International Trade, Technical Change and the Demand for Skills: How Important is Trade in Quality Differentiated Products?

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List of Abbreviations

AT	Austria
ATC	Agreement on Textiles and Clothing
AU	Australia
BIBB	German Federal Institute for Vocational Training (Bundesinstitut für Berufsbildung)
BL	Belgium
BMBF	Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung)
BRZ	Brazil
BUL	Bulgaria
CA	Canada
CD	Cross-sectional dependence
CEEC	Central and Eastern European Countries
CH	Switzerland
CHI	China
CN	Combined Nomenclature
CZ	Czech Republic
DIHK	German Chambers of Commerce (Deutscher Industrie- und Handelskammer-tag)
DK	Denmark
ECU	European currency unit
EST	Estonia
ET	Egypt
EU	European Union
EUROSTAT	Statistical Office of the European Communities
FD	First-difference estimation
FDI	Foreign direct investments
FE	Fixed effect estimation
FGLS	Feasible generalized least squares estimation
FI	Finland

FISI	Frauenhofer Institute for Systems and Innovation Research (Frauenhofer Institut für System- und Innovationsforschung)
FR	France
GATT	General Agreement on Tariffs and Trade
GLS	Generalized least square estimation
GR	Greece
GSOEP	German Socio-Economic Panel
HIIT	Horizontal intra-industry trade
HK	Hong Kong
HS	Harmonized System
HU	Hungary
IAB	German Federal Employment Agency (Institut für Arbeitsmarkt- und Berufsforschung)
IABS	IAB Employment Sample (IAB-Beschäftigungsstichprobe)
ICT	Information and communication technology
ID	Indonesia
IE	Ireland
IIT	Intra-industry trade
IND	India
IT	Italy
JP	Japan
KMK	Educational Ministers' Conference (Kultusministerkonferenz)
LIAB	Linked employer-employee data set of the German Federal Employment Agency (Linked Employer-Employee Daten des Instituts für Arbeitsmarkt- und Berufsforschung)
LM	Breusch-Pagan lagrangian multiplier test
LT	Lithuania
LV	Latvia
MEX	Mexico
MFA	Multi-Fibre Agreement
NAFTA	Northern American Free Trade Agreement
NL	Netherlands
NOR	Norway
OECD	Organization for Economic Cooperation and Development

OLS	Ordinary least square estimation
OWT	One-way trade
PL	Poland
PT	Portugal
R&D	Research and development
RE	Random effect estimation
RO	Romania
RUS	Russia
SBTC	Skill-biased technical change
SG	Singapore
SKR	South Korea
SLK	Slovakia
SLV	Slovenia
SP	Spain
SW	Sweden
SYPRO	Version for Statistics in Producing Industries to classify economic branches
TH	Thailand
TR	Turkey
TW	Taiwan
TWT	Two-way trade
UA	Ukraine
U.K.	United Kingdom
U.S.	United States
VIIT	Vertical intra-industry trade
WTO	World Trade Organization
WZ 1993	German Classification of economic activities 1993
WZ 2003	German Classification of economic activities 2003
ZA	South Africa

List of Symbols

a_i	Industry-specific error term
β	Regression coefficient
CV_i	Variable cost of industry *i*
D_t	Set of year dummies
E_i	Capital stock of industry *i* comprising machines and equipment
EX	Exports
Hs	Unemployment rate of high-skilled workers
h_i	Employment share of industry i in total manufacturing employment
IM	Imports
IMP_{i*}	Imported intermediate inputs from foreign industry *i**
i	Industry
*i**	Foreign industry
j	Product category
K_i	Capital stock of industry *i*
k	Declaring country
k'	Partner country
L	Total employment in the manufacturing sector
L_i	Total employment in industry *i*
L_i^{HS}	Employment of high-skilled labour in industry *i*
L_i^{LS}	Employment of low-skilled labour in industry *i*
Ls	Unemployment rate of low-skilled workers
$OUTS_i$	Outsourcing activity of industry *i*
P_i	Capital stock of industry *i* comprising building and plants
ΔS^{LS}	Overall change in the share of low-skilled labour
S_i^{LS}	Proportion of low-skilled labour in industry *i*
T_i	Technology parameter for industry *i*
t	Year
UV	Unit value

u_i	Idiosyncratic error
$VIIT_i$	Share of vertical intra-industry trade in total trade of industry *i*
v_i	Industry-specific error term
W_i^{HS}	Wage rate for high-skilled labour in industry *i*
W_i^{LS}	Wage rate for low-skilled labour in industry *i*
WS_i^{LS}	Wage bill share of low-skilled labour in industry *i*
w	Weight factor
Y_i	Output of industry *i*

1. Introduction

During the last decades, world trade patterns have changed dramatically. At the same time, the position of low-skilled workers in Germany and many industrialised countries has deteriorated steadily. Both phenomena were linked with each other and resentment against international trade has been rising among the public, particularly against the integration of newly emerging markets into the world economy. Until today, however, there has been no consensus about the contribution of international trade to the large and well-documented skill upgrading of employment that many industrialised countries have experienced.

Earlier empirical studies in this field of research primarily concentrated on separating the impact of international trade on the demand for skills from the effect of skill-biased technical change. Most studies concluded that trade plays some role but is not the driving force behind the labour market outcome of low-skilled employees in advanced countries. Instead, more weight has been attributed to technical change. More recent theoretical and empirical literature has introduced international outsourcing into the analysis as an alternative explanation to technical change. However, the linkage between outsourcing and skill upgrading is also controversial.

When analysing the labour market impact of international trade, there is a need for a profound understanding of the nature, extent and dynamics of trade flows. One aspect that has largely been neglected in empirical analysis is that there are different kinds of trade flows and that each of these trade flows may provoke different reactions in the labour market. In general, the literature distinguishes between three categories of trade flows: inter-industry trade (i.e., one-way trade), horizontal intra-industry trade (i.e., two-way trade in products within the same product category and with the same quality, but with different product attributes, such as colour or design), and vertical intra-industry trade (i.e., two-way trade in products within the same product category, but with different quality levels).

The present thesis focuses on the role of vertical intra-industry trade in affecting the demand for skills. The impact on the labour market of this type of trade is much less frequently highlighted in the literature which primarily focuses on trade in the sense of inter-industry trade or international outsourcing and on skill-biased technical change. Considering that trade in quality differentiated products not only plays a substantial role in German trade with newly emerging markets but also with other advanced countries, taking this type of trade into account in empirical analysis might yield new insights on the linkage between trade and skill demand.

Germany provides an interesting case study since it is strongly engaged in international trade and characterised as a country where great importance is attached to product quality. In fact, examples of German companies that shifted their core activities from the manufacturing of standardised products to the production of first-rate quality niches in order to resist international competition within product categories are manifold. The company *Steiff*, for instance, produces relatively expensive high-quality soft toys in a highly competitive market. Meanwhile, the television manufacturer LOEWE has specialised within the luxury segment in the manufacture of sophisticated, high-quality televisions, and has thus been able to persist in the market despite increased international competition. The pressure to be innovative and to permanently upgrade product quality, however, has also increased the requirement for professional and technical flexibility. Given that fulfilling this job profile is especially difficult for workers with low qualifications, quality competition might have fostered a process of restructuring within firms, which shifted the demand away from unskilled toward skilled workers, thus contributing to the skill upgrading of employment.

The focus of the thesis will be on the linkage between trade, wages and employment in the manufacturing sector, rather than on the effects of trade on the German labour market as a whole. This is important to emphasise, given that declining employment opportunities for low-skilled workers in the manufacturing sector might, at least partly, be compensated for through the creation of jobs for this skill group in other sectors of the economy, especially the service sector.

The manufacturing sector deserves particular attention for various reasons. First and foremost, employment opportunities for low-skilled workers worsened markedly in this sector where a relatively large number of unskilled workers are employed and which belongs to those sectors of the economy most strongly exposed to international competition. Second, the dynamics of international trade can best be observed in this sector. Third, the focus on the manufacturing sector allows exploiting the richness of empirical and theoretical studies already conducted in this field of research.

The thesis adds to the existing literature on trade and employment in several ways: The impact of trade in quality differentiated products on skill demand has received little attention in empirical analysis so far. By analysing this channel through which trade might affect the labour market in industrial countries, the thesis contributes to a more comprehensive understanding of the forces acting through trade and of how these forces interact with one another. Beyond that, the study explicitly deals with the potential labour market impact of trade between developed countries. Given that quality competition prevails to a considerable extent among advanced countries, it might affect skill composition through this channel. To the best of the author's knowledge, this issue has not been considered in previous empirical investigations, which primarily focus on the effects of trade with developing countries.

The thesis proceeds as follows: Chapter 2 briefly sketches out changes in the labour market position of low-skilled workers in Germany during the last four decades. The focus will be on the evolution of skill-specific unemployment rates and wage inequality. Chapters 3 and 4 theoretically discuss the numerous channels through which international trade and technical change might affect the demand for skills; these chapters also deliver an overview of empirical studies on this issue for Germany and, comparing the results, for a range of other industrial countries. Naturally, special focus will be directed toward the role of trade in quality differentiated products. Chapter 5 is concerned with measuring trade in different qualities. It presents and discusses several indicators applied in the empirical literature. Chapter 6 draws upon the most detailed trade data available to elaborate the relevance of trade in qualities in German foreign trade by partner country and by industry. This chapter also illuminates Germany's specialisation pattern in terms of quality within vertical intra-industry trade. Furthermore, a more-detailed analysis of trade data will be conducted for the textile industry to gain deeper insights on the dynamics of trade flows within an industry. In addition, it will be described how vertical intra-industry trade may interact with other forces that may affect an industry's activities and thus its requirement for skills, especially technical change and international outsourcing. Chapter 7 carries out empirical analysis to determine whether the shift toward high-skilled workers in Germany has occurred within or between industries. This chapter aims at restricting the number of potential forces that might be responsible for the labour market outcome of low-skilled workers. Empirical results from Chapter 7 provide the basis for the empirical analysis in Chapter 8. This chapter assesses econometrically to what extent Germany's specialisation on products with superior quality has affected the skill structure of employment in the manufacturing sector. Chapter 9 concludes the thesis with a summary of the main findings. It also delivers an outlook on the link between trade, technical change and skill demand and provides some recommendations for public policy.

2. Qualification matters: Low-skilled workers in Germany

In accordance with the common pattern observed in industrial countries, qualification has become a key determinant for a worker's position in the German labour market. As pointed out by Reinberg and Hummel (2007), qualification is more important on the labour market than are age or gender. Indeed, it has been well documented that, over the past decades, the labour market situation for low-qualified workers in Germany deteriorated steadily. In contrast, the employment prospects of highly qualified workers have improved significantly. With the growing demand for highly qualified employees, severe skill shortages for some occupations have become evident in recent years, especially in the areas of engineering and other occupations that require technical qualifications (Koppel, 2008).

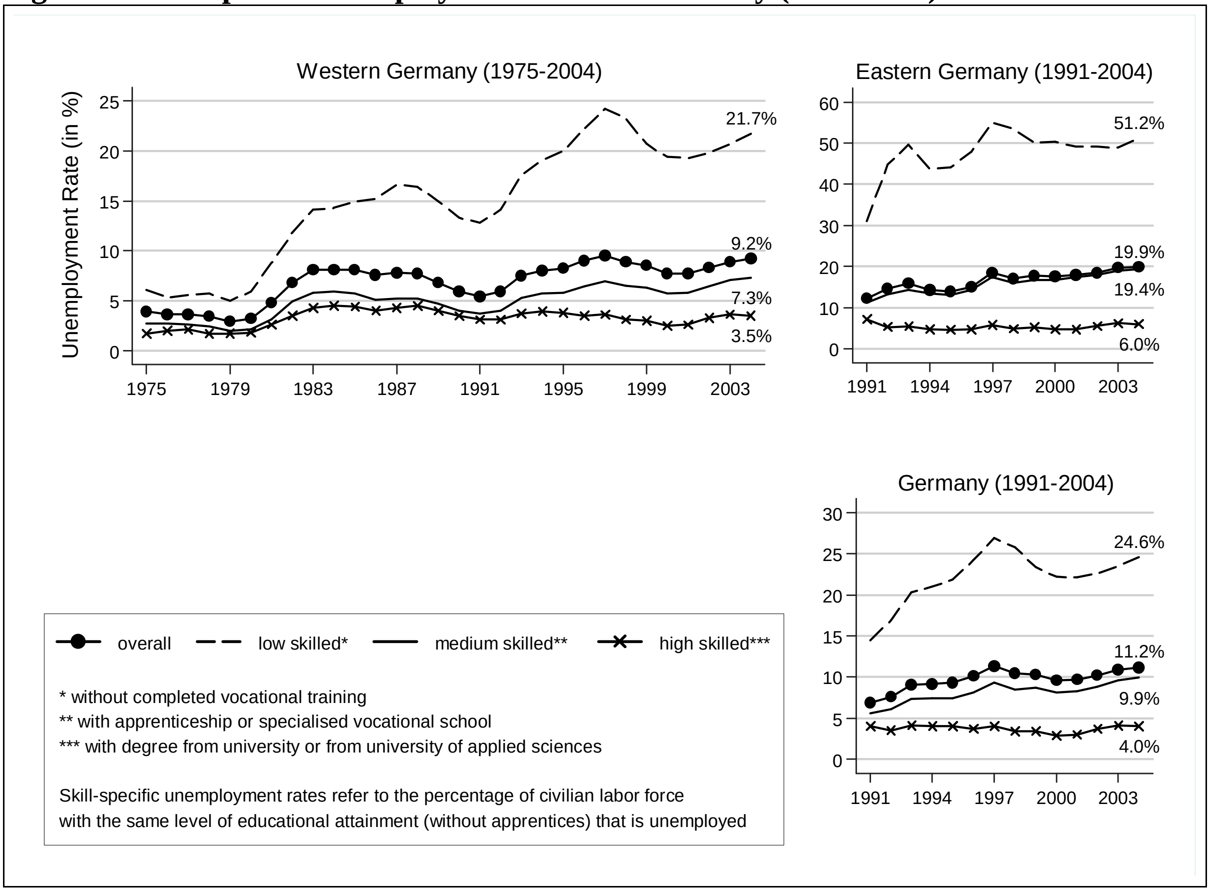
This chapter examines the labour market outcome of workers with different skills in more detail. First, this is done by analysing the development of skill-specific unemployment rates in Germany. To compare and validate the results, the development will be put to an international context by taking into account the development of skill-specific unemployment rates in other selected advanced countries. Afterwards, the same analysis will be done for the development of German wage inequality.

2.1 Development of skill-specific unemployment

After the end of the Second World War, which was followed by industrial expansion in the 1950s, unemployment had not been a severe problem until the 1970s. As a consequence of the first oil crisis in 1973/74, however, Germany, along with many other industrial countries, experienced a severe recession accompanied by a strong and persistent contraction of industrial activity in 1974/75 and, hence, an increase in overall unemployment (Paqué, 1999). As Paqué (1999) pointed out, blue collar workers suffered from relatively strong increases in unemployment compared to white collar workers at that time. Until the end of the 1970s, the overall unemployment situation improved only slightly. After the second oil crisis in 1980/81, unemployment started to increase sharply and did not decline markedly thereafter, despite economic recoveries following the recession periods. Figure 1 shows the development of the overall, as well as the skill-specific, unemployment rate in Germany between 1975 and 2004.

The figure delivers a first impression of how far the position of low-skilled workers on the labour market worsened in the last four decades. Within the group of workers, distinction is made between individuals with no completed vocational training (low-skilled workers), individuals that have passed apprenticeship or specialised vocational school (medium-skilled workers), and individuals with a degree from university or from university of applied sciences (high-skilled workers).

Figure 1: Skill-specific unemployment rates in Germany (1975-2004)



Source: Reinberg and Hummel (2007); author's illustration. Notes: 1) Data are based on the German Microcensus and structural surveys of the German Federal Employment Agency (IAB). 2) Separate time series data for western and eastern Germany can only be depicted for the period between 1975 and 2004 as data for western and eastern Berlin are no longer available thereafter. 3) Although data for unified Germany are also available for 2005 they are not included here as their comparability with earlier data is limited. This is due to substantial modifications of the German Microcensus in 2005 and the Harz IV labour market reform in 2005 which has affected the number of officially registered unemployed.

Figure 1 shows that low-skilled workers were especially hard-hit by the economic crisis in 1980/81, where a large number of production workers were released from German manufacturing industry. Compared to workers with higher skills (i.e., medium-skilled and high-skilled workers), they experienced a sharp and disproportionate growth in unemployment rates, which could not be reversed despite economic upswings that set in after recessions. Although the unemployment rate of unskilled workers decreased to some extent at the end of the 1980s, substantial structural imbalances (especially between low-skilled and high-skilled workers) have remained persistently high ever since. These imbalances became particularly pronounced after the German reunification boom in the early 1990s, when the German economy was hit by a severe recession, with both the western and eastern regions experiencing strong increases in overall unemployment, with the least-skilled, once again, suffering the most.

Apparently, the completion of vocational training seems to be the minimum for a competitive position in the German labour market. Although the unemployment rate among medium-skilled workers in western Germany has increased, especially after German reunification (reaching a value of 7.3% in 2004), it is much lower than among those without completed vocational training (21.7%). The risk of becoming unemployed is the lowest for workers with higher educational attainment. Workers with a degree from a college or higher education or university were hardly affected by any of the economic crises mentioned previously. Compared to other skill groups, the unemployment rate among high-skilled workers in western Germany remained roughly constant at relatively low levels between 1975 and 2004. It reached a maximum level of 4.5% in the wake of the second oil crisis at the beginning of the 1980s and declined thereafter, reaching approximately 3.5% in 2004. In eastern Germany, the tendency regarding skill-specific unemployment rates is basically the same, apart from general differences in the level of unemployment, with western Germany exhibiting much lower unemployment rates for all skill groups.

Further insights emerge when the development of skill-specific unemployment rates in Germany is analysed in an international context. Hagemann and Rukwind (2009) analysed data on skill-specific unemployment rates for Germany, the United Kingdom (U.K.) and the United States (U.S.) for selected years between 1991 and 2004, using data provided by the Organization for Economic Cooperation and Development (OECD). In the present study, a similar analysis has been conducted by including more recent data for the years 2005 and 2007 (see Table 1). Data show that the unemployment rate of low-skilled workers in Germany has been well above those of the U.K. and the U.S., as well as above the OECD average for all years under study, except for 1991.

Table 1: Skill-specific unemployment rates in Germany, the U.K. and the U.S. (1991-2007)

		1991	1995	1997	1999	2001	2003	2005	2007
Germany	Low-skilled	7.4	13.3	15.4	15.9	13.5	18.0	20.2	18.0
	Medium-skilled	4.7	7.9	9.9	8.8	8.2	10.2	11.0	8.3
	High-skilled	3.2	4.9	5.7	5.0	4.2	5.2	5.5	3.8
	Ratio Ls/Hs	**2.3**	**2.7**	**2.7**	**3.2**	**3.2**	**3.5**	**3.7**	**4.7**
United Kingdom	Low-skilled	10.4	12.8	8.4	7.1	7.6	6.9	5.1	6.5
	Medium-skilled	6.5	7.5	5.5	4.4	3.9	3.9	3.1	3.9
	High-skilled	3.3	3.7	3.1	2.6	2.0	2.4	2.1	2.3
	Ratio Ls/Hs	**3.2**	**3.5**	**2.7**	**2.7**	**3.8**	**2.9**	**2.4**	**2.8**
United States	Low-skilled	12.3	10.0	10.4	7.7	8.1	9.9	9.0	8.5
	Medium-skilled	6.5	5.0	4.8	3.7	3.8	6.1	5.1	4.5
	High-skilled	2.9	2.7	2.3	2.1	2.1	3.4	2.6	2.1
	Ratio Ls/Hs	**4.2**	**3.7**	**4.5**	**3.7**	**3.9**	**2.9**	**3.5**	**4.0**
OECD average	Low-skilled	8.9	10.8	10.1	9.3	8.9	10.2	10.5	9.0
	Medium-skilled	5.9	7.3	6.7	6.1	5.6	6.2	6.0	4.8
	High-skilled	3.5	4.6	4.1	3.8	3.3	4.0	3.9	3.3
	Ratio Ls/Hs	**2.5**	**2.3**	**2.5**	**2.4**	**2.7**	**2.6**	**2.7**	**2.7**

Source: OECD (2006, 2009a); adapted from Hagemann and Rukwind (2009); own calculations. Note: 1) Unemployment rates are calculated as the number of 25-to-64-olds in unemployment as a percentage of the labour force between the age of 25 and 64 by educational attainment. The group of low-skilled workers comprises individuals with below upper secondary education. The group of medium-skilled workers covers individuals with upper secondary and post-secondary non-tertiary education. High-skilled workers include individuals with tertiary education.

To get a more differentiated picture, Hagemann and Rukwind (2009) additionally controlled for general differences in the level of unemployment, in order to compare the risk between countries for unskilled workers to be unemployed.[1] This is done by calculating for each country the ratio between the unemployment rate of low-skilled and high-skilled workers (ratio Ls/Hs). Table 1 shows that in all countries, the lower the level of education, the higher the risk of being unemployed. Data for Germany indicate the relative unemployment risk for the less educated has been increasing steadily throughout the 1990s. Whereas in 1991 the risk to be without a job was 2.3 times higher for a person with a low educational level, it was 4.7 times higher in 2007. In this regard, the OECD average ratio remained relatively constant over time and the ratio does not show any clear tendency for the U.K. and the U.S. An

[1] As Table 1 reveals, the German unemployment rates of other skill groups tend to be higher compared to other countries. To control for general differences in the level of unemployment by calculating the ratio between the unemployment rate of low- and high-skilled workers, comparing the risk of low-skilled workers to be unemployed has been suggested by Nickell and Bell (1996).

international comparison implies that the relative risk of low-skilled workers to become unemployed is particularly high in Germany. Except in 1991, the German ratio between the unemployment rate of low-skilled and high-skilled workers lies above the OECD average for all years. Compared to the U.K. and the U.S., the German ratio tended to be above the ratios for these countries since 1999 and 2003, respectively.[2]

2.2 Development of wage inequality between different skill groups

For a long time, the view prevailed among economists that, due to Germany's labour market rigidities and its relatively inflexible wage structure, wage inequality in Germany did not increase markedly compared to industrial countries with more flexible labour markets, such as the U.K. and the U.S., which had already been experiencing increases in wage inequality since the 1970s (see Krugman, 1994; Freeman and Katz, 1996; Katz and Autor, 1999). In this regard, it is often referred to as the "two sides of the same coin" hypothesis, stated first by Krugman (1994). According to this hypothesis, the decline in the relative demand for less-skilled workers that could be observed during that time has either i) resulted in terms of payment in countries where the flexibility of the wage structure made it less difficult to absorb a large number of less-skilled employees into the employment, or ii) resulted in terms of possibilities to find a job in countries where wages were sticky and employment levels had to carry the burden of adjustment (see also Paqué, 1999).

