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**Working Paper**

# 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 a long time span with sector-level bilateral trade data for merchandize 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 their relevance grows especially in the early decade; (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.

JEL-Code: F160, F140, J230, J240.

Keywords: trade in tasks, offshoring, demand for labour, labour force survey.

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# 1 Introduction

Offshoring of production stages, and the accompanying global integration of production, are widely thought 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 general equilibrium.[1]

The offshorability of jobs need not even be directly related to skills as measured by formal education. Blinder (2009) argues that low-skilled and high-skilled jobs are equally likely to be affected by offshoring. The prominent two examples of janitors and tele-radiologists illustrate that there is no simple one-to-one relationship between skills and offshorability. Janitors are typically low-skilled but the nature of their tasks ties them to their local workplace. In contrast, the medical 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 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 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 want to document how Germany's trade pattern developed over three decades at the turn to the 21st century, how the composition of tasks performed by German workers evolves and whether those developments are connected. We believe that these issues are policy relevant but even simple stylized facts characterizing trends over such a long time period are lacking. To examine the relationship between offshoring and the composition of tasks in the home economy, we combines representative worker-level data that cover *time-varying* job-level task characteristics of an economy over a period of decades. Rich micro data from the German Qualifications and Career Survey (BIBB survey) for the years 1979, 1986, 1992, 1999 and 2006 provide various measures of workplace characteristics, typically referred to as tasks.[2] We carefully create mappings across the

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

[2] For earlier studies using the BIBB survey in different contexts see, for instance, Acemoglu and Pischke (1998) or

five survey waves to obtain longitudinally consistent workplace characteristics.

There are three sets of workplace characteristics. First, the BIBB survey asks workers to state whether they perform activities from a given list—including activities such as *manufacture/produce*, *analyze/research*, *organize/plan* or *oversee/control*. These reported activities have been used in earlier research by Spitz-Oener (2006) and Gathmann and Schönberg (2010), for example. Our data preparation goes beyond their work both in time span and in coverage of additional workplace variables. Second, the BIBB survey asks workers whether they use tools from a given list to carry out their work. Reported tool use—such as the usage of computers, pencils, or fork lifts, for instance—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 inhouse offshoring and vertical foreign direct investment. In this paper, we concentrate on workplace characteristics beyond tool use. Third, the BIBB survey asks the worker how frequently performance requirements apply to the job—including the frequency of deadlines to complete tasks, the frequency with which the worker has to improve or adopt new techniques, and the frequency with which work procedures are described in detail. This is a so far largely unexplored group of BIBB survey questions and arguably closely related to task types that are relevant for offshorability.

Combined with sector-level trade information, our worker 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 and final goods imports by year. Imports of intermediate inputs are commonly associated with offshoring. The bilateral nature of the trade data allows us to relate trade flows to the composition of labour-market characteristics of the foreign countries, where German imports originate. Four main facts emerge. One, intermediate inputs constitute a major share of imports, and their relevance grows especially in the early decade. Two, 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. Three, the imputed activity and job requirement content of German imports grows relatively more intensive in work characteristics typically considered offshorable. Four, labour-market institutions at German trade partners are largely unrelated to the changing task content of German imports but German sector-level unionization rates exhibit some covariation consistent with faster task offshoring in more unionized sectors.

Earlier empirical research typically pre-defines task dichotomies based on survey answers (Spitz-Oener 2006; Gathmann and Schönberg 2010; Becker et al. 2013). Two common such task dichotomies are routine/non-routine and non-interactive/interactive. In this paper, we take a step back and let the original data speak. We keep a rich set of individual workplace characteristics and use regressions of employment frequencies to track how the task content has evolved across sectors and occupations, and most importantly within sectors and occupations, over the period 1979-2006. In a preliminary imputation exercise, we weight sectoral import flows to Germany with typical German task content seven years prior and use similar regressions to describe the evolution of task trade, for the full set of individual workplace characteristics. The stylized facts that emerge from

Spitz-Oener (2006).

our data document the importance of time-varying task information within sectoral occupations, where most variation occurs, and draw attention to subtle distinctions between offshorability and workplace changes. In contrast, much existing research uses time-invariant classifications from the U.S. Dictionary of Occupational Titles Job Description (DOT) or the Occupational Information Network (ONET) descriptions of occupations (Autor, Levy and Murnane 2003; Goos, Manning and Salomons 2009).

Our research 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 et al. 2009). Beyond offshoring and task trade (Grossman and Rossi-Hansberg 2008), which is the focus of our paper, those 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 et al. 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 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 survey, which we use to construct detailed and time consistent task measures at the worker-level; (ii) sector-level bilateral trade data from the World Trade Flows (WTF) database; (iii) sector-level unionization rates from the German Socioeconomic Panel (GSOEP); (iv) internationally comparable measures of labour-market institutions from the World Bank, 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 conducting 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 characteristics, 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 employer size in some years.)

We have created time consistent information across all five waves (see the Data Appendix 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 almost three decades. The BIBB data characterize the task profile of German workplaces through the surveyed worker's response 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).[3] In this paper, we restrict our attention to the worker's declaration of performed activities and the worker's assessment of the job's performance requirements.

**Activities.** For a longitudinally consistent series of activities on the job, we extract binary indicators from the BIBB data. These activity indicators record whether an activity is performed or not on a worker's job. To our knowledge for the first time, we obtain fifteen longitudinally consistent activity indicators across all five survey waves. For details on the activity variables see Appendix A.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 Techn. 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. As Table 1 shows, workers report that they perform considerably more simultaneous activities in later waves than in early waves. While 58.7 percent of workers report no more than one activity in 1979, the fraction of workers who report to perform

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

Table 1: SIMULTANEOUS ACTIVITIES BY SURVEY WAVE

| | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (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 | .053 | .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 | .067 |
| *Total* | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| *Average* | 1.67 | 2.17 | 2.11 | 5.25 | 7.24 |
| *Observations* | 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 Techn. Processes.

no more than one activity drops to 2.4 percent by 2006. To account for potential differences in reporting conventions over time, we condition on survey-wave fixed effects in all later regressions.

**Performance requirements.** The BIBB survey reports task requirements to perform a 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 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 Appendix A.2.

For empirical comparability to the more widely known activities definitions, 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

Table 2: SIMULTANEOUS PERFORMANCE REQUIREMENTS BY SURVEY WAVE

| | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (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 | |
| *Total* | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| *Average* | 4.91 | 5.13 | 4.18 | 4.76 | 5.83 |
| *Observations* | 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 Table A.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).

cutoffs (such as 1-3 vs. 4, and 1 vs. 2-4, available upon request), and find consistent 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. For the tabulation, we consider a performance requirement as present if the worker reports it to apply occasionally, or frequently or almost always. 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 remarkably stable. A plurality of workers faces between four and seven simultaneous performance requirements with high frequency in all survey waves.

The lacking change in the simultaneity of performance requirements over time is not only interesting in its own right. The stability in performance requirement reporting perhaps also suggests that the observed change in the simultaneity of activities above is not a statistical artefact of chang-

ing reporting conventions over time, but may reflect an actual workplace enrichment over time.

## 2.2 Trade

**Merchandize and services trade.** We obtain bilateral merchandize 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 to 2006. 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 sector information to our common sector definition with 39 industries across all waves of the BIBB data (20 merchandize producing industries; see Appendix A.4). We transform the US$ 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 industries can be identified (see Appendix B). 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.

**Imports of intermediate inputs.** We collect the import matrices from input-output tables in 1978 (no table for 1979), 1986, 1992, 1999 and 2006 by the German Statistical Office *destatis*. We map the sector classification from the NACE oriented classifications in Germany's import matrices to our common sector definition with 39 industries. In line with OECD standards, the German import matrix is based on the import proportionality assumption. This technique assumes that an industry uses an import of a particular input in proportion to its total use of that input. For example, if an industry such as motor vehicles uses steel in its production processes and 10 percent of all steel is imported, it is assumed that 10 percent of the steel used by the motor vehicle industry is imported. So time variation in imported steel for intermediate use comes from two independent changes over time: more steel imports and changing shares of steel use by industry, but does not come from a direct measure of import use shares by input and output. Using the import matrix, we compute the value of imports of intermediate inputs. We translate the 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 unioniza-

tion, and map the NACE 1.1 sector information in GSOEP to our common sector definition across all waves of the BIBB data (see Section A.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).

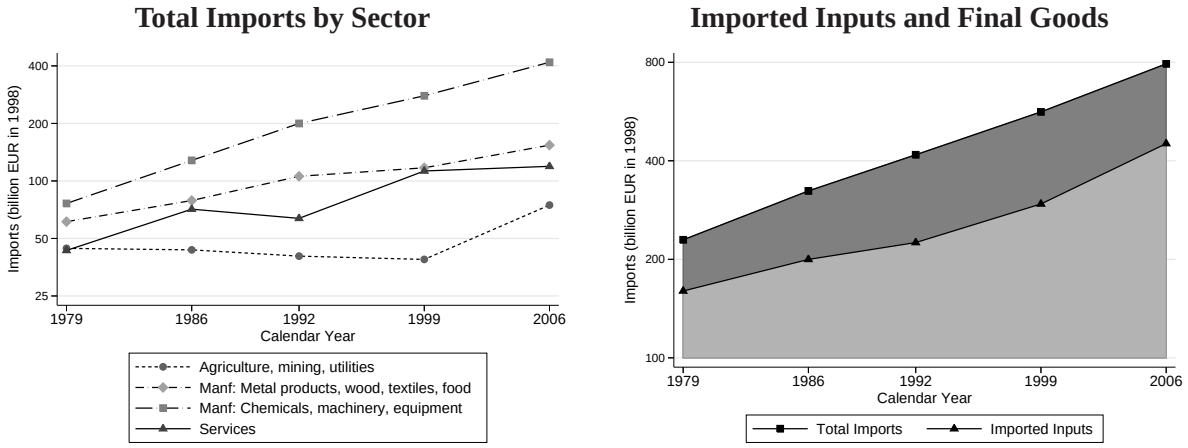
**Foreign labour-market rigidity.** From the IMF and Fondazione Rodolfo DeBenedetti (fRDB), we use a database of labour-market regulations for the period 1980-2005 and 91 countries, prepared by Aleksynska and Schindler (2011) using ILO, OECD and national sources. The IMF-fRDB labour-market regulations 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. However, there is some heterogeneity. Imports of machinery and equipment as well as of transport equipment have grown

Figure 1: **German Imports, 1979-2006**




*Source*: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandize 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.

considerably faster than average imports, while agricultural imports have declined slightly in real terms until 1999 and then rebounded.

Classic trade theory used to emphasize trade in final goods. Table 3 and the right-hand panel of Figure 1 show, in contrast, that most imports are for intermediate use and not for final consumption. In the right-hand side panel for Figure 1, we pair up imported inputs and final products by the same source-country sector, irrespective of what receiving sector in Germany might purchase the imported inputs. 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 input 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 decade and half (from 1979 to 1986 or 1992). In all sectors, however, the share of intermediates imports falls between 1979 and 2006. This different shift in trade patterns between the early half and the late half of our sample period leads us to track changes in German workplace characteristics between 1979 and 1986 and between 1986 and 2006.

One economic interpretation of globalization is that the pattern of trade has shifted from a classical exchange of final goods to trading predominantly unfinished products across production stages in the past century. Table 3 quantifies the shifting pattern of trade and documents that trade in intermediates is not a recent phenomenon in Germany. The import of intermediate products has been the predominant type of importation since 1978, exceeding 55 percent in all sample years. On average over all product groups, the share of imported intermediates in total imports has been

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 |
| *Total* | .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.

declining in Germany since 1978 with only a recent rebound after 1999. For many product groups imported into Germany, globalization understood as the shift from mostly final-goods trade to trade in intermediates has been faster in the early part of our sample period, and slower in more recent years. 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 Appendix B.1).

Table 4 assesses the importance of intermediate imports for domestic production.[4] The first 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. On the other hand, the share of outsourced inputs in the total production value, on the second line of the table, has remained 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 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

[4]Whereas Table 3 made a comparison across columns of uses within the rows of Germany's input-output matrices, Table 4 makes comparisons across rows of production components within the 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.

more offshore outsouring 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 merchandize production and services performed in-house and one-half by a separate party. 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 in the 19th century 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). Several such activity types and 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 the detailed information on workplace tools, activities or job characteristics into subjectively defined task dichotomies such as codifiable/non-codifiable, routine/non-routine and non-interactive/interactive. Instead, we let the data speak for themselves.

We investigate two sets of task characteristics 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

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

for task $i$ (activity or performance requirement), year $t$, gender $s$ and age $a$, as well as sector $j$ and occupation $k$, where the $\beta$ 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[5]

$$\ln L_{itsajk} = \beta_{it} + \beta_t + \beta_s + \beta_a + \beta_j + \beta_k + \varepsilon_{itsajk}. \tag{2}$$

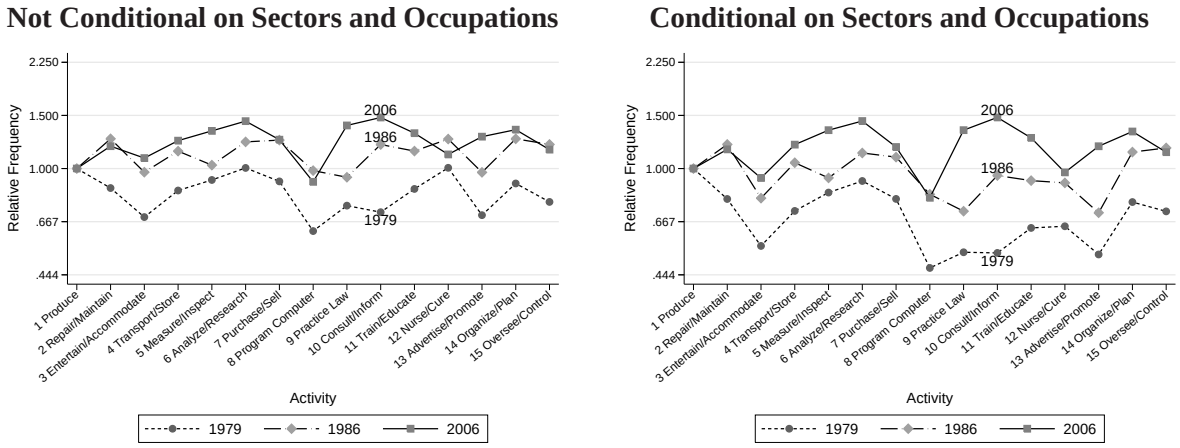
We estimate standard errors under two-way clustering (Cameron, Gelbach and Miller 2011) at the level of 2-digit sectors and tasks, which are not nested within sectors.

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, was arguably the one activity that could be offshored most easily because most naturally ties to final-goods trade alone. With the increasing slicing up of the production chain, other activities might as well become more and 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 is considered easily offshorable because it involves codifiable, rather than tacit, information to perform the job (Leamer and Storper 2001). Note that our inclusion of a full set of year dummies $\beta_t$ 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

[5]We can also condition on joint sector year effects $\beta_{st}$ instead of $\beta_t + \beta_s$ to assess the robustness of our results.

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, as reported in Tables D.1 and D.2. Coefficients $\beta$ from log employment regressions 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.

performance requirement *E Work procedures prescribed in detail*, for example, is implicitly standardized to $\exp\{\beta_{\cdot t}\} = 1$ 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 D.1 and D.2 in the Appendix, we report coefficient estimates for $\beta_{it}$ and overall regression statistics. In Figure 2 we present the $\beta_{it}$ estimates in graphical form. Each one of the two panels in Figure 2 depicts coefficient estimates from one single regression.[6] Our hypothesis is that under 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 D.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. Third, the shift away from *1 Manufacture, Produce Goods* affects both "high-end activities" such as *14 Organize/Plan*

[6] We 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.

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 as the reference activity. In 2006, it is 30 percent more frequent than the reference activity. These are substantial changes: 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 in fact and more of those are 'high-end' activities.

The regressions underlying Table D.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 D.2 and the corresponding right panel of Figure 2, we condition out occupation and sector means (through according fixed effects). It turns out that the coefficients barely change, suggesting 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.

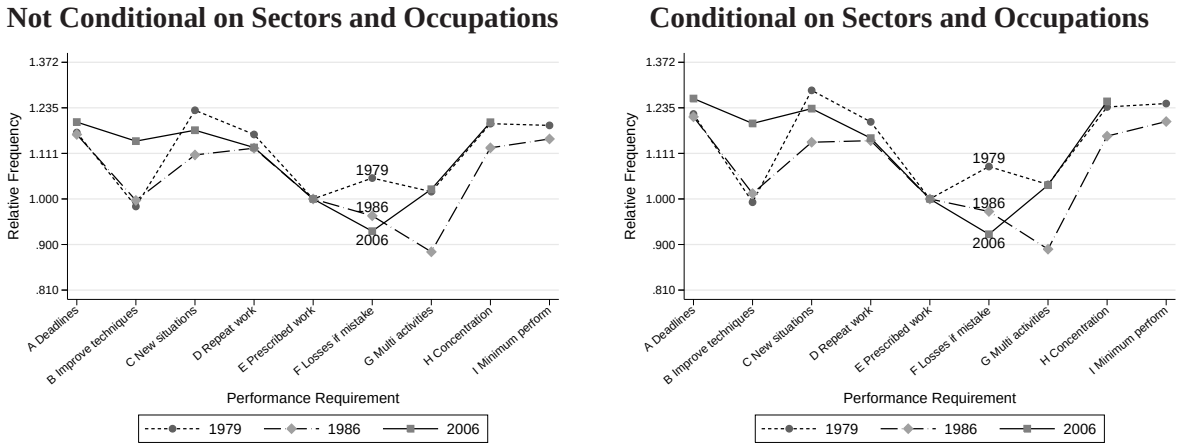
**Intensity of performance requirements.** Similarly to activity content, under increasing offshorability of codifiable, routine and non-interactive tasks, we should see a shift in the relative frequency of performance requirements other than *E Work procedures prescribed in detail* to higher and higher 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 D.3 and D.4 in the Appendix, we report coefficient estimates for $\beta_{it}$ and overall regression statistics. In Figure 3 we present the $\beta_{it}$ estimates in graphical form.[7]

Several observations emerge. First, across all five waves, we detect the expected U-shape: performance requirements other than the reference category *E Work procedures prescribed in detail* are more prevalent. Second, this pattern varies little over time. A noticeable exception is the category *B Improve/adopt new techniques*, whose importance increases significantly over time. 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 lacking difference between the short and long regressions for activities above, if anything coefficient estimates becomes somewhat more pronounced in the long regression that conditions on sector and occupation fixed effects. This evidence suggests that the main source of variation in performance requirements is *within* occupations and sectors, not between them.

[7] We 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.

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, as reported in Tables D.3 and D.4. Coefficients $\beta$ from log employment regressions 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.

# 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 interact. 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,

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

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

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

For German exports, we use task weights $\sigma_{ijt}$ of the current period to obtain tasks embedded

in total exports

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

where $X_{jt}$ are sectoral export flows of final products to destination country $c$.[8]

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 $\beta_{it}$ 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.[9] 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.

