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Trade and Tasks: An Exploration over Three Decades in Germany*

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Abstract

This paper combines representative worker-level data that cover *time-varying* job-level task characteristics of an economy over several decades with sector-level bilateral trade data for merchandise and services. We carefully create longitudinally consistent workplace characteristics from the German Qualification and Career Survey 1979-2006 and prepare trade flow statistics from varying sources. Four main facts emerge: (i) intermediate inputs constitute a major share of imports and dominate German imports since at least the 1970s; (ii) the German workforce increasingly specializes in workplace activities and job requirements that are typically considered non-offshorable, mainly *within* and not between sectors and occupations; (iii) the imputed activity and job requirement content of German imports grows relatively more intensive in work characteristics typically considered offshorable; and (iv) labour-market institutions at German trade partners are largely unrelated to the changing task content of German imports but German sector-level outcomes exhibit some covariation consistent with faster task offshoring in sectors exposed to lower labour-market tightness. We discuss policy implications of these findings.

Keywords: Trade in tasks; offshoring; demand for labour; labour force survey

JEL Classification: F16, F14, J23, J24

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1 Introduction

Offshoring of production stages, and the accompanying global integration of production, are widely perceived to affect employment and wages. The direction of effects is theoretically ambiguous and likely depends on the type of labour. If jobs of the least educated workers are those most frequently offshored, one might expect a widening of the wage gap between skilled and unskilled labour (Feenstra and Hanson 1999). To the extent that offshoring is associated with consumer price reductions, less skilled workers may still benefit overall from an increase in real wages. Grossman and Rossi-Hansberg (2008) point to the theoretical possibility that quasi-rents from offshored jobs might accrue to the apparently most vulnerable workers who command a wage premium in the offshorable jobs that remain onshore in equilibrium. Jones and Kierzkowski (1990) and Grossman and Rossi-Hansberg (2008) stress that, if the associated cost reductions are particularly strong in industries employing low-skilled labour intensively, offshoring might shrink the wage gap between skilled and unskilled labour as resources are reallocated towards low-skill intensive industries in equilibrium.¹

The offshorability of jobs need not be directly related to skills as measured by formal education. The tasks to be performed in an occupation and sector may circumscribe more relevant labour-market characteristics than the worker's skill. There is no obvious correspondence between skills and offshorability, and their relation arguably depends on the tasks performed. Compare a handyman and a radiologist, for instance. Handymen typically have relatively little formal schooling, while the nature of their tasks ties them to their local workplace. In contrast, a radiologist's interpretation of computer-tomography images or X-rays typically requires at least upper-secondary or tertiary education but the images can easily be read remotely. The link between task content and offshorability has been explored by Leamer and Storper (2001); Markusen (2006); Jensen and Kletzer (2006); Blinder (2006), among others. Blinder (2009) argues that low-skilled and high-skilled jobs are equally likely to be affected by offshoring, while Blinder and Krueger (2013) argue that more educated workers appear to hold more offshorable jobs in the United States. Several important task characterizations have been proposed as relevant for the offshorability of occupations: the prevalence of codifiable instructions rather than tacit information to perform the job (Leamer and Storper 2001); the prevalence of routine tasks, especially if they can be summarized in deductive rules (Levy and Murnane 2004); or the job's lacking requirement of physical contact and geographic proximity (Blinder 2006). Whereas the nature of tasks could be strongly correlated with the skill-intensity of the occupation, there is no *a priori* reason for this to be the case.

In this paper, we document how Germany's trade pattern has developed since the 1970s, how the composition of tasks that German workers perform has evolved by occupation and sector, and how these developments are related. Despite the policy relevance of those issues, we often lack basic stylized facts that can characterize trends and connections over long time periods to provide perspective. Classic trade analysis used to be about the trade of final goods and services. That was globalization 1.0. With the integration of production across borders and the ensuing offshoring of production stages, the trade of intermediate goods and services has taken a prominent role. This is globalization 2.0. How recent is globalization 2.0? When it comes to our earlier example of tele-

¹See also Baldwin and Robert-Nicoud (2007) and Kohler (2009) for alternative presentations of this argument.

medicine (health care at a distance using telecommunications), U.S. media covered the prospects of tele-medicine as early as the 1920s.² But most health care arguably continues to be delivered in person.

We document for the German economy as a whole that outsourcing to third parties, including domestic suppliers, has remained roughly constant at around one-half of production in German merchandise and services industries since the 1970s. Yet, within the outsourced half of production, the share of imported intermediate inputs from producers located offshore has grown at a rate of between 1 and 2 percent a year over three decades. However, globalization 2.0 is nothing new. When we discern import flows by intermediate use and final consumption using Germany's precise, and separately measured, input-output tables for imported goods, we find that the bulk of goods and services has been shipping to Germany for intermediate use since at least the late 1970s and has, if anything, fallen since. In that sense, globalization 2.0 has been dominant for a long time and appears to be a surprisingly old phenomenon.

To examine the relationship between offshoring and the composition of tasks in the workplace, we bring in representative worker-level data that cover *time-varying* job-level task characteristics *within* occupations and sectors over decades. Rich micro data from the German Qualifications and Career Survey (BIBB survey) for the years 1979, 1986, 1992, 1999 and 2006 provide numerous worker-reported job characteristics, typically referred to as tasks. We carefully create mappings across the five survey waves to obtain longitudinally consistent task measures. In contrast to much of the existing literature, which maps the task content of occupations at a given moment in time (say the present task information from U.S. ONET) to historic occupations, our data allow us to track task information from individual workers within occupations and sectors over time. We find that the most pronounced changes in tasks indeed occur within occupations and sectors—a finding that the time-invariant mapping of tasks to occupations used to preclude.

The workplace characteristics in our data offer rich task measures, in addition to the common categories of codifiability and routineness, and permit an analysis of multitasking (the simultaneous performance of multiple tasks). The survey design allows us to group workplace characteristics into two basic types of tasks. On the one hand we can query “what” is being done in the workplace: we discern 15 *activities* (which a worker may report as performed or not). Examples of such workplace activities are: *Produce Goods*; *Develop, Research, Construct*; *Organize, Plan, Prepare (others' work)*; and *Oversee, Control Machinery or Processes*. Our data show that these activities exhibit a pronounced change towards more multitasking over time. German workers perform six times more of the 15 possible activities in 2006 than they did in 1979.

On the other hand we observe “how” a worker performs the job. We newly construct 9 time-consistent *performance requirements* (which a worker may report as frequent or less frequent in the workplace). The two most prominent examples of such performance requirements are *Work procedures prescribed in detail* and *Repeated work steps*, which capture the two common categories of codifiability and routineness much used in the U.S. ONET data. The German data also offer additional performance requirements such as *Deadlines/pressure to perform*; *New situations/activities*; *Improve/adopt new techniques*; and *Financial losses by small mistakes*. In stark contrast with the

²The *Economist* magazine, October 11, 2014 reports that *Radio News* magazine devoted a cover story in 1924 to a patient's virtual visit with a surgeon via television link.

“what” activities, the “how” performance requirements exhibit no evidence of additional multitasking over time. Workers remain similarly focused in an average of around 5 (out of 9) performance requirements throughout the sample period. This evidence suggests that faster workplace change is to be expected in performance dimensions beyond codifiability or routineness.³

Combined with sector-level trade information, our worker-reported task data provide evidence on the responsiveness of onshore tasks to trade flows and thereby indicate the degree of offshorability or tradability of jobs (Jensen and Kletzer 2010; Blinder 2009). Using the import matrix from the German input-output tables, we can separate imports of intermediate inputs from final-goods imports by year and sector of origin. The German statistical agency does not place the common assumption of proportionality with domestic inputs on the import matrix, rendering the information on imports of intermediate inputs more precise than that available for several other OECD countries. Imports of intermediate inputs are commonly associated with offshoring. We combine the information on import uses with publicly available data on merchandise trade flows to and from Germany and construct novel bilateral services trade flows using data at Deutsche Bundesbank. The bilateral nature of those comprehensive trade data allows us to relate trade flows to the composition of labour-market characteristics of the foreign countries, where German imports originate, while controlling for German exports. To return to the example of tele-medicine, offshoring can run in both directions. While radiologists in high-income countries might be susceptible to foreign competition, other specialties might export medical services. The Cleveland Clinic, a leading hospital in the United States, provides tele-oncology to Rwanda.

Four main facts emerge from our German data. First, intermediate inputs constitute a major share of imports and dominate trade flows throughout the sample period. Second, the German workforce increasingly specializes in workplace activities and performance requirements that are typically considered non-offshorable, mainly *within* and not between sectors and occupations. Third, we weight sectoral import flows to Germany with typical German task content seven years prior in an imputation exercise, and use similar regressions to describe the evolution of task trade. We find that the imputed activity and job requirement content of German imports grows relatively more intensive in work characteristics typically considered offshorable. To investigate the susceptibility of tasks to offshoring, we relate tasks to trade flows in regressions and find that task responses to intermediate-input offshoring are similar to the same tasks’ responses to exports from Germany, but typically respond in the reverse way to final-use imports. For example, German workers specialize more in research activities and computer programming in response to both more intermediate-input imports and more product exports, but those activities become less frequent in response to final-use imports of competing products. Fourth and last, labour-market institutions at German trade partners are largely unrelated to the changing task content of German imports. But

³The BIBB survey also asks workers whether they use certain tools—such as computers, pencils, or fork lifts, for instance. Reported tool use has been extracted for research by DiNardo and Pischke (1997) and Acemoglu and Pischke (1998) in different settings before, and by Becker, Ekholm and Muendler (2013) in the context of offshoring through vertical foreign direct investment. In this paper, we concentrate on workplace characteristics beyond tool use. Select survey questions related to our 15 activities have also been used in earlier research, for example by Acemoglu and Pischke (1998), Spitz-Oener (2006) and Gathmann and Schönberg (2010). Our variables related to 9 performance requirements come from a so far largely unexplored group of BIBB survey questions, though performance requirements are arguably closely related to task types that are relevant for offshorability.

German sector-level outcomes exhibit some covariation consistent with faster task offshoring in sectors exposed to lower labour-market tightness. Those findings are consistent with the hypothesis that industries active in more flexible labour markets adjust task assignments faster in response to globalization 2.0.

Our work is closely related to Timmer, Los, Stehrer and de Vries (2013), who study manufacturing in multiple EU countries during the period 1995-2008 using constructed imports of intermediate inputs from the World Input-Output Database. We extend the time period back to 1979 and the sector coverage to services for Germany and use the country's observed input imports, not requiring the common fixed proportionality assumption for foreign relative to domestic inputs. Our work adds a worker-reported task perspective beyond the analysis of labour demand by skill at the industry level. In a single-country analysis similar to ours, Akçomak, Borghans and ter Weel (2011) investigate for the Netherlands links between trade and tasks. Their analysis covers the years 1996-2005 and relies on task measures imputed from the British Skills Survey (BSS), which consequently vary only between occupations. Our German evidence complements their findings by tracking tasks within occupations and sectors. Our research also relates to the widely documented hollowing-out of intermediate-skill employment in industrialized countries, and the accompanying polarization of the earnings distribution with relative compensation losses for intermediate-skill groups (Autor, Katz and Kearney 2006; Goos, Manning and Salomons 2009).

Feenstra and Hanson (1996) and Baldwin and Forslid (2013) conceptualize offshoring as the integration of production stages across country borders, driven by an ongoing fractionalisation that unbundles supply chains into finer stages of production. In a complementary conceptual approach Grossman and Rossi-Hansberg (2008) consider the tasks embedded in international trade flows and treat the tasks as virtually traded themselves. Beyond offshoring and task trade, which is the conceptual focus of our paper, recent labour-market changes may be related to four additional explanations: (i) immigration (Ottaviano, Peri and Wright 2013); (ii) product demand shifts at high earning households that favor low-skill compensation (Mazzolari and Ragusa 2013); (iii) technical change (e.g. Acemoglu 2002; Autor, Levy and Murnane 2003; Spitz-Oener 2006); and (iv) changing human resource management practices such as training and teamwork (Lazear and Shaw 2007). As to the former two hypotheses, our empirical treatment controls for both labour-supply effects from immigration and labour-demand effects from product-demand shifts, by conditioning out sector and year effects. As to the latter two hypotheses, our data include information on the use of technically advanced equipment and human-resource management practices such as training and teamwork. In future work we will include those additional workplace characteristics and implement identification strategies to empirically discern alternative explanations.

This paper has six more sections. In Section 2, we give an overview of the data. Section 3 documents trade patterns in Germany between 1979 and 2006. Section 4 turns to evidence on the German workforce and investigates the shifts in workplace activities and tasks over time, within and between sectors and occupations. Section 5 then combines the data and imputes the likely task content of Germany import and export trade flows, and documents their changes over time. Section 6 relates the workplace and trade flow changes to select labour-market institutions: the sectoral degree of unionization and labour-market tightness in Germany and the extent of labour-market rigidity among German trade partners. Section 7 discusses potential policy implications.

Section 8 concludes.

2 Data

This section describes our novel micro-level data set, covering nearly three decades (1979-2006) of workplace and trade information. We draw on various sources: (i) the German Qualifications and Career (BIBB) survey, which we use to construct detailed and time consistent task measures at the worker level; (ii) sector-level bilateral merchandise trade data from the World Trade Flows (WTF) database and sector-level bilateral services trade data from Deutsche Bundesbank; (iii) sector-level unionization rates from the German Socioeconomic Panel (GSOEP) and labour-market tightness measures from the German Federal Labour Office (IAB); (iv) internationally comparable measures of labour-market institutions from the IMF and Fondazione Rodolfo DeBenedetti (fRDB), characterizing labour-market rigidities of Germany and its trading partners. We describe each of these data sources in turn.

We take account of German unification in 1990 and of changes in the WTF data construction by including year dummies in all our regressions. We have confirmed the robustness of our results by restricting the analysis to West Germany alone.

2.1 German Qualifications and Career survey

Our main data source is the German Qualifications and Career survey (*Qualifikation und Berufsverlauf*), meanwhile renamed to German work survey (*Erwerbstätigenbefragung*). We refer to this data source for short as the BIBB survey because Germany's Federal Institute for Vocational Education and Training BIBB (*Bundesinstitut für Berufsbildung*) is the lead institution carrying out the survey. The BIBB survey allows us to infer the time varying activity content and job requirements of occupations and to obtain detailed worker characteristics. The survey has been conducted in five waves—in 1979, 1985-86, 1991-92, 1998-99 and 2005-06. The BIBB data is a random sample of around one tenth of a percent of the German labour force in each wave and forms a repeated cross section of workers with detailed information on workplace characteristics, worker attributes, the occupation and earnings, as well as the job's industry. (There is only rudimentary information on the employer, such as the employer's region and size in select years.)

We have created time consistent information across all five waves (see the Online Supplement for more detail). For the first time, these data enable us to track the changing workplace characteristics of jobs within sectors and occupations for a country over three decades. The BIBB data characterize the task profile of German workplaces through the surveyed workers' responses to relatively objective questions (such as the declaration of the main activity on the job and the use of workplace tools) as well as somewhat more subjective questions (the worker's assessment of the skills required to perform a job and the worker's assessment of the intensity of job requirements to conduct the job such as the degree of repetitiveness, the relevance of deadlines, or the adaptation to new situations).⁴ In this paper, we restrict our attention to the worker's declaration of performed

⁴For earlier work on select workplace characteristics in a labour-market context see DiNardo and Pischke (1997),

activities and the worker’s assessment of the job’s performance requirements.

Activities. For a longitudinally consistent series of activities relating to “what” the worker does, we extract binary indicators from the BIBB data. These activity indicators record whether a worker performs an activity on the job. We obtain 15 longitudinally consistent activity indicators across all five survey waves. For details on the activity variables see our Online Supplement I.1. Examples of longitudinally consistent BIBB activities are: *Manufacture, Produce Goods; Gather Information, Develop, Research, Construct; Organize, Plan, Prepare (others’ work);* or *Oversee, Control Machinery and Technical Processes*. We will use manufacturing activities (*Manufacture, Produce Goods*) as our arguably easily offshorable benchmark in subsequent activity analysis.