German wage compression has thereby mainly been ascribed to institutional rigidities caused by the power of labour unions in the system of central wage bargaining and to specific labour market regulations (e.g., Blau and Kahn, 1996; 2002; Fitzenberger, 1999a; Paqué, 1999; Fitzenberger et al., 2001; Prasad, 2004; Möller, 2005). Although no general statutory minimum wage exists in Germany, both wage-setting institutions and regulations have created

[2] It is worthy to note that the relative risk of being without a job had been higher for unskilled workers in the U.K. and the U.S. than in Germany until the end of the 1990s and the early years of the new century, respectively, despite the supposedly higher and more rigid real wages of this skill group. According to Abraham and Houseman (1995) this phenomenon might be attributed to the German education and training system, which has done better in supplying workers with an appropriate mix of skills. Due to the system of apprenticeship, education or training occurs not only in school, but also in the working environment, which provides workers with a good general foundation that enables them to learn new tasks more easily. Hence, low-skilled workers in Germany might be more skilled than low-skilled workers, for example, in the U.S. (see also Nickell and Bell, 1996; Freeman and Schettkat, 2001).

de-facto minimum wage floors. On the one hand, standard wages negotiated by labour unions have prevented relative wages of low-skilled workers from downward adjustments as a response to the decline in the relative demand for this skill group. On the other hand, the German system of welfare benefits has most likely affected the willingness of workers to accept low-paid jobs through increasing reservation wages.

However, to get a comprehensive picture on low-skilled workers' labour market position in Germany, the development of wage inequality should be examined in more detail. In order to investigate the evolution of wage disparities between different skill groups, various indicators have been employed to measure wage inequality, with the ratio of wage percentiles (e.g. the 90^{th} /10^{th} percentile ratio) as the indicators most frequently used.[3] To define percentile ratios, individuals are first sorted according to their wages and then allocated to different percentiles; the 10^{th} percentile, for instance, indicates the wage level which is not exceeded by 10% of individuals.[4] The ratio between different percentiles is then used to analyse the development of earnings inequality, with the $90^{th}/10^{th}$ percentile ratio commonly used as the central measure for overall wage inequality and the $90^{th}/50^{th}$ and $50^{th}/10^{th}$ percentile ratios as its subgroups which provide more detailed information about the tendency of wages in the upper and lower part of the distribution. If the gap between quantiles is rising, growing wage inequality is assumed to prevail and vice versa. Since a large part of earnings is labour market income, earnings inequality and wage inequality will be used as synonyms in the material that follows.

In Germany, there are two main data sources used for analysis of wage inequality. One is the German Socio-Economic Panel (GSOEP) which is a longitudinal household survey conducted on a yearly basis, with the first wave starting in 1984 and covering around 12,000 individuals in approximately 6,000 households. Since that time, the number of households and

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[3] Ammermüller and Weber (2003) presented an overview of different wage inequality measures.

[4] In general, different wage measures are possible, e.g., net/gross wages, weekly/monthly/annual earnings, part-time/full-time wages, real/nominal wages and wages of males/females/both sexes. The measures that are chosen for studies that aim at examining the evolution of wage disparities mainly depend on (i) the suitability and (ii) the availability of the respective data. Mostly, gross hourly wages are chosen since they reflect the price of labour for a fixed unit on the labour market. As an alternative, gross monthly earnings are used, though with the disadvantage that they depend on the hours one has worked. The reason why gross and not net earnings (i.e., taxes and social contributions are not included) are the focus of wage inequality studies is that it is usually the aim to detect differences in the price of labour on the labour market rather than differences in the labour income of individuals (see, e.g., Ammermüller and Weber, 2003).

individuals participating has been changed due to dropouts and the inclusion of eastern Germany into the sample. In 2010, the sample covered around 11,000 households and 19,000 individuals. The second dataset is the micro data from the Employment Register of the German Federal Employment Agency (IAB). The IAB Employment Sample (IABS) contains data from the German social security system and covers information regarding 2% of all individuals that are subject to social insurance contribution.[5]

Each of those data sets has its advantages and drawbacks when analysing the evolution of wages, with the consequence that results on the evolution of wage inequality might differ slightly. One difference between both datasets is particularly noteworthy. First, the IABS is censored at the top and provides only information of earnings up to the social security threshold, with the consequence that around 10% of the high-wage earners are not fully reported (Ammermüller and Weber, 2003). Due to this wage censoring and the succeeding difficulty in analysis, especially changes at the top of the wage distribution, a range of studies uses the 85th or 80th percentile instead of the 90th percentile (e.g., Kohn, 2006; Dustman et al., 2009). Since the GSOEP constitutes a representative sample of the whole working population, censoring problems do not exist. Consequently, GSOEP data are preferred to the IABS data when analysing distinct parts of the wage distribution with the disadvantage, however, that data from the GSOEP do not exist before 1984.[6] In the following, results of studies analysing the evolution of wages in Germany in different periods either with the GSOEP or the IABS will be briefly summarised.[7]

When reviewing the empirical literature on wage dispersion in Germany, a majority of studies analysing the evolution of wages during the 1970s and 1980s recorded increases in real wages for all major percentiles, at the top (i.e., the 90th or 85th percentile), the middle (i.e., the 50th percentile), and the bottom (i.e., the 15th or 10th percentile) of the wage distribution. In addition, most studies concluded that, during that time, wage inequality across skill groups remained relatively stable, with studies primarily focusing on western Germany (e.g.,

[5] For general information on the GSOEP and the IABS, refer to Haisken-DeNew and Frick (2005) and the IAB-homepage respectively.
[6] For a detailed discussion of advantages and disadvantages of both datasets when analysing the development of wage inequality, see, for instance, Ammermüller and Weber (2003) or Dustman et al. (2009).
[7] The results of studies presented here largely refer to the development of males' wages.

Abraham and Houseman, 1995; Steiner and Wagner, 1998; Fitzenberger et al., 2001; Pfeiffer, 2003; Prasad, 2004). A few studies discovered some degree of wage flexibility, among them Dustman et al. (2009) and Fitzenberger (1999a), who focused on the development of the interquantile differences in western Germany between 1975 and 2001, using data from the IABS. They argued that a structural break in 1984 in the IABS data (caused by the inclusion of bonuses as well as other one-time annual payments) has led to changes in the wage measure and might give misleading results if it is not controlled for. When correcting for this break, the increases in wage inequality they unveiled had already started in 1975 and wage inequality increased nearly steadily through the mid-1970s and the 1980s. However, the increase in wage inequality at that time has primarily been concentrated at the upper part of the wage distribution ($85^{th}/50^{th}$ percentile ratio).

Independent of the dataset, empirical findings for West German wage inequality trends during the 1990s revealed increases in real wages for workers at the 90^{th} and the 50^{th} percentile but falling real wages of workers at the 10^{th} percentile of the wage distribution since the early 1990s (Dustman et al., 2009) or since the middle of the 1990s, respectively (Gernandt and Pfeiffer, 2007). However, when analysing the evolution of wage gaps for distinct parts of the wage distribution (e.g. the top and the bottom) during that time, evidence is less clear cut. Gernandt and Pfeiffer (2007), for instance, analysed the development of wage inequality in western Germany on the basis of the GSOEP for the period between 1984 and 2005, and documented relatively compressed wages from 1984 to 1994. They concluded that rising wage inequality thereafter occurred primarily at the lower part of the wage distribution (i.e., the $50^{th}/10^{th}$ percentile ratio).[8] In contrast, Dustman et al. (2009) focused on the development of the interquantile differences in western Germany between 1975 and 2001 using IABS data. They identified not only increases in wage inequality at the bottom of the earnings distribution (i.e., $50^{th}/15^{th}$ and particularly $40^{th}/5^{th}$ percentile ratio) since the early 1990s but also further increases in wage inequality at the top of the distribution (i.e., $85^{th}/50^{th}$ percentile ratio) which, according to them, had already started in the 1970s.

[8] Similar results have been obtained by Prasad (2004), who analysed development of wages on the basis of the GSOEP from 1984 to 1997. He detected some increases in wage inequality between 1992 and 1996 at the lower bottom of the wage distribution ($50^{th}/10^{th}$ percentile ratio); however, he considers this to be only marginal in nature. Hence, Prasad (2004) confirmed "the unbearable stability of the German Wage Structure" until the end of the 1990s.

A growing majority of studies dealing with the evolution of wage gaps across skill groups during the 1990s included eastern Germany in the analysis, using data after reunification. Studies that conjointly examined the development of wage dispersion in both regions, i.e., eastern and western Germany, basically reported the same results: wage inequality has been rising in both parts of Germany during and since the 1990s. In the early years after the German reunification, general wage dispersion in eastern Germany was lower compared to western Germany but converged to the western German level during the 1990s (Möller, 2005; Kohn, 2006; Gernandt and Pfeiffer, 2007). The rapid increase in wage dispersion in eastern Germany after reunification is thereby primarily ascribed to its move from a socialist toward a market economy, which was associated with adoption of market wages. As a consequence, the distribution of wages which had been artificially compressed under the former centrally planned system widened markedly (see, e.g., Krueger and Pischke, 1995).

Möller (2005) and Kohn (2006) analysed the evolution of the wage gap between different skills in eastern Germany on the basis of the IABS between 1992 and 2001 and identified increases for several percentile ratios ($90^{th}/10^{th}$, $90^{th}/50^{th}$ and $50^{th}/10^{th}$) and for the $80^{th}/20^{th}$ percentile ratio, respectively, during that time.[9] Both studies revealed that eastern Germany had caught up in terms of wage inequality in 2001 compared to western Germany. A general rise in wage inequality in eastern Germany is also broadly supported by studies with data from the GSOEP. Gernandt und Pfeiffer (2007) analysed the evolution of the wage gap in eastern and western Germany from 1994 to 2005 and found an increase in wage inequality in both regions. However, according to Gernandt and Pfeiffer (2007), wage dispersion in eastern Germany was concentrated in the upper part of the wage distribution scale, whereas in western Germany, rising wage inequality was concentrated at the lower part of the distribution.[10] They attributed the development in the eastern part particularly to the willingness of firms in this region to pay higher wages in order to prevent high-skilled workers from moving to the western part of Germany or, alternatively, to attract them from western Germany. On the contrary, the observation in western Germany that wage inequality mainly concerned wages below the median is ascribed to the growing supply of low-skilled workers in this region.

[9] Möller (2005) actually used decile ratios.
[10] Steiner and Hölzle (2000) also analysed the development of wages in eastern and western Germany for the period between 1990 and 1997, using data from the GSOEP, and obtained similar results.

There are few empirical studies that examined the time period beyond the 1990s. They suggested that the process of growing wage inequality that started in the 1990s slowed down at the beginning of the new century. For eastern Germany, Peters (2007) even reported slight decreases of the $90^{th}/10^{th}$ percentile ratio between 2003 and 2006. However, since this trend has to be followed up further, it is very difficult to draw any final conclusion.

Several studies also analysed the development of German wage inequality, particularly in comparison with the U.K. and the U.S., both of which are commonly viewed as having more flexible labour markets and are thus supposed to show higher wage gaps. Basically, these studies revealed a tendency for Germany to "catch up" in recent years in terms of wage inequality with both countries. Rukwind (2007), for instance, showed that, compared to the U.K., which has long been considered one of the advanced countries with the highest wage inequality in Europe (see European Commission, 2005), Germany has not only caught up but even surpassed the country in terms of wage inequality since the end of the 1990s.[11] In comparison with the U.S., data indicated that, although wage gaps became smaller with a tendency of Germany moving toward the U.S., Germany is still considered to show much lower values of wage dispersion (see, e.g., Freeman and Schettkat, 2001; Peters, 2007; Rukwind, 2007).

Summing up, information on the development of unemployment and wage inequality in Germany imply that declining relative demand for low educated workers in the 1980s took place primarily through a disproportionally growing unemployment rate of less-skilled workers, but started to increasingly affect this skill group in terms of relative remuneration since the mid-1990s, as rising wage inequality across skill groups suggests. In addition, unskilled workers have also lost in real terms. An international comparison furthermore shows that Germany is catching up in terms of wage inequality with other industrialised countries such as the U.K. and the U.S.

Projections on skill requirements in Germany by Bonin et al. (2007) indicate that the above described labour market outcome of low-skilled workers might become more pronounced in the future. Table 2 illustrates the job requirement in the German economy according to

[11] Rukwind (2007) used Gini-coefficients to measure wage inequality.

educational level for selected years between 2003 and 2020. Bonin et al. (2007) estimated a gradual drop in the share of workers without completed vocational training from 12.0% in 2003 to 9.0% in 2020, and also a declining share of workers that have merely completed apprenticeship (from 58.9% in 2003 to 55.7% in 2020). On the contrary, the share of workers that are in possession of a master craftsman's diploma or a degree from a specialised vocational school is predicted to rise from 10.8% to 11.8% during that time. The strongest rise in demand can be observed for workers with a degree from university or from university of applied sciences, with the share rising constantly from 18.3% in 2003 to 23.6% in 2020.

Table 2: German labour demand by skill level in % (2003-2020)

Year	2003	2010	2015	2020
without vocational training	12.0	10.5	9.7	9.0
with vocational training	58.9	57.6	56.6	55.7
master craftsman's diploma or degree from specialised vocational school	10.8	11.4	11.6	11.8
with degree from university or university of applied sciences	18.3	20.5	22.2	23.6

Source: Bonin et al. (2007); author's illustration. Note: Data refer to unified Germany.

In this regard, it is worth noting that there is not necessarily a lack of jobs traditionally considered as being unskilled-labour-intensive. Rather, there seems to be a tendency for changing requirements for this type of job (e.g. Zeller, 2002; Jaehrling and Weinkopf, 2006). As pointed out by Jaehrling and Weinkopf (2006), typical unskilled workers' jobs have long been considered as requiring no vocational education and relatively little background knowledge. On-the-job trainings were supposed to be sufficient. However, several studies highlight the growing importance of specific skills, such as mobility, flexibility, and the ability to work in a team even for supposedly low-skilled jobs. Also cognitive (i.e., mental) skills that are used in the process of acquiring knowledge, such as reasoning, perception, and intuition, have become important prerequisites for jobs previously considered to be unskilled-labour-intensive; a rising number of tasks within firms is characterised by a mixture of routine jobs and activities that require additional skills. Hence, there has been a reduction of routine manual or clerical skills (i.e., routine cognitive tasks) which can be found in the middle or bottom of the wage distribution and an increase in non-routine cognitive and interpersonal skills mostly found at the top of the wage distribution (Zeller, 2002). This development might, at least partly, explain the replacement of low-skilled workers with low or no formal education by workers with higher qualifications.

That changes in the profiles of rudimentary jobs have made it even more difficult to integrate untrained and low-qualified workers into modern working processes can also be supported by the observation that, despite high unemployment of low-qualified workers, German firms seem to face difficulties in recruiting appropriate employees even for ordinary jobs. In a survey carried out by the German Chambers of Commerce (DIHK), 33% of the companies surveyed reported they are confronted with problems when trying to fill menial jobs due to applicants' lack of qualification and their low productivity (DIHK, 2006).[12]

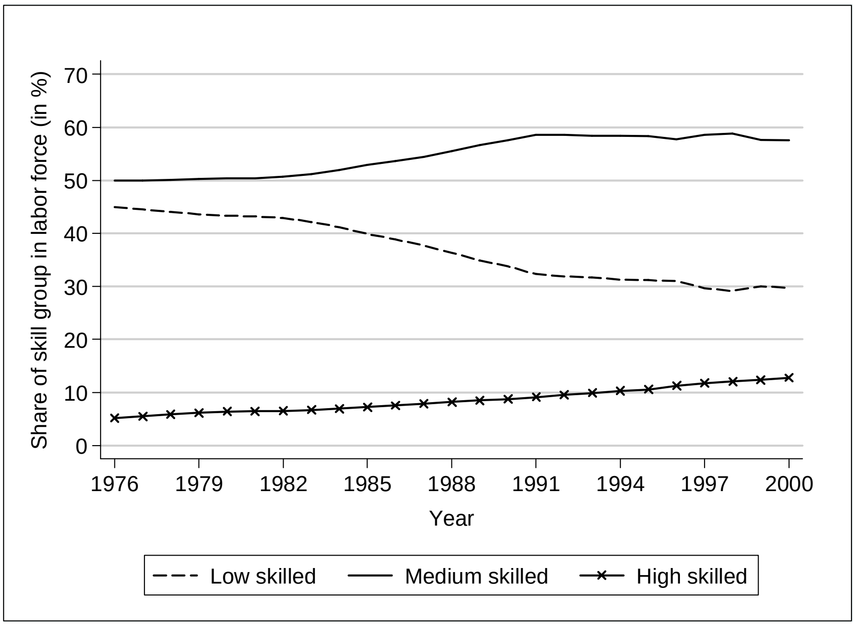
Having the substantial and disproportionate exclusion of less-skilled workers in mind, the question immediately arises as to which factors can be claimed to be responsible for this development. In general, labour markets can be affected by various forces. As emphasised by Chusseau et al. (2008), it is possible to distinguish between factors affecting the supply side of the labour market (e.g. education, training, skill obsolescence, migration) and the demand side (e.g. international trade, technical progress, changes in product demand). Furthermore, institutional factors (e.g. unionisation, minimum wages, labour flexibility) might play a role. Although opinions among economists are divided regarding the forces responsible for the above-described development and the extent to which they adversely affected workers with lower qualifications, there is a consensus that these structural changes do not reflect changes in the labour supply. This view has been justified by the observation that, in a wide range of advanced countries, the relative employment situation for workers with low educational levels has worsened markedly since the 1970s, despite a growing relative supply of workers with higher educational attainment (Chusseau et al., 2008).

In Germany, the western as well as the eastern part experienced a process of substantial skill upgrading in its work force in the decades after the Second World War, which was mainly

[12] The survey is based on approx. 20,000 company responses comprising firms of different sizes and from various sectors of the economy with 35% from the manufacturing sector, 6% from the building and construction sector, 22% from retail trade, and 37% from the service sector.

triggered by improvements in the educational system coinciding with the strong cohorts of the baby-boom generation from 1950s and 1960s (Reinberg, 2003a). Figure 2 shows the development of the national labour supply by educational attainment in western Germany between 1976 and 2000. As illustrated, the share of workers without any vocational training decreased massively since the middle of the 1970s, whereas especially the share of workers with apprenticeship or specialised vocational school, but also of workers with degree from university of applied sciences or from university increased. In 1976, 45% of West German workers were without any qualification and only 5% were in possession of a degree from university of applied sciences or from university. By 1991, i.e., 20 years later, the number of workers without completed vocational training had decreased to 31%, whereas the number of university of applied sciences or university graduates had increased to 11%.[13]

Figure 2: Skill Composition of the (West) German labour force (1976-2000)



Source: IAB/Bildungsgesamtrechnung. Note: Data include all 15-to-64-year-old individuals in the Old Federal States and West Berlin. The group of low-skilled workers considers workers without completed vocational training. Medium-skilled workers comprise workers with apprenticeship or specialised vocational school and high-skilled workers refer to workers with degree from university or from university of applied sciences.

[13] Data on skill composition of the western German labour force can only be obtained for the period between 1976 and 2000 and for eastern Germany between 1991 and 2000. For unified Germany, data are available from 1991 onwards. Since skill composition changed markedly before the 1990s and remained relatively constant thereafter in both parts of Germany, more recent data are not reported here.

In the face of the growing supply of skilled workers in Germany, a simple labour market model reflecting relative supply of and demand for labour would either predict a decline in wage inequality or a disproportionate increase in skilled workers' unemployment. However, there has been no tendency for the position of the skilled labour to worsen. Instead, the employment prospects of workers with higher qualification improved significantly. Apparently, the supply of more educated workers has been increasing over time, but so too has the demand. In total, changes in the structure of labour demand in favour of skilled workers seemed to have dominated the supply effects. Consequently, researchers commonly focus on the demand side of the labour market in order to find out why the labour market position for less-qualified employees and for those without any qualification has been deteriorating steadily during the last decades (e.g., Peters, 2007).

3. Trade versus technical change

When economists began to search for the causes of the rising educational demand in Germany and many other industrialised countries, various explanations emerged. Thereby, advanced countries' trade engagement with newly emerging markets (so-called "North-South trade") has been identified as one prime suspect. However, that is only one out of several explanations. Skill-biased technical change (SBTC) has been considered as another potential "job killer". Similar to international trade, it is supposed to decrease the relative demand for low-skilled labour. Separating these forces from one another, when measuring their impact on wages and employment, has turned out to be one of the most difficult tasks of empirical analysis.

This chapter briefly surveys the most important theoretical and empirical findings on both international trade and SBTC with respect to their impact on the demand for skills. Naturally, special focus will be put on studies that analyse this issue for Germany. However, to better interpret the results, studies on other countries will be taken up as well. The aim of this chapter is not to provide a comprehensive survey, but to highlight the most salient trends to anchor the discussion on the linkage between international trade, employment, and wages in the upcoming chapters.

3.1 Trade and skill demand

The early 1970s are often identified as the beginning of the modern globalisation era, and the subsequent years of international trade were characterised by changing world trade patterns (Giersch et al., 1992). In the post war era, world trade was mainly characterised by advanced countries trading manufacturing products among one another. Trade between developed and less-developed countries was largely restricted to the exchange of manufacturing products and primary materials, with advanced countries exporting the former and importing the latter. However, the early 1970s witnessed the beginning of an impressive rise of some newly industrialising economies as producers and exporters of manufactured products. According to Akin and Kose (2008), the average share of manufacturing exports among total exports of newly emerging countries rose from around 23% between 1960 and 1972 to approximately 39% between 1973 and 1985, and to nearly 74% between 1986 and 2005.