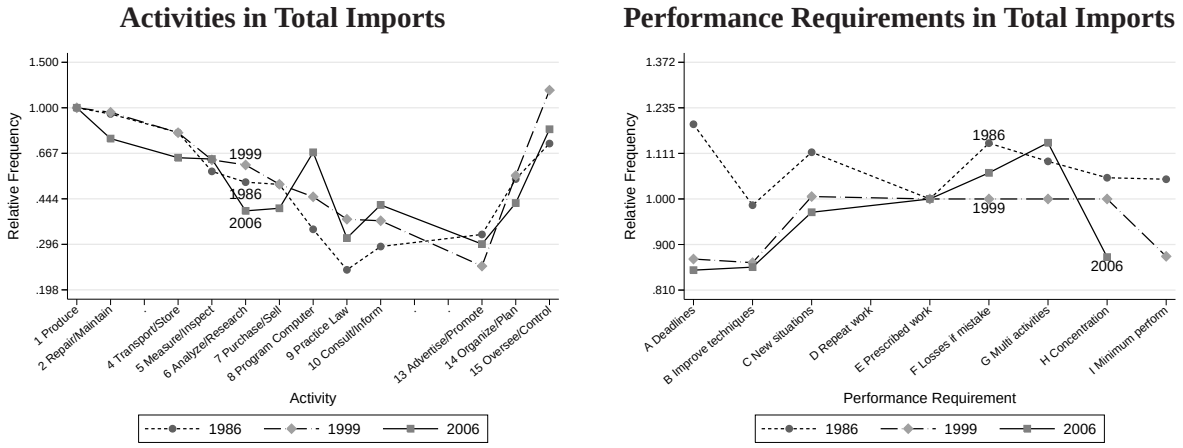
As before, for activity content we choose as our omitted reference categories *1 Manufacture, Produce Goods* in each survey year. For performance requirements, we choose as our omitted reference categories the performance requirement *E Work procedures prescribed in detail* in each survey year. Our inclusion 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 *1 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 *1 Manufacture, Produce Goods*. Similarly, we should see a shift in the relative frequency of performance requirements other than *E Work*

[8]These are crude measures and, similar to much prior work on trade in the literature, based on final goods trade. However, as Table 3 above documented, most German imports are for intermediate use and not for final consumption. In future statistical work, we are planning to use ILO data on foreign occupations and industries to compute the occupation composition behind country-level import flows and transform the import flows of final products into flows of intermediate goods imports using the import matrix from German input-output tables.

[9]To use possibly much source-country variation, which is more limited for services trade flows, we restrict the sample to merchandize 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 merchandize 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 Tables D.5 and D.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 $\beta$ 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.

*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 D.5 reports exponentiated coefficient estimates from OLS regressions of activities embedded in German imports, relative to the activity *manufacture, produce goods*. (Note that we use 1979 weights also for 1979 because no data is available for $t - 7 = 1972$.) Similarly, Table D.6 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 Table D.5 and in the Appendix).[10]

[10]From 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).

The left panel of Figure 4 indicates that most activities embedded in German imports have remained roughly constant over time or lost over in importance over time relative to the reference category *manufacture, produce goods*. In terms of magnitudes, consider *2 Repair/Maintain*. While in 1986 and 1999, its relative trade frequency (relative 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 *9 Apply Legal Knowledge*, which have become more prominent in German imports over time. Overall, we do not seem to observe dramatic effects of new forms of globalization on job activities.

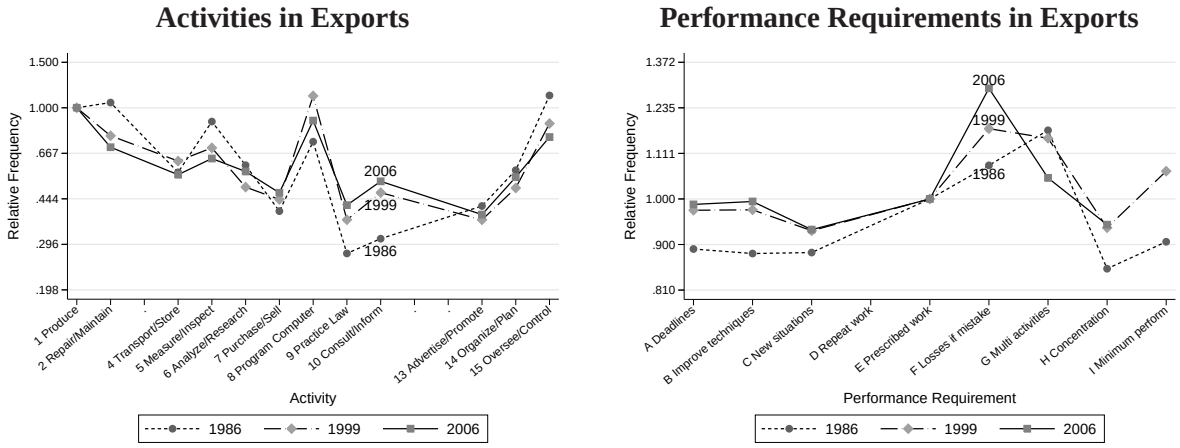
The picture is more clear cut for performance requirements embedded in German imports. The right panel of Figure 4 shows that, except for *G Versatility/multi activities*, where the 2006 value is slightly above the 1986 one, the 1986 values exceed the ones from 1999 and 2006. So, we do see that performance requirements embedded in German imports other than the reference category *E Work procedures prescribed in detail* 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. Overall, the performance requirement profile roughly resembles a U shape in 1986 (and 1979) and 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, however, 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. Overall, trade flows exhibit a marked difference in task content across tasks within any period of time, but no dramatic shifts over time as new forms of globalization evolve.

**German exports.** We perform the same exercise for German exports. 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*.

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 D.7 in the Appendix).[11] 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 for exports of final products as well as for imports of

[11] For 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 merchandize 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 Tables D.7 and D.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 $\beta$ 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.

competing goods in the product market and imports of intermediate goods in the input markets.

Our hypothesis receives support for performance requirements in German exports, however. Table D.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.

**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:

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

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 $\beta$ parameters denote regression coefficients on according sets of dummy variables, where the trade flow coefficients $\beta_i^T$ are task and trade-flow specific. Again, restricting coefficient estimates to reflect effects within sectors and occupations, we specify the corresponding

long regression

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

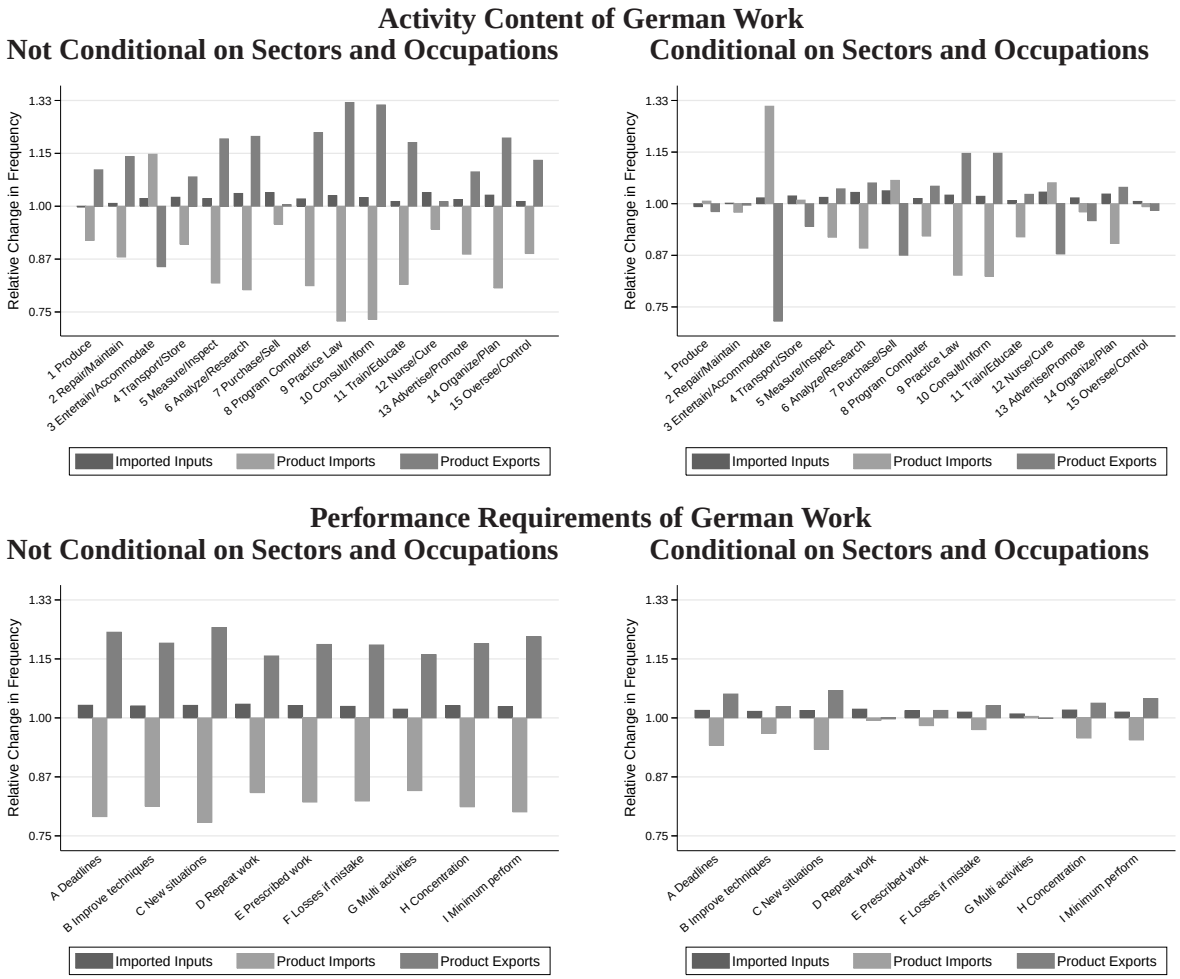
In both regressions, we can estimate a full set of $\beta_i^T$ coefficients (for all tasks), obviating the need of a reference category for these specifications. For the mapping of import flows to sectors, we use the source country's sector for final-goods imports. But we use Germany's receiving sector 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 coefficient 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 Produce*, 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 intermediate input trade is not a recent phenomenon in our sample period but, if anything, 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 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

Figure 6: **Trade Predictions of Task Frequencies**




*Sources*: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandize 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 activity-year-gender-age-sector-occupation cells, as reported in Tables D.9 and D.10 as well as Tables D.11 and D.12. Coefficients $\beta$ from log employment regressions 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.

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 E.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" activities 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 support the idea that Germany specializes in more elaborate tasks as globalization 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—such as organizing, planning, and consulting activities under deadlines, often changing business constellations and tougher performance standards.

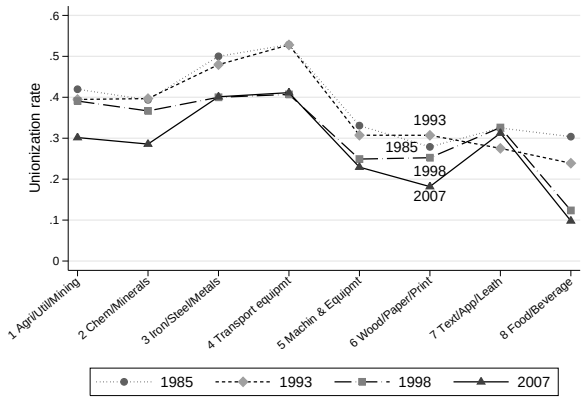
# 6 Institutional Aspects

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.

## 6.1 Highly unionized vs. less unionized sectors in Germany

In our subsequent analysis, 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 patters vary with the degree of influence of a key domestic labour-market institution.

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.

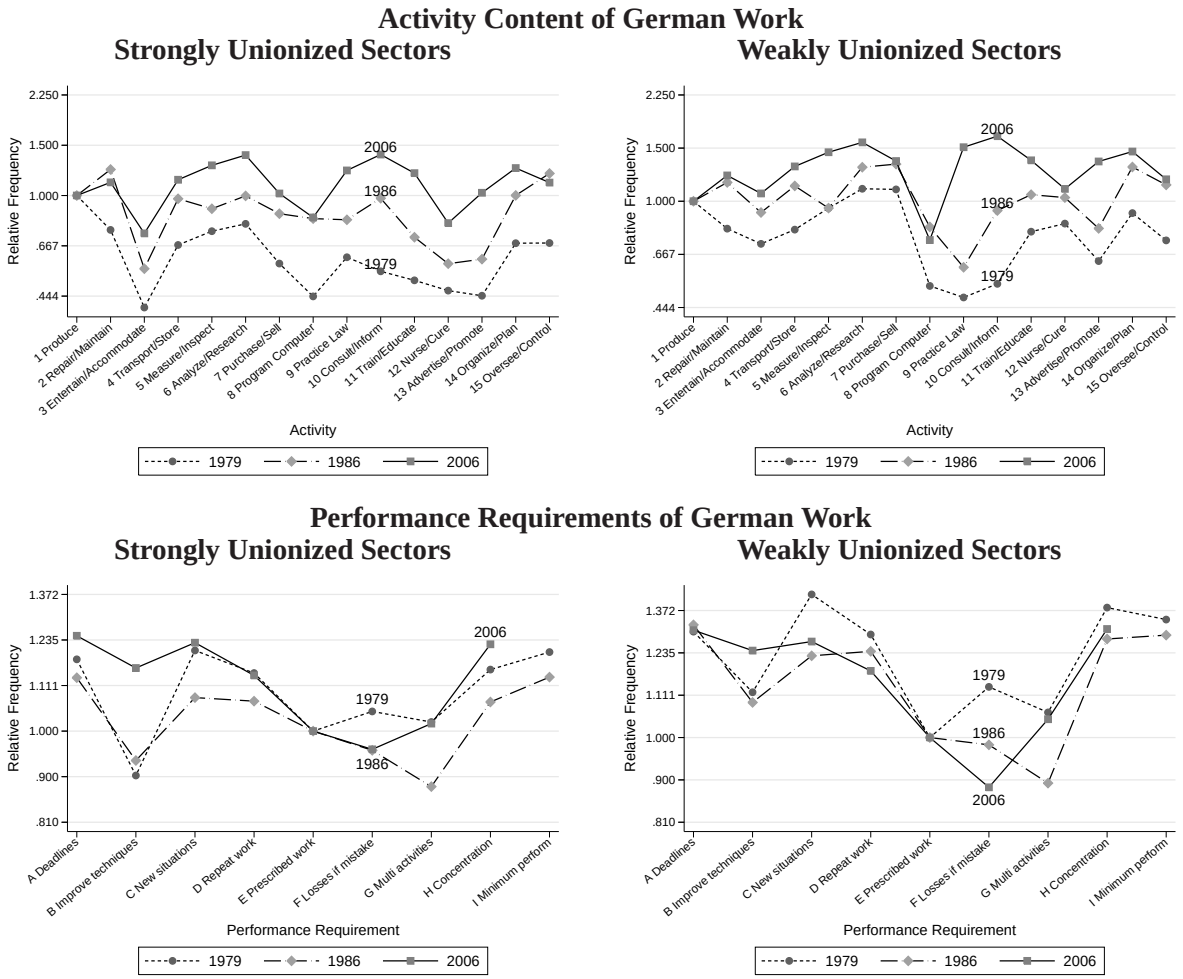
To inspect unionization rates across sectors over time, we aggregate sectors to the same eight aggregate sectors that we used to depict trends in German imports over time (Figure 1). Figure 7 shows several interesting features: first, unionization rates vary considerably across (aggregated) sectors. 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 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 39 sectors 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. The regression results are in Tables D.13 through D.16 in the Appendix.

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 Produce* 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 sectors still lies above that of strongly unionized sectors (i.e. compare the 2006 curve across graphs, or compare column (5) in Tables D.13 through D.16).

Similarly, as can be seen in the lower panel of the figure, performance requirements are overall more demanding in weakly unionized sectors. Over time, the changes in performance require-

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, as reported in Tables D.13 and D.14, and 89,092 requirement-year-gender-age-sector-occupation cells with high unionization and 83,667 cells with low unionization, as reported in Tables D.15 and D.16. Coefficients $\beta$ from log employment regressions 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.

ments 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 Prescribed work*.

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 we observe to evolve during this period of rapid globalization.

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

We look at a second 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 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. 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. The regression results are in Tables D.17 through D.20 in the Appendix.

The upper panel of Figure 9 shows that, in 1979, activities other than the reference activity *1 Produce* 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 what seems to be a similarly sized parallel shift upward in the left- and right-hand side graphs corresponds to a larger percentage increase in the right-hand side graph due to the log-scale.

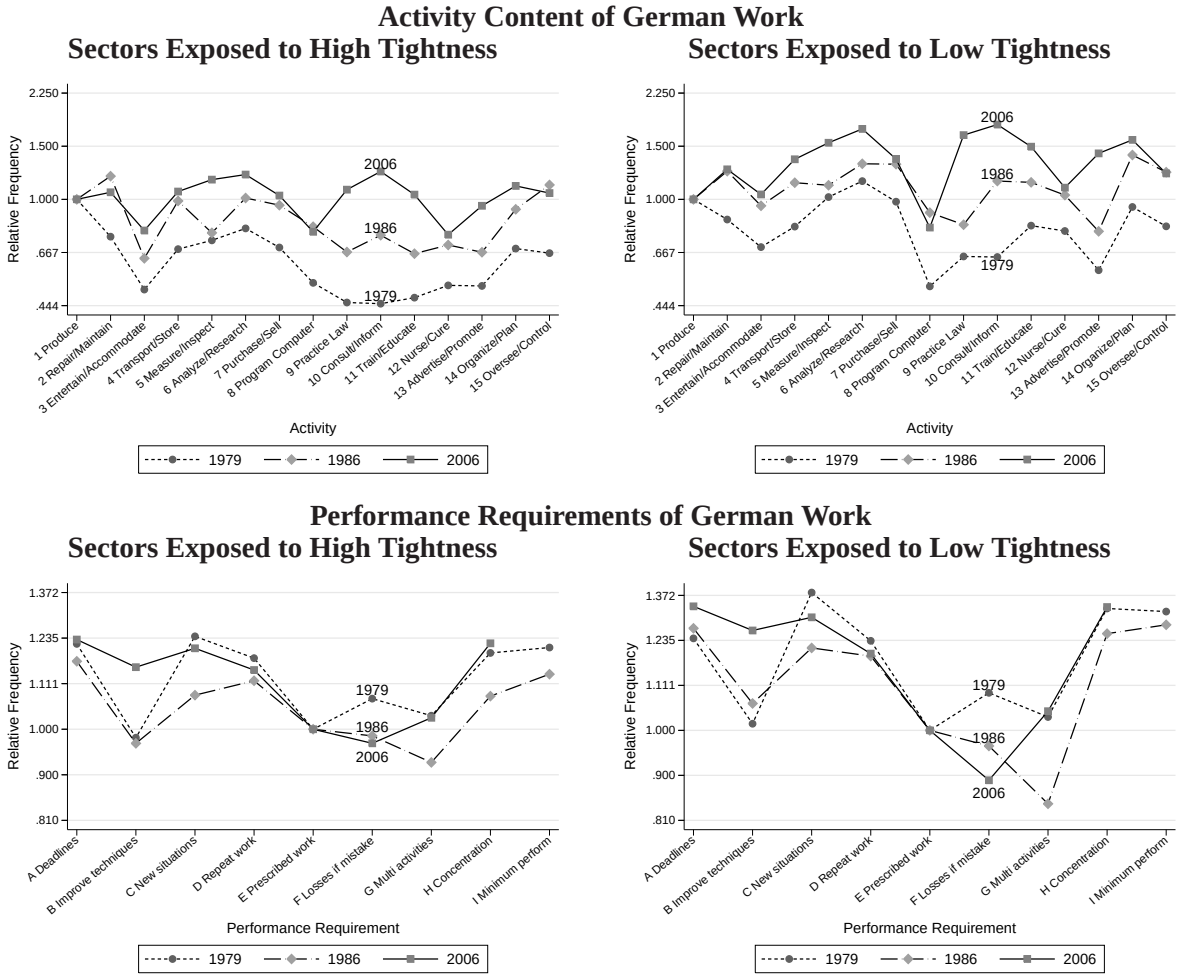
Similarly, as can be seen in the lower panel of the figure, performance requirements are overall more demanding in sectors exposed to low labour-market tightness. For performance requirements, the changes over time do not seem to display discernible differences across the two sector samples.

Both pieces of evidence together suggest that firms operate in a constrained environment and react to the threats and opportunities of globalization in the context of the institutional and labour market setting they operate in. These findings are consistent with the idea that labour-market conditions in Germany influence changes in German workplace tasks.

## 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

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, as reported in Tables D.17 and D.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, as reported in Tables D.19 and D.20. Coefficients $\beta$ from log employment regressions 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: LABOR MARKET REGULATIONS AT GERMANY'S IMPORT AND EXPORT PARTNERS

| | Unemployment Benefits Gross replacement rate | | Advance Notice Period 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 labor-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.

trade partners regarding advance notice requirements, the other main 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 36 and 38 percent of their last gross earning prior to separation (gross replacement rate in column 1). That ratio 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 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.[12] 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 D.25 through D.28 in the Appendix); Figure E.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.