The activities are not mutually exclusive. Activities cumulate. With the possible exception of a few narrower activities—such as nursing, practicing law, and entertaining—tasks are not occupation or sector specific. Even for occupation or sector specific tasks, activities such as organizing/preparing/planning or overseeing/controlling can occur in common production or logistics jobs as well as in service occupations. As Table 1 shows, workers report that they perform considerably more simultaneous activities in later years than in early years. The average worker in 2006 performs multitasking across more than seven activities, whereas the average worker in 1979 performed fewer than two activities—a sixfold increase in the average number of tasks performed over the sample period. While 58.7 percent of workers report no more than one activity in 1979, the fraction of workers who report to perform no more than one activity drops to 2.4 percent by 2006. For most occupations, too, multitasking is rare in 1979: only in six occupations (with more than ten worker observations) is the reported average number of activities larger than three. By 2006, all but two occupations (out of 180 occupations with more than ten observations) show more than three activities on average, and for 17 occupations the reported average number of activities is larger than nine. To account for potential differences in reporting conventions over time, we condition on survey-wave fixed effects in all later regressions.

Given the specific nature of the “what” activities in the survey, workers in select occupations report zero activities, with a particularly noteworthy frequency in 1979. However, even in 1979, there are only three out of 336 occupations for which every worker reports no activity.⁵ There is no single occupation with three or more workers in 1979, for which all workers report no activity. Pooling all sample years, there is no single three-digit occupation for which every worker would report no activity. These patterns suggest that reports of no activity are rare outliers at the worker level and not a characteristic of any occupation.

Performance requirements. The BIBB survey reports task requirements that characterize “how” a worker performs the job. In contrast to the activity indicators, a job requirement is recorded in BIBB by the frequency with which a worker executes the tasks on the job. We obtain nine longitudinally consistent job requirement categories but information for four requirement categories is

Acemoglu and Pischke (1998) or Spitz-Oener (2006), for instance, and for tool use and global integration of German firms see Becker et al. (2013).

⁵The occupations for which every worker reports no activity in 1979 are: Milkers (1 observation), stowers and furniture packers (1 observation), and machinery and container cleaners (2 observations).

Table 1: SIMULTANEOUS ACTIVITIES BY SURVEY WAVE

	y1979	y1986	y1992	y1999	y2006
	(1)	(2)	(3)	(4)	(5)
0	.184	.071	.105	.035	.008
1	.403	.331	.350	.064	.016
2	.204	.263	.236	.087	.028
3	.096	.156	.138	.113	.048
4	.053	.093	.078	.121	.070
5	.029	.052	.046	.126	.103
6	.015	.023	.025	.119	.125
7	.008	.006	.013	.110	.131
8	.004	.002	.006	.084	.128
9	.002	.001	.003	.061	.114
10	.001	.0006	.001	.038	.092
11	.0005	.0001	.0004	.025	.068
12 or more	.0003		.0001	.017	.068
<i>Total</i>	1.000	1.000	1.000	1.000	1.000
<i>Average</i>	1.67	2.17	2.11	5.25	7.24
<i>Observations</i>	29,737	26,361	24,090	27,634	16,964

Source: BIBB 1979-2006.

Note: Shares of worker observations per wave with given number of reported activities. Missing entries are less than one-tenth percent of a percent of observations. Activities are: 1. Manufacture, Produce Goods; 2. Repair, Maintain; 3. Entertain, Accommodate, Prepare Foods; 4. Transport, Store, Dispatch; 5. Measure, Inspect, Control Quality; 6. Gather Information, Develop, Research, Construct; 7. Purchase, Procure, Sell; 8. Program a Computer; 9. Apply Legal Knowledge; 10. Consult and Inform; 11. Train, Teach, Instruct, Educate; 12. Nurse, Look After, Cure; 13. Advertise, Promote, Conduct Marketing and PR; 14. Organize, Plan, Prepare (others' work); 15. Oversee, Control Machinery and Technical Processes.

missing in a single wave each. To our knowledge, the performance requirement variables are so far largely unexplored workplace characteristics in research and we construct longitudinally consistent variables for the first time. We describe details of our performance requirements construction in Online Supplement I.2.

For empirical comparability to the more widely known activity definitions and to maintain the convention of dichotomous classifications for codifiability and routineness, in this paper we transform the intensity scale into a set of binary task variables that indicate frequent requirements (intensity of 3 or 4—occasionally, frequently or almost always) or infrequent requirements (intensity of 1 or 2—never or almost never, or seldom). We have conducted robustness checks with alternative cutoffs (such as 1-3 vs. 4, and 1 vs. 2-4, available upon request), and find closely comparable empirical facts. Examples of longitudinally consistent BIBB job requirements are: *Deadlines/pressure to perform*; *Improve/adopt new techniques*; *New situations/activities*; or *Work procedures prescribed in detail*. We will use the presence of detailed work routines (*Work procedures prescribed in detail*) as our arguably easily offshorable benchmark in subsequent analysis of performance requirements.

Just as activities before, performance requirements are not mutually exclusive. In contrast to activities, however, German workers do not report more simultaneous performance requirements over time, as Table 2 documents. As mentioned, for the tabulation we consider a performance requirement as present if the worker reports it to apply occasionally, or frequently or almost always (intensity of 3 or 4). Except for the survey waves 1991-92 and 2005-06, where three and one requirements are not reported, respectively, the fractions of workers with a given number of simultaneous high-frequency performance requirements remain stable. A plurality of workers faces between four and seven simultaneous performance requirements with high frequency in all survey waves.

The stability in the simultaneity of performance requirements over time is remarkable, especially when compared to the above observed increase in activities. The steady cumulation of additional activities suggests that there is a marked workplace enrichment over the sample period, but conventional performance requirements including codifiability and routineness may not be closely related to those workplace enrichments. The different behavior of activities and performance requirements over time indicates that those two types of tasks capture distinct dimensions of inherently separate workplace characteristics.

2.2 Trade

Merchandise and services trade. We obtain bilateral merchandise trade data to and from Germany by foreign country and sector for the years 1979, 1986 and 1992 using the World Trade Flows (WTF) database over the period 1979-1993 by Feenstra, Lipsey, Deng, Ma and Mo (2005), and using their recent revision files (2011) for the years 1994 and 2006 (for details also see the Online Supplement II.1). We aggregate the individual country information from the recent files (for 1999 and 2006) to the country groups as defined by Feenstra et al. (2005) in the early years (1979, 1986 and 1992). We map the SITC Rev. 2 industry information to our common sector definition with 34 industries across all waves of the BIBB data (20 merchandise producing industries; see Online

Table 2: SIMULTANEOUS PERFORMANCE REQUIREMENTS BY SURVEY WAVE

	y1979	y1986	y1992	y1999	y2006
	(1)	(2)	(3)	(4)	(5)
0	.056	.022	.009	.004	.004
1	.040	.034	.028	.035	.014
2	.065	.061	.073	.054	.035
3	.103	.099	.159	.101	.074
4	.143	.138	.312	.150	.162
5	.168	.186	.234	.184	.240
6	.156	.196	.185	.182	.228
7	.129	.138		.143	.167
8	.085	.085		.088	.076
9	.055	.041		.059	
<i>Total</i>	1.000	1.000	1.000	1.000	1.000
<i>Average</i>	4.91	5.13	4.18	5.30	5.30
<i>Observations</i>	29,737	26,361	24,090	27,634	16,964

Source: BIBB 1979-2006.

Note: Shares of worker observations per wave with given number of reported performance requirements that are applicable occasionally, frequently or almost always. Missing entries occur in survey waves 1991-92 (three missing performance requirements) and 2005-06 (one missing performance requirement), as documented in Online Supplement Table I.2. Performance requirements are: 1. Deadlines/pressure to perform; 2. Improve/adopt new techniques; 3. New situations/activities; 4. Repeated work steps; 5. Work procedures prescribed in detail; 6. Financial losses by small mistakes (missing in 1992); 7. Minimum performance/time/quantity given to execute activity (missing in 1992); 8. Versatility/multiple activities at same time (missing in 1992); 9. Concentration on activity (missing in 2006).

Supplement I.4). We transform the U.S. Dollar data to Euro and deflate them with the German CPI to the end of the year 1998, at the eve of the Euro's introduction for financial transactions.

We obtain bilateral services trade data (*Dienstleistungsverkehr*) to and from Germany by foreign countries or country groups and subsectors for the years 1979-2007 from the German central bank *Deutsche Bundesbank* (BuBa), which kindly prepared its historic records for us so that a possibly large group of eleven individual source and destination countries as well as 19 services sectors can be identified, which we map to 14 BIBB services industries (see Online Supplement II.2). Given the more aggregate country and regional coverage, we do not use services trade data for exercises that require country-level evidence in this paper. We also deflate the services trade data with the German CPI to the end of the year 1998.

Imports of intermediate inputs. We collect matrices of imported inputs by industry in 1978 (no table for 1979), 1986, 1992, 1999 and 2006 from the German Statistical Office *destatis*. Those imported input matrices come with Germany's input-output tables. We map the sector classification from the NACE oriented classifications in Germany's import matrices to our common sector definition with 34 industries (Online Supplement I.4). Beyond OECD standards, the German import

matrix itself is not based on the import proportionality assumption, by which the imports matrix would be constructed so that an industry uses an import of a particular input in proportion to the country's total use of that import as an input.⁶ We therefore do not need to attempt an empirically complex breakdown of the use table into domestic and foreign origins, this breakdown is resolved by Germany's statistical agency. However, we cannot discern the exact share of individual foreign source countries for any given input of an industry. In select empirical exercises, where we investigate source country characteristics (related to labour-market institutions), we therefore need to impose a country-level proportionality assumption (similar to Reimer 2006; Trefler and Zhu 2010): if one-third of the German absorption of electronics is sourced from China, for instance, then we impose that one-third of any German industry's use of electronics originates from China. Puzzello (2012) documents for trade flows in East Asia, where industry-level bilateral trade data is available separately for input and final use, that the net effect of the country-level proportionality assumption on measured factor trade is small. We translate the reported import values in the early years from Deutsche Mark to Euro and deflate all years with the German CPI to our base year 1998.

2.3 Labour-market institutions

Unionization rates. We infer sector-level unionization rates from the German Socioeconomic Panel (GSOEP), a longitudinal survey of individuals in private households. We retain only observations of West German households which provide an arguably more precise reflection of unionization, and map the NACE 1.1 sector information in GSOEP to our common sector definition across all waves of the BIBB data (see Section I.4). Then we compute unionization rates by sector as the average over the years for which they are available (1985, 1989, 1993, 1998, 2001, 2003 and 2007).

Labour market tightness. We obtain data on labour-market tightness produced by the German Federal Labour Office (IAB). This data is not available sector by sector. Instead, labour-market tightness is defined as the number of vacancies per 1,000 unemployed persons at the level of German states for the years 1980 through 2005. We use the sectoral distribution of workers in the BIBB data across (West German) states to compute a (country-wide) sector-level measure of labour-market tightness. If a sector is more strongly represented in a state with high labour-market tightness, the representative worker in that sector is exposed to a tighter labour market than a worker in another sector which has a stronger presence in a state with lower tightness. Then we compute labour-market tightness sector by sector as the average over the years for which it is available (1980, 1990 through 2004).

Foreign labour-market rigidity. From the IMF and Fondazione Rodolfo DeBenedetti (fRDB), we use a database of labour-market regulations for the period 1980-2005 and 91 countries, prepared

⁶In matrix terminology, the German statistical agency does not impose a fixed import proportion for all cells in a use row but calculates different import proportions across the cells of a use row.

by Aleksynska and Schindler (2011) using ILO, OECD and national sources. The IMF-fRDB labour-market regulations 1980-2005 data combine information on minimum wage regulations, unemployment insurance systems, and employment protection legislation and exhibit considerable institutional changes over the sample period in particular in low- and middle-income countries. Using the IMF-fRDB data, Boeri and Macis (2010) document, for example, that 27 out of 91 countries introduced unemployment benefits for the first time between 1980 and 2002 and that the adoption of unemployment benefits had a marked effect on job reallocation in those economies. We use the information from 1980 for analysis related to German tasks in 1979. Country coverage drops to just 54 countries in 2006, so we reuse the 2005 information for 91 countries in 2006.

As an alternative contemporary data source on labour-market institutions, the World Bank computes internationally comparable measures since 2004 following Botero, Djankov, La Porta, Lopez de Silanes and Shleifer (2004). These measures summarize employment laws across countries with respect to the implied rigidity of labour markets, covering hiring costs, restrictions on changing work hours, firing costs, as well as the World Bank's overall rigidity index summarizing the aforementioned three indexes. While the World Bank data offer information on alternative institutions, historical data are unavailable, so we use the initial World Bank survey from 2004, which is closest to our sample period from 1979-2006.

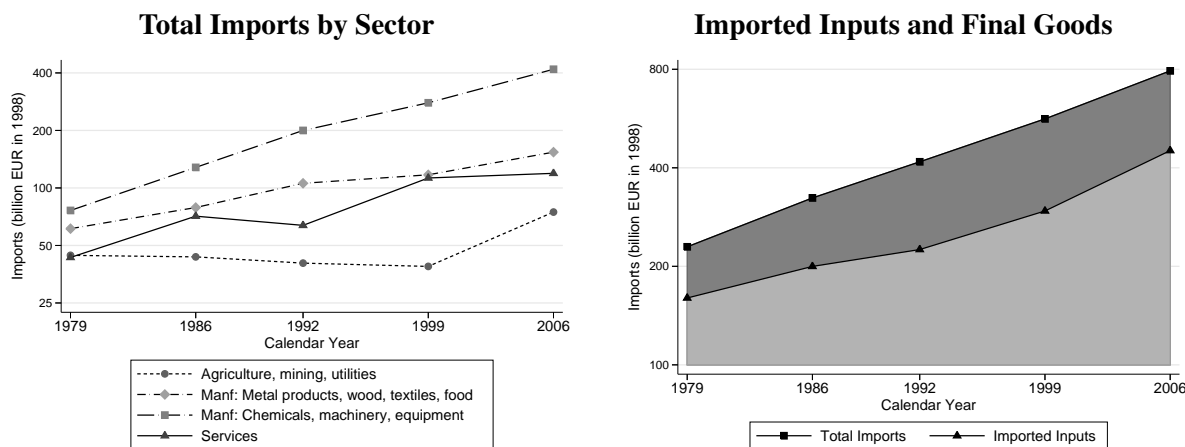
3 German Trade Patterns

We start out by looking at the pattern of German imports over time. The left-hand panel of Figure 1 shows that German imports grew considerably across all sectors. Imports of machinery and equipment as well as of transport equipment have grown considerably faster than average imports, while agricultural imports have declined slightly in real terms until 1999 and then rebounded.

Classic trade theory was formulated to capture trade patterns during the first historic wave of globalization (globalization 1.0 until the early to mid 20th century) and used to emphasize trade in final goods. The nature of globalization 2.0 in more recent decades may differ. The right-hand side panel of Figure 1 plots total imports of a given product and the product's imports destined for intermediate-input rather than final use. The figure shows that most imports since at least the 1970s are for intermediate use and not for final consumption. The share of intermediates imports falls between 1979 and 2006 (a widening gap between total imports and imported inputs on the log scale). In that sense, globalization 2.0 is not a new phenomenon for the Germany economy and is, if anything, losing some of its importance.

Table 3 documents that the dominance of intermediate uses is particularly pronounced for services imports and imports of iron, steel and metals, where intermediate uses account for more than 80 percent of uses over three decades. At the other extreme, in textiles and apparel as well as in transport equipment, imports of intermediate inputs make up less than 40 percent of total imports. The share of intermediates in total imports is relatively stable over time across most sectors. In some sectors, such as transport equipment, machinery, wood and food, the fraction of imports for intermediate use increases in the early part of the sample period (from 1979 to 1986 or 1992). This different shift in trade patterns between the early part and the late part of our sample period leads us

Figure 1: German Imports, 1979-2006



Source: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandise trade, Deutsche Bundesbank for services trade 1979-2006; Destatis import matrices, releases 2009 (1978 and 1986) and 2010 (1992, 1999, 2006).