The increased integration of less-developed countries into the world market and the rapid expansion of advanced countries' manufacturing imports from less-developed countries were triggered by several factors. First, there have been several efforts to cut tariffs and non-tariff barriers, for instance, through the establishment of the General Agreement on Tariffs and Trade (GATT), followed by the World Trade Organization (WTO) (Kohler, 2004). Second, a range of less-developed countries (especially in Asia) switched over from import substitution to an export-promoting strategy. Thereby, their industrial policies mainly targeted labour-intensive sectors, such as production of textiles and apparel, as those sectors are considered to be optimal industries for starting the process of industrialisation (Kucera and Milberg, 2003). Third, growth in world trade has been promoted by technological advances like jet engines and improved containerisation, as well as enhanced ways to manage complex supply chains which led to reductions in transportation and communication costs (e.g., Kohler, 2004).

Since the labour market position of low-skilled workers in many advanced countries started to deteriorate in the 1970s, when a large number of these countries experienced a rapid increase in manufacturing imports from emerging economies, both phenomena were linked to each other, and the fear of a "giant sucking sound" started to prevail among the public (Lawrence and Slaughter, 1993).[14] People were particularly concerned about low-paid, unskilled-labour–abundant countries (so-called "South") flooding the markets of industrial countries (so-called "North") with low-wage products and substituting domestically produced goods, in this manner threatening domestic employment.

[14] The "giant sucking sound" is an often-cited phrase, first used by the U.S. politician Ross Perot in reference to increasing trade liberalisation of the U.S. through the foundation of the Northern American Free Trade Agreement (NAFTA) and succeeding closer ties to Mexico, and to its negative effects on the labour market in the U.S. (Lawrence and Slaughter, 1993).

3.1.1 German foreign trade and skill demand

During several decades of persistent trade liberalisation after the Second World War (e.g., through agreements that paved the way for the creation of the Single Market in Europe), there had hardly been any fear in Germany that increased global integration might negatively influence workers' positions in the labour market. In fact, trade had been hailed as one important determinant in the historically high growth rates of the post war era (e.g., Giersch et al., 1992; Sachs and Warner, 1995). Beginning in the early 1970s, however, Germany experienced a slowdown of economic growth and an increase in the unemployment rate. As pointed out in Chapter 2, the growth in the unemployment rate that could be observed in subsequent decades was strongly biased toward low-skilled workers. Given that the decrease in low-skilled workers unemployment rate coincided with an increase of manufacturing imports from newly industrialising economies and that employment opportunities worsened markedly in the manufacturing sector, where predominantly low-skilled workers were employed, international trade has been eminent among the "natural" candidates to explain the reduction in the relative demand for low-skilled workers (Kucera and Milberg, 2003).

Resentment against international trade with emerging markets was primarily grounded in the belief that within the realm of industrialised countries not everyone benefits from foreign trade engagements to the same extent. In particular, it was feared that increased trade with less-advanced countries might lead to a demise of industries that traditionally rely intensively on unskilled labour such as steel construction, shipbuilding, production of toys, watches or optical devices as well as textile and apparel, as Germany was supposed to be no longer able to engage in international cost competition due to high labour costs. In fact, employment losses since the 1970s have been most severe in these sectors (Doering-Manteuffel and Raphael, 2011). In addition, these sectors have also been among those sectors most strongly exposed to international competition. In contrast, trade with newly emerging economies was expected to promote exports in other sectors (e.g., production of machinery) that employ a relatively large number of high-skilled workers. Thus, rather than changing the overall level of employment, trade was assumed to provoke a structural shift toward certain sectors of the economy and, hence, toward the demand for certain qualifications. Consequently, a growing concern started to prevail among the public at large that globalisation may not be "*a bowl of cherries* (Rodrik, 1999, p. 117)" for everyone, and that it might create winners and losers.

In the beginning, the concern that increased German foreign trade with emerging markets might especially destroy low-skilled workers' jobs in Germany primarily referred to Germany's increased engagement with industrialising countries from Southeast Asia. During the 1990s, this concern deepened when Germany intensified its trade relationship with the formerly planned economies of Central and Eastern Europe (CEEC), such as Poland, Hungary and the Czech Republic, which were gradually integrated into the EU, and with China. Increased German foreign trade with CEEC can be primarily attributed to the Association Agreements between the EU and ten countries undergoing transformation at the beginning of the 1990s.[15] These agreements aimed at the total liberalisation of trade in manufacturing products between the EU and the countries under consideration until 2003, and they have finally paved the way for the expansion of the economic relationship between Western, Central and Eastern Europe (European Bank for Reconstruction and Development, 1999). In contrast, Germany's enhanced ties with China can be attributed to China's process of economic liberalisation and the open-door policy that the Chinese government pursued to promote economic growth (e.g., Yan, 2005).

3.1.2 Theory

The consequences of trade liberalisation for an economy as well as for wages and employment of certain skill groups are formalised and manifested in the Heckscher-Ohlin trade model. To this day, the Heckscher-Ohlin theory, elaborated by Eli Heckscher and Bertil Ohlin (1933), has been one of the most influential theories in international trade and determined the way of thinking about world trade for a long time. The idea of the Heckscher-Ohlin theorem can be briefly described as follows:

[15] The ten countries included Estonia, Latvia, Lithuania, Poland, Slovakia, Slovenia, Hungary, Czech Republic as well as Bulgaria and Romania. These countries became members of the EU in 2004 and 2007, respectively (European Commission, 2009).

It is assumed in this model that there are two factors of production, namely skilled and unskilled labour.[16] In addition, there are two countries, both differing with respect to their endowments: One country is abundantly endowed with skilled labour (industrialised country) and the other country is abundantly endowed with unskilled labour (developing country). Furthermore, there are two goods, and the production of these goods requires different compositions of factor inputs: The production of one good requires a relatively large amount of skilled labour, whereas the production of the other good requires a relatively large amount of unskilled labour. Production technology is assumed to be identical in both economies.

In autarky, relative prices of the goods are supposed to differ across countries: In the country that is well endowed with skilled (unskilled) labour, the skilled-labour-intensive good (unskilled-labour-intensive good) will be relatively cheap. Beyond that, the relative price of skilled labour will be lower in the country abundantly endowed with skilled labour than in the country abundantly endowed with unskilled labour. In the absence of trade, the country where skilled labour is abundant will have a comparative advantage in the production of the skilled-labour-intensive good, whereas the unskilled-labour-abundant less-developed country has a comparative advantage in the production of the unskilled-labour-intensive good.

In accordance with its comparative advantage, the industrial country will export the skilled-labour-intensive commodity and import the unskilled-labour-intensive commodity when trade is liberalised. The developing country does the reverse. After trade is opened up, relative prices are supposed to converge. The relative price of the unskilled-labour-intensive good falls in the skill-rich industrial country. As a consequence, production in the industry that experiences a relative increase in prices (i.e., the skilled-labour-intensive industry) expands, whereas production in the industry exposed to declining relative prices contracts. Hence, trade liberalisation leads to an (albeit imperfect) specialisation and a reallocation of production in each country, with every country specialising in products that rely intensively in production on the factor with which the country is relatively well endowed.

[16] In the original model, the two factors of production are capital and labour (Ohlin, 1933). However, to analyse the impact of trade on wage inequality and/or employment, labour is usually treated as a heterogeneous factor of production. Thereby, skilled labour can be seen as a complement for capital (e.g., Wood, 1994).

This process also implies a shift in the demand for factors of production in both countries. In the industrial country, there is an increased demand for skilled workers due to increased production of the human-capital-intensive good. On the other hand, fewer additional jobs for unskilled workers are created through the expansion of production of the skill-intensive good than are lost due to the demise of low-skilled-labour-intensive goods production. Consequently, an excess supply of less-skilled labour would prevail. When labour markets are flexible, the relative wages of unskilled workers are supposed to fall and, hence, wage inequality between high- and low-skilled workers rises.[17] Accordingly, wage flexibility is a necessary requirement to prevent unemployment of low-skilled workers, as it leads to the creation of new low-skill-intensive jobs in both industries, as companies increasingly implement skilled labour-saving methods of production.

More recent models take into account the possibility that workers might become unemployed in the course of industrial restructuring caused by the opening up of trade if relatively rigid labour market structures prevent the relative wages of unskilled workers from falling (e.g., Krugman, 1994). This issue might be particularly relevant when applying the Heckscher-Ohlin theory to Germany, as the country has been characterised by a relatively rigid labour market especially between the 1970s and the middle of the 1990s. Thus, if the expansion of trade with less-developed countries during that time has lowered the relative demand for less-educated workers, the impact would have been reflected rather in disproportionately growing unemployment rates than in an increase in wage inequality. However, since wages became more flexible during the 1990s, low-skilled workers might have increasingly felt the consequences of international trade in terms of relative wages.

3.1.3 Empirics

The question of how far and to what extent international trade affects the labour markets of industrial countries is the topic of a large body of empirical research. Profound empirical research on this elusive link between trade and the labour market started in the early 1990s. In the beginning, it was mainly motivated by the theoretical contributions of Heckscher-Ohlin

[17] In the country relatively well endowed with unskilled labour, the opposite should be observed.

and Stolper-Samuelson. Since that time, massive empirical research has been devoted to verifying the predictions of the Heckscher-Ohlin model regarding the distributional impact of international trade, ranging from simple judgments based on stylised facts to more sophisticated methodologies differing with respect to their assumptions regarding the transmission channels.

In the first wave of empirical literature, three methodologies have been of major importance: product price studies, factor content studies, and decomposition analysis. All of these methods aim (either implicitly or explicitly) at separating the impact of technical change from the impact of international trade. Clearly, each of the three methodologies has its deficiencies and even today there is no consensus on how to measure the influence of trade on labour markets adequately. As it is beyond the scope of the present study, these deficiencies will not be discussed in detail.[18]

Product price studies. The product price concept is one approach that has been widely used to apply the Heckscher-Ohlin theory to the existing data. According to Heckscher-Ohlin and Stolper-Samuelson predictions, changes in relative product prices are the central channel through which trade can influence domestic labour markets. Therefore, researchers conducting this approach use data on the prices of tradable goods to investigate whether increased imports from less-developed to advanced countries have led to a substantial fall in the relative prices of low-skilled-labour-intensive-, import-competing goods and, in this manner, substantially affected employment and/or wages of this skill group (Freeman, 1995).

The first product price studies aimed at testing whether prices of skilled-labour-intensive goods (e.g., chemicals, automobiles, and machinery) rose compared to prices of goods produced unskilled-labour-intensively (e.g., textiles, apparel, or footwear) in times of rising wage inequality or disproportionately growing unemployment of low-skilled workers (the so-called “Consistency Check”). This was mainly accomplished by regressing changes in prices observed in different industrial sectors on the share of low-skilled employees in these sectors. In cases where changes in prices of low-skilled-labour-intensive goods varied inversely with the employment share of this skill group, it was concluded that trade had at least partly

[18] For a discussion of these methodologies see, for instance, Wood (1995).

depressed wage and/or employment opportunities of low-skilled workers (e.g., Slaughter, 1999).

With respect to Germany, Heitger and Stehn (2003) examined the relationship between production worker's employment proportion and trends in supplier prices from 1970 to 1995 for 33 manufacturing industries. They did not find a strong relationship between price trends and labour intensity during that time and, hence, were not able to confirm the Stolper-Samuelson theorem's assertion that international trade contributed to the labour market outcome of low-skilled workers in Germany by decreasing the relative prices of unskilled-labour-intensive products. Similar conclusions for Germany were drawn by Neven and Wyplosz (1999), who use import prices instead of supplier prices. They analysed the period between 1975 and 1990. These results for Germany are basically in line with studies conducted on other industrial countries (e.g., for the U.S. see Bhagwati, 1991; Lawrence and Slaughter, 1993; Sachs and Shatz, 1994; for France, Italy and the U.K. see Neven and Wyplosz, 1999).

More subsequent and sophisticated versions of the product price concept have addressed one of the major deficits of this methodology, namely that product prices might be influenced by other forces besides trade, especially technical change. Leamer (1997) suggested a more advanced approach to estimate the effect of trade on wage inequality for the U.S. between the 1960s and the 1990s. He decomposed product price changes into various factors. Thereby, he explicitly allowed for technical progress affecting product prices and attempted to separate the effects of technology from the effects of "globalisation", using data on changes in prices and factor costs as well as on technological improvements (measured as the growth of total factor productivity).

Leamer's (1997) analysis comprised two-steps: In the first step, he estimated an equation that split changes in prices into changes in factor costs and in total factor productivity. This equation served as a foundation for separating the impacts of globalisation and technology in a second step. The estimation yielded a coefficient on factor costs which he called "mandated" changes in wages, and which were interpreted as the changes in factor costs required to yield a zero-profit condition across sectors in the face of changes in technology and product prices. These “mandated” changes in wages (factor costs) were then compared to changes that had been observed in reality. If the “mandated” changes in wages were consistent with changes in wages observed, the equation was considered to have accurately explained the trends in wages.

In a second step, Leamer (1997) decomposed actual changes in product prices into one component associated with technical progress and another component attributed to “globalisation” to disentangle the effects of both forces on product prices. First, he isolated the effect of changes in product prices induced by technological change. Thereby, he assumed a constant pass-through rate from total factor productivity growth to product prices for all sectors (i.e., that a given percentage of technological improvements is passed on to consumers in the form of lower prices). Having controlled for the impact of technical progress, Leamer (1997) attributed the residual variability in actual product prices to the term “globalisation”. To relate changes in product prices induced by globalisation to changes in mandated earnings, and thus to wage inequality, the component calculated for globalisation was regressed on factor shares of production. In his study, Leamer (1997) did not confirm the Heckscher-Ohlin and Stolper-Samuelson hypotheses for the U.S. in the 1960s and 1980s, but recorded a minor impact of globalisation on growing wage inequality during the 1970s.

Following Leamer’s approach, Fitzenberger (1999a) investigated the linkage between international trade and skill demand for 49 German industries between 1970 and 1990, using data on employment and wages from the Employment Sample of the German Federal Employment Agency (IABS). He put forward evidence supporting the supposition that trade had contributed to the disproportionate increase in unemployment rates of low-skilled workers during that time by decreasing the demand for this skill group and favouring the demand for high-skilled and medium-skilled workers.

Factor content studies. Instead of using data on prices of imports, factor content analysis uses data on trade flows as a proxy for price movements to measure the distributional effects of international trade (e.g., Borjas et al., 1992; Katz and Murphy, 1992; Sachs and Shatz, 1994; Kucera and Milberg, 2003). This approach is based on the idea that countries do not only exchange goods when trading with one another, but also factors of production embodied in these goods. Researchers applying this approach aimed at estimating the change in a country's "effective" labour endowment induced by trade. As a matter of fact, exported goods reduce the "effective" supplies of factors of production, whereas imports increase them. To measure how changes in trade flows affect a country's "effective" labour endowment, input coefficients are used to weight the observed changes in trade volumes. Thereby, the change in labour endowment resulting from a change in trade flows is calculated as the multiplicand of a matrix of sectoral labour skill inputs and a vector of changes in sectoral imports, minus exports. In some studies, changes in endowment are additionally transformed into changes in relative wages to measure not only the impact of trade on employment but also on wage inequality (e.g., Borjas et al., 1992; Katz and Murphy, 1992).[19]

Kucera and Milberg (2003) conducted factor content studies for 10 countries of the OECD, Germany among them. The period of examination for Germany, in particular, covers the years from 1978 to 1990. According to the estimates, there was a trade-induced net loss of 76,193 jobs in German manufacturing during this time. Considering that total employment losses in German manufacturing amounted to 272,667 in this period (Kucera and Milberg, 2003), trade was found to be responsible for around 28% of these losses. In their analysis, Kucera and Milberg (2003) further revealed that employment losses caused by trade could be entirely attributed to trade with less-developed countries, which led to the disappearance of 446,461 jobs. In contrast, trade with other advanced countries turned out to be beneficial and largely offset these losses by generating 370,268 additional jobs.

Factor content studies for other industrial countries deliver mixed results. In fact, these results vary strongly, with some studies unveiling only a modest impact of trade on employment

[19] If Germany, for instance, imports 8 additional units of t-shirts from abroad which are produced with an unskilled labour input coefficient of 0.5, there would be an estimated increase of 4 of the domestic "effective" endowment of unskilled employees (or alternatively, the demand for low-skilled workers would be reduced by 4), compared to the situation observed in the absence of trade, where those 8 units would be produced domestically (example adapted from Freeman, 1995). This shift in the balance of supply and demand of workers puts pressure on unskilled workers' wages according to the existing elasticity of substitution. In contrast, a trade-balancing flow of skill-intensive exports decreases the "effective" endowment of skilled labour (or alternatively, increases the demand for it), and thus increases relative remuneration for skilled workers. The difference between both estimates yields the net effect on the demand for skills as a consequence of trade. To establish a link between changes in labour demand and wages, the estimated shifts in quantities are transformed into changes in relative wages using available estimates of the elasticity of factor substitution from other studies analysing the impact of changes in supply and demand for skills on relative wage compensation. This might be, for instance, studies that examine changes on wages caused by an increase of employees with university degree (Freeman, 1995).

and/or wages (for the U.S. see Borjas et al., 1992; Katz and Murphy, 1992; Sachs and Shatz, 1994; for France see Cortes et al., 1995), and other studies showing that the impact is large (for the U.S. see Wood, 1994).

In how far factor content methodology is appropriate to measure the whole extent to which North-South trade affects labour markets remains an open question. Among the three methodologies introduced in this chapter, this method is the one most harshly criticised. Leamer (1995), for instance, claimed that trade volumes are not suitable to verify factor price equalisation as the essential of the Stolper-Samuelson theorem, considering that factor price equalisation is driven by product price equalisation and not by the size of trade flows. Consequently, even if a country's trade with developing or emerging economies is small or does not exist at all, the mere potential threat of imports from those countries is sufficient to reduce the prices of domestic goods to internationally competitive levels and thus to equalise the wages for each skill group across countries as well. In this regard, Lawrence and Slaughter (1993) further noted that even if increased competition from less-developed countries forces less-skilled employees to reduce their wages, domestic firms might still be able to keep their market share. Another point of criticism refers to the lack of a consensus regarding the utilisation of input coefficients to estimate the factor content of imports. Conducting factor content study for the U.S., Borjas et al. (1992) used input coefficients for advanced countries and found a weak impact of trade on relative wages in the U.S. Using the same data but input coefficients for developing countries, Wood (1994) calculated an effect of trade on labour demand that is 10 times higher than the one estimated by Borjas et al. (1992). As pointed out by Freeman (1998), the usage of different input coefficients explains the strong variation of results, ranging from "trade explains nothing" to "trade explains everything".

Decomposition analysis. A third method to measure the impact of trade on the labour market is the decomposition approach. This approach concentrates on the Stolper-Samuelson theorem's implication that trade liberalisation leads to a change in the mix of factor inputs used in production. Thereby, it is assumed that increased trade causes an expansion of industries experiencing relative increases in prices and a contraction of industries exposed to declining relative prices. Specifically, trade affects labour markets by shifting labour demand across industries.

In order to measure the impact of trade on the relative demand for skills and to separate it from other forces, first and foremost SBTC, changes in employment (or wage bill shares) of high-skilled workers are decomposed into within- and between-industry changes. The between-industry shift, which is considered to be particularly a consequence of increased international trade, is measured as the shift in product demand away from industries with high shares of low-skilled workers in their labour forces. In contrast, the within-industry shift, which is surmised to be mainly a consequence of labour-saving technological change, is measured by the shift from low-skilled to high-skilled employees within manufacturing industries (e.g., Berman et al. 1994; 1998).

In studies that conducted decomposition analysis, it was largely concluded that the shift away from unskilled to skilled workers has been mainly due to within-industry changes which, in turn, were predominantly attributed to SBTC. Using data from the United Nations General Industrial Statistics Database, Berman et al. (1998) reported this tendency for Germany as well as for other industrial countries during selected years of the 1970s and 1980s. Geishecker (2006) yielded similar results for Germany between 1991 and 2000 with data on production and non-production workers provided by the German Federal Statistical Office. As this insight delivers important implications for studying industrial skill upgrading in Germany, it will be dealt with in more detail in Chapter 7.

3.2 Skill-biased technical change

In order to explain rising wage inequality or the disproportionately growing unemployment rates of low-skilled workers, SBTC has been considered as another important factor. This phenomenon is broadly associated with the information and communication technology (ICT) revolution that started around the early 1980s and, hence, roughly coincided with the growing wage inequality or the disproportionately growing unemployment of low-skilled workers that many countries experienced since that time. At that time, technical innovations in the field of telecommunication and computer networking had spawned a number of sophisticated electronic products that induced a process of technical change and revolutionised the way many industries were operating (Card and DiNardo, 2002).

Despite the fact that it enabled firms to realise more flexibility in terms of the production structure and paved the way for productivity increases, the introduction of new technologies was accompanied by the fear that cost-reducing and labour-saving new technologies would lead to an automation of production processes, making many jobs redundant (Freeman et al., 1995). In this regard, low-skilled workers' jobs were supposed to be particularly threatened, given that innovations like the personal computer, computer-assisted production techniques and robotics were surmised to decrease the requirement for primarily physical and manual ability and, hence, primarily replace tasks previously performed by this skill group. At the same time, technical change was assumed to enhance the value of education by increasing the ability to be flexible and to acquire and process information. For this reason, it is commonly referred to as *skill-biased technical change* (Acemoglu, 2002; Katz and Murphy, 1992).[20]

3.2.1 Technical change in Germany

The world has experienced several technical revolutions, with all of them having far-reaching economic consequences. The discovery of steam power and electricity in the early nineteenth century, for instance, paved the way for the Industrial Revolution by generating power for factories, trains, and ships (e.g., Paqué, 2010). However, there are particular features and characteristics of the kind of technical change triggered by innovations in the field of ICT that make it differ from the kind of technical change that could be observed in the 19th century. As pointed out by Freeman et al. (1995): "*…, ICT is unique in affecting every function within the firm as well as every industry and services. Scientific and market research, design and development, machinery, instruments and process plant, production systems and delivery systems, marketing, distribution and general administration are deeply affected by this revolutionary technology* (Freeman et al., 1995, p. 588)".

As in many other industrial countries, production methods in Germany have changed tremendously since the 1980s due to the adoption of ICT into the manufacturing process. Especially the increased use of microelectronics in production processes (e.g., for controlling machines, automated handling, testing, and quality control or automated storage) has played

[20] Clearly, the implementation and adaption of new technologies in the working process might have reduced the demand for skilled people, but more disproportionately affected low-skilled workers.

an important role in SBTC. Based on an industry survey, Graham and Northcott (1995) delivered some facts and figures on the form and the extent of the usage of microelectronics in German manufacturing at the beginning of the 1980s. They found that technical diffusion reflected in the application of microelectronics-based product-equipment such as pick-and-place machines could be observed in all manufacturing industries. However, the usage of innovative production technologies at that time was particularly pronounced in printing and publishing, electrical and mechanical engineering, in the production of food and beverages, as well as in the chemical industry and metal production. By contrast, lower levels of use could be observed in the production of textiles, leather, and clothing.

