within industries. Although we therefore do not expect the same changes in occupational compositions, it would nonetheless be worthwhile to assess whether the effects on wage inequality are comparable and whether these effects are also mediated by change in between- and within-occupation wage heterogeneity. Second, we note that there remains a significant share of the effect of export exposure on wage inequality that is unexplained by current theoretical frameworks. We would therefore encourage further theoretical work in this direction. Third, even though we are able to show the short-term effects of trade exposure, long-term effects might play out differently. Thus, we especially encourage research comparing effects of trade, tasks, and occupations comparatively over contexts and time. Analyzing the consequences and mechanisms of trade exposure remains important as rising inequality becomes an increasingly important topic in today's societies.

Acknowledgements We would like to thank the editors and two anonymous reviewers for their valuable comments and suggestions. We would also like to thank David Brady, Simon Janssen, Wolfgang Dauth, and the participants of the ASA 2019 sessions on Organizations, Occupations, and Work for helpful discussions and comments.

References

Acemoglu, Daron, and David H. Autor. 2010. Skills, tasks and technologies: Implications for employment and earnings. *NBER Working Paper* (16082).

Akçomak, Semih, Suzanne Kok and Hugo Rojas-Romagosa. 2016. Technology, offshoring and the task content of occupations in the United Kingdom. *International Labour Review* 155:201–230.

Autor, David H. 2013. The "task approach" to labor markets: an overview. *Journal for Labour Market Research* 46:185–199.

Autor, David H., David Dorn and Gordon H. Hanson. 2013. The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *The American Economic Review* 103(6):2121–2168.

Autor, David H., David Dorn and Gordon H. Hanson. 2015. Untangling trade and technology: Evidence from local labour markets. *The Economic Journal* 125(584):621–646.

Autor, David H., Frank Levy and Richard J. Murnane. 2003. The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics* 118(4):1279–1333.

Bartel, Ann, Casey Ichniowski and Kathryn Shaw. 2007. How does information technology affect productivity? Plant-level comparisons of product innovation, process improvement, and worker skills. *The Quarterly Journal of Economics* 122(4):1721–1758.

Bartels, Charlotte. 2019. Top incomes in Germany, 1871–2014. *Journal of Economic History* forthcoming.

Becker, Sascha O., and Marc-Adreas Muendler. 2015. Trade and tasks: An exploration over three decades in Germany. *Economic Policy* 30(84):589–641.

Bhagwati, Jagdish. 1995. Trade and wages: Choosing among alternative explanations. *Economic Policy Review* 1(1):42–47.

Blau, Francine D., and Lawrence M. Kahn. 2002. *At home and abroad: US labor market performance in international perspective*. Russell Sage Foundation. New York.

Blossfeld, Hans-Peter, and Karl Ulrich Mayer, 1988. Arbeitsmarktsegmentation in der Bundesrepublik Deutschland. Eine empirische Überprüfung von Segmentationstheorien aus der Perspektive des Lebenslaufs. *Kölner Zeitschrift für Soziologie und Sozialpsychologie,* 40:262–283.

Blossfeld, Hans-Peter, Erik Klijzing, Melinda Mills and Karin Kurz. Eds. 2006. *Globalization, uncertainty and youth in society*. Routledge.

Bol, Thijs, and Kim A. Weeden. 2015. Occupational closure and wage inequality in Germany and the United Kingdom. *European Sociologial Review* 31(3):354–369.

Brady, David. 2009. Economic globalization and increasing earnings inequality in affluent democracies. *Research in the Sociology of Work* 18:149–181.

Brady, David, and Michael Wallace. 2000. Spatialization, foreign direct investment, and labor outcomes in the American States, 1978–1996. *Social Forces* 79(1):1978–1996.

Brady, David, Jason Beckfield and Wei Zhao. 2007. The consequences of economic globalization for affluent democracies. *Annual Review of Sociology* 33:313–334.

Bustos, Paula. 2011. The impact of trade liberalization on skill upgrading evidence from Argentina. Working Papers 559, Barcelona Graduate School of Economics.

Damelang, Andreas, Florian Schulz and Basha Vicari. 2015. Institutionelle Eigenschaften von Berufen und ihr Einfluss auf berufliche Mobilität in Deutschland. *Schmollers Jahrbuch* 135:307–334.

Dauth, Wolfgang, Sebastian Findeisen and Jens Suedekum. 2014. The rise of the East and the Far East: German labor markets and trade integration. *Journal of the European Economic Association* 12(6):1643–1675.