Notes: Converted to Euro, deflated with German CPI (end of year 1998 as base). Log scale on vertical axes.

to track changes in German workplace characteristics between 1979 and 1986 and between 1986 and 2006. Across all products, however, the share of intermediates imports falls between 1979 and 2006.

To the extent that trade in intermediates is associated with tasks performed abroad that would otherwise remain onshore, imports of intermediate inputs can be viewed as trade in tasks. Interestingly, not only has the share of intermediate goods imports been remarkably stable. Germany's main trading partners have barely changed over our sample period: nine out of the top-ten import source countries are the same in every single sample year since 1979, and eight of those nine countries are also among Germany's top-ten export destinations in every sample year (see Online Supplement II.1). The one new top-ten importer country for Germany in 2006 is China, replacing Spain from 1999. A hypothesis consistent with this evidence might be that intermediate inputs previously sourced from low-income regions within Western Europe are now being sourced from East Asia. However, our data does not allow us to discern the foreign country of origin for intermediate inputs: we can tell apart input use from final use for total imports and we can identify the source country of imports, but we cannot pursue a further breakdown by both country-industry origin and use category. However, we can impose a country-level proportionality assumption (similar to Reimer 2006; Trefler and Zhu 2010) and discern between high-income and low-income source countries for Germany's imports. As we show in Appendix A, under that proportionality assumption we find imports from high-income and from low-income countries to keep relatively stable shares of intermediate inputs throughout the sample period.

Table 4 assesses the importance of intermediate imports for domestic production.⁷ The first

⁷Whereas Table 3 made a comparison across columns within a use row of Germany's input-output matrices, Table 4

Table 3: SHARE OF INTERMEDIATE PRODUCT IMPORTS IN TOTAL IMPORTS

Product groups (shares)	1978 (1)	1986 (2)	1992 (3)	1999 (4)	2006 (5)
Agriculture & Utilities	.844	.838	.771	.718	.790
Manf.: Chemicals and mineral products	.758	.746	.757	.728	.607
Manf.: Iron, steel and metal products	.902	.880	.847	.845	.836
Manf.: Transport equipment	.379	.409	.355	.335	.326
Manf.: Machinery, equipment and misc. prod.	.428	.441	.371	.378	.376
Manf.: Wood, paper and printing	.793	.810	.867	.742	.675
Manf.: Textiles, apparel and leather	.350	.283	.280	.229	.187
Manf.: Food and beverages	.394	.453	.394	.396	.344
Services	.948	.839	.843	.856	.909
<i>Total</i>	.658	.635	.591	.567	.563

Source: Destatis import matrices, releases 2009 (1978 and 1986) and 2010 (1992, 1999, 2006).

Notes: Deflated with German CPI, end of year 1998 as base year. Shares of imports for intermediate use in total imports (including both intermediate and final uses) by product group. Services includes traded public and commercial services.

line of Table 4 reports the share of intermediate product imports in total intermediate inputs of the German economy, where total intermediate input includes both domestically produced German and foreign-made imported intermediate products. This share of offshore outsourcing in total German outsourcing has risen from 14 percentage points to 22 percentage points, a one-and-a-half fold increase (equivalent to a one to two percent increase per year over the sample period). On the other hand, the share of outsourced inputs in the total production value, on the second line of the table, has remained largely the same at 51 percent between 1978 and 2006 for the German economy as a whole (but there was a temporary decline during the 1990s). In other words, not the extent of

makes comparisons across use rows within a total production column of Germany's input-output matrices.

Table 4: SHARE OF INTERMEDIATE PRODUCT IMPORTS IN PRODUCTION

Shares of	1978 (1)	1986 (2)	1992 (3)	1999 (4)	2006 (5)
Intermediate Product Imports in Total Intermediate Input	.143	.149	.156	.176	.217
× Total Intermediate Input in Production Value	.510	.513	.471	.473	.512
= Intermediate Product Imports in Production Value	.073	.077	.074	.083	.111

Source: Destatis import matrices, releases 2009 (1978 and 1986) and 2010 (1992, 1999, 2006).

Notes: Deflated with German CPI, end of year 1998 as base year. Total intermediate input on the first line includes both domestically produced intermediate products and intermediate product imports. The share of total intermediate input in the production value on the second line equals one less the share of value added in the production value. The share of intermediate product imports in production value on the third line is the product of the previous two rows.

outsourcing in the German economy as a whole has changed over the sample period of almost three decades, only the composition of outsourcing has shifted towards more offshore outsourcing using foreign-made instead of domestic intermediate inputs. Finally, the product of the two shares on lines one and two of the table is shown on the third line: the share of intermediate product imports in the total production value for the German economy as a whole. Given the monotonic increase of the share on line one (the share of offshored inputs in total outsourced inputs) and the roughly unaltered shares on line two, the share of foreign-made inputs in total production increases over the sample period. To the extent that trade in intermediates is associated with tasks performed abroad, the increasing importance of foreign-made intermediate inputs for overall production can be viewed as an expansion of trade in tasks that would lead to a reassignment of tasks within the domestic German workforce.

In summary, outsourcing of production activity was as prevalent at the beginning of our sample period in the later 1970s as towards the end in the 2000s, with around one-half of German merchandise production and services performed in-house and one-half by a separate supplier. However, the nature of the make-or-buy decision changed: the fraction of outsourced intermediate inputs that are imported from abroad has risen by around one-half over the past three decades. Yet, the heightened foreign sourcing of production-related activities does not imply that, as a fraction of total imports, the import of intermediate inputs increased. To the contrary, product imports for final use rose even faster than the import of intermediate inputs over the past three decades. The pattern of trade of final goods for final goods that David Ricardo envisaged when he first wrote about comparative advantage—Portuguese wine for British cloths—two centuries ago is no longer the prevalent type of trade. Around two-thirds of German imports are for intermediate use. However, the shift from mainly final-goods trade under globalization 1.0 to a large fraction of intermediate-input trade under globalization 2.0 happened far earlier than just in the recent three decades. If anything, over the last thirty years, the share of intermediates in imports fell.

4 Activity Content and Job Performance Requirements

The degree to which jobs can be offshored depends on their activity content and performance requirements (see e.g. Leamer and Storper 2001; Markusen 2006; Jensen and Kletzer 2006; Blinder 2006). Especially performance requirements have been proposed as relevant for the degree of offshorability in the literature: the prevalence of codifiable rather than tacit information to perform the job (Leamer and Storper 2001); the prevalence of routine tasks, especially if they can be summarized in deductive rules (Levy and Murnane 2004); or the job's lacking requirement of personal interaction and physical proximity (Blinder 2006). Beyond previous work, we do not lump performance requirements into subjectively defined task dichotomies such as codifiable/non-codifiable, routine/non-routine and non-interactive/interactive. Instead, we let the data on performance requirements speak for themselves. In addition to performance requirements, we investigate the nature of activities in the workplace.

We separately investigate the two basic types of tasks that a worker faces in a sectoral occupation: the activity content and the job performance requirements. For each set of tasks, we

aggregate the BIBB data to cells by sector, occupation, survey year, gender, age and task (activity or performance requirement) and count the number of workers performing the task in each cell. Then we regress the log number of workers, $\ln L$, performing the task on a set of indicators in two specifications. First, allowing task employment counts to vary *across* sectors and occupations, we specify

$$\ln L_{itsajk} = \beta_{it} + \beta_t + \beta_s + \beta_a + \varepsilon_{itsajk} \quad (1)$$

for task i (activity or performance requirement), year t , gender s and age a , as well as sector j and occupation k , where the β parameters denote regression coefficients on according sets of dummy variables. Second, restricting coefficient estimates to reflect effects *within* sectors and occupations, we specify the long regression

$$\ln L_{itsajk} = \beta_{it} + \beta_t + \beta_s + \beta_a + \beta_j + \beta_k + \varepsilon_{itsajk} \quad (2)$$

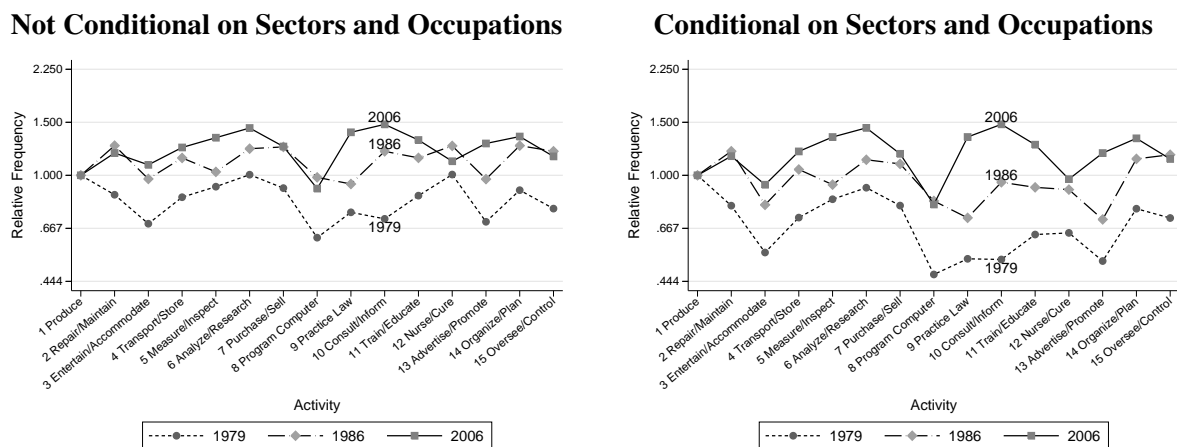
conditional on sector and occupation fixed effects. A comparison of estimates between (2) and (1) allows us to infer whether workplace outcomes change mainly across or mainly within sectors and occupations. We estimate standard errors under two-way clustering (Cameron, Gelbach and Miller 2011) at the level of 2-digit sectors and tasks, which are not nested within sectors.

First, for activity content, we choose as our omitted reference activity *1 Manufacture, Produce Goods* in each survey year. This activity is expectedly easily offshorable through merchandise trade. At the beginning of our sample period, in 1979, *1 Manufacture, Produce Goods* was arguably a candidate activity for early offshoring because it naturally ties to final-goods trade. With the increasing slicing up of the production chain, we expected other activities to become gradually more offshorable. Second, for performance requirements, we choose as our omitted reference performance requirement *E Work procedures prescribed in detail* in each survey year. This requirement arguably captures a task dimension that other data sources refer to as codifiability. Codifiable tasks are considered easily offshorable because they do not involve tacit information to perform the job (Leamer and Storper 2001). Note that our inclusion of a full set of year dummies β_t means that we have to exclude one reference task category per survey year.

To standardize results, we scale the coefficients from the log regressions to report $\exp\{\beta\}$ (and adjust the standard errors with the Delta method) so that the estimates reflect relative frequencies compared to the respective omitted reference categories. Under this convention the reference performance requirement *E Work procedures prescribed in detail*, for example, is implicitly standardized to $\exp\{\beta_t\} = 1$ for all survey years and a transformed coefficient estimate $\exp\{\beta_{it}\}$ for any other performance requirement i then shows whether the respective performance requirement is a more ($\exp\{\beta_{it}\} > 1$) or less frequent ($\exp\{\beta_{it}\} \leq 1$) workplace characteristic than the reference category in a given year. Deviations from the reference category can vary over time.

Activity content. In Tables IV.1 and IV.2 in the Online Supplement, we report coefficient estimates for β_{it} and overall regression statistics. In Figure 2 we present the β_{it} estimates in graphical form. Each one of the two panels in Figure 2 depicts coefficient estimates from one single regression: the left-hand panel of Figure 2 presents estimates from equation (1), not conditioning on sectors and occupations, whereas the right-hand panel shows estimates from equation (2)

Figure 2: Activity Content of German Work



Source: BIBB 1979-2006, workers ages 16 through 65.

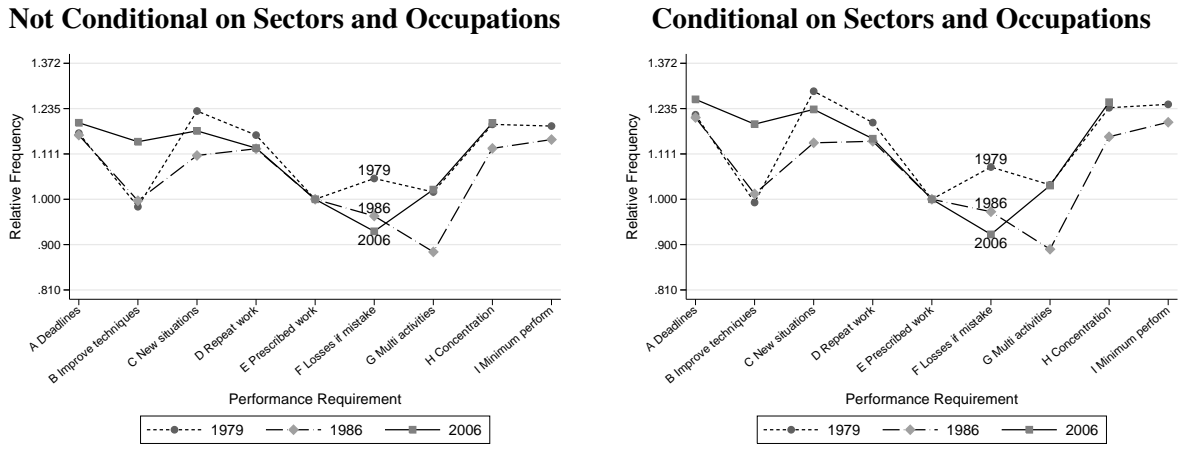
Notes: Measures of relative activity frequencies from log employment OLS regression over 168,466 activity-year-gender-age-sector-occupation cells for estimates of equation (1) in left-hand panel (estimates reported in Online Supplement Table IV.1) and equation (2) in right-hand panel (Table IV.2). Coefficients reported as $\exp\{\beta\}$ to reflect relative frequencies. Omitted baseline activity from regressions: *1 Manufacture, Produce Goods* in each survey wave. Log scale on vertical axis.

within sectors and occupations.⁸ Our hypothesis is that under globalization 2.0—the increasing offshorability of codifiable, routine and non-interactive tasks—we should see a shift in the relative frequency of activities other than *1 Manufacture, Produce Goods* to higher and higher levels over time, that is an upward turn of the activity profile to the right of the left-most reference activity *1 Manufacture, Produce Goods*.

Several important patterns can be discerned from Table IV.1 and the corresponding left panel of Figure 2. First, every single activity gains in importance after the base year 1979, relative to the arguably most offshorable reference category *1 Manufacture, Produce Goods*. Second, most of the shift away from the reference category has taken place already by 1986. This early shift in the task profile coincides with our descriptive evidence on the share of input use by import product (Table 3), which showed that, if at all, imports exhibited an increase in input uses mostly in the early sample years (between 1979 and 1986). Third, the shift away from *1 Manufacture, Produce Goods* affects both “high-end activities” such as *14 Organize/Plan* and *15 Oversee/Control* as well as “low-end activities” such as *2 Repair/Maintain*. To give a sense of magnitudes, in 1979, the activity *13 Advertise/Promote* is roughly 30 percent less frequent than the reference category *1 Manufacture, Produce Goods*. By 1986, it is nearly as frequent as the reference activity. In 2006, it is 30 percent more frequent than the reference activity. These are substantial changes:

⁸We use a logarithmic scale for the vertical axis, so division and multiplication by a given number both result in an identical change starting from any level. The axis labels reflect negative and positive powers of two-thirds for this and all subsequent activity content graphs.

Figure 3: Performance Requirements of German Work



Source: BIBB 1979-2006, workers ages 16 through 65.