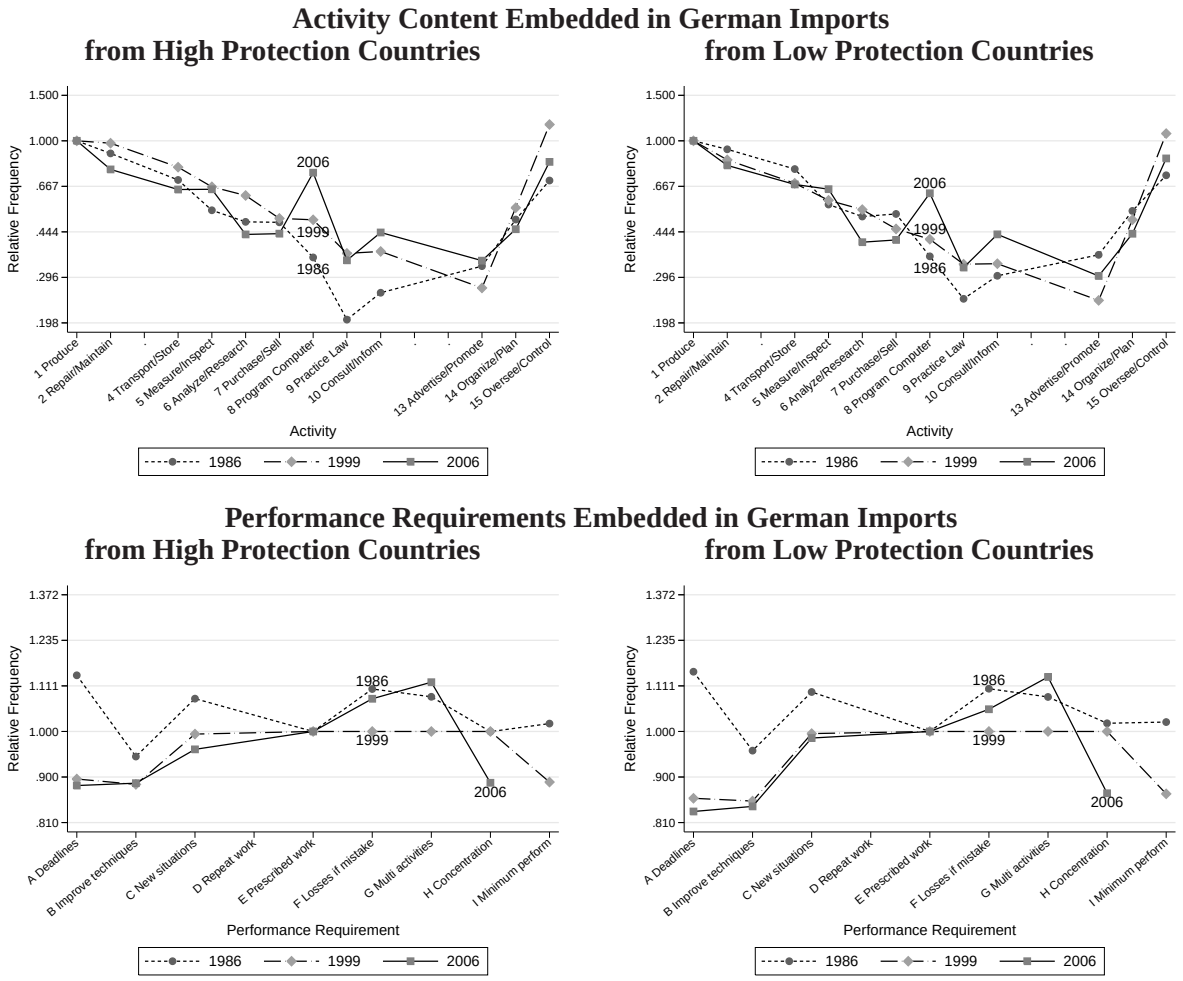
## 6.4 Labour market rigidity among German trade partners

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

[12] Unemployment 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 merchandize trade, Deutsche Bundesbank for services trade 1979-2006; BIBB 1979-2006, workers ages 16 through 65; IMF-fRDB labor-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 Tables D.25 and D.27, D.26 and D.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 $\beta$ 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: LABOR 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*: Labor-market rigidity indexes are coded on a scale from 1 to 100, where a higher level indicates more labor-market rigidity.

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. Similar 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.

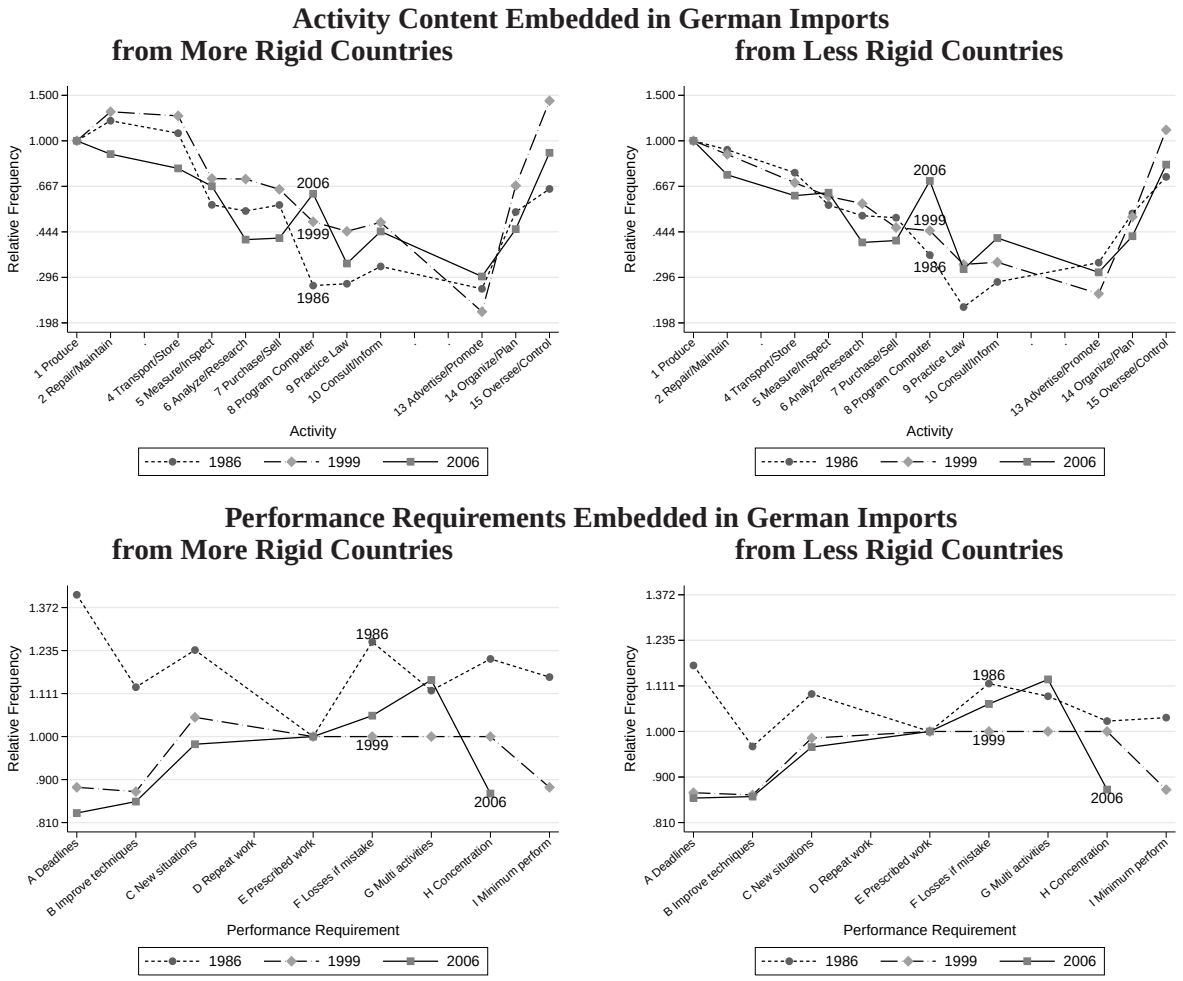
In a final exercise, we run separate regressions for imports from source countries with more rigid (overall rigidity index above German level) or less rigid labour markets than Germany. We use the World Bank's internationally comparable measure of overall labour-market rigidity following Botero et al. (2004) and compare each country's index to that in Germany. Figure 11 shows the results (regression Tables D.21 through D.24 in the Appendix).[13] Not surprisingly given 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 merchandize 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

[13] Select regressions result in non-negative definite Hessians when accounting for two-way clustering. In those cases we only cluster by importing destination country.

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




*Source*: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandize 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 Tables D.21 and D.23, D.22 and D.24. 37 source countries with more, 101 source countries with less rigid labor 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 $\beta$ 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.

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. At least 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 multi-tasking) 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 slow-down 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 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. 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 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 sector 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 globalization.

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Online **Appendix** to

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

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## A BIBB Survey

We use the German Qualification and Career Survey (*Qualifikation und Berufsverlauf*) to infer the time varying workplace characteristics and to obtain detailed worker characteristics. Since its inception, the survey was conducted in varying collabourations between federal goverment agencies and has meanwhile been renamed to German work survey (*Erwerbstätigenbefragung*). The survey has been conducted in five waves—in 1979, 1985-86, 1991-92, 1998-99 and 2005-06—by the German Federal Institute for Vocational Education and Training (*Bundesinstitut für Berufsbildung BIBB*) and collabourating agencies.[14] In each wave, the random worker sample represents around one tenth of a percent of the German labour force. We refer to this data source as the BIBB work survey, or just BIBB survey for short.

The BIBB survey reports workplace information in multiple ways. First, the BIBB survey asks workers to state whether or not they perform activities from a given list. These reported activities have been used in earlier research by Spitz-Oener (2006), for instance. Second, the BIBB survey asks workers whether they use tools from a given list to carry out their work, and about the main tool used. Reported tool use has been extracted for research by, for instance, DiNardo and Pischke (1997, pencil and computer use) and Becker et al. (2013, in a globalization context) before. Given varying collabourations between agencies and shifting interests over time, surveyed activities (and tool uses) differ across waves and we carefully create longitudinally consistent time series. Third, the BIBB survey asks about job performance requirements and skill requirements. To our knowledge, those are largely unexplored workplace characteristics from the BIBB survey and we build variables based on job performance requirements.

In this paper, we restrict our attention to longitudinally consistent definitions of activity content, which we prepare for all five waves in a time consistent way, and job performance requirements, which we prepare for the first time.

### A.1 Longitudinally consistent Activity definitions

BIBB reports a worker's workplace activity (*Tätigkeit*) on the job in addition to common occupation codes. Table A.1 presents our longitudinally consistent definition of activities. The BIBB

[14] Collaborating agencies include the Institute for Employment Research (*Institut für Arbeitsmarkt- und Berufsforschung*) at the Federal Employment Agency (*Bundesagentur für Arbeit*) in Nuremberg from 1979 through 1999 and the Federal Institute for Occupational Safety and Health (*Bundesanstalt für Arbeitsschutz und Arbeitsmedizin BAuA*) in Dortmund in 2005-06.

Table A.1: LONGITUDINALLY CONSISTENT ACTIVITY DEFINITIONS

| Activity | 1979 | 1985-86 | 1991-92 | 1998-99 | 2005-06 |
|---|---|---|---|---|---|
| 1. Manufacture, Produce Goods | | | | | |
| 2. Repair, Maintain | | | | | |
| 3. Entertain, Accommodate, Prepare Foods | | | | | |
| 4. Transport, Store, Dispatch | | | | | |
| 5. Measure, Inspect, Control Quality | | | entries | | |
| 6. Gather Information, Develop, Research, Construct | | | available | | |
| 7. Purchase, Procure, Sell | | | upon request | | |
| 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 Techn. Processes | | | | | |

*Notes*: Variable names as in BIBB surveys. Entries show values that a variable needs to take so that it is marked as being performed.

survey recognizes 51 distinct activities in the 1979 wave, but only 18 in 1985-86 and 1991-92, and 16 in 1998-99 and 2005-06. Not only the number of activities but also the activity definitions change over time. We define 15 longitudinally consistent activities, as shown in Table A.1. The columns report the variables in the BIBB data that characterize an activity and the values a variable needs to take so that our longitudinal concordance marks an activity as performed by a worker.

In some waves (1979, 1991-92), the worker is asked the binary question whether he or she performs an activity on the job. In other waves (1985-86, 1998-99 and 2005-06), the worker is asked to classify into three categories whether he or she performs a given activity frequently, infrequently or not at all. For longitudinal consistency, we reduce the three-category classification in the latter waves into a time-invariant binary classification as to whether an activity is performed at all or not. Our longitudinally consistent activity definitions ensure that there are no missing activities in any survey wave.

In defining our 15 longitudinally consistent activities, as shown in Table A.1, we made the following adjustments to the mapping for three waves. Without these adjustments, our 15 longitudinally consistent activities would have to be aggregated into 11 categories. To improve on mappings for the three slightly cruder waves of the BIBB survey, we use the following information from earlier waves that permits a strict many-to-one mapping: we apply the observed activity shares in earlier more detailed waves by single-digit KldB-88 occupation (Subsection A.3), gender, and industry (Subsection A.4) to randomly impute by worker the most likely detailed activity for a small set of activities in the waves 1985-86, 1991-92 and 1998-99.

Concretely, in wave 1985-86 a strict mapping of v28 (*apply and interpret laws and regulations, certify*) to 9 only and v29 (*educate, instruct, train, guide vocationally*) to 11 only would result in a completely missing activity 10 for the wave; and a strict mapping of v23 (*buy, sell, intermediate, attend customers, negotiate, promote*) to 7 only would result in missing activity 13. Instead of aggregating activities 9, 10 and 11 into a single activity and activities 7 and 13 into another single activity, we use the 1979 wave that permits a strict many-to-one mapping and apply the share of activity 10 in 9 and 10 for v28 and the share of 10 in 10 and 11 for v29 to map to 10, and the 1979 share of activity 13 in 7 and 13 to map v23 to 13. Similarly, in wave 1991-92, a strict mapping of v59 (*apply and interpret laws and regulations, certify*) to 9 only and v60 (*educate, instruct, train, guide vocationally*) to 11 only would result in a completely missing activity 10 for the wave; and a strict mapping of v54 (*buy, sell, intermediate, attend customers, promote*) to 7 only would result in missing activity 13. Instead of aggregating activities 9, 10 and 11 into a single activity and activities 7 and 13 into another single activity, we use the 1979 wave that permits a strict many-to-one mapping and apply the share of activity 10 in 9 and 10 for v59 and the share of 10 in 10 and 11 for v60 to map to 10, and the 1979 share of activity 13 in 7 and 13 to map v54 to 13. Finally, in wave 1998-99, a strict mapping of v201 (*support, serve, take care of persons*) to 12 only would result in a completely missing activity 3 for the wave. Instead of aggregating activities 3 and 12 into a single activity, we use the 1991-92 wave that offers the most recent strict many-to-one mapping and apply the share of activity 3 in 3 and 12 to map v201 to 3.

We only retain activities that match up in every single wave. As a consequence, some activities that are reported in richer waves cannot be related to any of our 15 longitudinally consistent activities. In the 1979 wave, numerous activities and groups of activities remain unmatched: *Collect*

*and dispose of garbage* (v200), *Construct and improve buildings and equipment, install, assemble* (v149-v153), *Keep stock and inventory accounts* (v178), *Negotiate and represent interests* (v213), *Pack, load, dispatch, deliver* (v160, v162, v164), *Cultivate and harvest plants, breed and farm animals* (v130-v135), *Publish, entertain, perform, create artistically* (v209-211), *Clean, iron and press, dry-clean* (v158-v159), *Mine, quarry, convey and produce primary products* (v136-v137), *Type, handle correspondence and forms* (v188-v192), *Protect, safeguard and regulate (buildings, traffic, work safety)* (v198-v199), *Arrange and sort, file, mark, archive* (v161, v163, v182), *Make, bake, distill, prepare* (v142). In the 1985-86 wave, the following six activities remain unmatched: *Cultivate, breed, farm; mine, quarry, convey* (v15), *Construct, improve, install, assemble* (v17), *Iron and press, dry-clean; collect and dispose of garbage* (v19), *Handle correspondence and forms* (v24), *Safeguard and regulate (buildings, work safety), protect* (v27), *Publish, entertain, perform* (v31). In the 1991-92 wave, the following ten activities remain unmatched: *Cultivate and harvest plants, breed and farm animals* (v43), *Mine, quarry, convey and produce primary products* (v44), *Construct and improve buildings and equipment, install, assemble* (v46), *Clean, iron and press, dry-clean* (v48), *Pack, load, dispatch, deliver* (v50), *Arrange and sort, file, mark, archive* (v51), *Type, handle correspondence and forms* (v55), *Protect, safeguard and regulate (buildings, traffic, work safety)* (v58), *Collect and dispose of garbage* (v49), *Publish, entertain, perform, create artistically* (v62). In the 1998-99 wave, the following single activity remains unmatched: *Conduct negotiations* (v198). In the 2005-06 wave, the following three activities remain unmatched: *Clean, dispose of garbage, recycle* (F319A), *Secure, protect, safeguard, monitor, regulate traffic* (F317), *Work with computers* (F318).

## A.2 Longitudinally consistent Job Performance Requirement definitions

BIBB asks the worker to report the intensity of requirements to perform a job (*Arbeitsanforderungen*). Table A.2 presents our longitudinally consistent definition of these job performance requirements. The columns report the variables in the BIBB data that characterize a performance requirement and the values a variable needs to take so that our longitudinal concordance marks a performance requirement as applicable to a worker at given intensity.

The BIBB survey recognizes 17 such performance requirements in the 1979 wave, 13 in 1985-86, 9 in 1991-92, and 14 each in 1998-99 and 2005-06. Out of those variables, we create nine longitudinally consistent job performance requirement definitions so that, for none of the performance requirements, information is missing for more than one survey year.

In the first four waves from 1979 through 1999, the surveyed worker ranks the frequency with which these performance requirements are applicable on a scale from 1 through 5 (5 “almost never”, 4 “seldom”, 3 “occasionally”, 2 “frequently”, 1 “almost always”). In the final wave 2005-06, the worker is given a scale from 1 through 4 (4 “never”, 3 “seldom”, 2 “occasionally”, 1 “frequently”). We map these intensity measures into a new scale of 1 through 4 (1 “never or almost never”, 2 “seldom”, 3 “occasionally”, 4 “frequently or almost always”), inverting the rank ordering to be increasing with the frequency of the requirement and mapping the two most frequent categories of the four early waves (“frequently” and “almost always”) into a single category (“frequently or almost always”).

Table A.2: LONGITUDINALLY CONSISTENT JOB REQUIREMENT DEFINITIONS BY INTENSITY

| Task and Intensity (1-4) | 1979 | 1985-86 | 1991-92 | 1998-99 | 2005-06 |
|---|---|---|---|---|---|
| A. Deadlines/pressure to perform 1 | | | | | |
| A. Deadlines/pressure to perform 2 | | | | | |
| A. Deadlines/pressure to perform 3 | | | | | |
| A. Deadlines/pressure to perform 4 | | | | | |
| B. Improve/adopt new techniques 1 | | | entries | | |
| B. Improve/adopt new techniques 2 | | | available | | |
| B. Improve/adopt new techniques 3 | | | upon request | | |
| B. Improve/adopt new techniques 4 | | | | | |
| C. New situations/activities 1 | | | | | |
| C. New situations/activities 2 | | | | | |
| C. New situations/activities 3 | | | | | |
| C. New situations/activities 4 | | | | | |

| | |
|---|---|
| D. Repeated work steps 1 | |
| D. Repeated work steps 2 | |
| D. Repeated work steps 3 | |
| D. Repeated work steps 4 | |
| E. Work procedures prescribed in detail 1 | |
| E. Work procedures prescribed in detail 2 | |
| E. Work procedures prescribed in detail 3 | |
| E. Work procedures prescribed in detail 4 | |
| F. Financial losses by small mistakes 1[a] | |
| F. Financial losses by small mistakes 2[a] | entries |
| F. Financial losses by small mistakes 3[a] | available |
| F. Financial losses by small mistakes 4[a] | upon request |
| G. Minimum performance/time/quantity given to execute activity 1[a] | |
| G. Minimum performance/time/quantity given to execute activity 2[a] | |
| G. Minimum performance/time/quantity given to execute activity 3[a] | |
| G. Minimum performance/time/quantity given to execute activity 4[a] | |
| H. Versatility/multiple activities at same time 1[a] | |
| H. Versatility/multiple activities at same time 2[a] | |
| H. Versatility/multiple activities at same time 3[a] | |
| H. Versatility/multiple activities at same time 4[a] | |
| I. Concentration on activity 1[b] | |
| I. Concentration on activity 2[b] | |
| I. Concentration on activity 3[b] | |
| I. Concentration on activity 4[b] | |

[a]Missing in 1992.
[b]Missing in 200F.