Figure 3 delivers further information on the capitalisation of production. It illustrates the development of the investment ratio measured as the share of physical capital investment in industry turnover for selected German manufacturing industries between 1976 and 2007. Clearly, data on capital stock would be more appropriate to gain insights on capital accumulation and technical progress. However, due to the limited availability of longer time series on capital stock data, the study instead draws upon data on gross investments expressed as a share of turnover. Figure 3 shows that during the 1980s, all manufacturing industries recorded substantial increases in capital investment. Strong increases could be observed in printing and publishing, chemicals as well as food and beverages. Increases were relatively modest in the textile, apparel, and leather industries.[21] In the majority of manufacturing industries, the investment ratio reached a peak at the end of the 1980s or the beginning of the 1990s and dropped sharply thereafter. Despite some temporary rises at the end of the 1990s, investment ratios have been much lower in all industries in the decades after the 1980s.

In this regard, it should be noted that the low flexibility of wages in the lower segment of the labour market prevailing during the 1980s might have increased the incentive to automate production and to invent as well as implement labour-saving technologies such as conveyor

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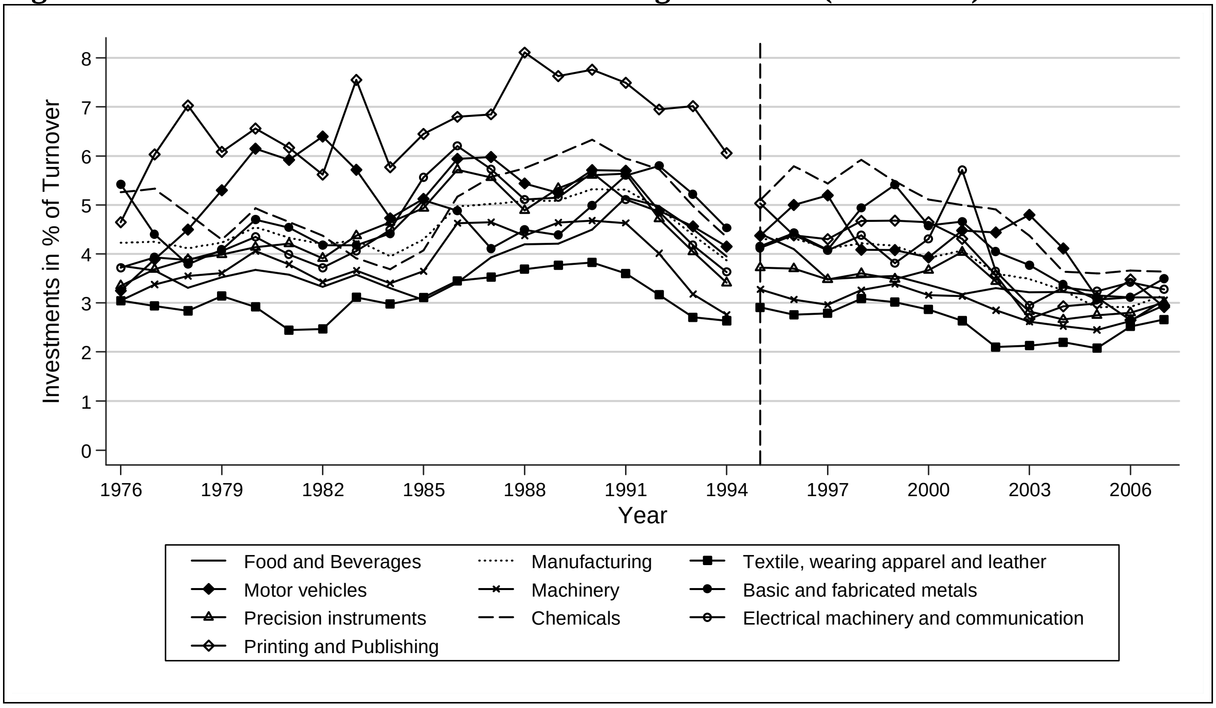
[21] Some industries (e.g., the motor vehicle and the printing and publishing industries) had already experienced considerable increases of investment during the 1970s. In fact, after a phase of reconstruction from the end of the 1940s until the end of the 1950s, and a phase of technical catching-up until the beginning of the 1970s (Bührer, 1995), the effort to systematically automate production through technical advancements (e.g., numerically controlled machine tools) could already be observed in the 1970s (Lay and Wengel, 1998). However, as public discussion on the wage and employment effects of technical change began in the 1980s, when sharp increases in unemployment rates coincided with the microelectronic revolution, the present study focuses on the technical evolution since that decade.

belts or automatic-control systems, as it prevented the wages of low-skilled workers from falling.

Figure 3: Investments in German manufacturing industries (1976-2007)



Source: Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.2.1; author's calculations. Notes: 1) Data capture gross investments in buildings, plants and machines as a share of industry turnover. 2) Figures between 1976 and 1994 refer to the former federal territory of western Germany. These data are classified according to the German SYPRO. 3) Figures for 1995 and later include eastern and western Germany. Data between 1995 and 2002 are delimited according to WZ 93-statistical frame and data from 2003 onwards according to WZ 2003.

Lay and Wengel (1998) emphasised that after the 1980s there were still efforts to optimise production techniques through the implementation of new technologies. However, since the 1990s the focus shifted toward the optimisation of organisations (e.g., administration, billing, designing, distribution, and marketing). Among other things, this was achieved through the implementation of new information technologies like the Internet. Apparently, the possibility to yield further efficiency increases in production by adopting new technologies has become much more limited in the decades since the 1980s.

3.2.2 Theory

Although there is broad consensus that technical change is biased against unskilled labour, SBTC is not defined precisely in the literature. This can be attributed to the fact that SBTC itself is a “black-box”, meaning that the reasons and mechanisms underlying the unskilled-labour-saving character of technical progress are widely unexplored (Chusseau et al., 2008). In fact, SBTC has many faces and can affect the demand for skills through several channels. As a consequence, the question of which mechanism makes technical change skill-biased remains controversial. Several transmission channels have been put forward to explain the unskilled-labour-saving character of technical progress.

One crucial aspect refers to whether the skill bias of technical change is exogenous or endogenous by nature. Earlier theoretical contributions on this issue introduced SBTC exogenously into the analytical framework (e.g., Acemoglu, 2002). In these contributions, the skill bias is supposed to be exogenous, with technical progress increasing the total relative demand for skills. Technical progress is thereby directly related to the utilisation of new information and communication technologies such as the computer. In other words, SBTC is considered as a process independent of other economic forces and merely triggered by scientific and technical progress (Katz and Murphy, 1992).

Two possible forms of SBTC have been the subject of extensive debate: factor-biased and sector-biased technical change (Haskel and Slaughter, 2002). In the case of factor bias, technical progress alters the productivity of production factors and induces a higher relative demand for skilled workers, thus provoking a substitution of unskilled workers by skilled workers within industries. In the case of sector bias, technical change is neutral in the production function, leaving the ratio between high-skilled and low-skilled workers intact. In fact, technical change is considered to increase total factor productivity, which is supposed to be higher in skill-intensive sectors of the economy than in unskilled-intensive ones. As production costs decrease, there is an incentive to shift production to the human-capital-intensive sectors.

Some authors consider the capital-skill complementary hypothesis as one of the key features of SBTC. This hypothesis, stating that the elasticity of substitution between (physical) capital and unskilled labour is higher than between capital and skilled labour, has already been formalised by Griliches (1969) and supported by other authors such as Nelson and Phelps (1966) and Welch (1970). In the context of the SBTC hypothesis, it is argued that technical advances in ICT, embodied in sophisticated capital equipment such as computer-assisted production techniques, tend to complement skilled workers and to substitute labour-intensive tasks. Consequently, if technical progress enhances the usage of capital through the increased introduction of machinery, equipment and components which incorporate new technology in the production process, the higher usage of capital as a carrier of technology will induce an increase in the relative demand for skilled workers (e.g., Krussel et al., 2000).[22] As Chusseau et al. (2008) put forward, technical progress can increase the demand for capital in production through a factor bias toward capital. Or, alternatively, technical change might enhance the usage of capital in production through a sectoral bias that leads to an improvement in productivity and thus lowers costs of production in the capital goods industry. Given that this process implies a drop in the price of capital goods, the substitution of low-skilled for high-skilled workers is fostered further.

More recent contributions on SBTC claim that technical change is not necessarily skill-biased by nature, but that the degree of skill bias is determined endogenously and the result of incentive-driven decisions by economic agents. These studies try to determine whether skill bias has permanent effects or is only a temporary phenomenon. Regarding the former, it is argued that new technologies can be the result of profit-incentive-driven decisions by entrepreneurs reacting to an increased supply of skilled labour (e.g., Acemoglu, 1998; 2002). In particular, it is pointed out that the larger supply of skilled labour caused, for instance, by an expansionary educational policy that many industrial countries experienced after the Second World War, is an inducement to the development and implementation of technologies

[22] It is worth noting that the relationship between capital and skilled labour has not always been complementary. Goldin and Katz (1998), for instance, single out the example of Britain in the nineteenth century, where the replacement of skilled artisan shops by factories and later by assembly lines was characterised by a substitution of capital and/or unskilled workers for skilled artisans. In other words, previously complex tasks were simplified by breaking them down into smaller and fewer skill-requiring steps which, in turn, reduced the demand for skills. Hence, the process of technical change and its impact on the demand for certain skills observed at that time can be described as the opposite of what is observed during the ICT revolution in the twentieth century. Caselli (1999) describes this phenomenon as de-skilling technical change.

that are skill-complementary. Consequently, there is a technology response toward a higher endowment of skilled labour in the long run, with research activities directed toward skill-based technologies that, in turn, increase the demand for skills.

Theoretical studies that consider the skill bias of technical change to be transitory often argue within the context of general purpose technology. More specifically, the introduction of general purpose technology (such as ICT) into the working processes of firms requires special capabilities and knowledge, considering that workers have to spend time on learning how to use these technologies. Hence, although in the long run all workers can adapt to new technologies, there is an increased demand for high-skilled workers in the short run, as they are assumed to adapt faster to changing technical labour conditions and to implement new technologies more quickly (e.g., Caselli, 1999; Galor and Moav, 2000).[23]

Regarding the relationship between SBTC and international trade, the independence of each of these forces from the other has increasingly been questioned. As expressed by Wood (1994), both forces are most likely interrelated phenomena that stimulate each other. On the one hand, international competition accelerates the development and the spread of new technologies, as companies are eager to improve production techniques or product designs to become more competitive. Consequently, trade can be considered as a channel for technical upgrading. In turn, new technologies influence the pattern of trade, for instance, through improved communication technologies and reduced transportation costs. Clearly, this interaction between international trade and technical change makes it difficult to measure precisely each variable's impact on skill demand.

3.2.3 Empirics

An extensive number of empirical studies are dedicated to the linkage between technical change and skill demand. Thereby, most studies focus on the verification of the capital-skill complementary hypothesis. Very often, factor demand equations are estimated by

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[23] The fact that skills facilitate acquiring and processing information has also been emphasised by Nelson and Phelps (1966). In addition, the advantage of skilled workers in coping with rapid technical change has already been empirically documented by Bartel and Lichtenberg (1987).

incorporating indicators that are closely associated with the process of technical change (e.g., use of computers, physical capital, research and development (R&D) intensity, size of the ICT sector, or patent activities). The idea that technical innovations in the field of ICT (e.g., computers) are skill-enhancing has been well documented with respect to the U.S. (e.g., Krueger, 1993; Autor et al., 1998) and has also been confirmed for a range of other industrial countries (e.g., for the U.K. see Haskel and Heden, 1999). The view of skilled labour and capital as being relatively more complementary as inputs than unskilled labour and capital has also been expounded in several empirical studies (for the U.S. see Hamermesh, 1986; Krussel et al., 2000; and for a large range of countries see Duffy et al., 2004).

Studies for Germany basically support the tendency toward a significant impact of technical change on skill demand. On the basis of the Qualification and Career Survey, Spitz-Oener (2006) investigated how skill upgrading has been affected by computerisation for selected years between 1979 and 1999.[24] She used data on task composition of occupations to measure skill requirements and found that the requirement for non-routine cognitive tasks (e.g., reasoning, perception, and intuition) and interpersonal skills had particularly increased in those occupations where the spread of computer technologies was most pronounced. By contrast, the demand for routine cognitive tasks that are not very complex (e.g., routine manual or clerical skills) had declined in those sectors. Falk and Koebel (2004) similarly confirmed that computers had substantially increased the demand for high-skilled and medium-skilled workers in German manufacturing between 1978 and 1994, using national account data and data on skill groups provided by the German Federal Statistical Office. In another study, Falk and Koebel (2001) concentrated on the substitution pattern between capital, materials and different types of skill groups. They attributed between 6% and 13% of the shift toward high-skilled labour that was observed in German manufacturing between 1976 and 1995 to capital accumulation.

Much of the literature on SBTC is closely related to the literature on North-South trade and aims at quantifying the impact of both forces on wages and employment. From earlier literature on this issue it can be conjectured that SBTC is considered to be the driving force of

[24] The Qualification and Career Survey is a survey of employees carried out by the German Federal Institute for Vocational Training (BIBB) and the IAB (Spitz-Oener, 2006).

changes in skill composition in many industrial countries (e.g., Berman et al., 1998; Machin and Van Reenen, 1998). On the one hand, this result has been obtained by direct estimates, namely by adding variables into the factor demand equation that capture international trade (e.g., share of imports from development countries). On the other hand, decomposition analysis has been conducted to determine whether the employment shift away from low-skilled workers has been within or between industries (e.g., Berman et al., 1994; Machin and Van Reenen, 1998; and Berman et al., 1998), as already pointed out in Section 3.1.3. The large contribution of within-industry adjustments to changes in skill composition was thereby interpreted as pointing to the predominance of SBTC over North-South trade.[25]

Whereas decomposition analysis for Germany provides pervasive evidence for the SBTC hypothesis (Berman et al., 1998; Geishecker, 2006), direct estimates are less clear-cut. Fitzenberger (1999b) analysed trends in prices, total factor productivity, wages and employment for selected German industries between 1970 and 1990, drawing information on different types of labour from the IABS. He discovered that international trade dominated the demand effects for low-skilled workers, whereas technical change dominated the demand effects for high-skilled workers. Ochsen and Welsch (2005) focused on German manufacturing for the period from 1976 until 1994 and used data on skill groups from the Education Accounts (Bildungsgesamtrechnung). They estimated a system of factor share equations for low-skilled labour, high-skilled labour, capital, energy, and materials, and they found that the impact of trade on the skill structure of employment is small compared to the influence of SBTC. Kölling and Schank (2003), however, concluded that the skill structure of employment is primarily determined by wages. They considered SBTC and international trade to have only a minor impact when unobserved plant heterogeneity is controlled for. Kölling and Schank (2003) examined the years between 1994 and 1997 on the basis of the Linked Employer-Employee Panel Data Set (LIAB) provided by the IAB.[26]

[25] In fact, SBTC might either cause within-industry or between-industry adjustments, depending on whether it is factor-biased or sector-biased (Haskel and Slaughter, 2002). Consequently, the large within-shift implies the predominance of factor-biased SBTC.

[26] The LIAB combines information from the German employment statistics and the IAB establishment panel (Kölling and Schank, 2003).

3.3 Summary

In the early years of research on this topic, several attempts were made to measure the impact of international trade on wages and employment. Some researchers tried to establish the impact of trade on relative wages through changes in relative commodity prices, whereas others focused on trade flows and estimated the factor content of imports less that of exports to analyse the net effect of trade on the relative demand for skilled and unskilled labour. A third approach used information on input mixes in production at an industrial level to evaluate whether trade liberalisation had shifted input mixes between sectors.

A majority of studies for Germany as well as for a range of other industrialised countries concluded that the relative prices of labour-intensive goods did not decrease sufficiently to explain the strong increase in wage inequality or the disproportionately growing unemployment rates of low-skilled workers. Similarly, factor content studies revealed that despite increased international trade with newly emerging markets, the share of imports from these countries within advanced countries' foreign trade was too small to have a substantial impact on the skill structure of employment in advanced countries. Last but not least, the shift away from low-skilled toward high-skilled workers has been mainly due to within-industry changes rather than between-industry changes. Hence, despite some disagreements about the appropriate methodology, it was conjectured that increased import penetration from less-developed countries plays some role but is not the main driving force behind increased wage disparities and/or the disproportionately growing unemployment rates of low-skilled workers in advanced countries. Instead, more weight has been attributed to SBTC.

4. International trade and skill demand: New answers to old questions

The overwhelming empirical support in the literature of the 1990s for the pre-eminence of unskilled-labour-saving technical change and the modest role of North-South trade in furthering the demand for skills has been questioned by more recent contributions. In fact, very soon it was recognised that the internalisation of markets for goods and services has many facets and might influence labour markets through several channels. More recent studies accounted for other essential features of international trade which had been omitted in the Heckscher-Ohlin framework. In contrast to earlier empirical research on this issue, more recent studies focused less on the role of imports in the form of finished goods that replace domestic production (and employment) when analysing the impact of trade on wages and employment. Instead, growing trade in intermediate imports, commonly referred to as international outsourcing, has been introduced into the theoretical and empirical literature as an alternative explanation to SBTC.

Another substantial drawback of the Heckscher-Ohlin model - one which has been less highlighted in the literature - is the assumption that traded goods are homogeneous. Particularly when countries become more advanced, there is an increased demand for product variety among the population (Rübel, 2008). New trade theory addresses this deficiency of the Heckscher-Ohlin model by accounting for the presence of heterogeneous products. In fact, a growing portion of trade literature focuses on such trade between countries that comprises the exchange of products belonging to the same sector. This type of trade is usually referred to as *intra-industry trade* or *two-way trade* (Grubel and Lloyd, 1975). Within intra-industry trade, there is a distinction made in the literature between horizontal intra-industry trade (HIIT) and vertical intra-industry trade (VIIT) (Greenaway et al., 1994; Fontagné and Freudenberg, 1997; Fontagné et al., 1997). The former refers to varieties of one product group that differ with respect to their product attributes (e.g., suits with different styles or colours) and the latter to varieties that differ with respect to their quality (e.g., low-quality suit vs. high-quality made-to-measure suit).

Section 4.1 provides some stylised facts on German outsourcing activities. Additionally, it briefly outlines changes in German outsourcing patterns and the findings of the theoretical and empirical literature on the linkage between outsourcing and skill demand. Sections 4.2 and 4.3 are concerned with HIIT and VIIT trade, respectively, with the focus clearly directed toward the latter. These sections illuminate both categories of intra-industry trade with respect to their impacts on the demand for skills.

4.1 International outsourcing

In the mid-1990s, the fragmentation of production across borders, often referred to as "international outsourcing" or "outsourcing", was identified as another potential "job killer" and introduced into theoretical and empirical analysis within the *trade versus technology* literature as an alternative explanation to SBTC. *International outsourcing* describes a process in which firms delocalise certain production stages to other countries, either through an "in-house" operation by establishing foreign subsidiaries or by cooperating with independently owned foreign firms (i.e., subcontracting) (OECD, 2007). In fact, in the literature on trade theory, several terms have been used to describe the process if one or several production activities are not located in the home country. Most common are the terms "international outsourcing" or "outsourcing" (Feenstra and Hanson, 1996a). More recently, it has also been referred to as "offshoring" (OECD, 2007). However, other terms, such as "international fragmentation of production" (Jones and Kierzkowski, 1990), "delocalization" (Leamer, 1997), "disintegration" (Feenstra, 1998), and "vertical specialisation" (e.g., Hummels et al., 2001) are used to describe the same phenomenon (see Hijzen et al., 2003).

Outsourcing is alleged to pose a threat to low-skilled workers within industries, as companies tend to outsource unskilled-intensive activities of production (such as work on assembly lines) rather than skill-intensive activities (like marketing, sales, or R&D) to foreign countries (e.g., Feenstra and Hanson, 1996a; 1996b; 1999). In many industrial countries, the observation that domestic companies move across the border to take advantage of lower wages in less-developed countries provoked rising public (and political) resentment against globalisation and particularly drew opposition to the integration of newly emerging markets into the world economy.

4.1.1 German outsourcing activities

The exploitation of wage differences between the home country and foreign countries is one prime motive of firms in advanced countries for relocating stages of the production process abroad. Primarily due to this motive, outsourcing has become a focus of intense debate and a persistent issue of concern in many industrialised countries (e.g., Kohler, 2004). However, despite the incentive to reduce labour costs, the decision to choose alternative locations of intermediate goods production abroad is influenced by several other factors. These factors affect a company's choice with respect to the target country to which production stages are relocated. One motive that has recently gained importance, particularly regarding the decision to outsource to emerging markets, is that outsourcing offers the possibility to tap into new markets and, in addition, helps to secure existing businesses in foreign markets (Hollekamp, 2005). Nevertheless, a partner country's level of taxes on profits, tariffs (Egger and Egger, 2005a; 2005b), social charges, as well as differences in administrative costs and expert salaries (Adler, 2004) might also influence a firm's decision to engage in international outsourcing. Apart from that, factors such as quality improvements, reduction of other-than-labour costs, access to intellectual property, gains in knowledge and experience (Hamilton and Quinlan, 2009), or economies of scale and synergy effects (Geishecker, 2006) might play a role, especially when advanced countries outsource to other advanced countries.

Although increased foreign sourcing activities of firms in advanced countries could already be observed since the early 1980s, international sourcing is predominantly a phenomenon of the 1990s (Hijzen et al., 2003). Throughout the 1990s, German companies' imports of components or assembly from newly emerging economies in Southeast Asia (e.g., China) as well as from the re-integrated Central and Eastern European countries (CEEC) grew significantly. Especially the latter have become preferential destinations for German outsourcing activities. After the fall of the Iron Curtain and decades under socialist regimes, CEEC have undergone a period of political and economic transition characterised by profound structural changes and extremely dynamic economic development. During this process, they opened up to global capital markets, hence increasing the investment opportunities for German companies. In particular, the Association Agreements with the EU in the early years of the 1990s paved the way for an expansion of Germany's economic relationship with these countries. Compared to Asian countries, economies in Central and Eastern Europe are attractive due to their geographical as well as cultural proximity, which reduces transportation costs and delivery time, and facilitates communication and coordination (Booker, 2007). In addition, these countries are characterised as having a relatively large pool of skilled labour compared to many other emerging markets (Kerkoff, 2005). Poland, the Czech Republic, and Hungary each is a major focus of German direct investment in Central and Eastern Europe (e.g., Kinkel and Maloca, 2008).