Dengler, Katharina, Britta Matthes and Wiebke Paulus. 2014. Occupational tasks in the German labour market—an alternative measurement on the basis of an expert database. *FDZ Methodenreport* 12.

DiPrete, Thomas A. 2002. Life course risks, mobility regimes, and mobility consequences: A comparison of Sweden, Germany, and the United States. *American Journal of Sociology* 108(2):267–309.

DiPrete, Thomas A. 2005. Labor markets, inequality, and change: A European perspective. *Work and Occupations* 32(2):119–139.

DiPrete, Thomas A., and Patricia A. McManus. 1996. Institutions, technical change, and diverging life chances: Earnings mobility in the United States and Germany. *American Journal of Sociology* 102(1):34–79.

Dustmann, Christian, Johannes Ludsteck and Uta Schoenberg. 2009. Revisiting the German wage structure. *Quarterly Journal of Economics* 124(2):843–881.
Eberle, Johanna, Peter Jacobebbinghaus, Johannes Ludsteck and Julia Witer. 2014. Generation of time-consistent industry codes in the face of classification changes. FDZ Methodenreport, 5(2008).
Fajgelbaum, Pablo D., and Amit K Khandelwal. 2016. Measuring the unequal gains from trade. *The Quarterly Journal of Economics* 131(3):1113–1180.
Feenstra, Robert C., and Alan M. Taylor. 2017. *International Economics, 4th edition.* New York: Macmillan.
Felbermayr, Gabriel, Giammario Impullitti and Julien Prat. 2018. Firm dynamics and residual inequality in open economies. *Journal of the European Economic Association* 16(5):1476–1539.
Goos, Maarten, and Alan Manning. 2007. Lousy and lovely jobs: The rising polarization of work in Britain. *The Review of Economics and Statistics* 89(1):118–133.
Goos, Maarten, Alan Manning and Anna Salomons. 2014. Explaining job polarization: Routine-biased technological change and offshoring. *American Economic Review* 104(8):2509–2526.
Grant, Don Sherman, and Michael Wallace. 1994. The political economy of manufacturing growth and decline across the American States, 1970–1985. *Social Forces* 73(1):33–63.
Grossman, Gene M., and Esteban Rossi-Hansberg. 2008. Trading tasks: A simple theory of offshoring. *The American Economic Review* 98(5):1978–1997.
Gu, Grace W., Samreen Malik, Dario Pozzoli and Vera Rocha. 2020. Trade-induced skill polarization. *Economic Inquiry* 58(1), 241–259.
Hällsten, Martin, Tomas Korpi and Michael Tåhlin. 2010. Globalization and uncertainty: Earnings volatility in Sweden, 1985–2003. *Industrial Relations: A Journal of Economy and Society* 49(2):165–189.
Helpman, Elhanan, Oleg Itskhoki, Marc-Andreas Muendler and Stephen J. Redding. 2017. Trade and inequality: From theory to estimation. *Review of Economic Studies* 84(1):357–405.
Kambourov, Gueorgui, and Iourii Manovskii. 2009. Occupational specificity of human capital. *International Economic Review* 50(1):63–115.
Keller, Wolfgang, and Hâle Utar. 2016. International trade and job polarization: Evidence at the worker level. Technical report, Working Paper: National Bureau of Economic Research.
Kemeny, Thomas, and David Rigby. 2012. Trading away what kind of jobs? globalization, trade and tasks in the us economy. *Review of World Economics* 148(1):1–16.
Kim, ChangHwan, and Arthur Sakamoto. 2008. The rise of intra-occupational wage inequality in the United States, 1983 to 2002. *American Sociological Review* 73(2):129–157.
Kracke, Nancy, Malte Reichelt and Basha Vicari. 2018. Wage losses due to overqualification: The role of formal degrees and occupational skills. *Social Indicators Research* 139(3):1085–1108.
Levy, Frank, and Richard J. Murnane. 2004. *The new division of labor: how computers change the way we work.* Princeton University Press, New York.
Li, Hongbin, Lei Li, Binzhen Wu and Yanyan Xiong. 2012. The end of cheap Chinese labor. *Journal of Economic Perspectives* 26(4):57–74.
Liu, Yujia, and Grusky, David B. 2013. The payoff to skill in the third industrial revolution. *American Sociological Review* 118(5):1330–1374.
Mahutga, Matthew C., Anthony Roberts and Ronald Kwon. 2017. The globalization of production and income inequality in rich democracies. *Social Forces* 96(1):181–214.
Matthes, Britta, Bernhard Christoph, Florian Janik and Michael Ruland. 2014. Collecting information on job tasks—an instrument to measure tasks required at the workplace in a multi-topic survey. *Journal for Labour Market Research* 47(4):273–297.
Morris, Martina, and Bruce Western. 1999. Inequality in earnings at the close of the twentieth century. *Annual Review of Sociology* 25(1):623–657.
Mouw, Ted, and Arne Kalleberg. 2010. Occupations and the structure of wage inequality in the United States, 1980s to 2000s. *American Sociological Review* 75(3):402–431.
Neckerman, Kathryn M., and Florencia Torche. 2007. Inequality: causes and consequences. *Annual Review of Sociology* 33:335–357.
Piketty, Thomas, and Emmanuel Saez. 2014. Inequality in the long run. *Science* 344(6186):838–843.
Rees, Kathleen, and Jan Hathcote. 2004. The US textile and apparel industry in the age of globalization. *Global Economy Journal* 4(1):1524–5861.
Reichelt, Malte, and Martin Abraham. 2017. Occupational and regional mobility as substitutes: A new approach to understanding job changes and wage inequality. *Social Forces* 95(4):399–1426.
Richardson, J. David. 1995. Income inequality and trade: how to think, what to conclude. *Journal of economic perspectives* 9(3):33–55.