*Notes*: Variable names as in BIBB surveys. Intensity ranking: 1 “never or almost never”, 2 “seldom”, 3 “occasionally”, 4 “frequently or almost always”. Entries show values that a variable needs to take so that it is marked as being performed with a given intensity.

Table A.3: LONGITUDINALLY CONSISTENT OCCUPATION DEFINITIONS

| Occupation classification KldB-88 | 1979 | 1985-86 | 1991-92 | 1998-99 | 2005-06 |
|---|---|---|---|---|---|
| *Occupation units*, 3-digit level (369) | | v5 (319) | | | |
| *Occupation classes*, 4-digit level (2,287) | | | v16 (1,329) | v9 (1,117) | F100_BA (983) |
| Individual KldB-88 occupations, 6-digit level | v67 (2,982) | | | | |

*Notes*: Occupation codes according to KldB-88 (*Klassifizierung der Berufe 1988*), maintained by the Federal Employment Agency, Nuremberg. Entries in brackets show the number of unique reported occupations at a given classification level.

## A.3 Longitudinally consistent Occupation definitions

The Federal Employment Agency (*Bundesagentur für Arbeit*) in Nuremberg and its research outfit Institute for Employment Research (*Institut für Arbeitsmarkt- und Berufsforschung*) maintain the detailed Classification of Occupations called KldB-88 (*Klassifizierung der Berufe 1988*) for internal reporting and research. The BIBB data from 1979 through 2006 consistently use the KldB-88 classification in every wave at the 3-digit level so that no longitudinal treatment is needed at that level.

The KldB-88 classification recognizes 6 *occupation areas* (*Berufsbereiche*) at the single-digit level, 33 *occupation sections* (*Berufsabschnitte*) at an intermediate level, 88 *occupation groups* (*Berufsgruppen*) at the 2-digit level, and 369 *occupation units* (*Berufsordnungen*) at the 3-digit level. At the 3-digit occupation-unit level, occupation classifications are available in all BIBB waves from 1979 through 2006. The KldB-88 specifies 2,287 *occupation classes* (*Berufsklassen*) at the 4-digit level, and all but the one wave 1985/86 adopt at least the 4-digit occupation-class level.[15] Table A.3 summarizes the available occupation information in the public-use version of the BIBB data.

For an understanding of occupation frequencies and their evolution, we tabulate the distribution of the six *occupation areas* (*Berufsbereiche*) at the single-digit level in KldB-88. Table A.4 shows that the importance of technical and services professionals grows over time whereas that of other occupation areas (most importantly manufacturing workers) declines over time. This provides evidence of a shift of the occupation distribution towards more white-collar occupations. The high frequency of services occupations throughout all periods also documents an important classification convention under KldB-88.

We reclassify occupation information for every wave to KldB-88 *occupation units* at the 3-digit level. In wave 1979 there are are 19 *occupation units* at the 3-digit level with no matching information in the KldB-88 classification (affecting 195 out of 29,737 observations); in wave 1985/86

[15]There are numerous individual occupations at the 7-digit level recognized by the Federal Employment Agency, but not used in BIBB. The public-use version of the 1979 BIBB wave records 2,982 KldB-88 occupations at the six-digit level.

Table A.4: OCCUPATION AREAS

| | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1 Farmers, Fishermen | .028 | .033 | .027 | .021 | .018 |
| 2 Miners, Quarriers | .004 | .003 | .003 | .002 | .0008 |
| 3 Manufacturing Occupations | .294 | .296 | .295 | .241 | .189 |
| 4 Technical Occupations | .069 | .062 | .075 | .067 | .079 |
| 5 Services Occupations | .564 | .600 | .592 | .659 | .709 |
| 6 Other Workers | .005 | .002 | .007 | .009 | .005 |
| *missing* | *.036* | *.005* | *.00003* | 0 | *.0003* |

*Source*: BIBB 1979-2006.
*Notes*: 144,718 worker observations. *Occupation areas* according to KldB-88 (*Berufsbereiche der Klassifizierung der Berufe 1988*).

there is one *occupation unit* at the 3-digit level with no matching information in KldB-88 (affecting 160 out of 26,361 observations); in wave 1991/92 there are four *occupation units* at the 3-digit level with no matching information in KldB-88 (affecting four out 34,277 observations). Given the small fraction of affected observations, we keep those unmatched occupation units as longitudinally undetermined, special occupations.

Conversions of KldB-88 to other official German occupation classifications are problematic, however. The KldB-88 classification in the BIBB data deviates from the official Federal Statistical Office's Classification of Occupations in 1975 and 1992 (called KldB-75 and KldB-92). To our knowledge, there is no converter from KldB-88 to either KldB-75 or KldB-92 and therefore also no official converter to the International Standard Classification of Occupations ISCO-68 or ISCO-88 (or the intra-European version ISCO-88(COM)). Although the most recent KldB-88 classification by the Federal Employment Agency and the most recent KldB-92 classification by the Federal Statistical Office are both based on a common classification from 1970 (KldB-70 reflecting the occupational stricture of the 1950 and 1960s), cross-walks are ambiguous. Conversions between KldB-88 and KldB-92 are imprecise at any level, as Alfons Geis (GESIS Mannheim) reports. Using the 4,910 dictionary entries that characterize unambiguous occupation terms, 97 percent of occupations coincide between KldB-88 and KldB-92 at the single-digit level and 88 percent at the 2-digit level, but only 65 percent at the 3-digit level and merely 38 percent at the 4-digit level.

An attempted conversion of KldB-88 to the International Standard Classification of Occupations ISCO-88 suffers frequent ambiguities. In the 2005-06 BIBB survey wave, occupations for all 20,000 surveyed workers are coded both under the KldB-88 system at the 4-digit level (*occupation classes*) and under the ISCO-88 system at the four-digit level.[16] This allows us to assess the conversion quality from KldB-88 4-digit level *occupation classes* to ISCO-88 at any level. The ISCO-88 classification recognizes 10 *major groups* at the single-digit level, 28 *sub-major groups* at the 2-digit level, 118 *minor groups* at the 3-digit level, and 390 *unit groups* at the 4-digit level.

[16]They are also coded under KldB-88.

Table A.5: IMPLIED CONCORDANCES FROM KLDB-88 TO ISCO-88 IN 2005-06 WAVE

| Duplicate KldB-88 *occupation classes* (4-digit level) | ISCO-88 *major groups* (4-digit) | *sub-major groups* (3-digit) | *minor groups* (2-digit) | *unit groups* (1-digit) |
|---|---|---|---|---|
| Unique | 783 | 818 | 828 | 850 |
| Single duplicates | 141 | 119 | 122 | 111 |
| 2 duplicates | 41 | 32 | 25 | 19 |
| 3 duplicates | 7 | 5 | 4 | 3 |
| 4 duplicates | 4 | 3 | 3 | |
| 5 duplicates | 2 | 2 | 1 | |
| 6 duplicates | 2 | 3 | | |
| 7 duplicates | 1 | 1 | | |
| 8+ duplicates | 2 | | | |
| *Total* | 983 | 983 | 983 | 983 |

*Notes*: Occupation codes according to KldB-88 (*Klassifizierung der Berufe 1988*), maintained by the Federal Employment Agency, Nuremberg. Attempted mappings from up to 2,287 KldB-88 *occupation classes* (4-digit level) to ISCO-88 at all levels (single-digit *major groups*, 2-digit *sub-major groups*, 3-digit *minor groups* and 4-digit *unit groups*), using occupation records under both systems in the BIBB Survey wave 2005-06 (20,000 individual workers). Of the 2,287 existing KldB-88 *occupation classes*, the 20,000 sample workers fill 983 unique *occupation classes*.

Whereas the official KldB-92 used by the German statistical office is widely considered to permit a fairly precise mapping from the KldB 4-digit level to the ISCO-88 3-digit level, considerable problems arise for the KldB-88 used in the BIBB survey (and at the German Federal Employment Agency more generally). Table A.5 reports the ambiguities. There are 2,287 *occupation classes* at the KldB-88 4-digit level, but the 20,000 workers in the 2005-06 wave fill only 983 of these *occupation classes*. Of these 983 *occupation classes*, the implied mapping from KldB-88 to ISCO-88 *major groups* in the 2005-06 wave touches 310 *occupation classes* more than once so that KldB-88 cannot be uniquely mapped to ISCO-88 *major groups*. While the ambiguities decrease, they do not go away even for an attempted mapping to ISCO-88 *unit groups* at the single-digit level. For an attempting conversion to this crudest ISCO-88 level, only 850 KldB-88 *occupation classes* satisfy a one-to-many mapping, whereas 133 KldB-88 *occupation classes* cannot be assigned unambiguously.

## A.4 Longitudinally consistent Sector definitions

We define a set of longitudinally consistent sectors in BIBB. These sectors are also defined in such a way as to concord trade and other outside data uniquely (in a many-to-one mapping) to a single set of longitudinally consistent sector definitions.

BIBB classifies an employer's sector at different levels of aggregation over time. Table A.6 presents our longitudinally consistent definition of sectors. In the first four waves 1979, 1985-86, 1991-92 and 1998-99, BIBB used a sector classification of its own, loosely related to common Ger-

Table A.6: LONGITUDINALLY CONSISTENT SECTOR DEFINITIONS

| Aggregate Sector | 1979 | 1985-86 | 1991-92 | 1998-99 | 2005-06 |
|---|---|---|---|---|---|
| 1. Agriculture and Livestock Production | | | | | |
| 2. Energy Supply, Water, Gas and Electricity | | | | | |
| 3. Mining | | | | | |
| 4. Manufacture of Chemicals, Rubber and Plastic Products | | | | | |
| 5. Manufacture of Non-metallic Mineral Products | | | | | |
| 6. Iron and Steel Industries, Manufacture of Basic Metal Products | | | | | |
| 7. Manufacture of Fabricated Metal Products | | | | | |
| 8. Manufacture of Machinery and Equipment | | | | | |
| 9. Manufacture and Repair of Road Transport Equipment | | | entries | | |
| 10. Manufacture and Repair of Aircraft and Ships | | | available | | |
| 11. Manufacture of Computing and Office Equipment | | | upon request | | |
| 12. Manufacture of Electrical Equipment and Apparatus | | | | | |
| 13. Manufacture of Mechanical and Optical Equipment, Watches | | | | | |
| 14. Manufacture of Miscellaneous Products[a] | | | | | |
| 15. Manufacture of Wood Products and Furniture | | | | | |
| 16. Manufacture of Paper and Paper Products | | | | | |
| 17. Printing and Reproduction | | | | | |
| 18. Manufacture of Leather and Leather Products, Shoes | | | | | |
| 19. Manufacture of Textiles and Apparel | | | | | |
| 20. Manufacture of Food, Beverages, Tobacco | | | | | |

[a]Including Manufacture of Miscellaneous Metal Products, Music Instruments, Toys, Sports Equipment, Jewellery.

| | |
|---|---|
| 21. Construction | |
| 22. Other Manufacturing, Craft or Trade | |
| 24. Mail and Telecommunications Services | |
| 25. Transportation and Logistics | |
| 26. Banking and Insurance | |
| 27. Hotels, Restaurants | entries |
| 28. Nursing Homes, Hospitals, Health Professionals | available |
| 31. Education | upon request |
| 32. Offices of Self-employed Professionals | |
| 33. Other Private Services | |
| 34. Civil, Economic and Religious Assoc., Political Parties | |
| 35. Public Sector | |
| 36. Wholesale Trade | |
| 38. Retail Trade | |
| 39. Not elsewhere classified, not applicable or missing | |

*Notes*: Sector codes as in BIBB surveys, variables v73 (1979), v8 (1985-86), v20 (1991-92), v134 (1998-99), F513NACE (2005-06).

man or European classification systems. With the last wave in 2005-06, the BIBB survey adopted a sector classification closely resembling NACE 1.1 for the European Communities (*Nomenclature générale des Activités économiques dans les Communautés Européenness* Revision 1.1 which is equivalent to the German *Klassifikation der Wirtschaftszweige* WZ 2003 at the 2-digit level).

The BIBB survey recognizes 100 distinct industries in the 1979 wave, but only 42 in 1985-86, 43 in 1991-92, 51 in 1998-99 and 65 in 2005-06. Not only the number of industries but also the industry classifications change over time. We define 39 longitudinally consistent industries (including one code for not elsewhere classified industries, not applicable classifications or missing information), as shown in Table A.6.

In defining our 39 longitudinally consistent industries for the full 1979-2006 period, as shown in Table A.6, we made adjustments to the mapping for certain services sectors so as to accommodate the 2005-06 wave, which is more aggregate in four specific services sectors. Contrary to the BIBB sector classifications for 1979 through 1999, the NACE 1.1 classification in 2005-06 does not break out *Commercial Agents* as separate from *Wholesale Trade*, does not break out *Railway Transportation* as separate from *Transportation and Logistics*, does not break out *Laundry and Dry Cleaning* as separate from *Other Private Services* and does not break out *Hairdressing and Cosmetician Services* as separate from *Other Private Services*. Since the more detailed BIBB 1979-1999 sectors are services sectors with arguably small traded components across countries, we choose to fold them into the more aggregate NACE 1.1 classification for our 39 longitudinally consistent industries in Table A.6.

There are other time varying industry classifications, however, which require more elabourate treatment. Without these elabourate adjustments, our longitudinally consistent industries would have to be aggregated into 36 categories, three of which would be unreasonably diverse. To avoid unreasonably diverse industry groupings, we use occupational information at the 2-digit and 3-digit KldB-88 level (Subsection A.3) to switch select subgroups of workers in specific waves from three aggregate industries to more finely defined industries.

Concretely, in wave 1985-86 *Hotels, restaurants, cafeterias, and nursing homes* (55) are joined in a single category (nursery homes in 55 are for the elderly or sick; nursery schools go in the education sector). Moreover, both in wave 1985-86 and in wave 1991-92, *Offices of self-employed doctors, lawyers, accountants and other professionals* (57) are joined in a single category. If these choices of aggregation were carried through to all waves in a longitudinally consistent way, a single and highly diverse pseudo-sector "Hotels, Restaurants, Nursing Homes, Hospitals, and Offices of Self-employed Professionals" would have to be formed. Instead, we use occupational information in 1985-86 and 1991-92 to select health professionals with KldB-88 2-digit codes 84, 85 and 86 from sectors *Hotels, restaurants, cafeterias, and nursing homes* (55 in wave 1985-86) and *Offices of self-employed doctors, lawyers, accountants and other professionals* (57 in waves 1985-86 and 1991-92) and map them to our longitudinally consistent aggregate sector 28 (*Nursing Homes, Hospitals, Health Professionals*).

In wave 2005-06, the NACE sector classification results in reassignments of individual economic activities to different industries than in the prior BIBB surveys between 1985 and 1999. Whereas BIBB assigns the *Manufacture of wooden furniture* (23 in waves 1985-86, 1991-92 and 1998-99, 40 in wave 1979) to the general *Manufacture of wood products*, NACE lumps furniture

of any material to a diverse residual sector *Manufacture of furniture; manufacturing n.e.c.*, which also includes the *Manufacture of miscellaneous metal products, music instruments, toys, sports equipment, and jewellery*. To reduce heterogeneity and to make the 2005-06 data more closely comparable to earlier waves, we use occupational information in 2005-06 to select furniture makers with KldB-88 3-digit code 492 (*Upholsterers, mattress makers*) or KldB-88 4-digit codes 5011 or 5013 (*Carpenters* making mobile or built-in furniture) from the diverse residual sector *Manufacture of furniture; manufacturing n.e.c.* (36 in 2005-06) and map them to our longitudinally consistent aggregate sector 15 (*Manufacture of Wood Products and Furniture*). Similarly, whereas BIBB assigns the *Repair of road transport equipment* (16 in waves 1985-86, 1991-92 and 1998-99, 30 in wave 1979) to the *Manufacture and repair of road transport equipment*, NACE assigns the repair of road transport equipment to the retail sector *Sale, maintenance and repair of motor vehicles and motorcycles*, which also includes the *retail sale of automotive fuel*. For comparability to earlier waves, we use occupational information in 2005-06 to select vehicle repair workers with KldB-88 3-digit codes 281 (*Motor vehicle repairers*), 282 (*Agricultural machinery repairers*) or 936 (*Vehicle cleaners, servicers*) from the retail sector *Sale, maintenance and repair of motor vehicles and motorcycles, retail sale of automotive fuel* (50 in 2005-06) and map them to our longitudinally consistent aggregate sector 9 (*Manufacture and Repair of Road Transport Equipment*).

These reassignments for specific occupations help us avert diverse industry groupings. A downside is, however, that occupations outside the core occupations of an industry—administrative staff, security personnel or cleaners in wooden furniture manufacturing say—will not be reassigned to the specific industry in the respective years but remain with the more crudely assigned industry—manufacturing not elsewhere classified in the wooden furniture example.

# B Trade Data

## B.1 WTF Trade Flows

We obtain trade flow data to and from Germany for the years 1979, 1985-86, 1991-92 from the World Trade Flows 1962-2000 database by Feenstra et al. (2005) and for the years 1998-99 and 2005-06 from their recent revision files (2011). When applicable, we aggregate the individual country information from the recent files (for 1998-99 and 2005-06) to the same aggregate country groups as defined by (Feenstra et al. 2005) in the early years (1979, 1985-86 and 1991-92). We transform the US$ data to Euro and deflate them with the German CPI to the base year 1998.

We map the SITC Rev. 2 sector information to a common sector definition across all waves of the BIBB data. Our consistent sector definition across all data sources is based on an aggregation of NACE 1.1 for the European Communities, which is equivalent to the German *Klassifikation der Wirtschaftszweige* WZ 2003 at the 2-digit level (see Section A.4). To create a concordance from SITC Rev. 2 to the 39 longitudinally consistent industries, as shown in Table A.6, we rely on existing mappings from SITC Rev. 2 to ISIC Rev. 3.1 and from ISIC Rev. 3.1 to WZ 2003. The WTF data contain aggregates that partly differ from the strict SITC sector definitions using higher-level aggregates. Whenever WTF aggregates would happen to enter more than one of our longitudinally consistent industries we use the mode of SITC 4-digit line items behind the aggregate to create a unique many-to-one mapping. Our final concordance *sitc2aggsec06-completed* is available upon request.

In the German system of statistical agencies, the German central bank *Deutsche Bundesbank* (BuBa) collects information on services trade as part of its legal mandate to compute the quarterly balance of payments. The statistical office at BuBa responsible for *Dienstleistungsverkehr* kindly prepared its historic records for us so that a possibly large group of individual source and destination countries as well as services subsectors can be identified. The services trade statistics span the years 1979 to 1987, 1988 to 1992, 1993 to 1997, 1998 to 2002 and 2003 to 2007 under varying statistical conventions that were made time consistent at Deutsche Bundesbank. Our services trade data for imports and exports allow us to discern the following eleven countries and regions: the fifteen EU members in 2003, Other Europe, China (mainland), India, Japan, Other Asia, North America, Central/South America, Oceania/Antarctica, Middle East/North Africa, and Subsaharan Africa. Our time consistent data preparation provides information at the level of the following 19 services subsectors: Travel, Transportation, Merchanting, Insurance services (cif), Financial services (cif), Patents and licenses, Research and development, Engineering and other technical services, Computer services, Construction and assembly work or repairs by German enterprises abroad, Construction and assembly work or repairs by foreign enterprises in Germany, Overhead expenses, Business services, Advertising and trade fair expenses, Communications services, Film industry, Services of self-employed individuals, Government services, Miscellaneous services (n.e.c.). Combining the services flow with information from the input-output tables for imports allows to break services imports into intermediate input uses and final uses, similar to merchandize trade. 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.