Notes: Measures of relative performance requirement frequencies from log employment OLS regression over 180,022 requirement-year-gender-age-sector-occupation cells for estimates of equation (1) in left-hand panel (estimates reported in Online Supplement Table IV.3) and equation (2) in right-hand panel (Table IV.4). Coefficients reported as $\exp\{\beta\}$ to reflect relative frequencies. Omitted baseline performance requirement from regressions: *E Work procedures prescribed in detail* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Log scale on vertical axis.

they measure the percentage change in the number of workers performing a certain task. At the same time, remember that those activities are not mutually exclusive. According to Table 1, there is a trend towards more ‘multi-tasking’, so workers perform more activities over time, and more of those are “high-end” activities. The regressions underlying Table IV.1 only control for gender, 48 age groups, and 5 years (survey waves), but not for occupation and sector. The trend towards certain high-end activities could thus just reflect an expansion of sectors and occupations that are intensive in these activities. To probe this further, in Table IV.2 and the corresponding right panel of Figure 2, we condition out occupation and sector means (through according fixed effects). The coefficients change little, and if anything point to stronger changes over time, consistent with the hypothesis that the main driver of the trends in activities is a shift *within* occupations and sectors towards less offshorable activities, not between occupations and sectors.

Intensity of performance requirements. Similarly to activity content, under increasing offshorability of routine and non-interactive tasks, we should see a shift in the relative frequency of performance requirements other than *E Work procedures prescribed in detail* (codifiability) to higher and higher levels over time. Now using as a reference category the mid bin *E* of the range from *A* to *I*, we should see a U-shaped upward turn of the performance requirement profile to the left and to the right of the reference requirement *E Work procedures prescribed in detail*.

In Tables IV.3 and IV.4 in the Online Supplement, we report coefficient estimates for β_{it} and

overall regression statistics. In Figure 3 we present the β_{it} estimates in graphical form.⁹

Several observations emerge. First, across all five waves, we detect the expected U shape in levels: performance requirements other than the reference category *E Work procedures prescribed in detail* (codifiability) are more prevalent. Second, this pattern varies little over time for several performance requirements but the “left arm”, which includes relatively hard-to-offshore tasks such as *A Deadlines* and *B Improve/adopt new techniques*, turns upwards to form an expectedly more pronounced U shape by 2006. The hard-to-offshore activities in the “left arm” also become more frequent compared to *D Repeated work steps* (routineness). While in 1979 and 1986, category *B Improve/adopt new techniques* is as frequent as the reference category, in 2006 it is 15 percent more frequent than the reference category. Note that the “right arm” of the performance requirement profile is arguably less precisely measured because in 1992 *F-H* are missing, and in 2006 *I* is missing. Similar to the minor difference between the short and long regressions for activities above, if anything coefficient estimates become slightly more pronounced in the long regression that conditions on sector and occupation fixed effects. This evidence suggests that the main source of variation also in performance requirements is *within* occupations and sectors, not between them.

5 Activity Content, Job Performance Requirements and Trade

So far, we separately presented Germany’s import patterns and the evolution of activities and job performance requirements in Germany. Now we bring both together and investigate how trade and tasks relate. To obtain first proxies to the likely activity content and the likely job performance requirements behind German trade flows, we impute implied task trade flows through a weighting procedure. Consider import flows to Germany first. To obtain weights, we aggregate the BIBB data to cells by sector, survey year, and task (activity or performance requirement) and count the number of workers in each cell. We compute a task’s employment share in the sector and year total,

$$\sigma_{ijt} \equiv L_{ijt} / (\sum_j L_{ijt}),$$

for task i , survey year t and sector j . Then we match to these task shares the import flows of final products in a given sector M_{jtc} from source country c and obtain imputed task shares in import flows $\sigma_{ij,t-7}M_{jtc}$, where we use the German task share in a sector in the prior survey wave $t - 7$ under the assumption that a typical foreign source country’s task composition resembles that of Germany seven years earlier. Finally, we impute the volume of final goods imports associated with task i embedded in total imports from country c with

$$m_{itc} \equiv \sum_j \sigma_{ij,t-7}M_{jtc}.$$

For German exports, we use task weights σ_{ijt} of the current period to obtain tasks embedded in total exports

$$x_{itc} \equiv \sum_j \sigma_{ijt}X_{jtc},$$

⁹We use a logarithmic scale for the vertical axis. The labels are negative and positive powers of nine-tenths for this and all subsequent performance requirement graphs.

where X_{jt} are sectoral export flows of final products to destination country c .

We regress the log embedded task trade flow on a set of indicators in specifications similar to the exercises before:

$$\ln m_{itc} = \beta_{it} + \beta_t + \beta_c + \varepsilon_{itc}, \quad (3)$$

$$\ln x_{itc} = \beta_{it} + \beta_t + \beta_c + \varepsilon_{itc}, \quad (4)$$

for task i (activity or performance requirement), year t and country c . We control for source country fixed effects (in regressions of log task imports) and for destination country fixed effects (in regressions of log task exports) but their omission changes β_{it} estimates hardly at all. We estimate standard errors under two-way clustering at the level of countries and tasks (Cameron et al. 2011).

On the import side, we strive to uncover possible shifts in the task content of trade flows to Germany. The source-country composition of trade flows provides us with variation in the data that help track the evolution of sectoral trade flows to Germany. After conditioning on both source-country and sector fixed effects, the remaining explanatory variation in the data is at the joint sector-country level.¹⁰ However, the source-country information does not allow us to discern between uses of the imports for intermediate inputs or final consumption. We therefore defer the analysis of intermediate inputs and final-product imports to an upcoming separate exercise.

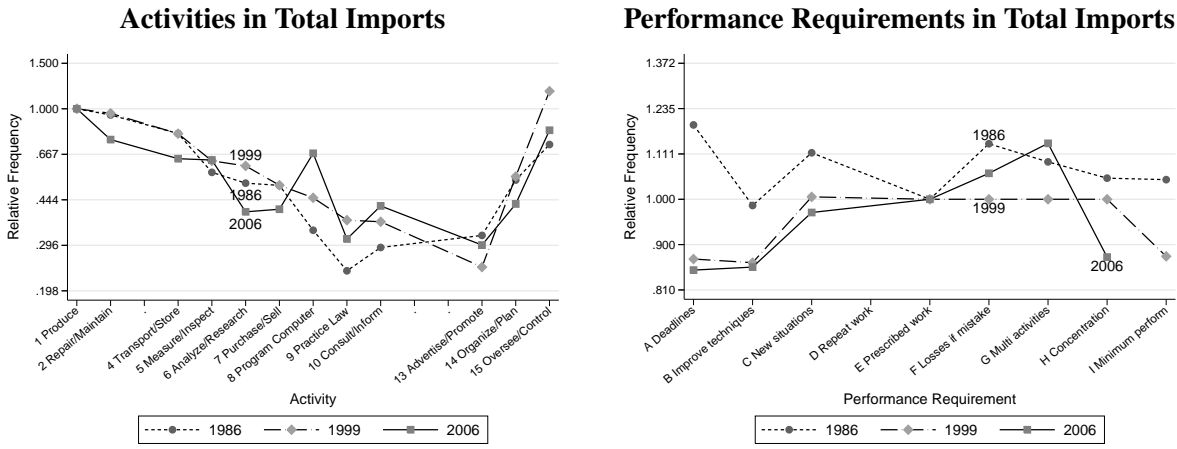
As before, for activity content we choose as our omitted reference categories *I Manufacture, Produce Goods* in each survey year. For performance requirements, we choose as our omitted reference categories the performance requirement *E Work procedures prescribed in detail* (codifiability) in each survey year. Our inclusion of a full set of year dummies means that we have to exclude one reference task category per survey year. To standardize results, we scale the coefficients from the log regressions to report $\exp\{\beta\}$ (and adjust the standard errors with the Delta method) so that the estimates reflect relative trade frequencies (relative trade values) compared to the respective omitted reference categories.

German imports. Our hypothesis is that under increasing offshorability of codifiable, routine and non-interactive tasks, we should see a shift in the relative import frequency of activities other than *I Manufacture, Produce Goods* to lower and lower levels over time, that is a downward turn of the activity profile to the right of the reference activity *I Manufacture, Produce Goods*. Similarly, we should see a shift in the relative frequency of performance requirements other than *E Work procedures prescribed in detail* to lower and lower levels over time, that is a U-shaped downward turn of the performance requirement profile to the left and right of the reference requirement *E Work procedures prescribed in detail*. In the extreme case, we might see an inversion from an initially U-shaped profile open upwards to an inverted U with the opening downwards.

Table IV.5 reports exponentiated coefficient estimates from OLS regressions of activities embedded in German imports, relative to the activity *I Manufacture, Produce Goods*. (Note that we use 1979 weights also for 1979 because no data is available for $t - 7 = 1972$.) Similarly, Table IV.6

¹⁰To use possibly much source-country variation, which is more limited for services trade flows, we restrict the sample to merchandise trade in this exercise.

Figure 4: Activity Content and Performance Requirements Embedded in German Imports



Sources: WTF 1979-1993 and recent revisions 1994-2006 for merchandise trade, Deutsche Bundesbank for services trade 1979-2006; BIBB 1979-2006, workers ages 16 through 65.

Notes: Measures of relative task (activity or performance requirement) frequencies from log import value OLS regression over task-year-source country cells (12,398 observations for activities and 6,918 observations for performance requirements, as reported in Online Supplement Tables IV.5 and IV.6). Import value of embedded tasks imputed using 7-year lags of German task shares by sector. Services activities 3, 11 and 12 not reported in graphs, performance requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Coefficients β from log import value regressions reported as $\exp\{\beta\}$ to reflect relative import frequencies. Omitted baseline activity 1 *Manufacture, Produce Goods* in each survey wave, omitted baseline performance requirement E *Work procedures prescribed in detail* in each survey wave. Log scale on vertical axis.

presents the estimates for performance requirements embedded in German imports. Graphically, we present estimates for the years 1986, 1999 and 2006 in Figure 4. We exclude 1992 because of many missing performance requirements. We exclude 1979 because weights for 1972 are not available so that we have to use concurrent weights instead. Given identical task weights for trade flows in 1979 and 1986, and our conditioning on year fixed effects, it is not surprising that our estimates for 1979 and 1986 are very similar (compare Tables IV.5 and IV.6 in the Online Supplement).¹¹

The left panel of Figure 4 indicates for the cross section of activities that the easy-to-offshore reference category 1 *Manufacture, Produce Goods* is considerably more frequent in German imports than it is in German workplaces (Figure 2). Most activities embedded in German imports have remained roughly constant over time or lost over in importance over time relative to the reference category 1 *Manufacture, Produce Goods*. This evidence is consistent with the idea that globalization 2.0 had already taken hold in Germany in the early sample years. In terms of magnitudes, consider 2 *Repair/Maintain*. While in 1986 and 1999, its relative trade frequency (relative

¹¹From the activity graphs, we drop the pure services activities 3 *Entertain/Accommodate*, 11 *Train/Educate* and 12 *Nurse/Cure* off the shown task trade flow statistics because we do not have services trade data at this stage. However, we include these three services categories in the underlying regression to condition out their relative effects (see Appendix tables).

trade value) compared to the respective omitted reference category was 95 percent and 96 percent respectively, this dropped to 76 percent in 2006. Prominent exceptions from the general pattern are activities *8 Program a Computer* and *10 Consult/Inform*, which have become more prominent in German imports over time. Overall, however, we do not seem to observe dramatic effects of new forms of globalization on job activities.

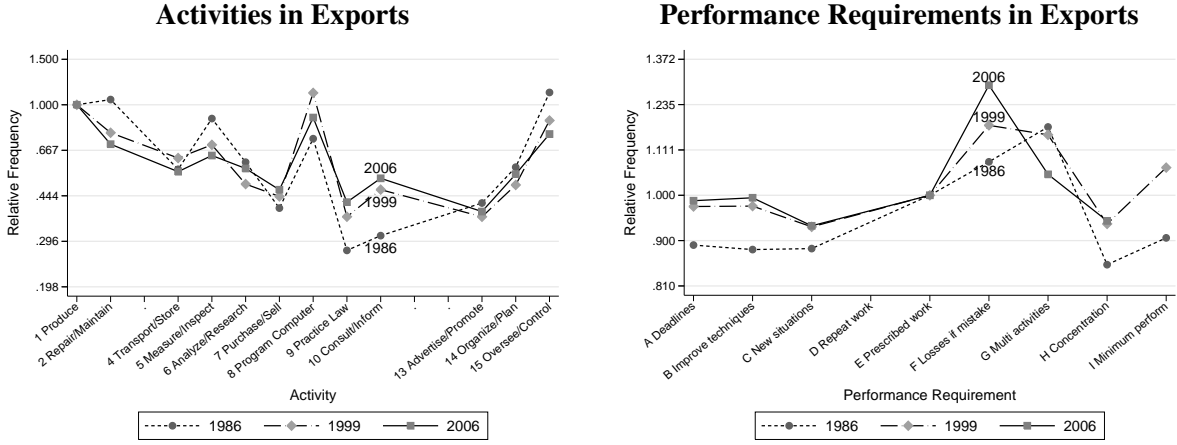
The picture is perhaps more clear cut for performance requirements embedded in German imports. The right panel of Figure 4 shows that, except for *G Versatility/multi activities*, where the 2006 value is slightly above the 1986 one, the 1986 values exceed the ones from 1999 and 2006. So, we do see that performance requirements embedded in German imports other than the reference category *E Work procedures prescribed in detail* (codifiability) lose importance over time. To the extent that these performance requirements are more “high-end” than *E Work procedures prescribed in detail*, they matter relatively less in German imports, mirroring their prominence in the job requirements of Germany’s domestic labour force. As task specialization under globalization 2.0 leads us to expect, the performance requirement profile changes from a rough U shape in 1986 (and 1979) to the hypothesized inverted U shape in later years. The profile strictly resembles an inverted U shape in 1999 with its peak at the arguably easily offshorable baseline task *E Work procedures prescribed in detail*, as expected. In 2006, there are two exceptions for the performance features *F Financial loss by small mistake* and *G Versatility/multiple activities*, consistent with a concentration of German imports in sectoral activities that enrich jobs with more responsibilities between 1999 and 2006. Most notably, the “left arm”, which includes relatively hard-to-offshore tasks such as *A Deadlines* and *B Improve/adopt new techniques*, turns downward to form the expectedly more pronounced inverted U shape by 2006—thus mirroring precisely the opposite turn in the task composition at German workplaces (Figure 3).

German exports. We perform a similar exercise for German exports based on estimation equation (4). Our hypothesis is that the export pattern should reflect the task restructuring of the German economy as observed in Section 4 before. Under increasing offshorability of codifiable, routine and non-interactive tasks, we should see German export specialization with the relative frequency of activities other than *1 Manufacture, Produce Goods* shifting to higher and higher levels over time, that is an upward turn of the activity profile to the right of the reference activity *1 Manufacture, Produce Goods*. Similarly, we should see a shift in the relative export frequency of performance requirements other than *E Work procedures prescribed in detail* to higher and higher levels over time, that is a U-shaped upward turn of the performance requirement profile to the left and right of the reference requirement *E Work procedures prescribed in detail* (codifiability).

For activities, we do not find evidence of a strong temporal shift similar to the import side (see the left panel of Figure 5, or Table IV.7 in the Online Supplement).¹² The similarity of the activity weighted export patterns with the import patterns is consistent with the idea that products from sectors with these activity patterns become more tradable overall. For future more detailed analysis of shifts in task content, we will need to account simultaneously for exports of final products, for imports of competing goods in the product market, and imports of intermediate goods in the input

¹²For comparability to imports we choose the same years 1986, 1999, 2006 for exports in Figure 5.

Figure 5: Activity Content and Performance Requirements Embedded in German Exports



Sources: WTF 1979-1993 and recent revisions 1994-2006 for merchandise trade, Deutsche Bundesbank for services trade 1979-2006; BIBB 1979-2006, workers ages 16 through 65.