During the 1990s, German production sharing with China also intensified considerably. After years of a closed-door policy, China launched a process of economic liberalisation starting in the late 1970s. Since that time, the Chinese government has been implementing a series of structural and institutional reforms, among them the liberalisation of the conditions for Foreign Direct Investments (FDI) to make foreign investments in China more attractive (Yan, 2005). In addition, due to China's large amount of unskilled labour and very competitive wages, sourcing intermediates from China appeared to be appealing (Mion et al., 2010). Whereas advanced countries' investors could take advantage of the new market and cheaper production costs, increased foreign investment allowed China to gain access to new technology and products and to increase the skill level of the labour force. This, in turn, was and is still an important prerequisite for China's development process and economic growth. The same can be said for newly emerging markets from Middle and Eastern Europe.

The debate about outsourcing in Germany is very often based on anecdotal evidence and the description of individual cases where companies have outsourced particular stages of their production process abroad. However, lack of a precise definition as well as detailed and systematic data hampers the empirical measurement of outsourcing and, hence, makes it difficult to examine this phenomenon (OECD, 2007). In order to capture the common trends in industrial activities and entrepreneurial strategies at the same time, the present analysis draws upon official statistics as well as representative surveys.

One indicator that is closely linked to international sourcing activities is FDI (OECD, 2007). Table 3 shows German FDI stock for the years 1991, 1995 and 2005, by target country. Data have been taken from the German central bank (Deutsche Bundesbank, 1998; 2010).

Although the table illustrates that until today, the German FDI is largely directed toward major Western European countries (denoted as EU15) and the U.S., the figures clearly depict Germany's intensified engagement with newly emerging markets between 1991 and 2005: In 1991, the German FDI directed toward CEEC and China did not reach even 1% in total FDI. Instead, nearly 80% of German FDI stock was concentrated on EU15 countries and the U.S. However, FDI shares of CEEC and China experienced gradual increases in the years thereafter, especially at the expense of FDI toward EU15 countries. In 2005, the shares of the German FDI in CEEC and China made up 6.51% and 1.39%, respectively.

Table 3: German Foreign Direct Investments (1991-2005)

Year	Total	Share in total (in %)				
	FDI Stock (in Mio DM/EUR*)	EU15	CEEC	China	USA	Other Countries
1991	262,670	55.48	0.59	0.13	22.80	21.00
1995	384,779	54.89	2.85	0.41	21.68	20.16
2005	786,207	45.78	6.51	1.39	29.77	16.55
	Employees (in 1000)					
1991	2,408	42.65	2.82	0.37	19.98	34.18
1995	2,834	40.08	9.46	1.41	18.17	30.88
2005	4,996	33.47	16.87	4.66	16.35	28.64
	Enterprises					
1991	20,895	56.21	1.61	0.18	12.43	29.57
1995	23,369	52.38	7.68	0.73	11.65	27.57
2005	24,188	42.85	12.09	3.28	14.51	27.27

Source: Deutsche Bundesbank (1998, 2010); author's calculations. Note: * Total FDI stock is given in DM for 1991 and 1995 and in EUR for 2005. The values are in nominal terms due to a lack of appropriate deflators for foreign FDI stocks; EU15 include Austria, Belgium, Denmark, Finland, France, Greece, Italy, Ireland, Luxemburg, the Netherlands, Portugal, Sweden, Spain, United Kingdom (and Germany which is the reporting country); CEEC comprise Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

Germany's increased engagement with newly emerging markets is even more strongly reflected in the rising share enjoyed by these countries with respect to the number of German enterprises abroad as well as the number of employers associated with these enterprises (Table 3). The share of affiliate employment in CEEC and China increased from 2.82% and

0.37%, respectively, in 1991 to 16.87% and 4.66%, respectively, in 2005. Similarly, the share of foreign affiliates in CEEC and China amounted to 12.09% and 3.28%, respectively, in 2005, compared to only 1.61% and 0.18% in 1991.

One major shortcoming of using FDI is that the data do not include subcontracting activities. Therefore, another way of measuring outsourcing activities is the usage of input-output tables or the exchange of intermediate inputs (OECD, 2007). Geishecker (2006) analysed outsourcing activities in German manufacturing between 1991 and 2000, using information on industries' imports of intermediate inputs from abroad with data provided by the OECD. The study revealed that although outsourcing activities with newly emerging markets, especially with CEEC, have been growing steadily during the 1990s, a large majority of German intermediate inputs are still sourced from other advanced, especially EU15 countries. This result completes the insights derived from Table 3 and is interesting insofar as it is very much in contrast to the common belief that German outsourcing activities are primarily directed toward newly emerging markets. The result further shows that German firms also have motives other than cost-saving when engaging in outsourcing activities abroad.

Geishecker (2006) shows that the propensity to outsource stages of production abroad varies significantly across industries. Outsourcing intensity is thereby calculated as the value of a domestic industry's imported goods from all manufacturing industries abroad as a share of the industry's production value. Geishecker (2006) identifies relatively high levels of outsourcing intensity of up to 40% in the production of office and computing machinery, transport equipment other than motor vehicles (e.g., ships, airplanes), and clothing. Whereas industries such as the manufacture of radio, TV and communication equipment, the textile and leather industry, and the pulp and paper industry all show medium levels of outsourcing intensity of around 20%, in industries such as printing and publishing, non-metallic mineral products (e.g., glass, ceramics), the production of fabricated metals, or the wood industry, outsourcing intensity does not exceed 10% during the time period under consideration. However, Geishecker (2006) revealed that for almost all manufacturing industries, outsourcing intensity increased during the 1990s.

Insights on outsourcing activities of German manufacturing industries can also be obtained from a range of surveys conducted by the Frauenhofer Institute for Systems and Innovation Research (FISI) in 2003, 2006 and 2009 (see Kinkel and Lay, 2004; Kinkel and Maloca, 2008; 2009, respectively, for each of the survey years). According to these surveys, the industries most active in outsourcing are the motor vehicle industry, the electrical machinery industry, and the textile, apparel and leather industry. The midfield ranges from the engine building industry and the production of rubber and plastics to the production of metal and metal products, and the chemical industry. Relatively low outsourcing activities are recorded for the food and tobacco industry, as well as pulp and paper. As the surveys for different years indicate, this sector-specific behaviour has remained remarkably stable over the years.

This picture can be completed by another survey conducted by the FISI in 2004, where certain characteristics of companies with a higher propensity to outsource segments of their production abroad have been identified (Kinkel and Lay, 2004). According to the survey, this propensity is the higher, the larger the companies are, the lower the integration in local cooperation and the lower the share of R&D expenditures in relation to turnover. Beyond that, foreign procurement activities tend to be lower for products that show high complexity. Apparently, it is more difficult to automate production processes in this case. Additionally, the production of products that are more complex requires a larger number of skilled employees.

One further trend worth mentioning is the observation that a range of German companies that once outsourced, has *insourced* or *backsourced* parts of the production sourced from abroad. According to the survey of the FISI conducted in 2006, one out of four to six companies has made use of the option to insource production stages between 2004 and 2006 (Kinkel and Maloca, 2008). Backsourcing occurs on average four to five years after relocation and has been particularly pronounced in the motor vehicles industry, the production of rubber and plastics, the engine building industry, as well as the chemical industry. Prime motives for backsourcing have been losses in flexibility and the ability to supply, as well as quality problems. Too-high coordination and communication costs, infrastructure problems, and the limited availability of qualified personnel have all been mentioned as additional reasons.

4.1.2 Theory

If people were asked whether outsourcing destroys jobs or lowers wages, a large number of observers would presumably answer these questions with “Yes”. Indeed, the concern that outsourcing by firms in industrialised countries might destroy jobs and depress wages has been frequently expressed by the public, mass media, politicians and economists. Very often, this fear is backed up with anecdotal evidence about firms shutting down production sites and sourcing inputs from abroad, particularly from newly emerging countries. A representative survey carried out by the German Allensbach Institute in 2006, for instance, revealed that 78% of the people surveyed believed that “globalisation” leads to a displacement of domestic jobs, particularly with low-skilled jobs in mind (IFD Allensbach, 2006).

From a theoretical point of view, earlier models on international outsourcing supported the general perception that increased globalisation in the form of fragmentation of production poses a threat to low-skilled workers. The most prominent and most cited model had been developed by Feenstra and Hanson (1996b), who analysed the impact of outsourcing on low-skilled workers in the context of standard trade theory. In a North-South framework, they assumed that different factor endowments, and hence different relative factor prices for low and high-skilled workers, prevail in the North and the South. In addition, a single manufactured final good is produced by a continuum of inputs that differ with respect to skill intensity. Due to lower relative wages of high-skilled workers, the North has a comparative advantage in the production of high-skilled intensive intermediates. As a consequence of Hicks-neutral technological progress, the new inputs outsourced to the South become increasingly skill-intensive, hence reducing the comparative advantage of the North. In turn, the North specialises in the production of increasingly skill-intensive inputs which, subsequently, further reduces the relative demand for less-skilled workers.

However, the view that outsourcing adversely affects unskilled workers has been challenged by more recent theoretical contributions, and certain conditions have been identified where low-skilled workers in industrial countries might even benefit from outsourcing (e.g., Arndt, 1997; Venables, 1999; Jones and Kierzkowski, 2001; Kohler, 2004). Most notably, Arndt (1997) and Kohler (2004) argued that sourcing intermediates from low-wage countries is one strategy for higher profitability and allows companies to obtain efficiency gains by specialising in certain core competencies. Thus, relocating stages of production might ensure corporate survival since it enables producers to strengthen their competitive positions in international markets for end products.

Arndt (1997) concentrated on outsourcing activities undertaken by the labour-intensive import-competing sector of an industrialised country. According to the author, outsourcing may raise (nominal and real) wages in the import-competing industry, given that producers can increase competitiveness in world markets for end products by outsourcing the relatively inefficient stages of the production abroad. The attendant decrease in labour and, hence, production costs make producers increase output. This increases the demand for labour relative to capital (at a given relative labour-intensity) and, thus, leads to an increase in wages relative to capital rents, not only in the import-competing industry but throughout the economy.[27] With respect to the overall effects on jobs, Arndt (1997) showed that due to a higher production of the import-competing good, the import-competing industry employs a larger amount of labour and capital than before outsourcing has been undertaken. The resources are drawn from the other sectors of the economy.

Kohler (2004) explored the implications of outsourcing for wages and employment in a general equilibrium model. He demonstrated that the decrease in the demand for low-skilled workers caused by relocating certain stages of production abroad might be compensated for by other effects, considering that (i) cost savings associated with outsourcing allow firms to pay higher rewards to domestic factors of production; and (ii) there might be additional demand for low-skilled workers employed in those stages of the production that have not been outsourced (through an increase in output), or workers might find jobs in another sector of the economy. Whether labour benefits or not depends on the relation between the outsourcing industry and other sectors of the economy. If the production stage that is moved abroad is more capital-intensive than a second domestic industry, domestic wages may rise, although adjustment brings along more outsourcing. However, if the production stage that is moved abroad is less capital-intensive, any stages that have been outsourced previously may even be

[27] Note that higher relative wages induce a substitution of capital for labour in both industries (Arndt, 1997).

backsourced again. This process may also increase domestic wages. If the outsourcing industry as a whole is more capital-intensive than the other industry, domestic wages will rise.

4.1.3 Empirics

Apparently, the consequences of international outsourcing for low-skilled workers in advanced countries appear to be ambiguous from a theoretical point of view, depending on the modelling and underlying assumptions. Consequently, whether low-skilled workers gain or lose from international sourcing seems to be an empirical question after all. Empirically, the influence of outsourcing on employment and/or wages is mostly investigated by estimating cost functions and including measures of international outsourcing into the set of explanatory variables, as suggested by Feenstra and Hanson (1996b; 1999) in their seminal contributions.

For Germany, empirical research on the linkage between the international fragmentation of production and the relative demand for unskilled workers paints a diverse picture. Applying a translog cost function approach and drawing upon manufacturing and employment data provided by the German Federal Statistical Office, Geishecker (2004) found no significant impact of outsourcing on production workers’ wage bill share in German manufacturing between 1978 and 1993. However, when conducting regressions for each of the 29 two-digit manufacturing sectors separately, Geishecker (2004) identified a contribution of outsourcing to the decrease in production workers’ wage bill share in the electrical machinery, chemicals, office and computing machinery as well as the paper and pulp industries. In these industries, outsourcing is estimated to account for between 14% and 47% of manual workers’ decrease in the wage bill share that could be observed during that time. The results, however, should be interpreted with caution, considering that separate regressions had been carried out with only nine observations per industry.

Ochsen and Welsch (2005) estimated a complete system of factor share equations for low-skilled workers, high-skilled workers, capital, energy, and materials, merging national account data with data on skill groups from the Education Accounts. They found that intermediate inputs (especially materials and energy) substituted for relatively expensive low-skilled workers in the West German production sector during 1976 and 1994. Apparently, rigid wages in Germany, which prevailed until the middle of the 1990s, have fostered companies' incentives to outsource stages of the production process abroad, given that the low flexibility of wages in the lower segment of the labour market has prevented the downward adjustment of wages. In order to save labour costs, firms have increasingly shifted low-skilled intensive stages of the production process abroad. However, Ochsen and Welsch (2005) stated that this substitution effect was compensated for by a positive impact on low-skilled workers arising from a trade-induced change in the aggregate output mix that resulted from growing exports of low-skilled intensive products. The study by Ochsen and Welsch (2005) left it unclear whether low-skilled workers gain or lose in total from outsourcing.

With data from the German Socio-Economic Panel (GSOEP) for the 1990s, Geishecker and Görg (2008) estimated variants of a log wage equation for 21 two-digit manufacturing industries. They recorded a significant negative impact of outsourcing on real wages of low-skilled workers and found evidence that high-skilled workers were favoured in terms of higher real wages between 1991 and 2000. Geishecker (2006) investigated the same time period, including 22 two-digit German manufacturing sectors in an analysis based on the OECD data. He detected that increased German outsourcing activities toward CEEC have been especially detrimental to low-skilled workers, having reduced their wage bill share by 2.7 percentage points between 1991 and 2000. By contrast, he found no impact of outsourcing toward EU15 countries and a small negative effect for outsourcing toward countries outside Central and Eastern Europe and the EU15.

Whereas the linkage between outsourcing and skill upgrading in Germany is not clear-cut from an empirical point of view, evidence for other advanced countries appears to be less ambiguous. A number of studies provide evidence of a significant negative impact of outsourcing on the labour market position of less-skilled employees (for the U.S. see Feenstra and Hanson, 1996b; 1999; for France see Strauss-Kahn, 2004; for the U.K. see Hijzen et al., 2003; Anderton and Brenton, 1999; and for Austria see Egger and Egger, 2005a). However, although empirical results indicate that international trade plays a greater role in explaining the labour market outcome of low-skilled workers in advanced countries when trade in intermediate inputs is considered, the quantitative importance of outsourcing is much lower than expected (Kohler, 2008).

4.2 Horizontal intra-industry trade

Another issue that has received much less attention in the literature on trade, wages and employment, is the potential impact of intra-industry trade (i.e., the exchange of products belonging to the same product category) on the demand for skills. Effective research on intra-industry trade already started in the 1960s. Although the phenomenon of intra-industry trade had already been recognised by Ohlin (1935) and Hilgerdt (1935), its origin is primarily associated with its initial empirical revelation by Verdoorn (1960), Dréze (1961), and Balassa (1966), in the context of European integration following the creation of the Common Market in the late 1950s (Greenaway, 1987). At that time, the establishment of the Common Market had initially raised fears in various member countries that trade liberalisation might foster the demise of particular industries as predicted by the Heckscher-Ohlin model, and thus threaten domestic employment. However, empirical findings on the development of trade patterns in the post-war period were not consistent with these predictions. Instead, it was observed that export partners within the Benelux customs union, and thereafter within the six founding members of the European Economic Community (i.e., Benelux, France, Italy and Germany), became more uniform after tariffs had been reduced. Apparently, trade liberalisation between these countries entailed the specialisation of countries in a narrow range of products within industries, rather than the specialisation of countries in certain industries as suggested in the Heckscher-Ohlin model (Fontagné and Freudenberg, 2002).

4.2.1 Theory

As traditional explanations failed to explain the emergence of trade patterns, new trade theory models were developed at the end of the 1970s and the early 1980s to explain the rise of trade in products belonging to the same industry and to provide a more realistic picture of reality. Despite the assumption that products are homogeneous, this literature also aimed at relaxing some other central assumptions of traditional trade theory, such as the idea that there is always perfect competition, constant returns to scale, and identical consumer preferences. The first theoretical studies dedicated to intra-industry trade primarily equated this type of trade with horizontal intra-industry trade (HIIT) (Krugman, 1979 and 1980; Lancaster; 1980). When products are horizontally differentiated, commodities in the same statistical group are characterised by different attributes, such as colour or design, but do not differ significantly with respect to product quality. In other words, one product is not better than the next, but consumers simply have different preferences for them (Lancaster, 1980).

What all of these models on (horizontal) intra-industry trade have in common is that on the supply side they assume the presence of (internal) economies of scale in production and, hence, some kind of imperfect, monopolistic competition. Specifically, it is assumed that (i) firms are able to differentiate their products, thus enjoying some kind of protection from their competitors; and that (ii) firms take the prices of rivals as given and ignore the impact of their own prices on their competitors (e.g., Krugman, 1979; 1980). In addition to specifying supply-side characteristics, the models explicitly take demand-side considerations into account to explain the nature of intra-industry trade. In particular, it is assumed that there is a demand for variety, either because each consumer likes to have products in many varieties (Krugman, 1979; 1980) or because there are different tastes among consumers, with each consumer demanding a certain variety of a product (Lancaster, 1980).

On the basis of these assumptions, pioneering contributions by Krugman (1979; 1980) and Lancaster (1980) provided a theoretical basis to explain the phenomenon of intra-industry trade in a two-country setting. These models conclude that gains from trade emerge because (i) trade enlarges the market in which firms can operate and allows them to exploit economies of scale, which results in decreasing costs and prices; and because (ii) there is a larger amount of varieties of a certain commodity available for the consumers in each country after trade is liberalised. In contrast to the traditional Heckscher-Ohlin model, monopolistic competition models show how efficiency and welfare gains from trade can even arise when countries with similar tastes, technology, and factor endowments are trading with one another. Thus, in contrast to the Heckscher-Ohlin model, which serves to explain primarily trade between countries that are differently endowed with certain factors of production, models of intra-industry trade can explain why there is substantial trade between advanced countries. More specifically, the models suggest that countries with small differences in per-capita income and similar factor endowments also exhibit similar consumer preferences, which, in turn, opens up possibilities for trade in horizontally differentiated products.

Linder (1961) already deduced that the more similar countries are with respect to production and consumption patterns, the more similar will be the composition of their commodity trade and the larger will be the volume of trade among these countries. In this respect, it should be remarked that models of monopolistic competition lead only to limited implications for the trade pattern prevailing after the foundation of an integrated market. In other words, these models conclude that countries end up producing different product varieties, but they do not answer the question of which country will export and import which product variety. Broll (1989), for instance, highlighted the role of the domestic market. He pointed out that producers will specialise in those varieties where domestic preferences are most pronounced, as they will have a competitive edge with these products when they sell them to other countries. Krugman and Obstfeld (1997), in turn, emphasised the idea that production patterns in intra-industry trade and the variety of a good that a country sells might depend on a country's history and might simply emerge by accident.

With respect to the distributional consequences of a HIIT expansion, it can be stated that the trade literature considers the impact of this type of trade flow to be negligible on the demand for certain skills and on employment and remuneration. This is a corollary of the assumption that HIIT flows are considered to involve a relatively small amount of net exchanges of labour of different skill levels - compared to an equivalent amount of inter-industry trade - since horizontally differentiated goods are assumed to be produced with identical factor input intensities. Cabral et al. (2006) highlighted that this explanation is consistent with the assumption of monopolistic competition models according to which trade flows can rather be attributed to the existence of effects of economies of scale and to the heterogeneity of products than to disparities in factor endowments.

4.2.2 Empirics

The empirical literature on the linkage between trade in horizontally differentiated products and the labour market is scarce. Apparently, this can be attributed to the assumption that a HIIT expansion does not affect the demand for skills. To the best of this author's knowledge, there is no study for Germany. Cabral et al. (2006) examined the impact on skill demand of U.K. trade with middle income countries in 1995, applying factor content approach (i.e., estimating the change in a country's "effective" labour endowment induced by trade). They found that if trade comprises horizontally differentiated products, the exchanges of labour of different skill levels embodied in this type of trade are nearly matched. Therefore, Cabral et al. (2006) concluded that the increase in HIIT observed during this time did not affect wage inequality in the U.K.

4.3 Vertical intra-industry trade

Although new trade theory accounted for the presence of heterogeneous products, earlier theoretical contributions on intra-industry trade missed an important point by associating intra-industry trade only with the exchange of horizontally differentiated products (Krugman, 1979; 1980; Lancaster, 1980). In fact, intra-industry trade might also comprise the exchange of vertically differentiated products (e.g., Greenaway et al., 1994; Fontagné and Freudenberg, 1997; Fontagné et al., 1997).[28]

Compared to models of trade in horizontally differentiated products, where consumers have different preferences about product characteristics and goods tend to have similar prices, consumers in models of vertical product differentiation have identical preferences in the sense that they rank products according to their quality. When they have to choose between two goods that have the same price but one exhibits a higher quality, consumers will choose the high-quality good. In other words, consumers will prefer a high-quality to a low-quality product. The quality they choose finally depends on their income. Since the income of individuals differs within an economy, the products demanded will differ with respect to quality, as not all consumers end up buying the same product (see, e.g., Shaked and Sutton, 1984).

[28] Note that throughout this work, the periphrasis "vertical differentiation" is supposed to describe the exchange of products of different qualities and should not be confused with the exchange of intermediate goods and, hence, the fragmentation of production processes which is sometimes referred to as "vertical specialisation" in the literature (e.g., Hummels et al., 2001).

4.3.1 Theory

In the literature, the role of product quality in international trade was first highlighted by Linder (1961). He argued that countries tend to export products for which they have a large domestic market. Consequently, high-income countries have a comparative advantage in producing high-quality varieties, as consumers in these countries have higher incomes and tend to demand higher-quality varieties than consumers in less-advanced countries.