When it comes to merchandize trade, which we observe at the individual country level, Germany's top-ten import-source and export-destination countries are extremely stable over time and highly similar between each other. On Germany's import side, nine out of ten of Germany's top ten source countries are the same in every single sample year between 1979 and 2006: The Netherlands, France, Belgium-Luxembourg, the United States, Italy, the United Kingdom, Austria, Switzerland and Japan (in their order of importance in 2006). The one new top-ten importer country for Germany in 2006 is China, replacing Spain from 1999. The top-ten import source countries account for 65.0 percent of Germany's total imports in 1979 and for 60.2 percent in 2006 (the top source country, the Netherlands, alone accounts for 9.4 percent of Germany's imports in 2006). On Germany's export side, eight out of ten of Germany's top ten destinations are the same in every single sample year between 1979 and 2006: France, the United States, the United Kingdom, Italy, Belgium-Luxembourg, the Netherlands, Austria and Switzerland (in their order of importance in 2006). Among the few rotating countries are China (the tenth-most important export destination in 2006), Japan, Poland, Spain (sine 1999) and Sweden (until 1986). The top-ten export destinations account for 66.4 percent of Germany's total exports in 1979 and for 61.5 percent in 2006 (top destination France alone accounts for 9.5 percent of Germany's exports in 2006).

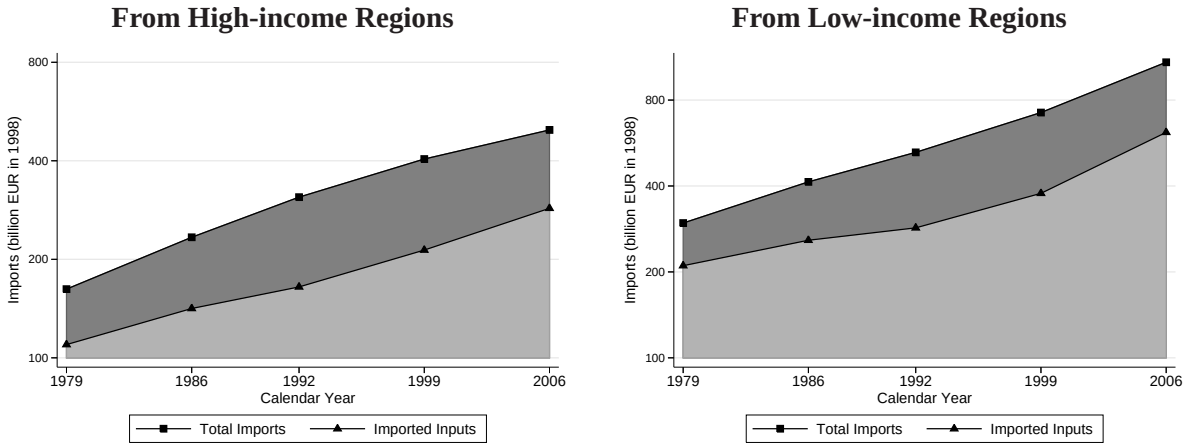
## B.2 Imported Intermediate Inputs

To infer the use of imported intermediate inputs by German sector, we collect the import matrices from input-output tables in 1978 (there is no input-output table for 1979), 1986, 1992, 1999 and 2006 by the German Statistical Office *destatis*. We deflate all import values with the German CPI to the base year 1998.

The import matrices in 1992, 1999 and 2006 (*Tabelle 1.2 Importmatrix zu cif-Preisen* from 2010) are reported in Euro and based on the German *Klassifikation der Wirtschaftszweige* WZ 2003 at the 2-digit level values, which we map to our 39 longitudinally consistent industries (Appendix A.4). The import matrices in 1978 and 1986 (*Tabelle 1.3 Einfuhr von Waren und Dienstleistungen zu Ab-Zoll Preisen* from 2009) are based on sector definitions related to NACE 1.1 and Deutsche Mark values, which we map to our 39 longitudinally consistent industries (Appendix A.4) and Euro. The mapping is incomplete only for our longitudinally consistent sector *33 Other Private Services*, which for 1978 and 1986 includes a fraction of *32 Offices of Self-employed Professionals*. We use the fraction of 32 in the sum of 32 and 33 for the years 1992, 1999 and 2006 to impute the likely total of *32 Offices of Self-employed Professionals* and reduce *33 Other Private Services* accordingly in the the early years 1978 and 1986.

Figure B.1 shows a mechanical break-down by country group for the earlier evidence on imports in the right-hand chart of Figure 1, which split German imports into intermediate inputs and final goods. 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 merchandize 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 super-

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




*Source*: WTF 1979-1993 and recent revisions 1994-2006 (Feenstra et al. 2005, update 2011) for merchandize 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.

impose the observed share of intermediate input imports in total imports across all source countries. As a comparison between the left-hand side and right-hand side charts of Figure B.1 documents, the relative proportion of total imports between high-income and low-income countries remains stable throughout the sample period.

Table C.1: OCCUPATION CONCORDANCE ISCO-68 AND ISCO-88

| | Occupation | ISCO-68 | ISCO-88 |
|---|---|---|---|
| 1. | Legislators, senior officials and managers | 2 | 1 |
| 2. | Professionals, technicians and assoc. professionals | 0/1 | 2, 3, 2¬3 |
| 3. | Clerical workers | 3 | 4 |
| 4. | Service workers and sales workers | 4, 5, 4¬5 | 5, 5,0, |
| 5. | Agricultural and fishery workers | 6 | 6 |
| 6. | Craft workers, production workers, laborers | 7/8/9 | 7, 8, 9, 7¬8, 7¬9, 8,9 |

*Note*: Individual and combined ISCO occupation codes as in ILO Labour Statistics Database.

# C ILO Labour Statistics

We obtain the shares of occupations by country from the Labour Statistics Database by the International Labour Organization, Geneva, Table 2C (*Total employment by occupation*) for 1975-2007 (extracted on 25/02/2009). At present, we retain only the information on the total of men and women. Between 1975 and 2007, some countries report occupations according to ISCO-68 (major group), others according to ISCO-88 (major group). We map the reported major groups into a single concordance with six occupation groups of our own as documented in Table C.1.

We remove the five countries that report incompatible occupational categories based on national classification systems (Brunei Darussalam, Guam, Jamaica, Macau China, Niue); these are minor trade partners of Germany. Some countries report more aggregate occupation groups than the ISCO major groups, but many aggregates coincide with our mapping in Table C.1. There are some cases, however, where countries report information in incompatible ways. In particular, managers are not separable from professionals in several reports: Barbados (2001), Dominican Republic (1991-96), Syrian Arab Republic (2001) and Jamaica (1998-2006). We drop those countries. Cuba (1995-2007) and the United Kingdom (1991-2007) report skilled agricultural workers not separate from unskilled labourers (and craft and production workers). For the United Kingdom is a large trade partner of Germany, we use information on employment by industry (from the Labour Statistics Database by the International Labour Organization, Geneva, Table 2E (*Total employment by industry*) for 1975-2007; extracted on 25/02/2009) to infer Cuba's and the UK's employment share of agriculture by year and split the aggregate occupation group into its likely major-group components. For Cuba, which reports agricultural workers and craft and production workers jointly, the share of agricultural jobs in the aggregate occupation group is broken out as the share of agriculture and fishing vis-a-vis mining, manufacturing, and construction in a given year. For the United Kingdom in contrast, which reports agricultural workers and unskilled labourers jointly, employment by industry is not available for the years 1991-1995 and 2006-07 so that we choose instead to assign the joint group to agriculture work under the assumption that British labourers are mostly employed in agriculture and that they perform relatively skilled tasks.

The Labour Statistics Database draws on various member-country sources for occupational information. If a country reports information from more than one source in a given year, we retain only information from a single source and disregard lower-ranking sources according to the

following hierarchy (first being most relevant for precise occupational records): 1. labour-related establishment census; 2. labour-related establishment survey; 3. labour force survey; 4. population census; 5. household survey; 6. insurance records; 7. official estimates. Similarly, some countries report occupations under both ISCO-88 and ISCO-68 in a given year. In those cases, we retain ISCO-88 information.

# D Supporting Tables

The following supporting tables report the point estimates and their standard errors. We present the point estimates in Figure 2 (Tables D.1 and D.2), Figure 3 (Tables D.3 and D.4), Figure 4 (Tables D.5 and D.6), Figure 5 (Tables D.7 and D.8), Figure 6 (Tables D.9, D.10, D.11 and D.12), Figure 8 (Tables D.13 and D.14, as well as Tables D.15 and D.16), Figure 9 (Tables D.17 and D.18, as well as Tables D.19 and D.20) and Figure 11 (Tables D.21 through D.24).

Table D.1: ACTIVITY CONTENT OF GERMAN WORK

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .86 | 1.25 | 1.23 | 1.24 | 1.19 |
| | (.02) | (.05) | (.05) | (.03) | (.05) |
| 3 Entertain/Accommodate | .69 | .97 | 1.03 | 1.37 | 1.08 |
| | (.04) | (.08) | (.06) | (.11) | (.10) |
| 4 Transport/Store | .84 | 1.14 | 1.18 | 1.30 | 1.25 |
| | (.05) | (.08) | (.05) | (.05) | (.06) |
| 5 Measure/Inspect | .91 | 1.02 | 1.04 | 1.32 | 1.34 |
| | (.05) | (.09) | (.07) | (.05) | (.06) |
| 6 Analyze/Research | .99 | 1.21 | 1.27 | 1.39 | 1.46 |
| | (.08) | (.09) | (.08) | (.11) | (.09) |
| 7 Purchase/Sell | .90 | 1.23 | 1.21 | 1.32 | 1.26 |
| | (.09) | (.11) | (.10) | (.08) | (.08) |
| 8 Program Computer | .62 | .97 | 1.19 | .77 | .89 |
| | (.04) | (.08) | (.09) | (.04) | (.05) |
| 9 Practice Law | .74 | .93 | .91 | 1.12 | 1.42 |
| | (.10) | (.10) | (.08) | (.10) | (.11) |
| 10 Consult/Inform | .71 | 1.18 | 1.17 | 1.56 | 1.50 |
| | (.08) | (.14) | (.12) | (.10) | (.09) |
| 11 Train/Educate | .85 | 1.13 | 1.09 | 1.29 | 1.33 |
| | (.10) | (.12) | (.11) | (.10) | (.10) |
| 12 Nurse/Cure | 1.00 | 1.23 | 1.41 | 1.23 | 1.11 |
| | (.10) | (.13) | (.15) | (.11) | (.10) |
| 13 Advertise/Promote | .70 | .95 | .94 | 1.24 | 1.30 |
| | (.05) | (.07) | (.07) | (.10) | (.10) |
| 14 Organize/Plan | .88 | 1.24 | 1.39 | 1.45 | 1.37 |
| | (.06) | (.10) | (.11) | (.09) | (.08) |
| 15 Oversee/Control | .77 | 1.20 | 1.24 | 1.16 | 1.16 |
| | (.02) | (.04) | (.05) | (.04) | (.04) |
| Observations | | | 168,466 | | |
| $R^2$ (overall) | | | .05 | | |
| Employment in omitted activity | 2.77 | 1.75 | 1.69 | 2.26 | 2.04 |

*Source*: BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 168,466 activity-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, and 5 survey waves; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.2: ACTIVITY CONTENT OF GERMAN WORK WITHIN SECTOR AND OCCUPATION

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .80 | 1.20 | 1.19 | 1.19 | 1.16 |
| | (.03) | (.06) | (.06) | (.02) | (.04) |
| 3 Entertain/Accommodate | .56 | .80 | .83 | 1.15 | .93 |
| | (.06) | (.11) | (.08) | (.07) | (.07) |
| 4 Transport/Store | .73 | 1.04 | 1.04 | 1.22 | 1.21 |
| | (.03) | (.05) | (.04) | (.04) | (.05) |
| 5 Measure/Inspect | .83 | .93 | .97 | 1.31 | 1.35 |
| | (.02) | (.04) | (.04) | (.04) | (.06) |
| 6 Analyze/Research | .90 | 1.12 | 1.20 | 1.34 | 1.46 |
| | (.04) | (.05) | (.06) | (.08) | (.09) |
| 7 Purchase/Sell | .79 | 1.08 | 1.08 | 1.23 | 1.20 |
| | (.06) | (.07) | (.06) | (.07) | (.06) |
| 8 Program Computer | .48 | .81 | 1.08 | .70 | .80 |
| | (.03) | (.05) | (.06) | (.03) | (.03) |
| 9 Practice Law | .53 | .73 | .75 | .96 | 1.37 |
| | (.06) | (.06) | (.05) | (.06) | (.10) |
| 10 Consult/Inform | .53 | .94 | .97 | 1.54 | 1.51 |
| | (.04) | (.08) | (.08) | (.08) | (.09) |
| 11 Train/Educate | .64 | .91 | .91 | 1.21 | 1.28 |
| | (.06) | (.08) | (.08) | (.07) | (.08) |
| 12 Nurse/Cure | .66 | .90 | 1.03 | 1.11 | .98 |
| | (.07) | (.11) | (.13) | (.08) | (.08) |
| 13 Advertise/Promote | .53 | .71 | .71 | 1.10 | 1.21 |
| | (.03) | (.05) | (.05) | (.08) | (.08) |
| 14 Organize/Plan | .77 | 1.12 | 1.30 | 1.41 | 1.35 |
| | (.02) | (.05) | (.07) | (.07) | (.07) |
| 15 Oversee/Control | .72 | 1.17 | 1.24 | 1.14 | 1.14 |
| | (.03) | (.05) | (.07) | (.03) | (.04) |
| Observations | | | 168,466 | | |
| $R^2$ (overall) | | | .24 | | |
| Employment in omitted activity | 2.77 | 1.75 | 1.69 | 2.26 | 2.04 |

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

*Notes*: 168,466 activity-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.3: PERFORMANCE REQUIREMENTS OF GERMAN WORK

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.17 | 1.17 | 1.20 | 1.28 | 1.20 |
| | (.01) | (.01) | (.01) | (.01) | (.01) |
| B Improve/adopt new techniques | .98 | 1.00 | 1.06 | 1.05 | 1.15 |
| | (.02) | (.01) | (.01) | (.02) | (.01) |
| C New situations/activities | 1.23 | 1.11 | 1.16 | 1.12 | 1.18 |
| | (.02) | (.01) | (.01) | (.02) | (.009) |
| D Repeated work steps | 1.16 | 1.13 | 1.13 | 1.12 | 1.13 |
| | (.009) | (.007) | (.006) | (.008) | (.008) |
| F Financial loss by small mistake | 1.05 | .96 | | .99 | .93 |
| | (.01) | (.008) | | (.01) | (.01) |
| G Versatility/multiple activities | 1.02 | .89 | | .94 | 1.02 |
| | (.01) | (.01) | | (.009) | (.008) |
| H Concentration on activity | 1.19 | 1.13 | | 1.11 | 1.20 |
| | (.02) | (.01) | | (.02) | (.01) |
| I Minimum performance to execute | 1.18 | 1.15 | 1.22 | 1.05 | |
| | (.01) | (.01) | (.01) | (.01) | |
| Observations | | | 180,022 | | |
| $R^2$ (overall) | | | .04 | | |
| Employment in omitted requirement | 3.11 | 3.23 | 3.50 | 3.70 | 3.01 |

*Source*: BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 180,022 requirement-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, and 5 survey waves; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.4: PERFORMANCE REQUIREMENTS OF GERMAN WORK WITHIN SECTOR AND OCCUPATION

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.21 | 1.21 | 1.27 | 1.37 | 1.27 |
| | (.02) | (.02) | (.02) | (.03) | (.02) |
| B Improve/adopt new techniques | .99 | 1.02 | 1.09 | 1.09 | 1.20 |
| | (.02) | (.02) | (.03) | (.04) | (.02) |
| C New situations/activities | 1.28 | 1.14 | 1.22 | 1.17 | 1.24 |
| | (.03) | (.02) | (.03) | (.03) | (.02) |
| D Repeated work steps | 1.19 | 1.15 | 1.17 | 1.16 | 1.16 |
| | (.02) | (.02) | (.01) | (.02) | (.009) |
| F Financial loss by small mistake | 1.08 | .97 | | 1.01 | .93 |
| | (.02) | (.02) | | (.02) | (.02) |
| G Versatility/multiple activities | 1.03 | .89 | | .94 | 1.04 |
| | (.01) | (.02) | | (.01) | (.02) |
| H Concentration on activity | 1.24 | 1.16 | | 1.16 | 1.26 |
| | (.02) | (.02) | | (.03) | (.02) |
| I Minimum performance to execute | 1.24 | 1.20 | 1.29 | 1.08 | |
| | (.02) | (.02) | (.03) | (.02) | |
| Observations | | | 180,022 | | |
| $R^2$ (overall) | | | .28 | | |
| Employment in omitted requirement | 3.11 | 3.23 | 3.50 | 3.70 | 3.01 |

*Source*: BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 180,022 requirement-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.5: ACTIVITY CONTENT EMBEDDED IN GERMAN IMPORTS

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .96 | .95 | .83 | .96 | .76 |
| | (.03) | (.03) | (.03) | (.03) | (.02) |
| 3 Entertain/Accommodate | .34 | .40 | .24 | .26 | .23 |
| | (.02) | (.02) | (.01) | (.01) | (.007) |
| 4 Transport/Store | .81 | .80 | .65 | .80 | .64 |
| | (.03) | (.04) | (.02) | (.04) | (.02) |
| 5 Measure/Inspect | .56 | .57 | .48 | .63 | .63 |
| | (.02) | (.009) | (.01) | (.009) | (.008) |
| 6 Analyze/Research | .51 | .51 | .48 | .60 | .40 |
| | (.01) | (.007) | (.007) | (.003) | (.006) |
| 7 Purchase/Sell | .49 | .51 | .44 | .50 | .41 |
| | (.01) | (.01) | (.02) | (.01) | (.008) |
| 8 Program Computer | .32 | .34 | .34 | .45 | .67 |
| | (.009) | (.008) | (.01) | (.008) | (.01) |
| 9 Practice Law | .24 | .23 | .18 | .37 | .31 |
| | (.008) | (.007) | (.005) | (.006) | (.006) |
| 10 Consult/Inform | .29 | .29 | .22 | .37 | .42 |
| | (.01) | (.007) | (.006) | (.009) | (.007) |
| 11 Train/Educate | .25 | .26 | .24 | .31 | .40 |
| | (.008) | (.006) | (.007) | (.006) | (.006) |
| 12 Nurse/Cure | .08 | .08 | .16 | .12 | .35 |
| | (.003) | (.002) | (.01) | (.007) | (.007) |
| 13 Advertise/Promote | .32 | .32 | .25 | .25 | .30 |
| | (.009) | (.007) | (.005) | (.009) | (.004) |
| 14 Organize/Plan | .53 | .53 | .44 | .55 | .43 |
| | (.01) | (.007) | (.007) | (.007) | (.006) |
| 15 Oversee/Control | .74 | .73 | .98 | 1.17 | .83 |
| | (.02) | (.02) | (.02) | (.01) | (.01) |
| Observations | | | 12,398 | | |
| $R^2$ (overall) | | | .88 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 12,398 activity-year-source country observations. Controlling for fixed effects of 5 survey waves and 191 source countries; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Import value of embedded activities imputed using 7-year lags of German activity intensity shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and country level): * significance at ten, ** five, *** one percent.