Notes: Measures of relative task (activity or performance requirement) frequencies from log export value OLS regression over task-year-destination country cells (12,629 observations for activities and 6,882 observations for performance requirements, as reported in Online Supplement Tables IV.7 and IV.8). Export value of embedded tasks imputed using current German task shares by sector. Services activities 3, 11 and 12 not reported in graphs, performance requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Coefficients β from log export value regressions reported as $\exp\{\beta\}$ to reflect relative export frequencies. Omitted baseline activity 1 *Manufacture, Produce Goods* in each survey wave, omitted baseline performance requirement E *Work procedures prescribed in detail* in each survey wave. Log scale on vertical axis.

markets.

Our hypothesis receives support for performance requirements in German exports, however. Table IV.8 and the right panel of Figure 5 show that German exports are increasingly intensive in “high-end” performance requirements. In all performance requirements except for *G Versatility/multiple activities* the coefficient estimates in 2006 are as high as (statistically not significantly different) or statistically significantly higher than in prior years. Again the most pronounced change occurs in the “left arm”, which includes relatively hard-to-offshore tasks such as *A Deadlines* and *B Improve/adopt new techniques*. These performance requirements become considerably more frequent in German exports by 2006, as they also do in the German workplace overall (Figure 3).

The predictive power of German imports and exports for task frequencies. An alternative way to analyze the role German imports and exports in changing task patterns is to extend specifications (1) and (2) as follows:

$$\ln L_{itsajk} = \sum_T \beta_i^T X_{jt}^T + \beta_{it} + \beta_t + \beta_s + \beta_a + \varepsilon_{itsajk} \quad (5)$$

for task i (activity or performance requirement), year t , gender s and age a , as well as sector j and occupation k , and a set of three trade regressors T (imported intermediate inputs, imported final products, exports). The β parameters denote regression coefficients on according sets of dummy variables, where the trade flow coefficients β_i^T are task and trade-flow specific. Again, restricting coefficient estimates to reflect effects within sectors and occupations, we specify the corresponding long regression

$$\ln L_{itsajk} = \sum_T \beta_i^T X_{jt}^T + \beta_{it} + \beta_t + \beta_s + \beta_a + \beta_j + \beta_k + \varepsilon_{itsajk}. \quad (6)$$

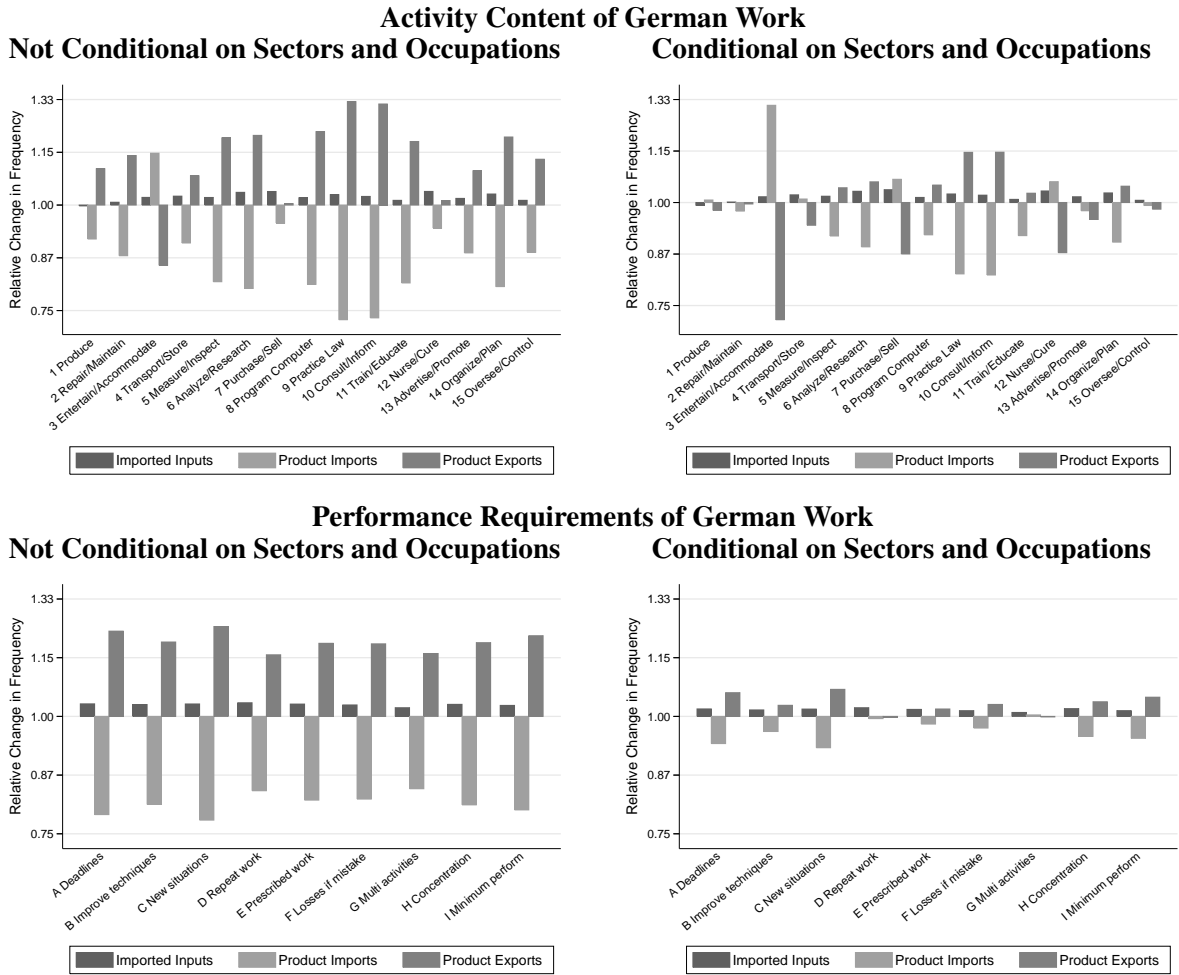
In both regressions, we can estimate a full set of β_i^T coefficients (for all tasks), obviating the need of a reference category for these specifications. For the mapping of import flows to sectors, we use the source country's sector for final-goods imports. But we use Germany's receiving sector for intermediate-input imports, aggregating over all source-country sectors.

Figure 6 shows effects of trade based on equations (5) and (6). We estimate a full set of task coefficients for each trade flow, so the coefficients include the mean effect of trade flows on sector-occupation employment in Germany. On the import side, we discern the predicted effects of intermediate-input imports and final-product imports. Starting with the upper-left chart, and activity *1 Manufacture, Produce Goods*, more exports are, not surprisingly, associated with a higher frequency of production tasks. Conversely, more final-product imports predict a reduced frequency of production tasks, because final-goods imports arguably compete against production tasks. However, imported intermediate inputs predict the opposite consequence and an increase in the production-task frequency. Similar patterns hold quite generally in the upper-left chart for activities, and also in the lower-left chart of Figure 6 for performance requirements: more exports from Germany and more imported inputs typically affect task frequencies positively, while final-goods imports affect task frequencies negatively. A possible reason for the predicted positive effects of imported inputs on task frequencies is that imported intermediates do typically not substitute in-house production in Germany but rather replace previously domestically outsourced inputs (recall the constant fraction of outsourced inputs in total production values of around one-half in Table 4). The newly foreign-sourced inputs might therefore help industries advance productivity and build towards their competitiveness, plausibly augmenting the frequencies of similar tasks as exports from those industries predict.

Consistently across all tasks, final-goods flows on both the import and the export side predict a larger marginal percentage change of task frequencies in absolute magnitude than do intermediate-input imports. The relatively weak effect of intermediate-input trade, compared to classic forms of trade in final goods, is consistent with our earlier descriptive evidence that globalization 2.0 is not a recent phenomenon in our sample period. In fact, intermediate input trade is losing again in relative importance compared to the beginning of our sample period in the 1970s (recall Table 3). New forms of trade matter for task frequencies, but so do classic trade flows. Among the tasks most frequently positively affected by both exports and imported inputs are activities that are not necessarily production related such as *8 Program Computer*, *10 Consult/Inform* and *14 Organize/Plan* as well as the "high end" performance requirements *A Deadlines*, *C New situations* and *I Minimum performance*.

From a purely statistical perspective, we expect predicted effects of sector-year trade flows

Figure 6: Trade Predictions of Task Frequencies



Sources: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandise trade, Deutsche Bundesbank for services trade 1979-2006; BIBB 1979-2006, workers ages 16 through 65.

Notes: Measures of relative activity and performance requirement frequencies from log employment OLS regressions over 168,466 and 180,022 task-year-gender-age-sector-occupation cells for estimates of equation (1) in left-hand panels and equation (2) in right-hand panels (estimates reported in Online Supplement Tables IV.9 and IV.10 as well as Tables IV.11 and IV.12). Coefficients reported as $\exp\{\beta\}$ to reflect relative frequencies. Baseline activity omitted from regressions: 1 Manufacture, Produce Goods; baseline performance requirement omitted: E Work procedures prescribed in detail in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Log scale on vertical axis.

to be mitigated in regressions that control for sector and occupation effects. Indeed, coefficients in the two right-hand side charts of Figure 6 are smaller in magnitude than those from the unconditional regressions on the left-hand side. It continues to be the case that the tasks most frequently positively affected by both exports and imported inputs are activities that are not necessarily production related such as *10 Consult/Inform* and *14 Organize/Plan* as well as the “high end” performance requirements *A Deadlines*, *C New situations* and *I Minimum performance*. The strongest within-sector and within-occupation prediction now is associated with the activity *3 Entertain/Accommodate*: direct exports of goods and services plausibly reduce the in-person provision of hospitality services, whereas final-goods imports correlate positively with hospitality services. Given the main variation of trade flows at the sector-year level, however, results presented in the left-hand side charts, which do not condition on sector and occupation, are arguably more informative.

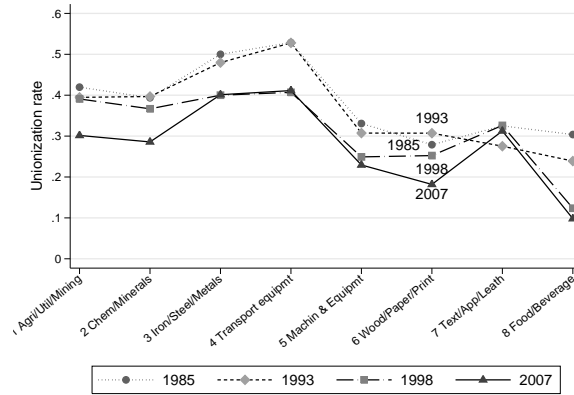
In another variation of our main specification (2), which conditions on sector and occupation effects, we follow the literature and investigate the potential sensitivity of our task frequency counts to technical change (workplace use of a computer), education (years of schooling), and to migration status (non-German citizenship). For all those variables, we aggregate the worker-level measures to the same cell levels as before and re-estimate (2). Remarkably, none of our task frequency counts appear to be noticeably affected (we report the results in Appendix B.1). For those three measures of workplace changes, the added variation beyond the year, age, gender, sector, and occupation fixed effects exhibits little explanatory power. It is against the backdrop of those findings that we evaluate the relative importance of trade flows for task demand and labour-market outcomes in Germany. Though arguably still relatively small in magnitude, effects of trade are more noticeable than those of technical change, education, and migration status.

Taking stock. Summarizing our main findings from this and the preceding Section, we find an increasing importance of “high end” tasks in German workplace characteristics during the sample period. At the same time, we find the task content of German imports to include fewer “high-end” performance requirements and the opposite for performance requirements embedded in German exports. This evidence supports theories of trade in tasks. Direct predictions of trade-flow variables are consistent with the idea that Germany specializes in more elaborate tasks as globalization 2.0 progresses: both exported final goods and imported inputs predict higher frequencies of high-end and not necessarily production related workplace activities and job performance requirements in Germany—such as organizing, planning, and consulting activities under deadlines, frequently changing business constellations and tougher performance standards.

6 Institutional Aspects

This section relates the workplace and trade flow changes to select labour-market institutions: on the domestic side, we look at the sectoral degree of unionization and at the degree of regional labour-market tightness as it affects sectors through their regional dispersion. On the foreign side, we look at labour-market rigidity among German trade partners.

Figure 7: Unionization rates by sector over time



Source: GSOEP, 1985-2007, workers ages 16 through 65; select years with unionization.

Note: Unionization rate is share of West German household members who report union membership and employment in an industry.

6.1 Highly unionized vs. less unionized sectors in Germany

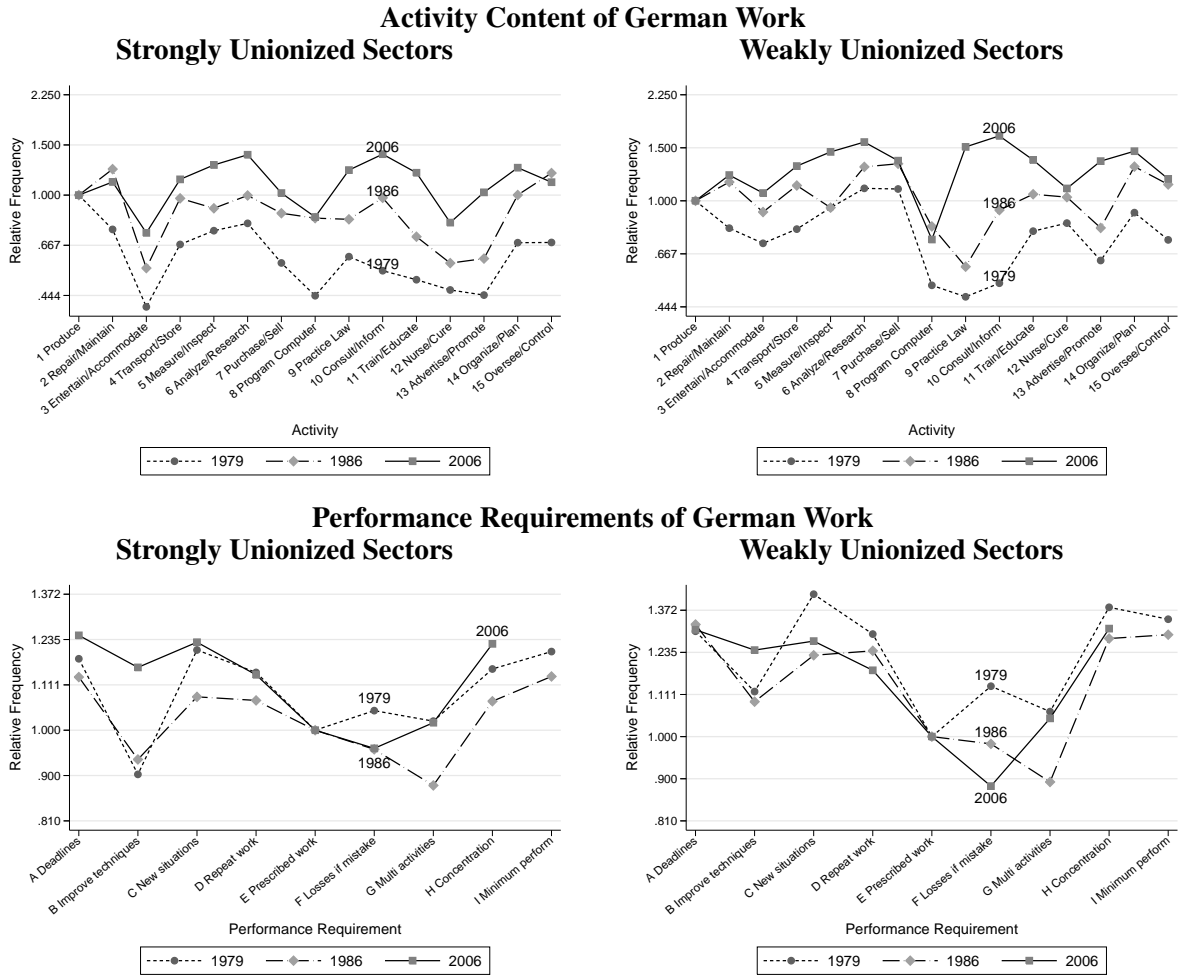
We run separate regression for highly unionized (above median) vs. less unionized sectors (at or below median) in Germany. This gives us insights into whether changing task patterns vary with the degree of influence of a key domestic labour-market institution.