RWI 2018. Überprüfung des Zuschnitts von Arbeitsmarktregionen für die Neuabgrenzung des GRW Fördergebiets ab 2021. *Endbericht Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie (BMWi)* 16. März 2018.
Schwengler, Barbara, and Jan Binder. 2007. Vorschlag und Neuzuschnitt der Arbeitsmarktregionen im Raum Berlin-Brandenburg. *Sozialer Fortschritt* 56(7/8):194–199.
Sklair, Leslie. 2002. *Capitalism and its alternatives* Volume 65. Oxford University Press.
Solga, Heike, and Dirk Konietzka. 1999. Occupational matching and social stratification: Theoretical insights and empirical observations taken from a German–German comparison. *European Sociological Review* 15(1):25–47.
Spilerman, Seymour. 2008. How globalization has impacted labour: A review essay. *European Sociological Review* 25(1):73–86.
Spitz-Oener, Alexandra. 2006. Technical change, job tasks, and rising educational demands: Looking outside the wage structure. *Journal of Labor Economics* 24(2):235–270.
Tomaskovic-Devey, Donald, Peter Jacobebbinghaus and Silvia Melzer. 2016. The organizational production of earnings inequalities in Germany, 1994–2010. *SSRN Working Paper*.
Wallace, Michael, Gordon Gauchat and Andrew S. Fullerton. 2011. Globalization, labor market transformation, and metropolitan earnings inequality. *Social Science Research* 40(1):15–36.
Williams, Mark, and Thijs Bol. 2018. Occupations and the wage structure: The role of occupational tasks in Britain. *Research in Social Stratification and Mobility* 53:16–25.
Yuasa, Masae. 2001. Globalization and flexibility in the textile/apparel industry of Japan. *Asia Pacific Business Review* 8(1):80–101.

Malte Reichelt 1986, Assistant Professor of Social Research and Public Policy, Social Science Division, New York University Abu Dhabi (NYUAD), UAE, and Research Associate at the Institute for Employment Research (IAB), Nuremberg, Germany. Areas of research: Social stratification, labor markets and work, trade, technological change and globalization, education, gender inequality. Latest publication: School tracking and its role in social reproduction: Reinforcing educational inheritance and the direct effects of social origin. British Journal of Sociology 70, 2019 (with M. Collischon and A. Eberl).

Samreen Malik 1984, Associate Professor of Economics, Social Science Division, New York University Abu Dhabi (NYUAD), UAE. Areas of research: International trade; macroeconomics and development economics. Latest publication: Trade-Induced Skill Polarization, Economic Inquiry 58, 2020 (with G. W. Gu, D. Pozzoli and V. Rocha).

Marvin Suesse 1983, Assistant Professor in Economics, Trinity College Dublin, Republic of Ireland, and Research Associate in Economic History, Lund University, Sweden. Areas of research: Political economy, international integration and inequality, economic history, finance and growth. Latest publication: Rural transformation, inequality, and the origins of microfinance, Journal of Development Economics 143, March 2020 (with N. Wolf).