Table D.6: PERFORMANCE REQUIREMENTS EMBEDDED IN GERMAN IMPORTS

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.18 | 1.19 | 1.03 | .87 | .85 |
| | (.03) | (.02) | (.03) | (.01) | (.01) |
| B Improve/adopt new techniques | .98 | .99 | .90 | .86 | .85 |
| | (.03) | (.01) | (.03) | (.008) | (.01) |
| C New situations/activities | 1.12 | 1.11 | 1.03 | 1.01 | .97 |
| | (.03) | (.01) | (.03) | (.008) | (.01) |
| D Repeated work steps | | | | | |
| F Financial loss by small mistake | 1.13 | 1.14 | | 1.00 | 1.06 |
| | (.03) | (.01) | | (1.49e-09) | (.01) |
| G Versatility/multiple activities | 1.09 | 1.09 | | 1.00 | 1.14 |
| | (.03) | (.01) | | (5.89e-09) | (.01) |
| H Concentration on activity | 1.04 | 1.05 | | 1.00 | .87 |
| | (.03) | (.01) | | (1.10e-09) | (.01) |
| I Minimum performance to execute | 1.04 | 1.05 | .94 | .88 | |
| | (.03) | (.01) | (.03) | (.007) | |
| Observations | | | 6,918 | | |
| $R^2$ (overall) | | | .89 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 6,918 performance requirement-year-source country observations. Controlling for fixed effects of 5 survey waves and 191 source countries; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Import value of embedded performance requirements imputed using 7-year lags of German performance requirements shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Clustered standard errors in parentheses (two-way clustered at performance-requirement and country level): * significance at ten, ** five, *** one percent.

Table D.7: ACTIVITY CONTENT EMBEDDED IN GERMAN EXPORTS

| Log Imputed Export Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .83 | 1.05 | 1.20 | .78 | .70 |
| | (.01) | (.01) | (.02) | (.007) | (.006) |
| 3 Entertain/Accommodate | .20 | .18 | .22 | .33 | .28 |
| | (.002) | (.002) | (.002) | (.003) | (.002) |
| 4 Transport/Store | .49 | .56 | .71 | .62 | .55 |
| | (.006) | (.005) | (.008) | (.004) | (.004) |
| 5 Measure/Inspect | .66 | .88 | .94 | .70 | .64 |
| | (.01) | (.009) | (.01) | (.005) | (.005) |
| 6 Analyze/Research | .52 | .60 | .78 | .49 | .57 |
| | (.007) | (.004) | (.007) | (.003) | (.004) |
| 7 Purchase/Sell | .38 | .40 | .46 | .44 | .47 |
| | (.005) | (.004) | (.003) | (.003) | (.003) |
| 8 Program Computer | .55 | .74 | .82 | 1.11 | .89 |
| | (.009) | (.009) | (.01) | (.01) | (.008) |
| 9 Practice Law | .19 | .27 | .41 | .37 | .42 |
| | (.002) | (.001) | (.003) | (.002) | (.003) |
| 10 Consult/Inform | .29 | .31 | .44 | .47 | .52 |
| | (.004) | (.003) | (.005) | (.003) | (.004) |
| 11 Train/Educate | .23 | .29 | .34 | .49 | .54 |
| | (.002) | (.002) | (.002) | (.003) | (.004) |
| 12 Nurse/Cure | .06 | .07 | .08 | .32 | .25 |
| | (.0007) | (.0008) | (.0009) | (.003) | (.002) |
| 13 Advertise/Promote | .41 | .43 | .49 | .37 | .38 |
| | (.005) | (.003) | (.004) | (.003) | (.002) |
| 14 Organize/Plan | .57 | .57 | .67 | .49 | .54 |
| | (.008) | (.004) | (.006) | (.003) | (.004) |
| 15 Oversee/Control | .91 | 1.12 | 1.37 | .87 | .77 |
| | (.02) | (.008) | (.01) | (.007) | (.005) |
| Observations | | | 12,629 | | |
| $R^2$ (overall) | | | .93 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 12,629 activity-year-destination country observations. Controlling for fixed effects of 5 survey waves and 192 destination countries; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Export value of embedded activities imputed using current German activity intensity shares by sector. Coefficients reported as exponential functions of coefficients from single log export value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and country level): * significance at ten, ** five, *** one percent.

Table D.8: PERFORMANCE REQUIREMENTS EMBEDDED IN GERMAN EXPORTS

| Log Imputed Export Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | .95 | .89 | .95 | .97 | .99 |
| | (.02) | (.004) | (.006) | (.007) | (.006) |
| B Improve/adopt new techniques | .85 | .88 | .95 | .97 | .99 |
| | (.01) | (.004) | (.006) | (.007) | (.006) |
| C New situations/activities | .91 | .88 | .93 | .93 | .93 |
| | (.02) | (.005) | (.005) | (.006) | (.006) |
| D Repeated work steps | | | | | |
| F Financial loss by small mistake | 1.03 | 1.08 | | 1.18 | 1.29 |
| | (.02) | (.005) | | (.009) | (.009) |
| G Versatility/multiple activities | 1.07 | 1.17 | | 1.15 | 1.05 |
| | (.02) | (.006) | | (.008) | (.008) |
| H Concentration on activity | .88 | .85 | | .94 | .94 |
| | (.02) | (.004) | | (.007) | (.007) |
| I Minimum performance to execute | .92 | .91 | .94 | 1.07 | |
| | (.02) | (.005) | (.006) | (.008) | |
| Observations | | | 6,882 | | |
| $R^2$ (overall) | | | .93 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 6,882 performance requirement-year-destination country observations. Controlling for fixed effects of 5 survey waves and 192 destination countries; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Export value of embedded performance requirements imputed using current German performance requirements shares by sector. Coefficients reported as exponential functions of coefficients from single log export value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Clustered standard errors in parentheses (two-way clustered at performance-requirement and country level): * significance at ten, ** five, *** one percent.

Table D.9: EFFECTS OF TRADE ON ACTIVITY CONTENT AT GERMAN WORK

| | Imported Inputs | Product Imports | Product Exports |
|---|---|---|---|
| | (1) | (2) | (3) |
| 1 Produce | 1.00 | .91 | 1.10 |
| | (.009) | (.05) | (.06) |
| 2 Repair/Maintain | 1.01 | .87 | 1.14 |
| | (.01) | (.04) | (.05) |
| 3 Entertain/Accommodate | 1.02 | 1.15 | .85 |
| | (.01) | (.10) | (.07) |
| 4 Transport/Store | 1.02 | .90 | 1.08 |
| | (.01) | (.03) | (.04) |
| 5 Measure/Inspect | 1.02 | .81 | 1.20 |
| | (.01) | (.03) | (.04) |
| 6 Analyze/Research | 1.04 | .80 | 1.21 |
| | (.009) | (.05) | (.07) |
| 7 Purchase/Sell | 1.04 | .95 | 1.00 |
| | (.02) | (.05) | (.05) |
| 8 Program Computer | 1.02 | .81 | 1.22 |
| | (.004) | (.04) | (.06) |
| 9 Practice Law | 1.03 | .73 | 1.33 |
| | (.02) | (.06) | (.12) |
| 10 Consult/Inform | 1.02 | .74 | 1.32 |
| | (.01) | (.06) | (.11) |
| 11 Train/Educate | 1.01 | .81 | 1.19 |
| | (.02) | (.05) | (.07) |
| 12 Nurse/Cure | 1.04 | .94 | 1.01 |
| | (.02) | (.05) | (.05) |
| 13 Advertise/Promote | 1.02 | .88 | 1.10 |
| | (.01) | (.06) | (.08) |
| 14 Organize/Plan | 1.03 | .80 | 1.20 |
| | (.01) | (.05) | (.07) |
| 15 Oversee/Control | 1.01 | .88 | 1.13 |
| | (.01) | (.03) | (.04) |
| Observations | | 164,851 | |
| $R^2$ (overall) | | .12 | |

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

*Notes*: 168,466 activity-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, and 5 survey waves; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.10: EFFECTS OF TRADE ON ACTIVITY CONTENT AT GERMAN WORK WITHIN SECTOR AND OCCUPATION

| | Imported Inputs | Product Imports | Product Exports |
|---|---|---|---|
| | (1) | (2) | (3) |
| 1 Produce | .99 | 1.01 | .98 |
| | (.01) | (.13) | (.14) |
| 2 Repair/Maintain | 1.00 | .98 | 1.00 |
| | (.01) | (.12) | (.12) |
| 3 Entertain/Accommodate | 1.02 | 1.31 | .72 |
| | (.01) | (.13) | (.07) |
| 4 Transport/Store | 1.02 | 1.01 | .94 |
| | (.01) | (.11) | (.09) |
| 5 Measure/Inspect | 1.02 | .91 | 1.04 |
| | (.01) | (.08) | (.09) |
| 6 Analyze/Research | 1.03 | .88 | 1.06 |
| | (.01) | (.08) | (.07) |
| 7 Purchase/Sell | 1.04 | 1.07 | .87 |
| | (.02) | (.10) | (.08) |
| 8 Program Computer | 1.01 | .91 | 1.05 |
| | (.01) | (.07) | (.07) |
| 9 Practice Law | 1.02 | .82 | 1.15 |
| | (.01) | (.09) | (.10) |
| 10 Consult/Inform | 1.02 | .82 | 1.15 |
| | (.01) | (.08) | (.09) |
| 11 Train/Educate | 1.01 | .91 | 1.03 |
| | (.01) | (.08) | (.07) |
| 12 Nurse/Cure | 1.03 | 1.06 | .87 |
| | (.02) | (.09) | (.07) |
| 13 Advertise/Promote | 1.02 | .98 | .95 |
| | (.02) | (.09) | (.08) |
| 14 Organize/Plan | 1.03 | .90 | 1.05 |
| | (.01) | (.08) | (.07) |
| 15 Oversee/Control | 1.01 | .99 | .98 |
| | (.01) | (.12) | (.11) |
| Observations | | 164,851 | |
| $R^2$ (overall) | | .27 | |

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

*Notes*: 168,466 activity-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.11: EFFECTS OF TRADE ON PERFORMANCE REQUIREMENTS AT GERMAN WORK

| | Imported Inputs | Product Imports | Product Exports |
|---|---|---|---|
| | (1) | (2) | (3) |
| A Deadlines/pressure to perform | 1.03 | .79 | 1.23 |
| | (.007) | (.03) | (.05) |
| B Improve/adopt new techniques | 1.03 | .81 | 1.20 |
| | (.007) | (.04) | (.05) |
| C New situations/activities | 1.03 | .78 | 1.25 |
| | (.007) | (.03) | (.05) |
| D Repeated worksteps | 1.03 | .83 | 1.16 |
| | (.008) | (.04) | (.05) |
| E Work procedures prescribed | 1.03 | .81 | 1.20 |
| | (.008) | (.03) | (.04) |
| F Financial loss by small mistake | 1.03 | .82 | 1.19 |
| | (.01) | (.03) | (.05) |
| G Versatility/multiple activities | 1.02 | .84 | 1.17 |
| | (.008) | (.02) | (.03) |
| H Concentration on activity | 1.03 | .81 | 1.20 |
| | (.008) | (.04) | (.06) |
| I Minimum performance to execute | 1.03 | .80 | 1.22 |
| | (.007) | (.03) | (.05) |
| Observations | | 176,040 | |
| $R^2$ (overall) | | .10 | |

*Source*: WTF 1979-1993 and recent revisions 1994-2006 for merchandize trade, Deutsche Bundesbank for services trade 1979-2006; BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 180,022 requirement-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, and 5 survey waves; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.12: EFFECTS OF TRADE ON PERFORMANCE REQUIREMENTS AT GERMAN WORK WITHIN SECTOR AND OCCUPATION

| | Imported Inputs | Product Imports | Product Exports |
|---|---|---|---|
| | (1) | (2) | (3) |
| A Deadlines/pressure to perform | 1.02 | .94 | 1.06 |
| | (.006) | (.07) | (.07) |
| B Improve/adopt new techniques | 1.02 | .96 | 1.03 |
| | (.007) | (.08) | (.08) |
| C New situations/activities | 1.02 | .93 | 1.07 |
| | (.006) | (.07) | (.07) |
| D Repeated worksteps | 1.02 | .99 | 1.00 |
| | (.006) | (.08) | (.07) |
| E Work procedures prescribed | 1.02 | .98 | 1.02 |
| | (.006) | (.07) | (.07) |
| F Financial loss by small mistake | 1.01 | .97 | 1.03 |
| | (.01) | (.08) | (.08) |
| G Versatility/multiple activities | 1.01 | 1.00 | 1.00 |
| | (.006) | (.08) | (.08) |
| H Concentration on activity | 1.02 | .95 | 1.04 |
| | (.007) | (.08) | (.07) |
| I Minimum performance to execute | 1.01 | .95 | 1.05 |
| | (.006) | (.07) | (.07) |
| Observations | | 176,040 | |
| $R^2$ (overall) | | .29 | |

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

*Notes*: 180,022 requirement-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method). Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.13: ACTIVITY CONTENT OF GERMAN WORK WITHIN SECTOR AND OCCUPATION: HIGH UNIONIZATION

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .76 | 1.23 | 1.23 | 1.12 | 1.11 |
| | (.03) | (.08) | (.08) | (.02) | (.04) |
| 3 Entertain/Accommodate | .41 | .57 | .62 | .95 | .74 |
| | (.06) | (.08) | (.09) | (.07) | (.03) |
| 4 Transport/Store | .67 | .97 | 1.00 | 1.10 | 1.13 |
| | (.05) | (.05) | (.07) | (.03) | (.05) |
| 5 Measure/Inspect | .75 | .90 | .95 | 1.18 | 1.26 |
| | (.03) | (.06) | (.06) | (.05) | (.06) |
| 6 Analyze/Research | .80 | 1.00 | 1.12 | 1.11 | 1.37 |
| | (.05) | (.05) | (.07) | (.09) | (.09) |
| 7 Purchase/Sell | .58 | .87 | .90 | .92 | 1.02 |
| | (.03) | (.05) | (.06) | (.04) | (.02) |
| 8 Program Computer | .45 | .83 | 1.06 | .69 | .84 |
| | (.04) | (.06) | (.08) | (.03) | (.03) |
| 9 Practice Law | .61 | .82 | .81 | .83 | 1.22 |
| | (.09) | (.08) | (.07) | (.11) | (.10) |
| 10 Consult/Inform | .54 | .97 | .99 | 1.26 | 1.38 |
| | (.05) | (.14) | (.12) | (.09) | (.09) |
| 11 Train/Educate | .51 | .72 | .74 | 1.01 | 1.19 |
| | (.03) | (.04) | (.02) | (.08) | (.08) |
| 12 Nurse/Cure | .46 | .59 | .59 | .88 | .80 |
| | (.04) | (.07) | (.07) | (.07) | (.04) |
| 13 Advertise/Promote | .45 | .60 | .63 | .85 | 1.02 |
| | (.03) | (.05) | (.06) | (.06) | (.07) |
| 14 Organize/Plan | .68 | 1.00 | 1.20 | 1.16 | 1.24 |
| | (.03) | (.06) | (.09) | (.08) | (.07) |
| 15 Oversee/Control | .68 | 1.19 | 1.34 | 1.11 | 1.11 |
| | (.03) | (.05) | (.08) | (.02) | (.03) |
| Observations | | | 76,676 | | |
| $R^2$ (overall) | | | .26 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; GSOEP select years with unionization.
*Notes*: 76,676 activity-year-gender-age-sector-occupation observations with high unionization. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.14: ACTIVITY CONTENT OF GERMAN WORK WITHIN SECTOR AND OCCUPATION: LOW UNIONIZATION

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .84 | 1.15 | 1.13 | 1.25 | 1.23 |
| | (.05) | (.11) | (.10) | (.05) | (.08) |
| 3 Entertain/Accommodate | .76 | .94 | .96 | 1.32 | 1.06 |
| | (.13) | (.15) | (.10) | (.12) | (.10) |
| 4 Transport/Store | .84 | 1.15 | 1.09 | 1.31 | 1.33 |
| | (.06) | (.11) | (.10) | (.09) | (.10) |
| 5 Measure/Inspect | .97 | .95 | .99 | 1.45 | 1.50 |
| | (.06) | (.07) | (.07) | (.11) | (.12) |
| 6 Analyze/Research | 1.11 | 1.30 | 1.35 | 1.59 | 1.64 |
| | (.08) | (.09) | (.10) | (.17) | (.17) |
| 7 Purchase/Sell | 1.14 | 1.33 | 1.32 | 1.49 | 1.40 |
| | (.15) | (.13) | (.12) | (.11) | (.10) |
| 8 Program Computer | .56 | .81 | 1.13 | .73 | .75 |
| | (.03) | (.05) | (.08) | (.04) | (.05) |
| 9 Practice Law | .51 | .62 | .69 | 1.05 | 1.58 |
| | (.03) | (.04) | (.04) | (.08) | (.18) |
| 10 Consult/Inform | .56 | .95 | .97 | 1.86 | 1.72 |
| | (.02) | (.07) | (.08) | (.18) | (.17) |
| 11 Train/Educate | .83 | 1.07 | 1.09 | 1.43 | 1.40 |
| | (.14) | (.13) | (.15) | (.14) | (.14) |
| 12 Nurse/Cure | .91 | 1.05 | 1.25 | 1.30 | 1.10 |
| | (.13) | (.13) | (.17) | (.17) | (.14) |
| 13 Advertise/Promote | .68 | .82 | .80 | 1.25 | 1.41 |
| | (.04) | (.04) | (.06) | (.12) | (.13) |
| 14 Organize/Plan | .94 | 1.30 | 1.47 | 1.67 | 1.52 |
| | (.05) | (.08) | (.11) | (.16) | (.14) |
| 15 Oversee/Control | .76 | 1.13 | 1.13 | 1.19 | 1.19 |
| | (.05) | (.09) | (.09) | (.08) | (.07) |
| Observations | | | 84,480 | | |
| $R^2$ (overall) | | | .28 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; GSOEP select years with unionization.
*Notes*: 84,480 activity-year-gender-age-sector-occupation observations with low unionization. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.15: PERFORMANCE REQUIREMENTS OF GERMAN WORK WITHIN SECTOR AND OCCUPATION: HIGH UNIONIZATION

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.19 | 1.13 | 1.25 | 1.31 | 1.24 |
| | (.03) | (.02) | (.04) | (.04) | (.03) |
| B Improve/adopt new techniques | .91 | .93 | 1.03 | 1.01 | 1.16 |
| | (.03) | (.02) | (.04) | (.04) | (.03) |
| C New situations/activities | 1.21 | 1.08 | 1.20 | 1.11 | 1.23 |
| | (.04) | (.02) | (.04) | (.04) | (.03) |
| D Repeated work steps | 1.15 | 1.07 | 1.12 | 1.11 | 1.13 |
| | (.01) | (.01) | (.02) | (.01) | (.02) |
| F Financial loss by small mistake | 1.05 | .95 | | 1.01 | .96 |
| | (.01) | (.02) | | (.03) | (.03) |
| G Versatility/multiple activities | 1.02 | .88 | | .94 | 1.02 |
| | (.02) | (.03) | | (.02) | (.02) |
| H Concentration on activity | 1.16 | 1.07 | | 1.10 | 1.22 |
| | (.03) | (.02) | | (.03) | (.03) |
| I Minimum performance to execute | 1.21 | 1.13 | 1.25 | 1.05 | |
| | (.02) | (.02) | (.04) | (.03) | |
| Observations | | | 89,092 | | |
| $R^2$ (overall) | | | .32 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; GSOEP select years with unionization.
*Notes*: 89,092 requirement-year-gender-age-sector-occupation observations with high unionization. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.16: PERFORMANCE REQUIREMENTS OF GERMAN WORK WITHIN SECTOR AND OCCUPATION: LOW UNIONIZATION