To inspect unionization rates across sectors over time, we aggregate sectors to the same eight aggregate sectors that we used to depict trends in German imports over time (Figure 1). Figure 7 shows several interesting features: first, unionization rates vary considerably across (aggregate) sectors. They are highest in 3 *Iron/Steel/Manufacturing* and 4 *Transport equipment* ranging from between 40 to 50 percent, and lowest in 8 *Food/Beverages* with 10 to 30 percent unionization. Second, with the exception of textiles and apparel, unionization rates have fallen over time. The relative changes over time are similar across sectors.

In the regression analysis, we exploit variation not only across the eight sectors used in the graphical presentation, but across all 34 industries in our data. In order to split sectors into high unionization and low unionization sectors, we compute unionization rates as averages over time and split the sample at the median sector. We re-run the regressions from Section 4, separately for strongly unionized sectors and weakly unionized sectors. (Regression results are reported in Tables IV.13 through IV.16 in the Online Supplement.)

For ease of comparison, we graphically depict the results in Figure 8. The upper panel shows that, in the base year 1979, in strongly unionized sectors, the reference activity 1 *Manufacture, Produce Goods* is overall more dominant than in weakly unionized sectors. Graphically, the 1979 curve reaches further down in strongly unionized sectors than in weakly unionized sectors. Over time, in both strongly and weakly unionized sectors, activities other than the reference activity become more prominent, but in weakly unionized sectors, the 2006 curve in weakly unionized

Figure 8: Activity Content and Performance Requirements of German Work by Unionization



Sources: BIBB 1979-2006, workers ages 16 through 65; GSOEP select years with unionization.

Notes: Measures of relative activity frequencies from log employment OLS regression over 76,676 activity-year-gender-age-sector-occupation cells with high unionization and 84,480 cells with low unionization for equation (2), as reported in Online Supplement Tables IV.13 and IV.14, and 89,092 requirement-year-gender-age-sector-occupation cells with high unionization and 83,667 cells with low unionization for equation (2), as reported in Tables IV.15 and IV.16. Coefficients reported as $\exp\{\beta\}$ to reflect relative frequencies. Omitted baseline task from regressions: activity 1 *Manufacture, Produce Goods* and performance requirement E *Work procedures prescribed in detail* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Log scale on vertical axis.

sectors still lies above that of strongly unionized sectors (compare the 2006 curve across graphs, or compare column (5) in Tables IV.13 through IV.16 in the Online Supplement).

Similarly, the lower panel of the figure suggests that performance requirements are overall more demanding in weakly unionized sectors. Over time, changes in performance requirements are less straightforward to interpret, but seem to point towards increasing performance requirements in most (but not all) categories other than the reference group *E Work procedures prescribed in detail* (codifiability).

Labour market institutions in the form of domestic unionization rates, while related to differences in task patterns across sectors, do not seem to have a differential impact on ‘slowing down’ or ‘speeding up’ the trend toward more high-end tasks that globalization 2.0 predicts.

6.2 Sectors facing tight vs. less tight labour markets in Germany

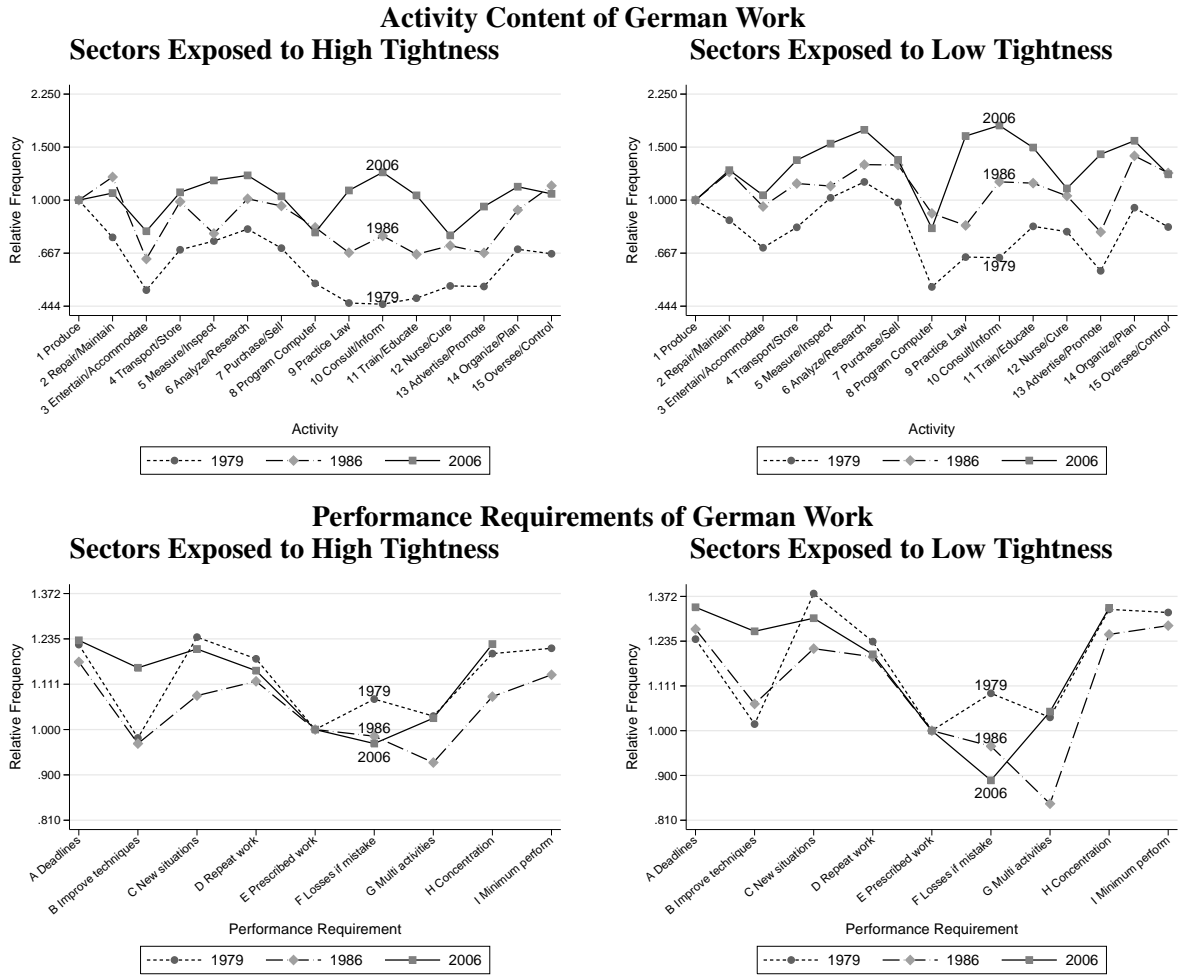
To gauge the importance of local labor pools, we look at a macroeconomic measure characterizing domestic labour markets: labour-market tightness. There is no direct measure of sector-level labour-market tightness. Instead, we start from regional information on the number of vacancies per 1,000 unemployed persons at the level of German states for the years 1980 through 2005. We use the sectoral distribution of workers across states to compute a (country-wide) sector-level measure of labour-market tightness. If a sector employs a larger workforce in a state with high labour-market tightness, the representative employer in that sector is exposed to a tighter labour market than an employer in another sector with a stronger presence in states with lower tightness. As before, we compute tightness rates as averages over time and split the sample at the median sector. We re-run the regressions from Section 4, separately for sectors exposed to labour markets with high and low tightness. (Regression results are in Tables IV.17 through IV.20 in the Online Supplement.)

The upper panel of Figure 9 shows that, in 1979, activities other than the reference activity *I Manufacture, Produce Goods* are overall more dominant in sectors exposed to low labour-market tightness (right-hand chart) compared to sectors exposed to high tightness. Interestingly, the changes over time work to further strengthen the differences across the two groups of sectors. Note that the similarly sized parallel shift upward in the left- and right-hand side graphs implies a larger percentage increase in the right-hand side graph under the log-scale.

Similarly, as can be seen in the lower panel of the figure, performance requirements are overall more demanding in sectors exposed to low labour-market tightness. For performance requirements, the changes over time do not seem to display discernible differences across the two sector samples.

Both pieces of evidence together are consistent with the idea that firms respond to market conditions, potentially including globalization, differently under varying institutional and labour market settings. In particular, employers adopt “high end” workplace activities, other than the baseline category *I Manufacture, Produce Goods*, more frequently in less tight labor markets. In this regard, more flexible local labour-market conditions appear to accelerate the changes in German workplace tasks.

Figure 9: Activity Content and Performance Requirements of German Work by Labour Market Tightness



Sources: BIBB 1979-2006, workers ages 16 through 65; IAB select years with labour-market tightness.

Notes: Measures of relative activity frequencies from log employment OLS regression over 68,941 activity-year-gender-age-sector-occupation cells with high labour-market tightness and 95,910 cells with low labour-market tightness for equation (2), as reported in Online Supplement Tables IV.17 and IV.18, and 80,051 requirement-year-gender-age-sector-occupation observations with high labour-market tightness and 95,989 cells with low labour-market tightness for equation (2), as reported in Tables IV.19 and IV.20. Coefficients reported as $\exp\{\beta\}$ to reflect relative frequencies. Omitted baseline task from regressions: activity 1 *Manufacture, Produce Goods* and performance requirement E *Work procedures prescribed in detail* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Log scale on vertical axis.

Table 5: LABOUR MARKET REGULATIONS AT GERMANY'S IMPORT AND EXPORT PARTNERS

	Unemployment Benefits		Advance Notice Period		
	Gross replacement rate		in months		
	Year 1	Year 2	After 9 mo.	After 4 yrs.	After 20 yrs.
	(1)	(2)	(3)	(4)	(5)
Germany 1979	.38	.34	1.00	1.00	4.50
Germany 1986	.35	.31	1.00	1.00	4.50
Germany 1992	.36	.32	1.00	1.00	4.50
Germany 1998	.35	.31	1.00	1.00	7.00
Germany 2006	.36	.16	1.00	1.00	7.00
Imports 1979	.40	.20	.82	1.34	3.08
Imports 1986	.40	.20	.83	1.37	2.99
Imports 1992	.40	.19	.85	1.40	2.88
Imports 1999	.39	.19	.86	1.38	2.83
Imports 2006	.38	.18	.90	1.38	2.87
Exports 1979	.41	.20	.82	1.39	3.09
Exports 1986	.41	.19	.77	1.34	2.89
Exports 1992	.41	.20	.83	1.43	2.96
Exports 1999	.40	.18	.81	1.41	2.72
Exports 2006	.39	.18	.85	1.44	2.69

Sources: IMF-fRDB labour-market regulations 1980-2005 (Aleksynska and Schindler 2011); WTF 1979-1993 and recent revisions 1994-2006.

Notes: The gross replacement rate is the ratio of unemployment benefits relative to the worker's last gross earning prior to separation, measured for the first year and the second year of unemployment. Advance notice requirements are reported for workers at 9 months of tenure, 4 years and 20 years of tenure.

6.3 Labour regulations among German trade partners

To assess a potential impact of labour regulations on incentives for task assignments, we turn to IMF-fRDB data on labour-market regulations. The data cover minimum wage regulations, unemployment insurance benefits, and employment protection legislation. Germany has no legally mandated minimum wage in place during the sample period and its employment protection legislation does not institute severance pay requirements upon job loss. We therefore compare Germany to its trade partners regarding advance notice requirements, another key component of employment protection legislation, and regarding the generosity of unemployment insurance benefits.

Compared to its trade partners, Germany regulates its labour markets more stringently with regards to long-term unemployment benefits and mandatory advance notice for employment protection. As Table 5 shows, displaced German workers recover during the first year of unemployment between 35 and 38 percent of their last gross earning prior to separation (gross replacement rate in column 1). That ratio is slightly lower than among Germany's trade partners, suggesting that Germany's unemployment insurance is less generous to workers during the first year of unemployment. During the second year of unemployment, however, Germany used to be considerably more

generous than its trade partners (gross replacement rate in column 1). Yet, since 2006, Germany has become slightly less generous than its trade partners also in that regard.

German employment protection legislation requires an advance notice of one month for workers with 9 months of tenure throughout the entire sample period, whereas its trade partners require on average only a little more than three weeks. At four years of tenure, Germany is less generous to workers than its trade partners. Whereas Germany grants the same one-month advance notice as to workers at lower tenure, its trade partners require an advance notice of one-and-a-third months on average. At very high tenure of 20 years, Germany is again more generous to workers and raised the advance notice even further from 4.5 to 7 months over the sample period, whereas its trade partners gradually lowered advance notice from on average over three months to under three months. Overall, neither regarding unemployment benefits nor employment protection legislation is Germany uniformly more or less generous than its trade partners. At different time horizons Germany can be less or more worker friendly.

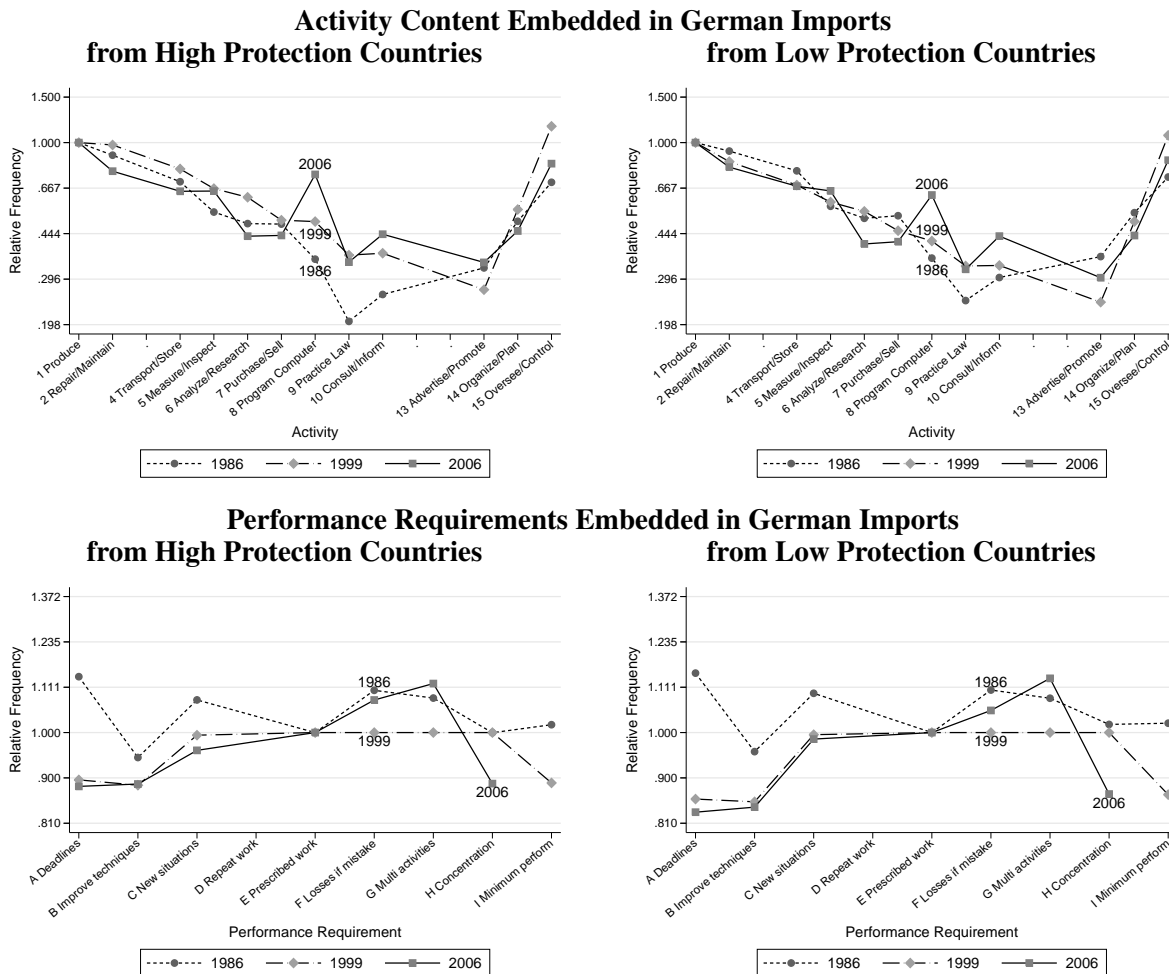
For both unemployment benefits and advance notice there is no marked difference between Germany's import and Germany's export partners, suggestive of the possibility that trade flows are not driven by labour-market institutions.