Based on Linder's hypothesis, several theories have been put forward to explain why countries specialise in different qualities in the frame of international trade. Basically, these theories can be separated into two groups: (i) models that rest upon perfect competition (Vernon, 1966; Falvey, 1981; Falvey and Kierzkowski, 1987; Flam and Helpman, 1987; Grossman and Helpman, 1991), and (ii) models that are based on the assumption of imperfect international markets and, hence, monopolistic (or oligopolistic) firm behaviour (Shaked and Sutton 1984; Motta, 1992). Whereas the former consider trade in qualities to be a reflection of endowment or technology-based factors, the latter show that this type of trade might also arise under increasing returns to scale.

As regards the perfect competition models, Falvey (1981) and Falvey and Kierzkowski (1987) explained the incidence of trade in vertically differentiated commodities through differences in endowments in a traditional North-South framework, whereas Flam and Helpman (1987) attributed the production of different qualities in international trade to a Ricardian-type of comparative advantage. Vernon (1966) provided a non-formalised product cycle theory and argued that when the market for a good in industrial countries matures and production reaches an advanced stage of standardisation, production is likely to be relocated to less-developed countries. The product ends up being exported back to the country where it has been originally innovated with the advanced country switching from being an exporter to an importer. Grossman and Helpman (1991) delivered a more sophisticated and formalised version of Vernon's (1966) product cycle theory. They looked upon the effects of trade liberalisation in a growth context and combined product cycle theory with aspects of quality ladders by setting up a theoretical framework to study the process of innovation and imitation. All models assume (either explicitly or implicitly) that individuals differ with respect to their income within and across countries, and thus with respect to their willingness or ability to pay for a certain product. This, in turn, results in the demand for different qualities. Given that there is an overlap in income distribution across countries, intra-industry trade emerges. Gains from trade result due to greater choice between different qualities, which enables consumers in each country to find those product qualities that best fit their budgets.[29]

Perfect competition models of trade in different qualities consider trade in vertically differentiated products to be the result of comparative advantages derived from a combination of differences in physical and human capital, as well as technology. Thus, they carry an important implication: Whereas earlier theoretical contributions on intra-industry trade (Krugman, 1979; 1980; Lancaster, 1980) suggested that this type of trade is supposed to occur primarily between countries whose factor endowments are fairly similar, models developed by Falvey (1981) and Falvey and Kierzkowski (1987) etc., can explain why intra-industry trade can emerge between countries at different stages of development.

The second group of models of VIIT highlights the idea that trade in different qualities might also be associated with an oligopolistic environment and economies of scale. These models are compatible with both trade in qualities between similar countries and between countries that differ with respect to income (Shaked and Sutton, 1984; Motta, 1992). Consequently, whereas contributions on HIIT primarily serve to explain trade among countries with similar stages of development, the literature on VIIT can explain both trade among similar and trade among different countries.

When dealing with the question in how far trade in quality differentiated products might affect the demand for certain skills in industrial countries, several answers have been put forward in the literature. In their pioneering studies, Falvey (1981) and Falvey and Kierzkowski (1987) used a traditional Heckscher-Ohlin–based North-South framework to analyse the labour market impact of VIIT. Thus, their contributions primarily deal with the

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[29] The endowment-based explanation of trade in qualities has been verified by several empirical studies. Schott (2004) and Hummels and Klenow (2005), for instance, showed that unit values of a country’s exports increase with per capita income. Aturupane et al. (1999) showed empirically that VIIT can be associated with economies of scale. They examined the bilateral trade relationships between Central and Eastern European Countries and selected western European countries for the period between 1990 and 1995.

labour market impact of VIIT between countries at different stages of development. Falvey (1981) and Falvey and Kierzkowski (1987) assumed a positive linkage between the quality of a product and capital intensity. In other words, higher quality commodities are assumed to require higher capital input in production. According to the authors, a country specialises in that type of variety that uses its abundant factor intensively: the relatively (physical) capital-abundant economy exports higher quality goods while the relatively labour-abundant country exports lower quality varieties. As Greenaway and Milner (1986) pointed out, similar results arise when human capital is introduced into the model and, hence, labour is no longer treated as a homogenous factor of production but comprises skilled and unskilled labour, respectively: The relative abundance of human capital (i.e., skilled labour) favours the production and export of high-quality varieties and vice versa.[30] An expansion in VIIT is alleged to lead to specialisation in skill-intensive, high-quality niches in countries well endowed with physical and human capital, while the production of unskilled-labour-intensive, lower-quality varieties shrinks. Thus, demand shifts toward skilled labour.

One central issue that has to be noted in this regard is the perception that vertical product differentiation involves different factor intensities. This implies that intra-industry trade can involve the same type of net exchanges of production factors as inter-industry trade, when it comprises the exchange of vertically differentiated products. Eventually, trade in goods of different qualities is nothing other than the exchange of goods of different natures (non-competing goods) (Wood, 1995). This implies that an expansion of VIIT might provoke similar reallocative effects on the labour markets in industrial countries as inter-industry trade, as that reduces the relative demand for low-skilled workers. However, although both types of trade might entail similar distributional consequences, their effects differ with respect to occurrence. Rather than changing the labour composition of different skills between industries, VIIT is assumed to affect labour composition within industries. This makes it an alternative explanation for both international outsourcing and technical change in affecting skill composition.

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[30] The positive linkage between the quality of a firm's output and the skill level of the labour force has been highlighted by several authors (e.g. Kremer, 1993; Duranton, 1999).

There are also more recent models that deal with the relationship between trade in qualities and skill composition. The models of the so-called new trade theory do not only account for the presence of heterogeneous products but also highlight the heterogeneity of firms and incorporate key elements of old and new trade theory.[31] The majority of firm-based trade models primarily focus on the question of why some firms export and other do not (e.g., Bernard et al., 2000; Melitz, 2003). Some authors, such as Manasse and Turrini (2001), however, have explicitly considered the impact of trade in different qualities on wage inequality in the presence of heterogeneous firms. Since their model rests upon the assumption that trade in different qualities is taking place between similar countries, it provides a theoretical explanation of how trade in qualities between advanced countries might affect the skill structure of employment. Manasse and Turrini (2001) used a framework of monopolistic competition and assumed that workers differ with respect to skill and that firms produce different varieties of a product. Higher-skilled employees are considered to enable firms to produce higher quality goods and, hence, to increase their profits. Since firms are confronted with fixed costs when they want to enter foreign markets, only those firms with a high pool of skilled workers will export, as only they benefit from exporting. To attract skilled employees, exporting firms (the so-called "superstars") will compete among one another, which leads to an increase in wages for this skill category in the exporting sector. Through this channel, in turn, income is redistributed from the non-tradable toward the tradable sector of the economy. Since exporting firms employ a large number of skilled workers, wage dispersion increases within the same industry.

Both the contributions by Falvey (1981) and Falvey and Kierzkowski (1987), as well as the work by Manasse and Turrini (2001) focused on the discussion of the long-term changes in labour demand that might arise out of a VIIT expansion. These long-term adjustments are also the focus of the present study. However, there is another strand of the literature on trade in qualities that deals with short-run alterations. This literature perceives trade as a cause for adjustment pressures and evaluates the adjustment costs associated with the process of adaption when the potential labour market impact of an IIT expansion is analysed. The costs of an expansion in IIT are usually compared with those arising from an inter-industry trade

[31] Similar to traditional trade theory, earlier models of new trade theory in general assumed that firms are homogenous and, hence, exhibit similar productivity levels (e.g., Schott, 2004).

expansion. Earlier studies proposed that IIT growth entails lower adjustment costs than inter-industry trade since an expansion in intra-industry trade is associated with factor reallocation within industries while an increase in inter-industry trade is concomitant with reallocation of production factors between industries (Balassa, 1966; Grubel and Lloyd, 1975; Greenaway and Milner, 1986). Moving workers from one industry to a completely different industry (e.g., from textile to automobile production) most likely entails higher trade-induced adjustment costs than redeploying workers among firms within the same sector (e.g., from one textile company to another). The proposition stating that an increase in inter-industry trade leads to a costlier displacement of resources than IIT is commonly referred to as the *Smooth Adjustment Hypothesis* (e.g., Brülhart et al., 2006).

When analysing the adjustment costs of an IIT expansion, it is, however, crucial to distinguish between VIIT and HIIT, as changes in the pattern of vertical specialisation induced by international trade are assumed to imply greater reallocative effects, as in case of horizontal specialisation. This can be attributed to the assumption that factors are relatively less mobile in vertically differentiated than in horizontally differentiated industries. Since labour requirements are likely to vary more strongly between vertically differentiated industries, greater retraining is needed to move displaced workers from one industry to another, which, in turn, implies higher adjustment costs. Moving workers from a company producing low-quality suits to one that produces bespoke suits most likely engenders higher adjustment costs than moving the same workers to another low-quality segment of the suit industry. This idea is concomitant with the perception that an increase in HIIT has no significant effect on the relative demand for skills, as it involves a smaller amount of net exchange of labour with different qualifications. In contrast, the impact of VIIT on skill demand might be sizable, as vertical product differentiation is associated with different factor intensities (Cabral et al., 2006).

4.3.2 Empirics

Econometric studies examining the impact of VIIT on skill demand in industrial countries are scarce. The majority of empirical studies analysing the role of IIT and/or VIIT are more oriented toward a better understanding of its determinants and less toward its influence on skill demand (e.g., Greenaway et al., 1994; 1995, Schott, 2004; Hummels and Klenow, 2005; Hallak, 2006). Studies that deal with the linkage between VIIT and skill demand are often dedicated to the verification of the smooth adjustment hypothesis and, hence, examine the adjustment costs of trade expansion in the short run (e.g., Brülhart et al., 2006; Elliott and Lindley, 2006).

Among those studies that examine the long-term consequences of trade, Cabral et al. (2006) scrutinised the impact on skill demand of U.K. trade with middle income countries in 1995, undertaking a factor content approach. They concluded that the impact of international trade with these countries on wage inequality in the U.K. is much larger when not only inter-industry trade but also VIIT is taken into account. Ito and Fukao (2005) examined the influence of trade in vertically differentiated products on the skill structure of employment in Japanese manufacturing between 1988 and 2000. Applying a translog cost function approach, they supplied empirical evidence for a positive and statistically significant influence of Japanese VIIT with newly industrialising Asian countries. However, the significant positive impact on intra-industry skill upgrading in Japan could only be observed when skilled workers were defined as employees holding professional and technical or managerial and administrative occupations. When the share of skilled workers was approximated by the share of non-production workers, VIIT was found to be statistically insignificant.

There is no study existing so far that directly investigates the impact of VIIT on skill demand for Germany. Neven and Wyplosz (1999), though, analysed the linkage between trade with less-developed countries and the process of restructuring in manufacturing industries for selected advanced European countries, Germany among them. In particular, they studied the relationship between the change in skill intensity and the initial skill level in each industry between 1975 and 1990. They found that especially in Germany, sectors with a high initial share of unskilled workers experienced a larger rise in skill intensity. They interpreted this result as an indicator that competition with developing countries might have fostered "defensive innovation" in these sectors. If it is assumed that the process of "defensive innovation" also includes quality improvements to existing products and the introduction of new high-quality goods into the market, this result delivers some supporting evidence for the hypothesis that quality competition in international trade has played a role in affecting the skill structure of employment in Germany.

4.4 Summary

New trade theory and more recent empirical estimates take into account some of the complexities of trade that have been neglected by traditional trade theory when analysing the labour market impact of trade. In this regard, Chapter 4 has introduced a range of alternative transmission channels beyond the classical model of inter-industry trade, through which international trade might affect the demand for certain skills in industrial countries. Regarding international outsourcing as one alternative transmission channel, theoretical contributions consider that its role in affecting the demand for low-skilled workers is ambiguous. Empirical studies for Germany also deliver no clear results.

The increased exchange of products belonging to the same industry (i.e., intra-industry trade) is perceived as another transmission channel. With respect to its impact on the demand for low-skilled workers, it can be stated that whereas HIIT is considered to have a minor impact on skill demand, the influence of VIIT might be sizable. Hence, in order to review the distributional consequences of intra-industry trade, it is convenient to distinguish between HIIT and VIIT, given that an expansion in each of both trade flows has different implications for the labour market. Another crucial insight from the theoretical literature is that IIT flows can involve the same type of net exchanges of factors as inter-industry trade, when they include the exchange of vertically differentiated products. In contrast to inter-industry trade that leads to a reallocation of resources between industries, VIIT is concomitant with an adjustment of resources within industries. Considering that skill upgrading in manufacturing can to an overwhelming extent be ascribed to within industries changes in skill composition, VIIT delivers an alternative explanation to international outsourcing and technical change in affecting the demand for skills.

For Germany, there is no empirical evidence so far on how VIIT might have contributed to the labour market outcome of low-skilled workers. Therefore, the remaining chapters of this thesis will be dedicated to this issue. First, some light will be shed on the importance of trade in quality differentiated products in German manufacturing. In this regard, the thesis examines to what extent international competition within product categories has led German companies to shift their core activities from the manufacturing of standardised products to the production of high-quality niches. Second, the thesis will deal with VIIT's impact on skill demand, keeping in mind the theoretical predictions of the major preceding studies in this field of research.

5. Disentangling trade flows: How to measure vertical intra-industry trade

The preceding chapter discussed how different types of trade flows provoke different reactions from the labour market. When measuring the impact of international trade on the demand for skills, it is crucial to segregate a country's trade into inter- and intra-industry trade and to distinguish between trade in vertically- and horizontally differentiated products. This chapter introduces and discusses various measures suggested in the literature to categorise trade flows into the aforementioned trade types. Section 5.1 presents the indices to define trade as either inter-industry or intra-industry. Section 5.2 discusses the measures used to divide intra-industry trade (IIT) into vertical intra-industry trade (VIIT) and horizontal intra-industry trade (HIIT). Finally, Section 5.3 scrutinises conceptual shortcomings.

5.1 Separating inter- from intra-industry trade

In the literature, two main methodologies are commonly used to break down trade flows into inter- and intra-industry trade. Both differ with respect to their definition of intra-industry trade. The first and more traditional index used to measure the extent of intra-industry trade is based on the concept developed by Grubel and Lloyd (1975). The Grubel-Lloyd index computes the proportion of balanced trade (overlap between exports *EX* and imports *IM*) in total trade of country *k* in a given industry *i* in year *t*:

$$IIT_{kit} = \frac{EX_{kit} + IM_{kit} - \left|EX_{kit} - IM_{kit}\right|}{EX_{kit} + IM_{kit}} * 100 = \left[1 - \frac{\left|EX_{kit} - IM_{kit}\right|}{EX_{kit} + IM_{kit}}\right] * 100 \qquad (1)$$

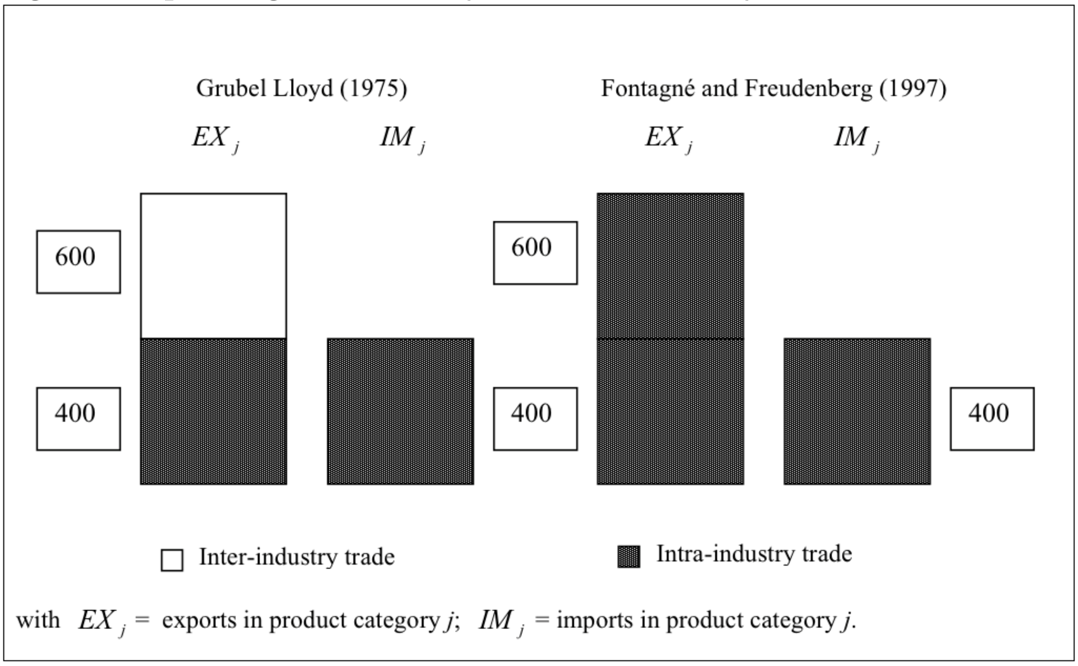
The index equals 100 if country *k*'s trade is completely intra-industrial and is equal to 0 if all trade is inter-industry trade.

An alternative measure of intra-industry trade was provided by Fontagné and Freudenberg (1997). Unlike Grubel and Lloyd (1975), Fontagné and Freudenberg did not focus on the overlap of exports and imports when measuring the share of intra-industry trade in total trade. Instead, their concept is based on the conception that there has to be sufficient reciprocal exchange of a product in a certain category to categorise the respective trade flow as intra-industry trade. In particular, they define the entire (bilateral) trade flow of a specific commodity as intra-industry trade if the value of the minority flow (e.g., imports) exceeds 10% of the value of the majority flow (in this case exports). If the value of the minority flow is below 10%, the entire trade flow of this commodity is defined as inter-industry trade.

Fontagné and Freudenberg's (1997) approach possesses one advantage that makes it more appropriate for the purpose of the present study. The methodology suggested by Fontagné and Freudenberg (1997) allows the treatment of the (total) trade flow of a commodity either as inter-industry- or intra-industry trade. Instead, when using the Grubel-Lloyd index, only those parts of the (total) trade flow are considered intra-industry where trade flows are overlapping. Consequently, the Grubel-Lloyd index does not allow for a clear theoretical and empirical distinction of inter- and intra-industry trade since trade flows in the same product category might partly be determined as intra-industry trade (in case of trade overlap), which is compatible with both perfect competition (e.g., Falvey, 1981; Falvey and Kierzkowski, 1987) and monopolistic (or oligopolistic) firm behaviour (e.g., Shaked and Sutton, 1984; Motta, 1992) - and partly as inter-industry trade (if there is no overlap) caused by perfect competition.

Assume, for instance, that a country exports the value of 1,000 EUR and imports the value of 400 EUR (Figure 4). The method proposed by Fontagné and Freudenberg (1997) would categorise the entire trade flow as intra-industry trade since the value of the minority flow (imports of 400 EUR) exceeds 10% of the value of the majority flow (exports of 1,000). Thus, both imports and exports are part of the same type of trade. In contrast, when measured with the Grubel-Lloyd index, the trade overlap between exports and imports, which corresponds to 400 EUR, would be categorised as intra-industry trade and the remaining 600 EUR would reflect inter-industry trade. Due to the ambiguity of the Grubel-Lloyd index, the present thesis relies upon the approach employed by Fontagné and Freudenberg (1997) to distinguish between inter- and intra-industry trade.

Figure 4: Separating inter-industry from intra-industry trade



Source : Adapted from Heitger et al. (1999); author's illustration.

5.2 Separating vertical- from horizontal intra-industry trade

After the bilateral trade flow of a certain commodity has been categorised as either inter-industry trade or intra-industry trade, the share of VIIT and HIIT has to be determined. To conduct this analysis, information on product quality is required. In general, official trade statistics do not contain specific information on product quality. Usually, only information on the volume of trade and on the quantity traded is provided. In the empirical literature, the lack of quality trade data is commonly tackled by using unit values as a proxy for quality (Abd-el-Rahman, 1991; Greenaway et al., 1994; 1995; Fontagné and Freudenberg, 1997). The unit value of a product is thereby computed by dividing the import (or export) value of a product through its import (or export) quantity. Consequently, the unit value measures nothing else than the average price of a number of items from the same product grouping.

One fundamental assumption made in the literature to separate vertical- and horizontal intra-industry trade is that the difference between export and import unit values for a given product reflects differences in quality between the exports and imports of this product. The idea to use the ratio of export to import unit values as an indicator for differences in product quality goes back to Abd-el-Rahman (1991). In particular, he assumes that the closer the ratio between export and import values is to 1, the more similar the home country's exports and imports are with respect to quality and trade. Foreign trade is then supposed to comprise the exchange of products with similar quality. By contrast, if price differences are sufficiently large and far from 1, it is assumed that a product's trade is vertically differentiated and that an exchange of products with different qualities is taking place.

In order to determine whether an intra-industry trade flow contains vertically- or horizontally-differentiated products, a cut-off point must be set. Seminal contributions by Abd-el-Rahman (1991), Greenaway et al. (1994, 1995), and Fontagné and Freudenberg (1997) suggested a range of relative export or import unit values of 15%, meaning that intra-industry trade is defined as vertical if relative export and import unit values differ by more than +/- 15%; otherwise, it is considered horizontal.

The decision on the cut-off point is, to some degree, arbitrary. Therefore, an alternative range of +/- 25% is used in the present study to test the sensitivity of the results (see Greenaway et al., 1994; 1995).[32] Furthermore, time series data are used in order to focus more on changes in the share of each trade category in total trade rather than on levels. Table 4 summarises the methodology adopted in the present study to separate the trade flow of a certain commodity into the three types of trade categories described above.

[32] Azhar and Elliott (2006) proposed a third, complementary approach to measure VIIT and HIIT. They use an index that has symmetrical limits and is equally distributed between both lower and upper bounds. Since this approach is closely aligned with the Grubel-Lloyd index and also involves an arbitrary dimension, it is not discussed in detail here.