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.30 | 1.35 | 1.32 | 1.42 | 1.33 |
| | (.03) | (.04) | (.04) | (.05) | (.06) |
| B Improve/adopt new techniques | 1.12 | 1.11 | 1.17 | 1.09 | 1.26 |
| | (.04) | (.04) | (.05) | (.05) | (.06) |
| C New situations/activities | 1.42 | 1.24 | 1.27 | 1.18 | 1.29 |
| | (.06) | (.06) | (.05) | (.05) | (.06) |
| D Repeated work steps | 1.30 | 1.26 | 1.23 | 1.18 | 1.20 |
| | (.04) | (.03) | (.02) | (.02) | (.03) |
| F Financial loss by small mistake | 1.13 | .99 | | .96 | .89 |
| | (.04) | (.03) | | (.03) | (.03) |
| G Versatility/multiple activities | 1.07 | .89 | | .91 | 1.06 |
| | (.02) | (.02) | | (.02) | (.03) |
| H Concentration on activity | 1.39 | 1.30 | | 1.19 | 1.33 |
| | (.05) | (.05) | | (.04) | (.06) |
| I Minimum performance to execute | 1.33 | 1.32 | 1.35 | 1.07 | |
| | (.05) | (.04) | (.05) | (.03) | |
| Observations | | | 83,667 | | |
| $R^2$ (overall) | | | .33 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; GSOEP select years with unionization.
*Notes*: 83,667 requirement-year-gender-age-sector-occupation observations with low unionization. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.17: ACTIVITY CONTENT OF GERMAN WORK WITHIN SECTOR AND OCCUPATION: HIGH LABOR MARKET TIGHTNESS

| | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .75 | 1.19 | 1.17 | 1.09 | 1.06 |
| | (.02) | (.12) | (.10) | (.03) | (.03) |
| 3 Entertain/Accommodate | .50 | .64 | .69 | .95 | .79 |
| | (.04) | (.05) | (.05) | (.07) | (.05) |
| 4 Transport/Store | .68 | .99 | 1.00 | 1.08 | 1.06 |
| | (.05) | (.07) | (.08) | (.05) | (.02) |
| 5 Measure/Inspect | .73 | .77 | .84 | 1.14 | 1.16 |
| | (.03) | (.05) | (.06) | (.04) | (.03) |
| 6 Analyze/Research | .80 | 1.01 | 1.11 | 1.04 | 1.21 |
| | (.04) | (.08) | (.10) | (.07) | (.05) |
| 7 Purchase/Sell | .69 | .96 | 1.00 | 1.01 | 1.03 |
| | (.06) | (.08) | (.05) | (.07) | (.03) |
| 8 Program Computer | .53 | .81 | 1.01 | .70 | .78 |
| | (.04) | (.06) | (.08) | (.04) | (.03) |
| 9 Practice Law | .46 | .67 | .72 | .74 | 1.08 |
| | (.03) | (.06) | (.04) | (.03) | (.04) |
| 10 Consult/Inform | .45 | .76 | .80 | 1.21 | 1.24 |
| | (.03) | (.05) | (.04) | (.07) | (.05) |
| 11 Train/Educate | .47 | .66 | .72 | .96 | 1.04 |
| | (.03) | (.04) | (.02) | (.04) | (.04) |
| 12 Nurse/Cure | .52 | .71 | .70 | .80 | .76 |
| | (.05) | (.05) | (.05) | (.04) | (.04) |
| 13 Advertise/Promote | .52 | .67 | .68 | .86 | .95 |
| | (.04) | (.03) | (.02) | (.07) | (.04) |
| 14 Organize/Plan | .69 | .93 | 1.10 | 1.12 | 1.11 |
| | (.03) | (.06) | (.09) | (.08) | (.03) |
| 15 Oversee/Control | .66 | 1.12 | 1.23 | 1.05 | 1.05 |
| | (.02) | (.08) | (.08) | (.03) | (.03) |
| Observations | | | 68,941 | | |
| $R^2$ (overall) | | | .24 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; IAB select years with labor market tightness.
*Notes*: 68,941 activity-year-gender-age-sector-occupation observations with high unionization. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 34 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.18: ACTIVITY CONTENT OF GERMAN WORK WITHIN SECTOR AND OCCUPATION: LOW LABOR MARKET TIGHTNESS

| | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .86 | 1.24 | 1.23 | 1.28 | 1.26 |
| | (.04) | (.09) | (.11) | (.04) | (.08) |
| 3 Entertain/Accommodate | .69 | .95 | .96 | 1.30 | 1.04 |
| | (.12) | (.18) | (.12) | (.10) | (.11) |
| 4 Transport/Store | .81 | 1.14 | 1.12 | 1.37 | 1.36 |
| | (.05) | (.11) | (.09) | (.06) | (.11) |
| 5 Measure/Inspect | 1.02 | 1.11 | 1.12 | 1.50 | 1.54 |
| | (.05) | (.08) | (.08) | (.08) | (.12) |
| 6 Analyze/Research | 1.15 | 1.31 | 1.36 | 1.67 | 1.71 |
| | (.11) | (.10) | (.11) | (.15) | (.17) |
| 7 Purchase/Sell | .98 | 1.31 | 1.23 | 1.46 | 1.36 |
| | (.14) | (.14) | (.13) | (.10) | (.12) |
| 8 Program Computer | .51 | .90 | 1.22 | .70 | .81 |
| | (.03) | (.06) | (.10) | (.04) | (.05) |
| 9 Practice Law | .65 | .82 | .80 | 1.12 | 1.63 |
| | (.10) | (.09) | (.08) | (.10) | (.19) |
| 10 Consult/Inform | .64 | 1.15 | 1.17 | 1.92 | 1.77 |
| | (.07) | (.15) | (.13) | (.16) | (.18) |
| 11 Train/Educate | .82 | 1.14 | 1.08 | 1.43 | 1.49 |
| | (.11) | (.14) | (.14) | (.13) | (.15) |
| 12 Nurse/Cure | .79 | 1.03 | 1.13 | 1.38 | 1.09 |
| | (.10) | (.15) | (.18) | (.13) | (.13) |
| 13 Advertise/Promote | .58 | .78 | .75 | 1.33 | 1.42 |
| | (.04) | (.07) | (.08) | (.11) | (.14) |
| 14 Organize/Plan | .94 | 1.40 | 1.58 | 1.74 | 1.57 |
| | (.05) | (.10) | (.14) | (.13) | (.14) |
| 15 Oversee/Control | .81 | 1.23 | 1.26 | 1.22 | 1.22 |
| | (.05) | (.08) | (.11) | (.06) | (.07) |
| Observations | | | 95,910 | | |
| $R^2$ (overall) | | | .31 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; IAB select years with labor market tightness.
*Notes*: 95,910 activity-year-gender-age-sector-occupation observations with high unionization. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 34 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table D.19: PERFORMANCE REQUIREMENTS OF GERMAN WORK WITHIN SECTOR AND OCCUPATION: HIGH LABOR MARKET TIGHTNESS

| | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.22 | 1.17 | 1.24 | 1.32 | 1.23 |
| | (.03) | (.03) | (.04) | (.04) | (.03) |
| B Improve/adopt new techniques | .98 | .97 | 1.06 | 1.02 | 1.15 |
| | (.04) | (.03) | (.05) | (.03) | (.03) |
| C New situations/activities | 1.24 | 1.08 | 1.18 | 1.11 | 1.21 |
| | (.04) | (.03) | (.05) | (.04) | (.03) |
| D Repeated worksteps | 1.18 | 1.12 | 1.16 | 1.14 | 1.15 |
| | (.02) | (.03) | (.02) | (.01) | (.01) |
| F Financial loss by small mistake | 1.07 | .98 | | 1.02 | .97 |
| | (.02) | (.02) | | (.03) | (.02) |
| G Versatility/multiple activities | 1.03 | .93 | | .98 | 1.03 |
| | (.01) | (.01) | | (.009) | (.01) |
| H Concentration on activity | 1.19 | 1.08 | | 1.09 | 1.22 |
| | (.04) | (.03) | | (.03) | (.02) |
| I Minimum performance to execute | 1.21 | 1.14 | 1.24 | 1.04 | |
| | (.02) | (.02) | (.04) | (.03) | |
| Observations | | | 80,051 | | |
| $R^2$ (overall) | | | .31 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; IAB select years with labor market tightness.
*Notes*: 80,051 requirement-year-gender-age-sector-occupation observations with high labor market tightness. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 34 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.20: PERFORMANCE REQUIREMENTS OF GERMAN WORK WITHIN SECTOR AND OCCUPATION:

| | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.24 | 1.27 | 1.34 | 1.47 | 1.34 |
| | (.03) | (.04) | (.03) | (.06) | (.05) |
| B Improve/adopt new techniques | 1.02 | 1.07 | 1.14 | 1.15 | 1.26 |
| | (.04) | (.04) | (.04) | (.07) | (.05) |
| C New situations/activities | 1.38 | 1.21 | 1.29 | 1.24 | 1.30 |
| | (.06) | (.05) | (.04) | (.06) | (.05) |
| D Repeated worksteps | 1.23 | 1.19 | 1.20 | 1.20 | 1.20 |
| | (.04) | (.03) | (.02) | (.03) | (.02) |
| F Financial loss by small mistake | 1.09 | .96 | | 1.00 | .89 |
| | (.03) | (.03) | | (.05) | (.04) |
| G Versatility/multiple activities | 1.03 | .84 | | .90 | 1.05 |
| | (.02) | (.03) | | (.03) | (.03) |
| H Concentration on activity | 1.33 | 1.25 | | 1.24 | 1.33 |
| | (.05) | (.04) | | (.05) | (.05) |
| I Minimum performance to execute | 1.32 | 1.28 | 1.37 | 1.10 | |
| | (.04) | (.04) | (.04) | (.04) | |
| Observations | | | 95,989 | | |
| $R^2$ (overall) | | | .38 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65; IAB select years with labor market tightness.
*Notes*: 95,989 requirement-year-gender-age-sector-occupation observations with low unionization. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 34 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table D.21: ACTIVITY CONTENT EMBEDDED IN GERMAN IMPORTS FROM HIGH RIGIDITY COUNTRIES

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | 1.08 | 1.20 | 1.20 | 1.30 | .89 |
| | (.07) | (.09) | (.17) | (.16) | (.05) |
| 3 Entertain/Accommodate | .42 | .54 | .35 | .36 | .18 |
| | (.08) | (.08) | (.05) | (.05) | (.02) |
| 4 Transport/Store | .98 | 1.07 | .92 | 1.25 | .78 |
| | (.09) | (.12) | (.11) | (.19) | (.04) |
| 5 Measure/Inspect | .57 | .57 | .54 | .71 | .67 |
| | (.02) | (.02) | (.06) | (.07) | (.03) |
| 6 Analyze/Research | .52 | .53 | .61 | .71 | .41 |
| | (.02) | (.02) | (.07) | (.06) | (.02) |
| 7 Purchase/Sell | .54 | .56 | .62 | .65 | .42 |
| | (.05) | (.06) | (.08) | (.06) | (.02) |
| 8 Program Computer | .29 | .27 | .35 | .49 | .62 |
| | (.02) | (.02) | (.05) | (.04) | (.05) |
| 9 Practice Law | .27 | .28 | .20 | .44 | .34 |
| | (.02) | (.02) | (.03) | (.04) | (.02) |
| 10 Consult/Inform | .32 | .32 | .29 | .49 | .45 |
| | (.02) | (.02) | (.04) | (.06) | (.02) |
| 11 Train/Educate | .27 | .28 | .32 | .39 | .41 |
| | (.01) | (.02) | (.04) | (.04) | (.02) |
| 12 Nurse/Cure | .08 | .09 | .27 | .21 | .41 |
| | (.007) | (.009) | (.05) | (.04) | (.02) |
| 13 Advertise/Promote | .31 | .27 | .25 | .22 | .30 |
| | (.02) | (.02) | (.02) | (.02) | (.02) |
| 14 Organize/Plan | .53 | .53 | .55 | .67 | .46 |
| | (.02) | (.02) | (.07) | (.06) | (.02) |
| 15 Oversee/Control | .69 | .65 | 1.28 | 1.43 | .90 |
| | (.05) | (.04) | (.15) | (.13) | (.05) |
| Observations | | | 2,653 | | |
| $R^2$ (overall) | | | .91 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65; World Bank Doing Business 2004.

*Notes*: 2,653 activity-year-source country observations with more rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 37 source countries with more rigid labor markets than Germany; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Import value of embedded activities imputed using 7-year lags of German activity intensity shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and country level): * significance at ten, ** five, *** one percent.

Table D.22: ACTIVITY CONTENT EMBEDDED IN GERMAN IMPORTS FROM LOW RIGIDITY COUNTRIES

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .94 | .92 | .75 | .89 | .74 |
| | (.04) | (.03) | (.03) | (.04) | (.02) |
| 3 Entertain/Accommodate | .33 | .38 | .20 | .23 | .25 |
| | (.02) | (.02) | (.01) | (.01) | (.01) |
| 4 Transport/Store | .77 | .75 | .56 | .69 | .61 |
| | (.04) | (.04) | (.02) | (.04) | (.02) |
| 5 Measure/Inspect | .54 | .56 | .46 | .61 | .63 |
| | (.02) | (.01) | (.02) | (.02) | (.008) |
| 6 Analyze/Research | .49 | .51 | .44 | .57 | .40 |
| | (.02) | (.01) | (.01) | (.006) | (.008) |
| 7 Purchase/Sell | .48 | .50 | .38 | .46 | .41 |
| | (.02) | (.02) | (.02) | (.01) | (.01) |
| 8 Program Computer | .31 | .36 | .35 | .45 | .70 |
| | (.01) | (.01) | (.02) | (.01) | (.02) |
| 9 Practice Law | .22 | .23 | .17 | .33 | .32 |
| | (.009) | (.01) | (.008) | (.009) | (.007) |
| 10 Consult/Inform | .27 | .28 | .21 | .34 | .42 |
| | (.01) | (.009) | (.009) | (.01) | (.007) |
| 11 Train/Educate | .24 | .25 | .21 | .28 | .40 |
| | (.009) | (.009) | (.009) | (.008) | (.006) |
| 12 Nurse/Cure | .08 | .08 | .13 | .11 | .34 |
| | (.003) | (.004) | (.01) | (.009) | (.009) |
| 13 Advertise/Promote | .31 | .34 | .24 | .26 | .31 |
| | (.01) | (.009) | (.006) | (.01) | (.007) |
| 14 Organize/Plan | .51 | .52 | .40 | .51 | .43 |
| | (.02) | (.01) | (.01) | (.009) | (.007) |
| 15 Oversee/Control | .71 | .73 | .89 | 1.10 | .81 |
| | (.03) | (.03) | (.02) | (.01) | (.01) |
| Observations | | | 6,657 | | |
| $R^2$ (overall) | | | .90 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65; World Bank Doing Business 2004.

*Notes*: 6,657 activity-year-source country observations with less rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 101 source countries with less rigid labor markets than Germany; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Import value of embedded activities imputed using 7-year lags of German activity intensity shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and country level): * significance at ten, ** five, *** one percent.

Table D.23: PERFORMANCE REQUIREMENTS EMBEDDED IN GERMAN IMPORTS FROM HIGH RIGIDITY COUNTRIES

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.33 | 1.42 | 1.14 | .88 | .83 |
| | (.07) | (.07) | (.07) | (.03) | (.03) |
| B Improve/adopt new techniques | 1.07 | 1.13 | .95 | .87 | .85 |
| | (.05) | (.04) | (.04) | (.02) | (.02) |
| C New situations/activities | 1.19 | 1.24 | 1.07 | 1.05 | .98 |
| | (.05) | (.03) | (.05) | (.02) | (.02) |
| D Repeated work steps | | | | | |
| F Financial loss by small mistake | 1.21 | 1.26 | | 1.00 | 1.05 |
| | (.05) | (.04) | | (3.60e-09) | (.02) |
| G Versatility/multiple activities | 1.11 | 1.12 | | 1.00 | 1.15 |
| | (.04) | (.03) | | (2.39e-09) | (.02) |
| H Concentration on activity | 1.15 | 1.21 | | 1.00 | .87 |
| | (.06) | (.05) | | (1.76e-09) | (.01) |
| I Minimum performance to execute | 1.11 | 1.16 | .97 | .88 | |
| | (.05) | (.03) | (.04) | (.02) | |
| Observations | | | 1,485 | | |
| $R^2$ (overall) | | | .92 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65; World Bank Doing Business 2004.

*Notes*: 1,485 performance requirement-year-source country observations with more rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 37 source countries with more rigid labor markets than Germany; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Import value of embedded performance requirements imputed using 7-year lags of German performance requirements shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Clustered standard errors in parentheses (two-way clustered at performance-requirement and country level): * significance at ten, ** five, *** one percent.

Table D.24: PERFORMANCE REQUIREMENTS EMBEDDED IN GERMAN IMPORTS FROM LOW RIGIDITY COUNTRIES

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.18 | 1.16 | .98 | .87 | .86 |
| | (.04) | (.02) | (.03) | (.02) | (.01) |
| B Improve/adopt new techniques | .98 | .97 | .88 | .86 | .86 |
| | (.03) | (.02) | (.03) | (.01) | (.01) |
| C New situations/activities | 1.11 | 1.09 | 1.00 | .98 | .96 |
| | (.04) | (.02) | (.03) | (.01) | (.01) |
| D Repeated work steps | | | | | |
| F Financial loss by small mistake | 1.13 | 1.12 | | 1.00 | 1.07 |
| | (.04) | (.02) | | (4.21e-09) | (.02) |
| G Versatility/multiple activities | 1.09 | 1.08 | | 1.00 | 1.13 |
| | (.04) | (.01) | | (3.41e-09) | (.02) |
| H Concentration on activity | 1.04 | 1.02 | | 1.00 | .87 |
| | (.04) | (.02) | | (2.40e-09) | (.01) |
| I Minimum performance to execute | 1.04 | 1.03 | .93 | .87 | |
| | (.03) | (.01) | (.02) | (.01) | |
| Observations | | | 3,705 | | |
| $R^2$ (overall) | | | .91 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65; World Bank Doing Business 2004.

*Notes*: 3,705 performance requirement-year-source country observations with less rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 101 source countries with less rigid labor markets than Germany; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Import value of embedded performance requirements imputed using 7-year lags of German performance requirements shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Clustered standard errors in parentheses (two-way clustered at performance-requirement and country level): * significance at ten, ** five, *** one percent.

Table D.25: ACTIVITY CONTENT EMBEDDED IN GERMAN IMPORTS FROM COUNTRIES WITH HIGH EMPLOYMENT PROTECTION

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .85 | .89 | .82 | .98 | .78 |
| | (.04) | (.04) | (.04) | (.04) | (.02) |
| 3 Entertain/Accommodate | .37 | .35 | .22 | .24 | .26 |
| | (.03) | (.03) | (.02) | (.02) | (.01) |
| 4 Transport/Store | .70 | .71 | .59 | .79 | .65 |
| | (.05) | (.06) | (.03) | (.06) | (.02) |
| 5 Measure/Inspect | .52 | .54 | .49 | .66 | .65 |
| | (.01) | (.01) | (.02) | (.02) | (.007) |
| 6 Analyze/Research | .47 | .49 | .46 | .61 | .43 |
| | (.01) | (.01) | (.02) | (.009) | (.008) |
| 7 Purchase/Sell | .49 | .48 | .42 | .50 | .44 |
| | (.02) | (.03) | (.03) | (.02) | (.01) |
| 8 Program Computer | .33 | .35 | .35 | .49 | .75 |
| | (.02) | (.02) | (.02) | (.01) | (.03) |
| 9 Practice Law | .20 | .20 | .16 | .37 | .34 |
| | (.01) | (.01) | (.008) | (.01) | (.008) |
| 10 Consult/Inform | .25 | .26 | .21 | .37 | .44 |
| | (.008) | (.009) | (.009) | (.01) | (.007) |
| 11 Train/Educate | .23 | .23 | .23 | .31 | .42 |
| | (.01) | (.01) | (.01) | (.01) | (.008) |
| 12 Nurse/Cure | .07 | .07 | .14 | .12 | .36 |
| | (.004) | (.004) | (.02) | (.01) | (.01) |
| 13 Advertise/Promote | .33 | .33 | .25 | .27 | .34 |
| | (.01) | (.01) | (.005) | (.01) | (.009) |
| 14 Organize/Plan | .48 | .50 | .41 | .55 | .46 |
| | (.009) | (.008) | (.01) | (.01) | (.007) |
| 15 Oversee/Control | .68 | .70 | .93 | 1.16 | .83 |
| | (.03) | (.03) | (.03) | (.02) | (.01) |
| Observations | | | 4,200 | | |
| $R^2$ (overall) | | | .95 | | |

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

*Notes*: 4,200 activity-year-source country observations with more rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 37 source countries with more rigid labor markets than Germany; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Import value of embedded activities imputed using 7-year lags of German activity intensity shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and country level): * significance at ten, ** five, *** one percent.