Similar to unemployment benefits, a legally mandated and binding minimum wage raises labour costs. Germany having no legal minimum wage during the sample period is a less worker friendly economy than its typical trade partner in that dimension.¹³ Similarly, at four years of tenure, Germany affords its workers less employment protection through advance notice than the average trade partner. In both regards, Germany is relatively more business friendly.

To quantify the potential sensitivity of German workplace tasks to foreign labour-market regulations with regards to the minimum wage and advance notice, we group foreign countries into those with below and those with above median regulations. We run separate regressions for imports from source countries with more worker friendly regulations (higher minimum wage per mean wage or longer advance notice than the median foreign country) vs. less worker friendly foreign economies. This sample split allows us to compare the imported trade-task relationship across levels of source-country regulations in two areas of labour-market legislation, in which Germany is less worker friendly than world average and therefore arguably more sensitive. Figure 10 shows the results for advance notice requirements at four years of tenure (regression Tables IV.25 through IV.28 in the Online Supplement); Figure B.1 in the Appendix presents similar results for the minimum wage. Perhaps expectedly, given the evidence from Table 5, there are no marked differences of embedded task trade between more and less worker friendly import source countries.

¹³Unemployment benefits constitute a varying outside option for workers of different earnings levels and may thus have an arguably differential impact on wage setting that minimum wages cannot exert. However, many countries appear to trade off severance pay arrangements with unemployment benefits over the sample period, with about one-third of countries introducing unemployment benefits for the first time during the sample period. This feature makes unemployment benefits legislation harder to quantify in its labour-market impact, and we focus our analysis on the minimum wage and advance notice instead.

Figure 10: Activity Content and Performance Requirements Embedded in German Imports by Foreign Employment Protection Levels



Source: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandise trade, Deutsche Bundesbank for services trade 1979-2006; BIBB 1979-2006, workers ages 16 through 65; IMF-fRDB labour-market regulations 1980-2005.

Notes: Measures of relative task (activity or performance requirement) frequencies from log import value OLS regressions over task-year-source country cells (2,653 observations for activities and 1,485 for performance requirements over more worker friendly source countries, 6,657 observations for activities and 3,705 for performance requirements over less worker friendly source countries than Germany), as reported in Online Supplement Tables IV.25 and IV.27, IV.26 and IV.28. Source countries with advance notice above (high protection) or below (low protection) world median for workers with four years of tenure. Import value of embedded tasks imputed using 7-year lags of German task shares by sector. Services activities 3, 11 and 12 not reported in graphs, performance requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Coefficients β from log import value regressions reported as $\exp\{\beta\}$ to reflect relative import frequencies. Omitted baseline activity 1 *Manufacture, Produce Goods*, omitted baseline performance requirement E *Work procedures prescribed in detail* in each survey wave. Log scale on vertical axis.

Table 6: LABOUR MARKET RIGIDITY AT GERMANY'S IMPORT AND EXPORT PARTNERS

Index of	Hiring costs	Hours changes	Firing costs	Overall rigidity	Firing costs
	(1)	(2)	(3)	(4)	(5)
Germany	44.0	80.0	40.0	55.0	80.0
Imports 1979	32.7	52.7	28.8	38.0	36.8
Imports 1986	33.4	52.8	28.5	38.2	35.9
Imports 1992	33.2	53.3	29.3	38.5	37.5
Imports 1999	31.2	51.7	29.6	37.5	38.1
Imports 2006	28.3	51.2	30.0	36.4	39.0
Exports 1979	31.1	52.8	29.3	37.7	37.1
Exports 1986	29.9	50.6	28.5	36.3	36.0
Exports 1992	33.7	54.6	31.3	39.8	40.9
Exports 1999	32.3	53.2	31.5	38.9	40.0
Exports 2006	31.3	53.5	32.1	38.9	41.4

Sources: World Bank Doing Business 2004 (Botero et al. 2004); WTF 1979-1993 and recent revisions 1994-2006.

Notes: Labour-market rigidity indexes are coded on a scale from 1 to 100, where a higher level indicates more labour-market rigidity.

6.4 Labour market rigidity among German trade partners

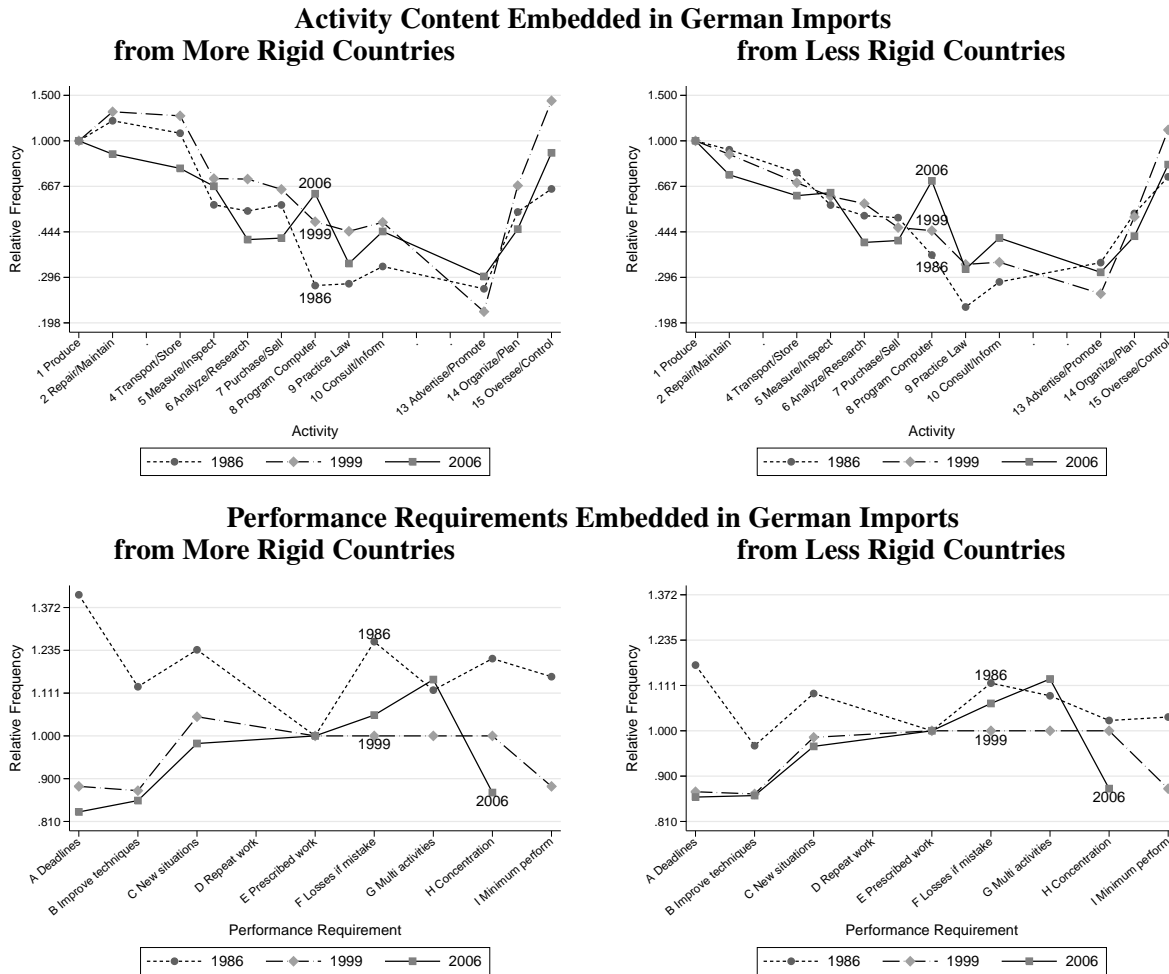
In our final piece of analysis, we turn to recent measures of labour-market rigidity and compare the rigidity of the German labour market to that of its trade partners, using the World Bank's classification of employment laws following Botero et al. (2004). We bring in import flows by year to compute the weighted mean rigidity index of the source countries of Germany's imports, and export flows for the weighted rigidity index of Germany's destination countries.

Table 6 lists the rigidity indexes by category for Germany and its trade partners. Three main insights emerge. First, by the World Bank's classification Germany has considerably more rigid employment laws in 2004 than its trade partners. Second, the rigidity composition of Germany's trade partners changes little over time; in other words, given the 2004 rigidity level, there is no marked change of trade flows related to foreign labour-market conditions over time. Third, Germany's main import and export partners have similar labour-market rigidities. Analogous to our earlier evidence from IMF-fRDB data on labour-market regulations, these patterns are consistent with the idea that Germany's trade flows are largely independent of foreign labour-market institutions.

In a final exercise, we run separate regressions for imports from source countries with more rigid (overall rigidity index above German level) or less rigid labour markets than Germany. We use the World Bank's internationally comparable measure of overall labour-market rigidity following Botero et al. (2004) and compare each country's index to that in Germany. Figure 11 shows the results (regression Tables IV.21 through IV.24 in the Online Supplement).¹⁴ Not surprisingly given

¹⁴Select regressions result in non-negative definite Hessians when accounting for two-way clustering. In those cases

Figure 11: Activity Content and Performance Requirements Embedded in German Imports by Foreign Labour-market Rigidity



Source: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandise trade, Deutsche Bundesbank for services trade 1979-2006; BIBB 1979-2006, workers ages 16 through 65; World Bank Doing Business 2004.

Notes: Measures of relative task (activity or performance requirement) frequencies from log import value OLS regressions over task-year-source country cells (2,653 observations for activities and 1,485 for performance requirements over more rigid source countries, 6,657 observations for activities and 3,705 for performance requirements over less rigid source countries than Germany), as reported in Online Supplement Tables IV.21 and IV.23, IV.22 and IV.24. 37 source countries with more, 101 source countries with less rigid labour markets than Germany. Import value of embedded tasks imputed using 7-year lags of German task shares by sector. Services activities 3, 11 and 12 not reported in graphs, performance requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Coefficients β from log import value regressions reported as $\exp\{\beta\}$ to reflect relative import frequencies. Omitted baseline activity *I Manufacture, Produce Goods*, omitted baseline performance requirement *E Work procedures prescribed in detail* in each survey wave. Log scale on vertical axis.

the evidence from Table 6, there are no marked differences of embedded task trade between high-rigidity and low-rigidity import source countries.

7 Implications for Policy

Our evidence covers a broad range of trade flows, including merchandise and services, and discerns imports of intermediate inputs from final-use imports as well as exports. We relate the evidence on trade to the task profile of the German workplace, so as to shed light on the consequences of increased globalization for the labour market. Our findings suggest that German workplaces have been exposed to elevated intermediate-input and services trade flows since at least the beginning of our sample period in the late 1970s. For Germany the exposure to intermediate-input and services trade is therefore no new phenomenon and fears of offshoring may be exaggerated. Our results do not point to any specific market failure, and thus provide no explicit rationale for government intervention. Germany has gone through periods of high unemployment during the sample period, especially after German unification in the 1990s. However, the fact that unemployment rates have fallen again towards the recent end of our sample period cautions against the hypothesis that Germany's heightened exposure to global markets over the last three decades has had a one-directional relationship with employment.

We find economically relevant but small marginal responses of workplace activities and job performance requirements to trade exposure over three decades. This evidence is consistent with the interpretation that the German labour market is capable of gradually adjusting to the implied economic change. We find that, over the sample period, jobs require workers to perform additional activities cumulatively (providing direct evidence on ever more prevalent multitasking) and that the German workplace has undergone a marked shift towards more "high-end" tasks, including activities such as consulting, organizing and planning. Our evidence on goods and services trade flows is consistent with the view that those workplace changes are related to trade in tasks. As globalization progresses, Germany's workforce has undergone, and expectedly will continue to experience, a move towards less production related activities, while deadlines, often changing business constellations and tougher performance standards alter the workplace profile. Of both employers and workers, these changes will arguably demand more adaptability to a cumulating variety of tasks and closer coordination with work steps performed outside the immediate realm of one's own occupation.

In taking an institutional perspective, we explore whether existing labour-market institutions may relate to an acceleration or slowdown of the workplace changes that we observe. We distinguish between the role of labour-market institutions among Germany's trading partners and the role of domestic labour-market institutions. As regards the former, there is no clear relationship between the German workplace characteristics and labour-market institutions abroad: the identity of the source country of imports or the destination country of exports does not seem to matter for workplace adjustments above and beyond the total trade volumes. Put simply, imports of identical goods and services at the same price, but from different source countries, affect domestic

we only cluster by import source country.

workplaces in no different way. When it comes to domestic labour-market institutions, our results indicate that sectors exposed to low regional labour-market tightness experience a faster shift towards high-end tasks. It is hard to assess the implications of those institution-related findings under an economic welfare perspective. To the extent that a slower shift towards multi-tasking job profiles eases pressure on workers, the transition may have been less demanding in sectors exposed to less tight labour market. However, our analysis does not permit any inference about relative wage effects or employment effects across sectors.

Our evidence arguably best serves as a guide to expected workplace adjustments and their relationship to trade in tasks. An implication for both employers and workers is that schooling and training will likely need to emphasize skills that enable the student to excel at coordinating tasks beyond the immediate realm of the individual workplace.

8 Conclusion

Novel data on time-varying German workplace characteristics over three decades show that the activities of German workers on the job change considerably over time within occupations. Workers perform more activities simultaneously and different activities over time, with a shift towards activities that are commonly considered little offshorable. These changes occur mostly within sectors and occupations, emphasizing the importance of worker-reported time-varying task measures. During this period, the bulk of German imports is destined for intermediate use and German imports expand mostly in sectors that are intensive in job performance requirements commonly considered highly offshorable. Foreign labour-market regulations, such as advance notice requirements and minimum wages, as well as the rigidity of foreign labour institutions are largely unrelated to the observed changes in German trade patterns, while local labour-market conditions in Germany, such as unionization rates and labour-market tightness, exhibit some covariation consistent with faster change in activity content of German work in sectors with low unionization rates and in sectors exposed to tighter labour markets. These patterns of evidence are consistent with the idea that, while foreign labour-market conditions are not a driving force for Germany's trade flows, labour-market conditions in Germany can accelerate or slow down responses to globalization.

Appendix

A Imported Intermediate Inputs

The right-hand chart of Figure 1 in the main text splits German imports into intermediate input use and final use. Figure A.1 shows a mechanical breakdown by country group for that evidence on import uses. The input-output tables on German imports from the German Statistical Office *destatis* do not discern imports by source country, and neither the WTF data on merchandise trade nor the BuBa data on services trade distinguish imports by the use for intermediate inputs or final consumption. The sample split of imports into those from high-income regions (the fifteen EU members in 2003, Japan, North America and Oceania/Antarctica) and those from the remaining low-income regions therefore applies only to total import flows to Germany, on which we impose a proportionality assumption. The assumption requires that the share of an industry's intermediate-input imports in its total imports is the same across all source countries. A comparison between the left-hand side and right-hand side charts of Figure A.1 suggests that the relative proportion of total imports between high-income and low-income countries remains stable throughout the sample period.