Table 4: Categorisation of trade types

Type	Degree of trade overlap	Disparity of unit value[33]
One-way trade (OWT)	$\frac{Min(EX_{kk'jt}, IM_{kk'jt})}{Max(EX_{kk'jt}, IM_{kk'jt})} \leq 0.1$	Not applicable
Horizontal intra-industry trade (HIIT)	$\frac{Min(EX_{kk'jt}, IM_{kk'jt})}{Max(EX_{kk'jt}, IM_{kk'jt})} > 0.1$	$\frac{1}{1.15} \leq \frac{UV^{EX}_{kk'jt}}{UV^{IM}_{kk'jt}} \leq 1.15$
Vertical intra-industry trade (VIIT)	$\frac{Min(EX_{kk'jt}, IM_{kk'jt})}{Max(EX_{kk'jt}, IM_{kk'jt})} > 0.1$	$\frac{UV^{EX}_{kk'jt}}{UV^{IM}_{kk'jt}} < \frac{1}{1.15}$ or $1.15 < \frac{UV^{EX}_{kk'jt}}{UV^{IM}_{kk'jt}}$

Source: Fontagné and Freudenberg (1997); author's illustration. Note: $EX_{kk'jt}$ is the value of declaring country *k*'s exports of product *j* to partner country *k'* and $IM_{kk'jt}$ the value of country *k*'s imports of product *j* from country *k'* at time *t*; $UV^{EX}_{kk'jt}$ is the average unit value of country *k*'s exports of product *j* to country *k'* and $UV^{IM}_{kk'jt}$ the average unit value of country *k* 's imports of product *j* from economy *k'* at time *t*.

5.3 Conceptual shortcomings

When analysing data on trade flows according to the aforementioned methodology, several shortcomings have to be taken into account. One of these shortcomings refers to the application of the unit value concept. The utilisation of unit values (or prices in general) as an indicator of product quality is based on the perception that a product sold at a higher price is supposed to be of higher quality than the same product sold at a lower price (Greenaway et al., 1994; Hallak, 2006; Azhar, 2006).

In fact, many activities carried out by firms to increase product quality lead to an increase of the price of the product in relation to its physical weight. Companies might use superior material inputs for the production of commodities (e.g., high-quality leather for the production of leather shoes) or raise the durability and reliability of products through special processing and/or high-quality inputs (e.g., handicrafts watches with sapphire crystals). Products might also be customised according to individual requests with respect to colour, design, or

[33] Note that when separating HIIT and VIIT, Fontagné and Freudenberg (1997) calculate the lower threshold by using the factor 1/1.5 instead of 0.85 to ensure symmetry between the upper and the lower threshold in terms of their relative distance from unity. More precisely, the threshold of 15% indicates that export unit values can be 1.15 times higher than those for imports to fulfil the similarity condition. If the lower bound would be set at 0.85, however, export unit values can be 1.18 (1/0.85) times higher than import unit values to fulfil the same criteria. By choosing the factor 1/1.5 instead of 0.85 on the left hand side, this incoherence between the lower and upper bound can be fixed.

functional aspects (e.g., customers choice between different seat covers in the car production). Beyond that, the provision of complementary services (e.g., technical assistance after sale) might enhance the (subjective or objective) quality of a product and, hence, its price.

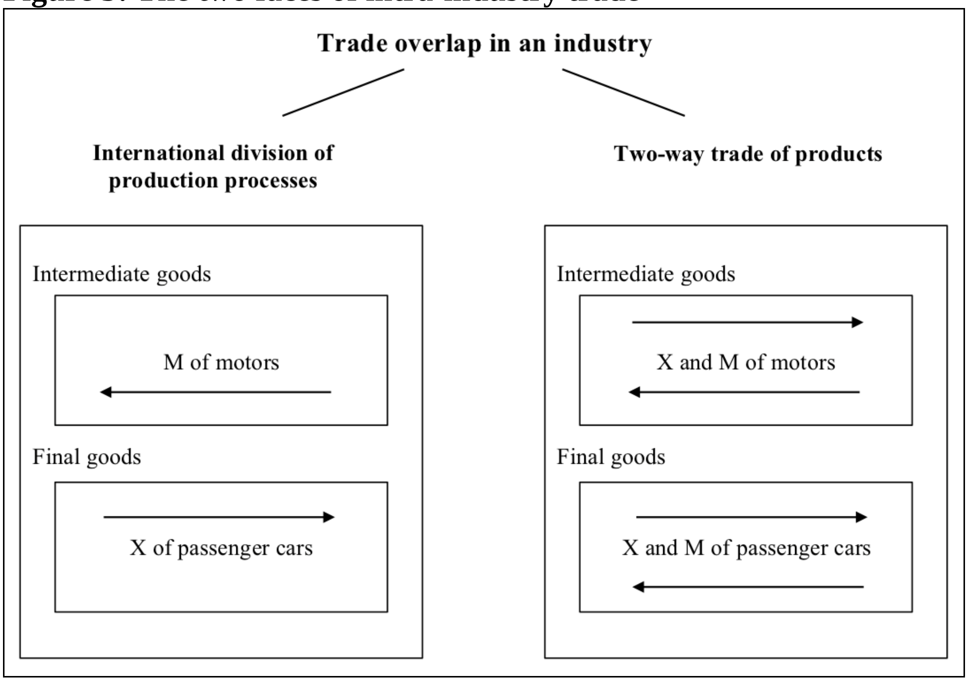
Although these examples underpin the positive correlation between unit values and quality, several factors might make unit values an imperfect substitute for quality and thus hamper the interpretation of unit value disparities. First, firms may obtain higher prices when the market situation is to their advantage (excess demand) or when they are able to obtain higher prices in the presence of monopoly positions (Stackelberg, 1991). Second, lower prices do not necessarily reflect lower quality. The effect of economies of scale or technological advances might cause production costs to decrease, which, in turn, enables producers to provide their product at lower prices (Fontagné and Freudenberg, 2002; Hallak, 2006). Lower prices also imply lower quality when companies act strategically and sell low-priced products to obtain a competitive advantage (Fontagné and Freudenberg, 2002). In addition, low unit values of imported commodities from less-developed countries might be due to the stronger bargaining power of firms in industrial countries (Schott, 2004). Third, exchange rate fluctuations or trade barriers can weaken the linkage between relative prices and product quality (Greenaway et al., 1994; Fontagné et al., 1997). If, for instance, a currency depreciates considerably, the competitiveness of domestic producers is enhanced through lower export prices. In this case, lower export prices might be wrongly associated with lower quality.

When analysing trade data, other problems might arise. These problems, though, can be minimised by choosing the right data. Above all, the separation of trade flows should be conducted using data at a disaggregated level. One reason is that the share of intra-industry trade in total trade obviously rises with the level of aggregation since a larger number of products accumulate. By inference, sectoral bias emerges (e.g., Fontagné and Freudenberg, 1997). In addition, it is very likely that variations in unit values that do not reflect quality differences are stronger, the higher the level of aggregation and, hence, the larger the range of heterogeneous products lumped together (e.g., Hallak, 2006). Using disaggregated data helps to reduce sectoral bias and allows for a comparison of relatively similar and homogeneous products.

Further problems might arise if the unit value of a product is calculated using the weight as the unit of measurement and a high-quality product possesses a high weight and a low-quality product a low weight. Compared to the high-quality product, the low-quality product may then exhibit a higher unit value. This, in turn, delivers biased results. Difficulties might also occur if the unit of measurement is the number of pieces and a large low-quality product exhibits a higher unit value than a small high-quality product. This deficiency of the unit value concept can be minimised by using data with a high level of disaggregation to compare products that are supposed to be relatively similar with respect to their weight (e.g. Greenaway et al., 1994).

Another reason for choosing a high level of disaggregation is to reduce the confusion between two-way trade and international outsourcing. As Fontagné et al. (2006) adverted, the higher the level of aggregation, the higher the possibility that the international division of production processes may lead to an increase in the share of intra-industry trade. This is, for instance, the case when automobile parts are exported abroad to be assembled and the finished passenger cars are imported thereafter (Figure 5). By analysing data at a product level rather than an industry level, both phenomena can be separated from one another since exported and re-imported goods no longer belong to the same commodity group.

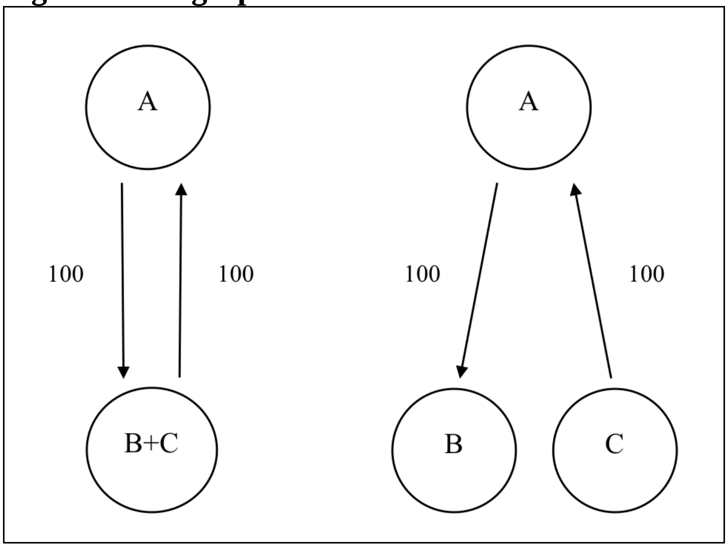
Figure 5: The two faces of intra-industry trade



Source: Fontagné et al. (2006).

Finally, the separation of trade flows should be conducted using data on bilateral trade to avoid geographical bias. Fontagné and Freudenberg (1997) emphasised that geographical bias may arise when data on a country's trade flows are summed up for all partner countries before calculating the indices. For example, if country A is trading with countries B and C, and data on trade flows for these two partner countries are bundled, country A's trade with B and C together may be denoted as intra-industry trade (Figure 6). If, however, A's trade with both countries is calculated on a bilateral basis, an analysis shows that trade with both partners is considered one-way trade with A exporting to B and importing from C. Hence, analysing data on a bilateral basis minimises the bias resulting from geographic aggregation.

Figure 6: Geographical bias



Source: Fontagné and Freudenberg (1997).

All in all, there are some shortcomings that have to be taken into account when analysing a country's trade flows with respect to quality. Some of them can be addressed by choosing a relatively high level of disaggregation. Shortcomings that are difficult to address should be kept in mind when interpreting the results of the analysis of unit values. Despite the weaknesses of the unit value concept, unit values are usually used as a proxy for quality in empirical studies. This is primarily because a systematic analysis of trade data that provide more reliable information on quality for such a large range of products is simply not available.

6. Vertical intra-industry trade in German foreign trade

This chapter uses the methodology of categorising trade flows as described in Chapter 5 to analyse the pattern of German foreign trade. It will focus on unveiling the importance of VIIT in German trade relationships and Germany's market segment specialisation in terms of product quality. Chapter 6 proceeds as follows. Section 6.1 describes the data used for analysis. Section 6.2 evaluates and discusses the development of German manufacturing trade structures. Partner country and industrial sectors check for potential differences through separate analysis. Section 6.3 delivers a more detailed analysis of the data on trade flows for the textile industry. This section provides an example of how trade in different qualities might be linked to changes in skill demand. In addition, it sheds light on the coincidence of product quality upgrading and other forces that can affect an industry's activities and skill structure of employment - namely, technical change and international outsourcing.

6.1 Data

The *Comext*-Database of the Statistical Office of the European Communities (EUROSTAT) provides the data on trade flows to analyse German foreign trade patterns. In this database, trade flows are classified according to the Harmonized System (HS) and the Combined Nomenclature (CN). The shape of the HS and CN classifications is illustrated in Table 5. The HS comprises several subdivisions where traded goods are recorded at different levels of aggregation. The CN is part of this subdivision and provides data on an eight-digit product level. This is the most disaggregated level at which trade statistics from this source are available.

Table 5: Shape of the Harmonized System (HS) and Combined Nomenclature (CN) classifications

Nomenclature	Levels of breakdown	Code	Number
Harmonized System (HS)	Section	one-digit	21
	Chapter	two-digits	99
	Heading	four-digits	1,244
	Sub-heading	six-digits	5,224
Combined Nomenclature (CN)	Sub-heading	eight-digits	9,842

Source: EUROSTAT (2006).

As pointed out in Chapter 5, data on trade flows should be analysed at a disaggregated level. For this reason, the analysis in this chapter is based on values and unit values of bilateral trade flows at the eight-digit level data of the CN. The CN covers approximately 10,000 manufacturing products, which have all been included in the analysis. To get a more detailed impression of the structure of the data and the richness of the dataset that are the basis of the present study, some examples of the HS and CN trade classifications are provided in Table 6.

Table 6: Examples of HS and CN trade classifications

HS one-digit industries	HS two-digit industries	HS four-digit products	HS six-digit products	CN eight-digit products
Prepared foodstuff, beverages, spirits and Vinegar, tobacco and manufactured tobacco substitutes	Beverages, spirits and vinegar	Wine of Fresh Grapes	Sparkling wine of fresh grapes	Champagne of actual strength of >=8.5% Vol.
Products of chemical or allied industries	Pharmaceutical products	Human blood, Animal blood prepared for therapeutic uses etc.	Antisera and other blood fractions	Haemoglobin, blood globulins and serum globulins
Footwear, headgear, umbrellas, sun umbrellas, walking sticks etc.	Footwear, Gaiters and the Like, parts of such Articles	Footwear with outer soles and uppers of rubber or plastics	Ski-boots, cross-country ski footwear and snowboard boots	Snowboard boots with outer soles and uppers of rubber or plastics
Vehicles, aircraft, vessels and associated transport equipment	Ships, boats and floating structures	Yachts and other vessels for pleasure or sports, rowing boats and canoes	Sailboats and Yachts, with or without auxiliary motor, for pleasure or sports	Sailboats, with or without auxiliary motor, of a length <=7.5 M

Source: EUROSTAT (2008); author's illustration.

To analyse German specialisation patterns in terms of product quality, unit values are used as a proxy for product quality. The computation of unit value indices requires information on the volume and quantity of trade. In the *Comext*-Database, the reported values of export data are based on f.o.b. (free on board) prices and therefore include only incidental expenses (i.e. freight, insurance). In contrast, the value of import data is measured on a c.i.f. (cost, insurance, and freight) basis.[34] These differences in measuring data on exports and imports might pose a problem for empirical analysis as the quality of German exports might be underestimated (e.g., Matthes, 2007). Using thresholds of +/- 15% and +/- 25%, respectively, to distinguish between

[34] In both cases, custom duties or taxes are not included.

horizontally- and vertically differentiated products can account for the bias caused by transport and other freight costs that are included in the value of imports but not in the value of exports. Regarding the quantity information on products, the unit of measurement recorded in most cases is the net mass (mass without packaging), expressed in tonnes. For certain goods, supplementary units are employed such as number of parts (e.g., of shirts in apparel), square meters (of carpet in textiles) or liters (of certain chemicals).

The investigation of trade data considers German trade with 45 major trading partners. These trading partners have been selected on the basis of nominal trade figures for the year 2007. In this year, manufacturing trade with these countries accounted for around 90% of total German manufacturing trade. The top 45 trading partners are further divided into advanced partner countries and less-developed countries. The study covers 20 advanced partner countries, primarily member countries of the European Union (EU) and other major trading partners such as the USA and Japan. The remaining 25 partner countries are newly emerging markets, particularly from Eastern Europe, Asia, and Latin America. The distinct countries are listed in Annex 1.

After data on trade flows were segregated into the three types described above using bilateral trade data on values and unit values of products at the eight-digit level, data were aggregated to a two-digit industry level of the WZ 2003 classification of economic activities. To aggregate the eight-digit level trade data to a two-digit industry level, concordance tables provided by the German Federal Statistical Office and the (eight-digit level) industry value of exports and imports as weights were used. Data on trade flows have not been corrected for inflation as price indices are not available at such a disaggregated level. Apart from that, the interest is primarily in structural changes as reflected in the distribution of trade flows across sectors.

The analysis covers data for 20 out of 23 German manufacturing industries, classified according to the WZ 2003. Among the three industries excluded from analysis, the recycling industry was dropped due to a lack of data. The tobacco, coke, and refined petroleum industries were excluded here because they were excluded from econometric analysis in Chapter 8, where they were identified as outlier industries. The industries included in analysis are listed in Annex 2.

The study takes advantage of the time coverage of the sample, focusing on a more recent development of trade patterns from 1993 to 2007. Data refer to unified Germany because data are not recorded separately for eastern and western Germany during this time. More recent figures were not available at the time the study was conducted. Although data on trade flows for unified Germany have been obtained since 1991, 1993 was chosen as a starting point for analysis because data at the beginning of the 1990s were most likely severely influenced by structural changes associated with German reunification. Earlier data on trade flows, such as that before 1990, are available only for western Germany. The comparability of data prior to the 1990s with data from 1990 onwards is further limited due to systematic changes in the classification of trade flows.[35]

6.2 Vertical intra-industry trade in the manufacturing sector

This section discusses and analyses the development of German manufacturing trade structures. It will carry out a detailed analysis by assessing trade flows separately for each trading partner and industrial sector to check for potential differences with respect to trade patterns and Germany's specialisation pattern in terms of quality. The results presented in this section refer to the analysis conducted with a range between export and import unit values used to distinguish between VIIT and HIIT of +/- 15%. Because using an alternative range of +/- 25% basically yielded similar results, these results are not reported here.

The analysis of German manufacturing trade flows delivers a range of interesting insights. Table 7 shows the share of inter-industry trade (i.e., one-way trade), intra-industry trade (i.e., two-way trade), as well as the share of its components VIIT and HIIT in total trade for German manufacturing for 1993 and 2007. Data show that two-way trade played an important role during this time. In 1993, the share of intra-industry trade in total trade was approximately 54%. Within intra-industry trade, trade in different qualities (i.e., VIIT) appeared to be much more important than trade in similar qualities (i.e., HIIT). This pattern remained relatively stable between 1993 and 2007.

[35] Before the introduction of the CN, trade statistics were classified according to the six-digit NIMEXE. This classification has been used to classify trade flows in the European Union until 1987 (EUROSTAT, 2006).

Figures in Table 7 elucidate that the relative importance of inter- and intra-industry trade crucially depends on the development level of the partner country. The trade relationship between Germany and other advanced countries was largely of an intra-industry type with a share of two-way trade of over 60% in both years under consideration. On the contrary, trade with emerging markets was dominated by inter-industry trade, although the share of intra-industry trade with these countries has grown steadily since 1993, reaching around 37% in 2007. These results are in line with trade theory in so far as they submit evidence that intra-industry trade appears primarily between countries with similar stages of development whereas inter-industry trade dominates trade between countries that differ in their development level.

Table 7 further reveals that within intra-industry trade, VIIT plays an overwhelming role, irrespective of the development level of Germany's trading partner. Hence, the exchange of varieties with different qualities does not only play a role in German trade relationships with newly emerging markets but also with advanced countries. This result is interesting as it is in contradiction to the theoretical predictions that intra-industry trade between countries of the same development level is largely horizontal by nature. Nevertheless, this finding is in line with other empirical evidence on the development of trade patterns among advanced countries (e.g. Fontagné et al., 2006).

Table 7: Share of trade types in German manufacturing trade in % (1993 and 2007)

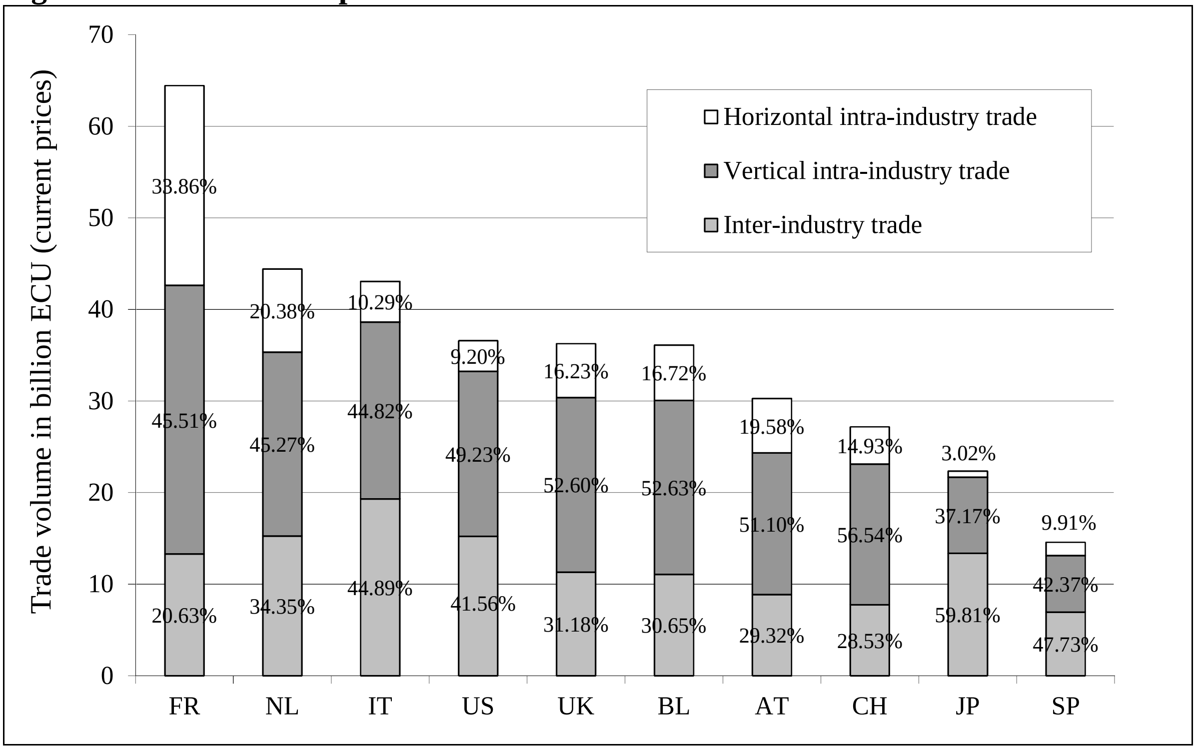
	1993				**2007**			
Trading partner	OWT	TWT	HIIT	VIIT	OWT	TWT	HIIT	VIIT
All countries	46.37	53.63	13.57	40.05	45.00	55.00	14.20	40.80
Advanced countries	38.23	61.77	16.16	45.61	37.83	62.17	17.10	45.06
Newly Industrialising countries	83.15	16.85	1.88	14.97	62.84	37.16	6.98	30.18

Source: *Comext* Database; author's calculations. Notes: 1) OWT = one-way trade/inter-industry trade; TWT = two-way trade/intra-industry trade; HIIT = horizontal intra-industry trade; VIIT = vertical intra-industry trade.