Table D.26: ACTIVITY CONTENT EMBEDDED IN GERMAN IMPORTS FROM COUNTRIES WITH LOW EMPLOYMENT PROTECTION

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .92 | .93 | .74 | .84 | .80 |
| | (.07) | (.06) | (.04) | (.09) | (.04) |
| 3 Entertain/Accommodate | .34 | .41 | .20 | .23 | .26 |
| | (.04) | (.04) | (.01) | (.02) | (.02) |
| 4 Transport/Store | .76 | .78 | .57 | .68 | .68 |
| | (.07) | (.07) | (.02) | (.08) | (.05) |
| 5 Measure/Inspect | .55 | .57 | .45 | .59 | .65 |
| | (.03) | (.03) | (.03) | (.04) | (.02) |
| 6 Analyze/Research | .49 | .51 | .42 | .54 | .41 |
| | (.03) | (.02) | (.01) | (.01) | (.02) |
| 7 Purchase/Sell | .49 | .52 | .37 | .46 | .41 |
| | (.03) | (.03) | (.02) | (.02) | (.02) |
| 8 Program Computer | .33 | .36 | .33 | .42 | .63 |
| | (.02) | (.03) | (.03) | (.03) | (.04) |
| 9 Practice Law | .23 | .24 | .17 | .33 | .32 |
| | (.02) | (.02) | (.01) | (.01) | (.02) |
| 10 Consult/Inform | .29 | .30 | .20 | .33 | .43 |
| | (.02) | (.02) | (.01) | (.02) | (.02) |
| 11 Train/Educate | .24 | .26 | .21 | .28 | .40 |
| | (.02) | (.02) | (.01) | (.01) | (.02) |
| 12 Nurse/Cure | .08 | .09 | .13 | .11 | .36 |
| | (.004) | (.008) | (.01) | (.01) | (.02) |
| 13 Advertise/Promote | .34 | .36 | .24 | .24 | .30 |
| | (.02) | (.02) | (.01) | (.03) | (.02) |
| 14 Organize/Plan | .53 | .54 | .39 | .49 | .44 |
| | (.03) | (.02) | (.01) | (.02) | (.02) |
| 15 Oversee/Control | .74 | .74 | .89 | 1.07 | .85 |
| | (.05) | (.05) | (.03) | (.03) | (.03) |
| Observations | | | 2,085 | | |
| $R^2$ (overall) | | | .91 | | |

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

*Notes*: 2,085 activity-year-source country observations with less rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 101 source countries with less rigid labor markets than Germany; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Import value of embedded activities imputed using 7-year lags of German activity intensity shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and country level): * significance at ten, ** five, *** one percent.

Table D.27: PERFORMANCE REQUIREMENTS EMBEDDED IN GERMAN IMPORTS FROM COUNTRIES WITH HIGH EMPLOYMENT PROTECTION

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.15 | 1.14 | 1.02 | .90 | .88 |
| | (.05) | (.04) | (.05) | (.01) | (.02) |
| B Improve/adopt new techniques | .94 | .94 | .90 | .88 | .89 |
| | (.04) | (.03) | (.04) | (.01) | (.01) |
| C New situations/activities | 1.09 | 1.08 | 1.00 | .99 | .96 |
| | (.04) | (.02) | (.05) | (.01) | (.01) |
| D Repeated worksteps | | | | | |
| F Financial loss by small mistake | 1.10 | 1.10 | | 1.00 | 1.08 |
| | (.04) | (.03) | | (1.39e-09) | (.01) |
| G Versatility/multiple activities | 1.08 | 1.08 | | 1.00 | 1.12 |
| | (.02) | (.02) | | (1.73e-09) | (.008) |
| H Concentration on activity | 1.00 | 1.00 | | 1.00 | .89 |
| | (.04) | (.03) | | (5.72e-10) | (.01) |
| I Minimum performance to execute | 1.02 | 1.02 | .93 | .89 | |
| | (.03) | (.02) | (.04) | (.007) | |
| Observations | | | 2,325 | | |
| $R^2$ (overall) | | | .96 | | |

*Sources*: WTF 1979-1993 and recent revisions 1994-2006; BIBB 1979-2006, workers ages 16 through 65; IMF-fRDB labor-market regulations 1980-2005.
*Notes*: 2,325 performance requirement-year-source country observations with more rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 37 source countries with more rigid labor markets than Germany; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Import value of embedded performance requirements imputed using 7-year lags of German performance requirements shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Clustered standard errors in parentheses (two-way clustered at performance-requirement and country level): * significance at ten, ** five, *** one percent.

Table D.28: PERFORMANCE REQUIREMENTS EMBEDDED IN GERMAN IMPORTS FROM COUNTRIES WITH LOW EMPLOYMENT PROTECTION

| Log Imputed Import Value | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.14 | 1.15 | .97 | .86 | .83 |
| | (.04) | (.05) | (.04) | (.02) | (.03) |
| B Improve/adopt new techniques | .95 | .96 | .87 | .85 | .84 |
| | (.03) | (.03) | (.03) | (.02) | (.02) |
| C New situations/activities | 1.09 | 1.10 | 1.00 | 1.00 | .98 |
| | (.02) | (.02) | (.02) | (.02) | (.02) |
| D Repeated worksteps | | | | | |
| F Financial loss by small mistake | 1.10 | 1.10 | | 1.00 | 1.05 |
| | (.02) | (.02) | | (2.93e-09) | (.02) |
| G Versatility/multiple activities | 1.08 | 1.08 | | 1.00 | 1.13 |
| | (.03) | (.03) | | (1.36e-09) | (.02) |
| H Concentration on activity | 1.01 | 1.02 | | 1.00 | .87 |
| | (.02) | (.02) | | (2.87e-09) | (.02) |
| I Minimum performance to execute | 1.02 | 1.02 | .92 | .87 | |
| | (.02) | (.02) | (.01) | (.02) | |
| Observations | | | 1,182 | | |
| $R^2$ (overall) | | | .92 | | |

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

*Notes*: 1,182 performance requirement-year-source country observations with less rigid labor markets than Germany. Controlling for fixed effects of 5 survey waves and 101 source countries with less rigid labor markets than Germany; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Import value of embedded performance requirements imputed using 7-year lags of German performance requirements shares by sector. Coefficients reported as exponential functions of coefficients from single log import value OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006, requirement D dropped to avert multi-collinearity. Clustered standard errors in parentheses (two-way clustered at performance-requirement and country level): * significance at ten, ** five, *** one percent.

# E Robustness

## E.1 Controlling for computer use, education and migration status

To analyze the robustness of our descriptive task frequency computations in Figures 2 and Figure 3 (Table D.2 and D.4 for the respective right-hand panels), We follow the literature and add measures capturing computerization, education and migration status to our regressions.

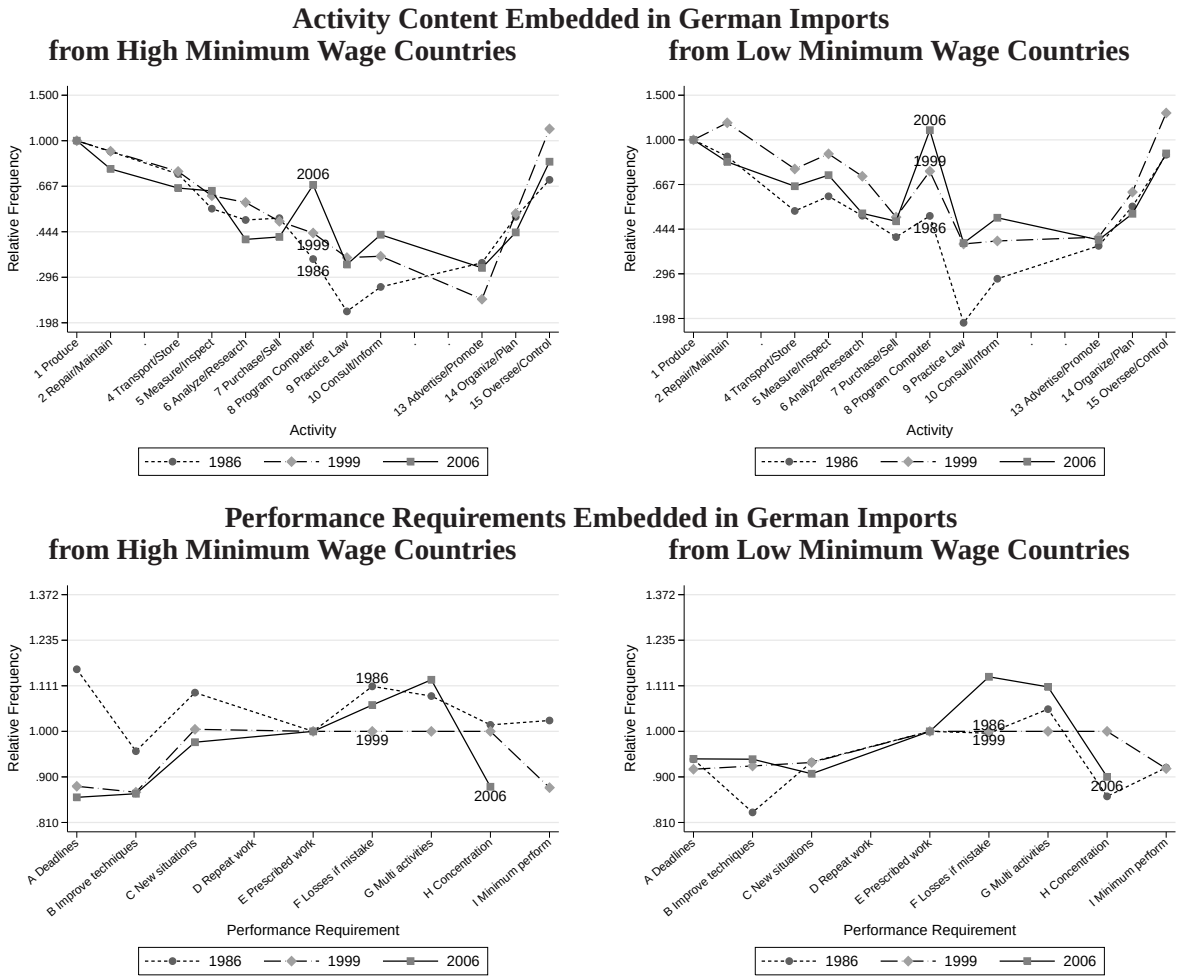
we condition on additional information at the individual worker level: computer use, education, and migration status. For computer use, we consistently extract from all BIBB survey waves an indicator variable that relates to a worker's use of a computer, workstation, or CAD equipment at the workplace. 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 measured or sampled across years). 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.

To probe the robustness of our findings to technical change, Tables E.1 and E.2 report the results when we include computer use in the specification. As a comparison to Tables D.2 and D.4 shows, coefficient estimates are hardly changed (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. Tables E.3 and E.4 report results conditional on years of schooling. Again, a comparison to Tables D.2 and D.4 shows no 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 measure add little explanatory power.

## E.2 Task content of imports by foreign minimum wage levels

As a further robustness exercise to our investigation of labour-market characteristics abroad, this appendix presents 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 E.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 E.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 labor-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 $\beta$ 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 E.1: ACTIVITY CONTENT OF GERMAN WORK WITHIN SECTOR AND OCCUPATION, CONDITIONAL ON COMPUTER USE

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .79 | 1.20 | 1.19 | 1.20 | 1.16 |
| | (.03) | (.06) | (.06) | (.03) | (.04) |
| 3 Entertain/Accommodate | .56 | .80 | .83 | 1.16 | .93 |
| | (.07) | (.11) | (.08) | (.07) | (.07) |
| 4 Transport/Store | .72 | 1.05 | 1.04 | 1.23 | 1.20 |
| | (.03) | (.05) | (.05) | (.04) | (.05) |
| 5 Measure/Inspect | .83 | .94 | .98 | 1.32 | 1.34 |
| | (.02) | (.04) | (.04) | (.04) | (.06) |
| 6 Analyze/Research | .90 | 1.14 | 1.22 | 1.35 | 1.44 |
| | (.04) | (.05) | (.06) | (.09) | (.09) |
| 7 Purchase/Sell | .79 | 1.10 | 1.10 | 1.24 | 1.18 |
| | (.06) | (.08) | (.07) | (.07) | (.06) |
| 8 Program Computer | .47 | .84 | 1.11 | .71 | .81 |
| | (.03) | (.05) | (.06) | (.03) | (.03) |
| 9 Practice Law | .52 | .73 | .74 | .96 | 1.35 |
| | (.06) | (.06) | (.05) | (.07) | (.10) |
| 10 Consult/Inform | .52 | .96 | .99 | 1.55 | 1.48 |
| | (.04) | (.08) | (.08) | (.09) | (.09) |
| 11 Train/Educate | .63 | .92 | .92 | 1.22 | 1.27 |
| | (.06) | (.08) | (.08) | (.07) | (.08) |
| 12 Nurse/Cure | .64 | .90 | 1.00 | 1.11 | .97 |
| | (.07) | (.11) | (.13) | (.08) | (.08) |
| 13 Advertise/Promote | .52 | .72 | .72 | 1.12 | 1.19 |
| | (.03) | (.05) | (.05) | (.08) | (.08) |
| 14 Organize/Plan | .77 | 1.15 | 1.32 | 1.43 | 1.33 |
| | (.02) | (.06) | (.07) | (.08) | (.07) |
| 15 Oversee/Control | .72 | 1.17 | 1.25 | 1.15 | 1.14 |
| | (.03) | (.05) | (.07) | (.04) | (.04) |
| Observations | | | 164,851 | | |
| $R^2$ (overall) | | | .25 | | |

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

*Notes*: 168,466 activity-year-gender-age-sector-occupation observations. Controlling for computer use (frequency of workers' uses of computer, workstation, or CAD equipment at the workplace), fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table E.2: PERFORMANCE REQUIREMENTS OF GERMAN WORK WITHIN SECTOR AND OCCUPATION, CONDITIONAL ON COMPUTER USE

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.22 | 1.22 | 1.28 | 1.38 | 1.26 |
| | (.02) | (.02) | (.02) | (.04) | (.02) |
| B Improve/adopt new techniques | .99 | 1.02 | 1.09 | 1.10 | 1.19 |
| | (.02) | (.02) | (.03) | (.04) | (.03) |
| C New situations/activities | 1.28 | 1.15 | 1.23 | 1.18 | 1.24 |
| | (.03) | (.02) | (.03) | (.04) | (.03) |
| D Repeated worksteps | 1.20 | 1.15 | 1.17 | 1.16 | 1.15 |
| | (.02) | (.02) | (.01) | (.02) | (.01) |
| F Financial loss by small mistake | 1.08 | .98 | | 1.02 | .92 |
| | (.02) | (.02) | | (.02) | (.02) |
| G Versatility/multiple activities | 1.03 | .89 | | .94 | 1.03 |
| | (.01) | (.02) | | (.01) | (.02) |
| H Concentration on activity | 1.24 | 1.16 | | 1.17 | 1.26 |
| | (.03) | (.02) | | (.03) | (.02) |
| I Minimum performance to execute | 1.25 | 1.20 | 1.30 | 1.09 | |
| | (.02) | (.02) | (.03) | (.03) | |
| Observations | | | 176,040 | | |
| $R^2$ (overall) | | | .29 | | |

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

*Notes*: 180,022 requirement-year-gender-age-sector-occupation observations. Controlling for computer use (frequency of workers' uses of computer, workstation, or CAD equipment at the workplace), fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).

Table E.3: ACTIVITY CONTENT OF GERMAN WORK WITHIN SECTOR AND OCCUPATION, CONTROLLING FOR YEARS OF SCHOOLING

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 2 Repair/Maintain | .80 | 1.20 | 1.18 | 1.19 | 1.16 |
| | (.03) | (.06) | (.06) | (.03) | (.04) |
| 3 Entertain/Accommodate | .55 | .80 | .82 | 1.16 | .93 |
| | (.06) | (.11) | (.08) | (.07) | (.07) |
| 4 Transport/Store | .73 | 1.05 | 1.04 | 1.23 | 1.20 |
| | (.03) | (.05) | (.04) | (.04) | (.05) |
| 5 Measure/Inspect | .83 | .93 | .96 | 1.32 | 1.34 |
| | (.02) | (.04) | (.04) | (.04) | (.06) |
| 6 Analyze/Research | .91 | 1.12 | 1.20 | 1.34 | 1.44 |
| | (.04) | (.05) | (.06) | (.08) | (.09) |
| 7 Purchase/Sell | .80 | 1.09 | 1.08 | 1.23 | 1.18 |
| | (.06) | (.08) | (.06) | (.07) | (.06) |
| 8 Program Computer | .47 | .82 | 1.08 | .70 | .80 |
| | (.03) | (.05) | (.06) | (.03) | (.03) |
| 9 Practice Law | .53 | .72 | .73 | .95 | 1.34 |
| | (.06) | (.06) | (.05) | (.06) | (.10) |
| 10 Consult/Inform | .53 | .94 | .98 | 1.54 | 1.48 |
| | (.04) | (.08) | (.08) | (.09) | (.09) |
| 11 Train/Educate | .64 | .91 | .91 | 1.21 | 1.26 |
| | (.07) | (.08) | (.08) | (.07) | (.08) |
| 12 Nurse/Cure | .65 | .89 | 1.00 | 1.11 | .97 |
| | (.07) | (.11) | (.13) | (.08) | (.08) |
| 13 Advertise/Promote | .52 | .71 | .71 | 1.11 | 1.18 |
| | (.03) | (.05) | (.05) | (.08) | (.08) |
| 14 Organize/Plan | .78 | 1.13 | 1.30 | 1.42 | 1.32 |
| | (.02) | (.05) | (.07) | (.08) | (.07) |
| 15 Oversee/Control | .72 | 1.17 | 1.24 | 1.14 | 1.13 |
| | (.03) | (.05) | (.07) | (.04) | (.04) |
| Observations | | | 164,828 | | |
| $R^2$ (overall) | | | .25 | | |

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

*Notes*: 168,466 activity-year-gender-age-sector-occupation observations. Controlling for years of schooling, fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted activity *1 Manufacture, Produce Goods* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers in an activity relative to activity *1* in each survey wave. Clustered standard errors in parentheses (two-way clustered at activity and sector level).

Table E.4: PERFORMANCE REQUIREMENTS OF GERMAN WORK WITHIN SECTOR AND OCCUPATION, CONTROLLING FOR YEARS OF SCHOOLING

| Log Employment | 1979 | 1986 | 1992 | 1999 | 2006 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| A Deadlines/pressure to perform | 1.22 | 1.21 | 1.27 | 1.37 | 1.26 |
| | (.02) | (.02) | (.02) | (.04) | (.02) |
| B Improve/adopt new techniques | .99 | 1.01 | 1.08 | 1.08 | 1.19 |
| | (.02) | (.02) | (.03) | (.04) | (.03) |
| C New situations/activities | 1.29 | 1.14 | 1.22 | 1.17 | 1.23 |
| | (.03) | (.02) | (.03) | (.03) | (.02) |
| D Repeated worksteps | 1.20 | 1.14 | 1.17 | 1.16 | 1.15 |
| | (.02) | (.02) | (.01) | (.02) | (.009) |
| F Financial loss by small mistake | 1.08 | .97 | | 1.01 | .92 |
| | (.02) | (.02) | | (.03) | (.02) |
| G Versatility/multiple activities | 1.03 | .89 | | .93 | 1.03 |
| | (.01) | (.02) | | (.01) | (.02) |
| H Concentration on activity | 1.24 | 1.15 | | 1.16 | 1.25 |
| | (.02) | (.02) | | (.03) | (.02) |
| I Minimum performance to execute | 1.25 | 1.19 | 1.29 | 1.08 | |
| | (.02) | (.02) | (.03) | (.02) | |
| Observations | | | 175,994 | | |
| $R^2$ (overall) | | | .29 | | |

*Source*: BIBB 1979-2006, workers ages 16 through 65.
*Notes*: 180,022 requirement-year-gender-age-sector-occupation observations. Controlling for fixed effects of 2 genders, 50 age groups, 5 survey waves, 6 occupation areas and 35 sectors; omitted performance requirement *E Work procedures prescribed in detail* in each survey wave. Coefficients reported as exponential functions of coefficients from single log employment OLS regression (standard errors computed with the Delta method) to measure the ratios of workers performing a requirement relative to requirement *E* in each survey wave. Performance requirements F-H missing in 1992, requirement I missing in 2006. Clustered standard errors in parentheses (two-way clustered at performance-requirement and sector level).