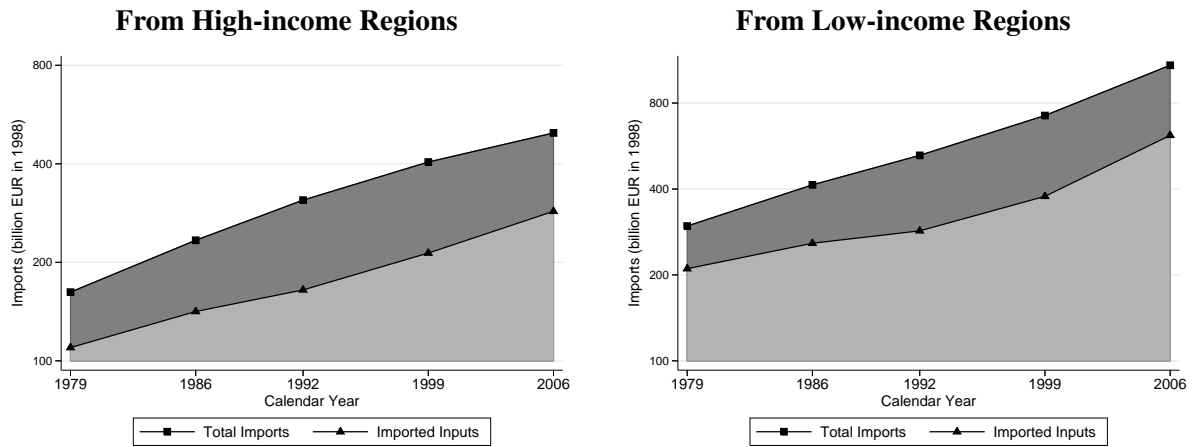
B Robustness

B.1 Controlling for computer use, education and migration status

We query the robustness of our descriptive task frequency computations in Figures 2 and Figure 3 (see Tables IV.2 and IV.4 in the Online Supplement for the respective right-hand panels). For the robustness checks, we follow the literature and add measures capturing technical change, educational attainment and inward migration to our regressions. Concretely, we condition on additional information at the individual worker level: computer use, schooling, and migration status. For computer use, we consistently extract from all BIBB survey waves an indicator variable that relates to a worker's use of a computer, workstation, or CAD equipment at the workplace. Similarly, we extract from the BIBB survey information on the worker's years of schooling. Finally, we use information on the worker's migration status from BIBB in 2006 in a single cross section (migration status is not consistently surveyed across waves). For comparability to our main specifications in equations (1) and (2), we aggregate the individual information to the same cells by sector, occupation, survey year, gender, age and task, and then re-estimate the linear regression model augmented with those control variables one at a time. We include the according regression tables in the Online Supplement (Tables V.1 and V.2 condition on computer use in the specification, Tables V.3 and V.4 condition on years of schooling).

Results show that coefficient estimates hardly change when we include computer use in the specification (alterations of the coefficients by .01 when at all). We also included a worker's computing skills, instead of computer use at the workplace, from the BIBB data and again found results not meaningfully altered. Similarly, results conditional on years of schooling show no

Figure A.1: Composition of German Imports, 1979-2006



Source: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandise trade, Deutsche Bundesbank for services trade 1979-2006; Destatis import matrices, releases 2009 (1978 and 1986) and 2010 (1992, 1999, 2006).

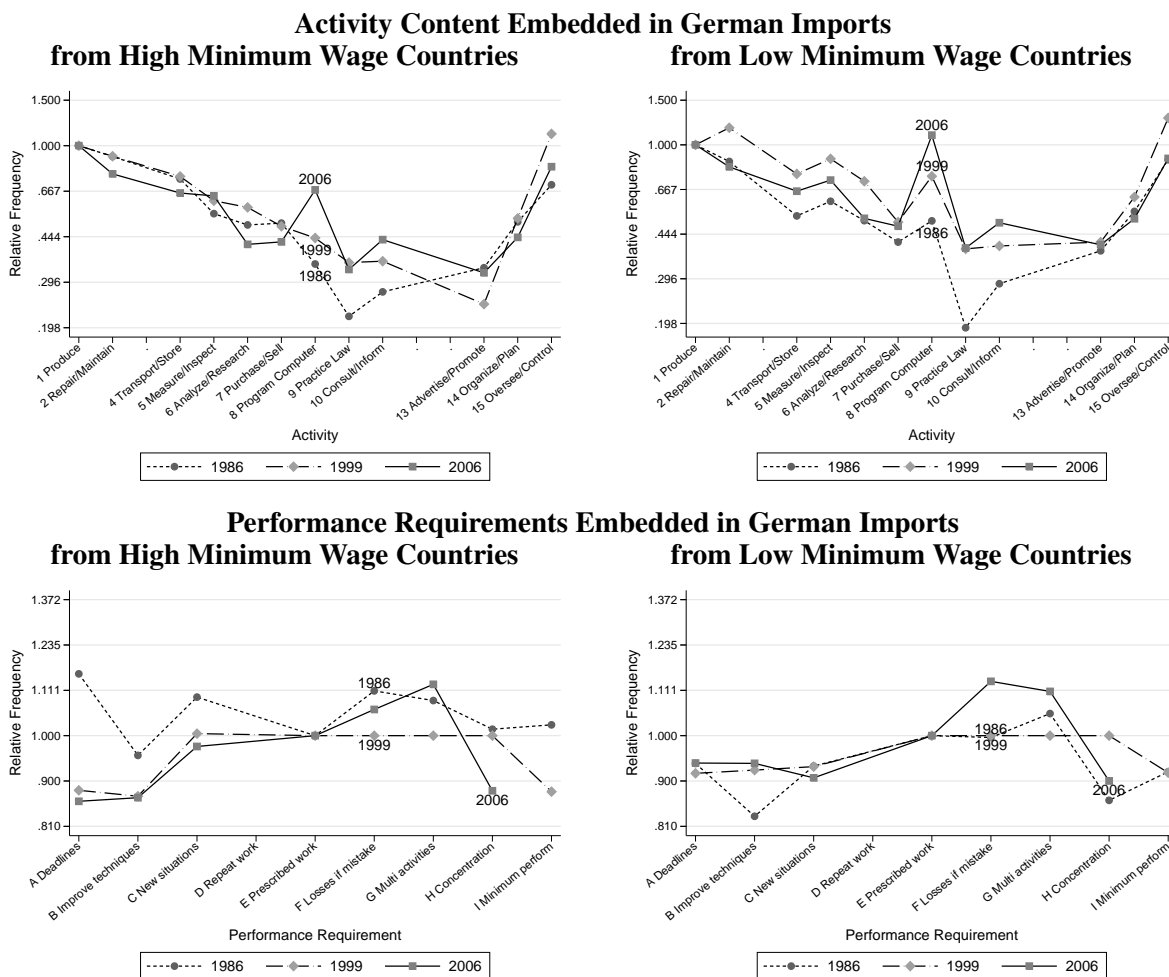
Notes: High-income regions are the 15 EU member countries in 2003, North America, Japan and Oceania. Converted to Euro, deflated with German CPI (end of year 1998 as base). Log scale on vertical axes.

economically important changes. Finally, inclusion of migration status does not notably change results for the year with observed migration status (to avert repetitiveness we make the results available upon request). A common reason for the absence of relevant effects appears to be that most of the variation in task frequencies is explained by year, age, gender, sector, and occupation fixed effects, so that the additional robustness measures add little explanatory power.

B.2 Task content of imports by foreign minimum wage levels

As a further robustness exercise to our investigation of labour-market characteristics abroad, we seek evidence on the task content of German imports by the minimum wage level in the import source countries, replicating similar evidence on employment protection through advance notice in Figure 10 in the text. Figure B.1 plots the relative task content estimated with separate regressions for imports from source countries with more worker friendly regulations (higher relative minimum wage than median) vs. less worker friendly foreign economies. Non-production activities are relatively more frequently embedded in import flows from countries with low minimum wages, but the overall patterns are otherwise strikingly unaltered between the two groups of low- and high-minimum-wage countries.

Figure B.1: Activity Content and Performance Requirements Embedded in German Imports by Foreign Minimum Wage Levels



Source: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65; IMF-fRDB labour-market regulations 1980-2005.

Notes: Measures of relative task (activity or performance requirement) frequencies from log import value OLS regressions over task-year-source country cells (2,653 observations for activities and 1,485 for performance requirements over more worker friendly source countries, 6,657 observations for activities and 3,705 for performance requirements over less worker friendly source countries than Germany). Source countries with ratio of minimum wage to mean wage above or below world median. Import value of embedded tasks imputed using 7-year lags of German task shares by sector. Services activities 3, 11 and 12 not reported in graphs, performance requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Coefficients β from log import value regressions reported as $\exp\{\beta\}$ to reflect relative import frequencies. Omitted baseline activity 1 *Manufacture, Produce Goods*, omitted baseline performance requirement E *Work procedures prescribed in detail in each survey wave*. Log scale on vertical axis.

References

- Acemoglu, Daron**, “Technical Change, Inequality, and the Labor Market,” *Journal of Economic Literature*, March 2002, 40 (1), 7–72.
- **and Jörn-Steffen Pischke**, “Why Do Firms Train? Theory and Evidence,” *Quarterly Journal of Economics*, February 1998, 113 (1), 79–119.
- Akçomak, I. Semih, Lex Borghans, and Bas ter Weel**, “Measuring and Interpreting Trends in the Division of Labour in the Netherlands,” *De Economist*, December 2011, 159 (4), 435–82.
- Aleksynska, Mariya and Martin Schindler**, “Labor Market Regulations in Low-, Middle- and High-Income Countries: A New Panel Database,” *IMF Working Paper*, July 2011, 154.
- Autor, David H., Frank Levy, and Richard J. Murnane**, “The Skill Content of Recent Technological Change: An Empirical Exploration,” *Quarterly Journal of Economics*, November 2003, 118 (4), 1279–1333.
- , **Lawrence F. Katz, and Melissa S. Kearney**, “The Polarization of the U.S. Labor Market,” *American Economic Review: Papers and Proceedings*, May 2006, 96 (2), 189–194.
- Baldwin, Richard and Rikard Forslid**, “The Development and Future of Factory Asia,” June 2013. Graduate Institute, Geneva, unpublished manuscript.
- Baldwin, Richard E. and Frédéric Robert-Nicoud**, “Offshoring: General Equilibrium Effects on Wages, Production and Trade,” *NBER Working Paper*, March 2007, 12991.
- Becker, Sascha O., Karolina Ekholm, and Marc-Andreas Muendler**, “Offshoring and the Onshore Composition of Tasks and Skills,” *Journal of International Economics*, May 2013, 90 (1), 91–106.
- Blinder, Alan S.**, “Offshoring: The Next Industrial Revolution?,” *Foreign Affairs*, March-April 2006, 85 (2), 113–28.
- , “How Many U.S. Jobs Might Be Offshorable?,” *World Economics*, April-June 2009, 10 (2), 41–78.
- **and Alan B. Krueger**, “Alternative Measures of Offshorability: A Survey Approach,” *Journal of Labor Economics*, April 2013, 31 (2), S97–128.
- Boeri, Tito and Mario Macis**, “Do Unemployment Benefits Promote or Hinder Job Reallocation?,” *Journal of Development Economics*, September 2010, 93 (1), 109–25.
- Botero, Juan C., Simeon Djankov, Rafael La Porta, Florencio Lopez de Silanes, and Andrei Shleifer**, “The Regulation of Labor,” *Quarterly Journal of Economics*, November 2004, 119 (4), 1339–82.
- Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller**, “Robust Inference with Multi-way Clustering,” *Journal of Business and Economic Statistics*, April 2011, 29 (2), 238–249.
- DiNardo, John E. and Jörn-Steffen Pischke**, “The Returns to Computer Use Revisited: Have Pencils Changed the Wage Structure Too?,” *Quarterly Journal of Economics*, February 1997, 112 (1), 291–303.

- Feenstra, Robert C. and Gordon H. Hanson**, “Foreign Investment, Outsourcing and Relative Wages,” in Robert C. Feenstra, Gene M. Grossman, and Douglas A. Irwin, eds., *The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati*, Cambridge and London: MIT Press, 1996, chapter 6, pp. 89–127.
- **and** — , “The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990,” *Quarterly Journal of Economics*, August 1999, 114 (3), 907–40.
- , **Robert E. Lipsey, Haiyan Deng, Alyson C. Ma, and Hengyong Mo**, “World Trade Flows: 1962-2000,” *NBER Working Paper*, January 2005, 11040.
- Gathmann, Christina and Uta Schönberg**, “How General Is Human Capital? A Task-Based Approach,” *Journal of Labor Economics*, January 2010, 28 (1), 1–49.
- Goos, Maarten, Alan Manning, and Anna Salomons**, “Job Polarization in Europe,” *American Economic Review*, May 2009, 99 (2), 58–63.
- Grossman, Gene M. and Esteban Rossi-Hansberg**, “Trading Tasks: A Simple Theory of Offshoring,” *American Economic Review*, December 2008, 98 (5), 1978–97.
- Jensen, J. Bradford and Lori G. Kletzer**, “Tradable Services: Understanding the Scope and Impact of Services Offshoring,” in Lael Brainard and Susan M. Collins, eds., *Offshoring white-collar work*, Vol. 2005 of *Brookings Trade Forum*, Washington, D.C.: Brookings Institution, 2006, chapter 3, pp. 75–133.
- **and** — , “Measuring Tradable Services and the Task Content of Offshorable Services Jobs,” in Katharine G. Abraham, James R. Spletzer, and Michael J. Harper, eds., *Labor in the New Economy*, number 71. In ‘Studies in Income and Wealth.’, Chicago and London: University of Chicago Press, 2010, chapter 8, pp. 309–35.
- Jones, Ronald W. and Henryk Kierzkowski**, “The Role of Services in Production and International Trade: A Theoretical Framework,” in Ronald W. Jones and Anne O. Krueger, eds., *The political economy of international trade: Essays in honor of Robert E. Baldwin*, Oxford and Cambridge, Mass.: Blackwell, 1990, chapter 3, pp. 31–48.
- Kohler, Wilhelm**, “Offshoring: Why Do Stories Differ?,” in Gabriele Tondl, ed., *The EU and Emerging Markets*, number 12. In ‘European Community Studies Association of Austria Publication Series.’, Vienna and New York: Springer, 2009, chapter 2, pp. 17–49.
- Lazear, Edward P. and Kathryn L. Shaw**, “Personnel Economics: The Economist’s View of Human Resources,” *Journal of Economic Perspectives*, Fall 2007, 21 (4), 91–114.
- Leamer, Edward E. and Michael Storper**, “The Economic Geography of the Internet Age,” *Journal of International Business Studies*, 4th Quarter 2001, 32 (4), 641–65.
- Levy, Frank and Richard J. Murnane**, *The New Division of Labor*, Princeton: Princeton University Press, 2004.

- Markusen, James R.**, “Modeling the Offshoring of White-Collar Services: From Comparative Advantage to the New Theories of Trade and Foreign Direct Investment,” in Lael Brainard and Susan M. Collins, eds., *Offshoring white-collar work*, Vol. 2005 of *Brookings Trade Forum*, Washington, D.C.: Brookings Institution, 2006, chapter 1, pp. 1–34.
- Mazzolari, Francesca and Giuseppe Ragusa**, “Spillovers from High-Skill Consumption to Low-Skill Labor Markets,” *Review of Economics and Statistics*, March 2013, 95 (1), 74–86.
- Ottaviano, Gianmarco I. P., Giovanni Peri, and Greg C. Wright**, “Immigration, Offshoring, and American Jobs,” *American Economic Review*, August 2013, 103 (5), 1925–59.
- Puzzello, Laura**, “A Proportionality Assumption and Measurement Biases in the Factor Content of Trade,” *Journal of International Economics*, May 2012, 87 (1), 105–11.
- Reimer, Jeffrey J.**, “Global Production Sharing and Trade in the Services of Factors,” *Journal of International Economics*, March 2006, 68 (2), 384–408.
- Spitz-Oener, Alexandra**, “Technical Change, Job Tasks, and Rising Educational Demands: Looking Outside the Wage Structure,” *Journal of Labor Economics*, April 2006, 24 (2), 235–70.
- Timmer, Marcel P., Bart Los, Robert Stehrer, and Gaaitzen J. de Vries**, “Fragmentation, Incomes and Jobs: An Analysis of European Competitiveness,” *Economic Policy*, October 2013, 76, 613–54.
- Trefler, Daniel and Susan Chun Zhu**, “The Structure of Factor Content Predictions,” *Journal of International Economics*, November 2010, 82 (2), 195–207.