6.2.1 Vertical intra-industry trade by partner country

Figure 7 pictures the share of each trade category in total trade for German trade relationship with 10 major advanced partner countries in 1993.[36] At this point in time, the share of intra-industry trade has been above 50% in trade with all partner countries, except Japan. Accordingly, the exchange of products belonging to the same product category has been the dominant form of German trade with advanced countries at that time. High shares of intra-industry trade (of over 70%) were especially registered in German trade with France, Switzerland, and Austria. When splitting up intra-industry trade into its VIIT and HIIT components, data show that the share of VIIT always greatly exceeded the share of HIIT. Thus, the exchange of products differing with respect to quality determined much of German bilateral trade relationships with major advanced trading partners. Intra-industry trade with Italy, Spain, the U.S., and Japan consisted of an overwhelming extent of trade in qualities.

Figure 7: German trade pattern with advanced countries in 1993

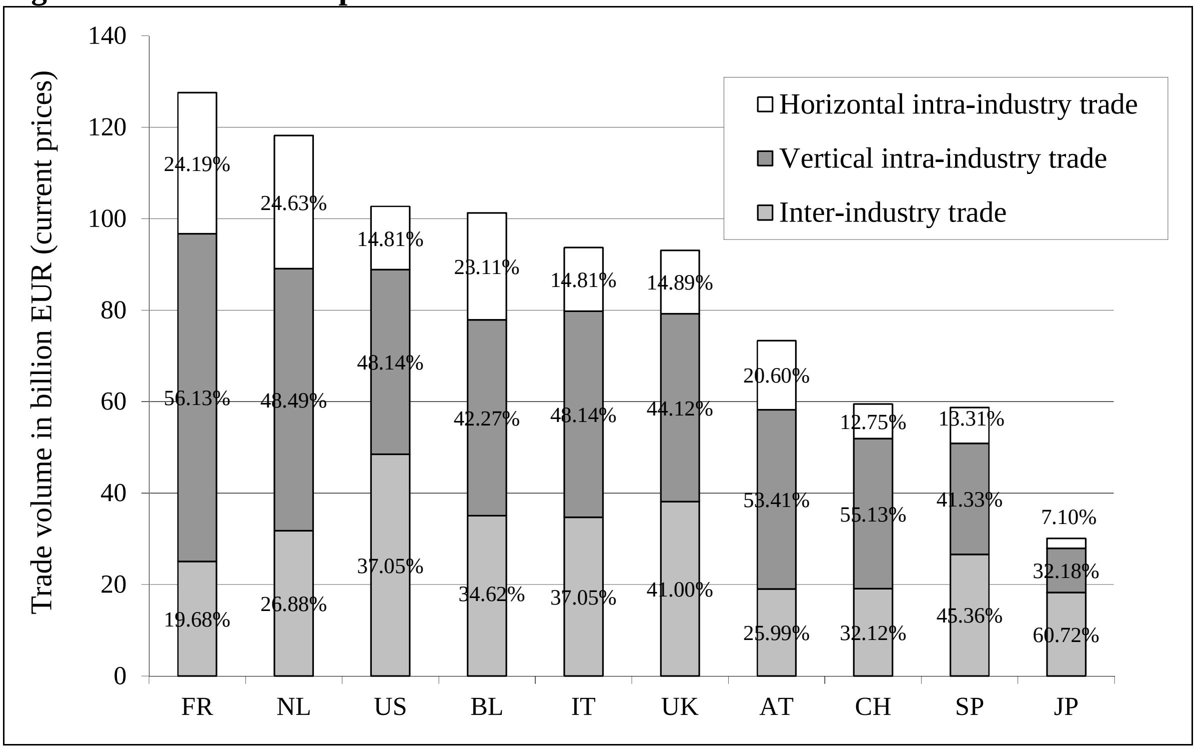


Source: *Comext* Database; author's calculations. Notes: 1) Trade volume is calculated as the sum of German exports and imports for each partner country. 2) Data on Belgium include data on Luxemburg. Definitions: FR = France, NL = Netherlands, IT = Italy, US = United States, UK = United Kingdom, BL = Belgium, AT = Austria, CH = Switzerland, JP = Japan, SP = Spain.

[36] The results for the remaining 9 advanced partner countries are depicted in Annex 3.

Figure 8 portrays trade patterns of German trade with advanced partner countries in 2007.[37] As in 1993, the share of intra-industry trade in total trade was much higher than the share of inter-industry trade for all countries under consideration, except for Japan. Compared to 1993, the share of intra-industry trade increased significantly in German trade with the Netherlands, Italy, Austria, and Spain; it remained relatively constant in trade with France and Japan and declined in trade with the U.S., Belgium, the U.K., and Switzerland. Apparently, no common trend regarding the evolution of Germany's intra-industry trade with advanced countries between 1993 and 2007 can be identified. However, results are unambiguous with respect to the enormous significance of VIIT within intra-industry trade. Similar to 1993, the share of VIIT dominated the share of HIIT for all partner countries in 2007. Between 1993 and 2007, the exchange of different qualities became even more pronounced in trade with France, the Netherlands, Italy, and Austria, reaching shares in total trade of up to 56% in the case of France. Inversely, VIIT lost relevance in German trade with the U.S., Belgium, the U.K., and Japan.

Figure 8: German trade pattern with advanced countries in 2007

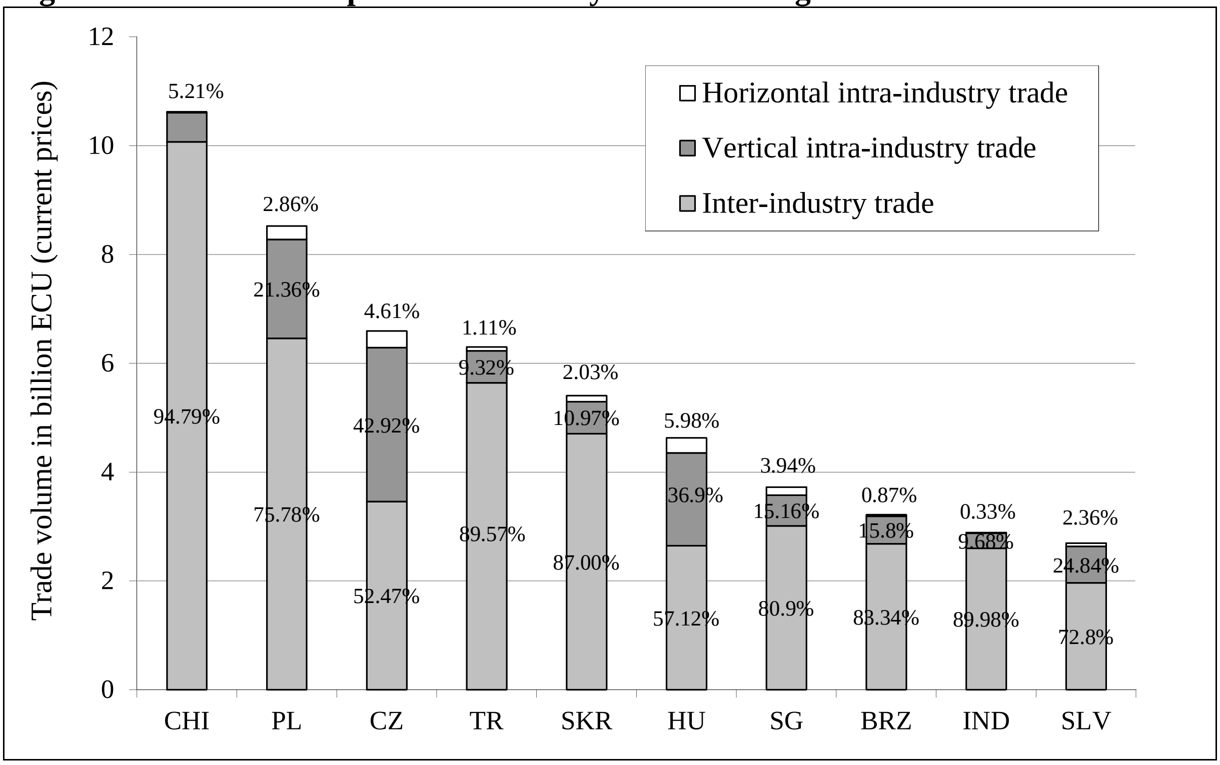


Source: *Comext* Database; author's calculations. Notes: 1) Trade volume is calculated as the sum of German exports and imports for each partner country. 2) Data on Belgium include data on Luxemburg.

[37] Figures for the remaining 9 advanced partner countries are depicted in Annex 4.

Figure 9 lists data on the German trade pattern for a range of newly industrialising trading partners in 1993.[38] The share of intra-industry trade was far below 50% for all countries under consideration. Hence, trade with less-developed countries at that time consisted to an overwhelming extent of inter-industry trade. However, some regional differences are visible. German intra-industry trade with emerging markets tended to be most prominent in trade with countries from Eastern Europe, especially the Czech Republic (48%). Relatively low shares of intra-industry trade, in turn, could be observed in trade with Turkey, Brazil, and Asian countries. In this regard, the impressively low share of roughly 5% in trade with China is particularly noteworthy. Figure 9, however, displays that German intra-industry trade with all emerging trading partners overwhelmingly consisted of the exchange of varieties differing with respect to quality. The exchange of horizontally differentiated products was virtually negligible.

Figure 9: German trade pattern with newly industrialising countries in 1993

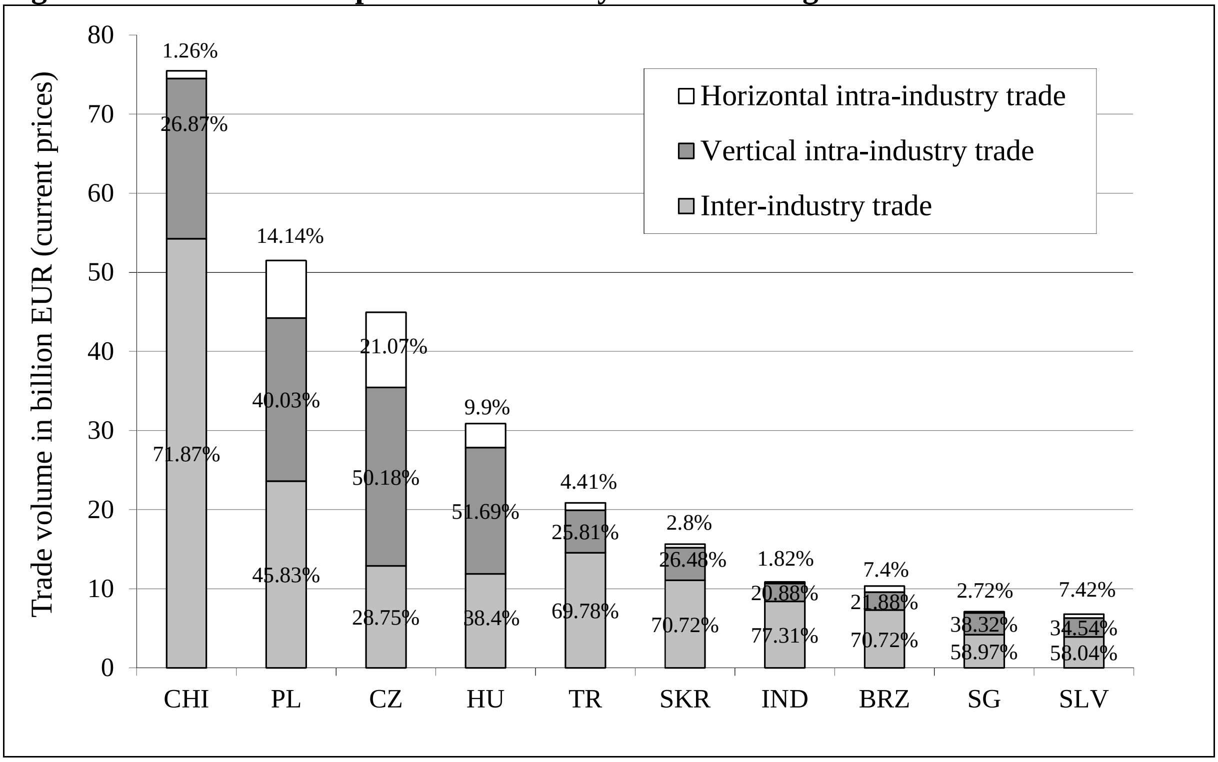


Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country. Definitions: CHI = China, PL = Poland, CZ = Czech Republic, TR = Turkey, SKR = South Korea, HU = Hungary, SG = Singapore, BRZ = Brazil, IND = India, SLV = Slovenia.

[38] Figures for the remaining 15 newly industrialising partner countries are depicted in Annex 5 and Annex 6.

Until 2007, the share of German intra-industry trade in trade with industrialising countries increased substantially (Figure 10).[39] In this year, Eastern European countries continued to show much higher levels of intra-industry trade than trading partners from other regions. For the Czech Republic and Hungary, the share of two-way trade reached more than 70% and 60%, respectively. Levels of less than 30% were reported for Asian countries like China, South Korea, or India. In all cases, the increase in intra-industry trade that occurred between 1993 and 2007 can primarily be ascribed to an expansion in VIIT, except in trade with the Czech Republic and Brazil. Although the exchange of varieties with different qualities continued to be the dominant form of intra-industry trade, the exchange of varieties with similar qualities started to play a role in German trade with emerging markets from Eastern Europe.

Figure 10: German trade pattern with newly industrialising countries in 2007



Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country.

A growing share of German foreign trade between 1993 and 2007 comprised the exchange of products belonging to the same product category but differing with respect to their quality. The strong expansion of VIIT that could not only be observed in German trade with newly emerging

[39] Figures for the remaining 15 industrialising partner countries in 2007 are depicted in Annex 7 and Annex 8.

countries, but also with some advanced partner countries, indicates that quality competition within product categories has increased substantially. Regarding the labour market impact of VIIT, this result suggests that the skill composition of employment in German manufacturing may not only be affected by trade with newly industrialising economies. The prevalence of sizable VIIT with advanced countries indicates that German trade with these countries might influence the demand for skills as well. This is an important aspect, considering that the influence of trade between advanced countries on the skill structure of employment was considered to be negligible for long time as trade between industrialised countries was assumed to consist largely of the exchange of varieties with similar qualities - i.e., HIIT.

To evaluate the labour market impact of VIIT, it makes sense to gain insights on Germany's specialisation pattern within VIIT. To find out on which quality segment German companies have specialised when exchanging varieties of different quality with other countries, the quality structure of German VIIT exports has been evaluated. VIIT exports were thus divided into two groups, namely high- and low-quality exports. To determine whether German VIIT exports are of high or low quality, the unit value ratio between export and import unit values has once again been used as an indicator. In case the relative unit value was above (below) 1.15 (1/1.15), German exports were categorised as high-quality (low-quality) goods.

Table 8 depicts the bilateral export share of German high- and low-quality products in total exports that are subject to VIIT by partner country.[40] For 1993, data show that Germany maintained a high-quality leadership in trade with almost all advanced trading partners. Except in trade with Belgium and Switzerland, high-quality shares always far exceeded 50%. For 2007, however, data deliver more ambiguous results. Compared to 1993, the share of German top-quality exports decreased in nearly all cases. Exceptions are France, Belgium, and Spain, where Germany was able to obtain substantial increases in the premium-quality segment. In 2007, Germany specialised in the export of high-grade varieties in trade with France, Belgium, Italy, and Spain. For these countries, the share of high-quality exports in total VIIT ranged between 68% for France and 79% for Spain. In contrast, much lower levels of German high-quality

[40] Figures for the remaining partner countries included in analysis are depicted in Annex 9.

exports were observed in trade with Switzerland (36%) and the U.K. (46%). For the remaining countries, the shares of high- and low-quality exports were relatively balanced.

Table 8: Quality structure in German vertical intra-industry trade by partner country (1993 and 2007)

		1993			2007		
	Partner Country	**VIIThigh[1]**	**VIITlow[2]**	**Average[3] UV ratio**	**VIIThigh**	**VIITlow**	**Average UV ratio**
Advanced countries	France	55.56	44.44	1.42	68.33	31.67	1.36
	Netherlands	58.16	41.84	1.36	47.83	52.17	1.16
	Belgium	39.08	60.92	1.13	73.29	26.71	3.59
	U.K.	69.28	30.72	1.55	46.20	53.80	1.26
	Italy	81.64	18.36	2.00	73.10	26.90	1.68
	U.S.	56.81	43.19	1.68	48.39	51.61	2.24
	Austria	61.92	38.08	1.41	56.57	43.43	1.35
	Switzerland	38.23	61.77	1.24	36.27	63.73	1.14
	Spain	73.80	26.20	1.59	79.14	20.86	1.51
	Japan	77.52	22.48	2.95	53.93	46.07	1.94
Newly industrialising countries	Poland	87.23	12.77	3.06	57.12	42.88	1.47
	Czech Republic	90.99	9.01	3.08	67.69	32.31	1.59
	Hungary	66.33	33.67	2.14	51.45	48.55	1.35
	Slovenia	83.09	16.91	2.97	64.18	35.82	2.03
	Turkey	84.16	15.84	3.41	80.58	19.42	2.42
	Brazil	85.88	14.12	3.56	53.31	46.69	1.67
	China	91.84	8.16	7.17	95.09	4.91	5.60
	India	63.00	37.00	3.49	70.88	29.12	3.35
	South Korea	85.02	14.98	4.64	80.93	19.07	2.62
	Singapore	37.83	62.17	1.49	74.54	25.46	4.50

Notes:

[1] Export share of high quality goods = $\left[\sum_j EX_j^{VIIThigh} / \sum_j EX_j^{VIIT}\right] * 100$, where *VIIThigh* if $\frac{UV_{kk'jt}^{EX}}{UV_{kk'jt}^{IM}} > 1.15$;

[2] Export share of low quality goods = $\left[\sum_j EX_j^{VIITlow} / \sum_j EX_j^{VIIT}\right] * 100$, where *VIITlow* if $\frac{UV_{kk'jt}^{EX}}{UV_{kk'jt}^{IM}} < \frac{1}{1.15}$;

[3] Average unit value ratio = $\sum_j \left(\frac{UV_{kk'jt}^{EX}}{UV_{kk'jt}^{IM}} * w_j \right)$, where $w_j = (EX_j^{VIIT} + IM_j^{VIIT}) / \sum_j (EX_j^{VIIT} + IM_j^{VIIT})$.

Source: *Comext* Database; author's calculations. Note: The figures for Belgium include Luxemburg.

When analysing the German specialisation pattern with major emerging partner countries, a clear picture emerges for both years under consideration (Table 8). In 1993, German companies evidently specialised in the upper-market segment in trade with these countries. Except in trade with Singapore, German premium-quality shares were always above 60%, ranging from 63% in trade with India to a remarkable share of roughly 92% in trade with China. Similar conclusions can be drawn from data for 2007. In this year, the share of German first rate quality exports was over 50% for all partner countries. However, some clear differences were once again apparent between regions. Regarding German trade with partner countries from Asia, the share of German high-quality exports was over 70%. Thus, Germany was able to further extend its specialisation in up-market products in trade with these countries. This tendency is most pronounced in trade with China, where Germany realised a share in the high-quality segment of 95%. Apparently, China continued to concentrate on the low-cost, technologically less sophisticated end of the product spectrum in 2007. Also interesting is the development in trade with Singapore. The share of German high-quality exports jumped markedly from 38% in 1993 to 75% in 2007, indicating a reversion of Germany’s competitive position with this country. There appears to be very little representation of Asian countries in the high-grade segment, but the opposite can be observed for a range of Eastern European trading partners and Brazil. German high-quality exports shares in trade with these countries declined substantially between 1993 and 2007, reaching particularly low values in the case of Hungary (51.5%), Brazil (53%), and Poland (57%).

To complete the analysis on Germany’s specialisation pattern, relative unit values of German VIIT have been illuminated. In doing so, it has been assessed to what extent varieties of products exchanged differ with respect to their price and, hence, their quality and whether a convergence of prices can be observed over time. The bilateral (average) unit value ratios for varieties exported by Germany and its trading partners in 1993 and 2007 are also presented in Table 8. The average ratio between German and French prices of 1.42 in 1993, for instance, indicates that German prices were on average 42% higher than French prices. Or, when using the reciprocal value, French prices made up 70% (1/1.42) of German prices. Given that unit value disparities are interpreted as differences in quality, German products were on average of higher quality than French products.

As Table 8 reveals, relative unit values in trade with advanced countries were always above one in 1993. Accordingly, German products tended to be of higher quality than the products of its competitors. The highest unit value ratios could be observed in trade with Japan and Italy, where German varieties were three or two times higher than Japanese and Italian varieties of the same products. By contrast, low unit value disparities could be registered for Belgium, Switzerland, and the Netherlands. German prices exceeded the prices of these trading partners by only 13%, 24%, and 36%, respectively. In 2007, this picture has changed slightly. Still, relatively low unit value ratios could be observed in VIIT with Switzerland and the Netherlands. Accordingly, quality competition within product groups has remained most severe in these two countries. By contrast, extraordinarily high unit value ratios occurred in trade with the U.S. and Belgium. The case of Belgium is particularly interesting as Germany has been able to take over Belgium's competitive advantage in the high-quality segment from 1993. Unlike in trade with Belgium and the U.S., however, quality competition within product groups rose significantly in trade with other advanced partner countries as declining unit value ratios between 1993 and 2007 suggest.

Compared to German trade with advanced countries, a much larger gap between export and import unit values prevailed in German VIIT with emerging markets. This was the case in 1993. Except in trade with Singapore, German products were always more than twice as high as products from newly industrialising countries. The largest unit value disparity could be observed in trade with China with prices for German varieties being more than 7 times higher. Or, to put it differently, Chinese prices amounted to roughly 14% (1/7) of German prices. In 2007, unit values disparities were much larger in German VIIT with major Asian trading partners than in trade with other emerging economies. Once again, the highest unit value disparity is reported for trade with China. It appears that China is still considerably behind Germany in terms of quality. Most notably, the country's market positioning did not change markedly throughout the 15 years under consideration. While many Asian economies tend to pose little threat to German firms in terms of product quality, Eastern European countries and Brazil seemed to have caught up significantly in terms of product quality between 1993 and 2007. Relative prices have converged considerably in trade with these partner countries.

Last but not least, one aspect should be noted with respect to the supposition that differences in prices are indicators for the existence of quality disparities. Naturally, if products were homogenous, we would have expected Germany to drop out of the market due to its relatively higher prices. Market shares would then have shifted toward other countries, primarily newly industrialising ones. However, the observation that Germany sustained in the market despite supposedly higher prices supports the assumption that price disparities primarily reflect differences in qualities.

6.2.2 Vertical intra-industry trade by sector

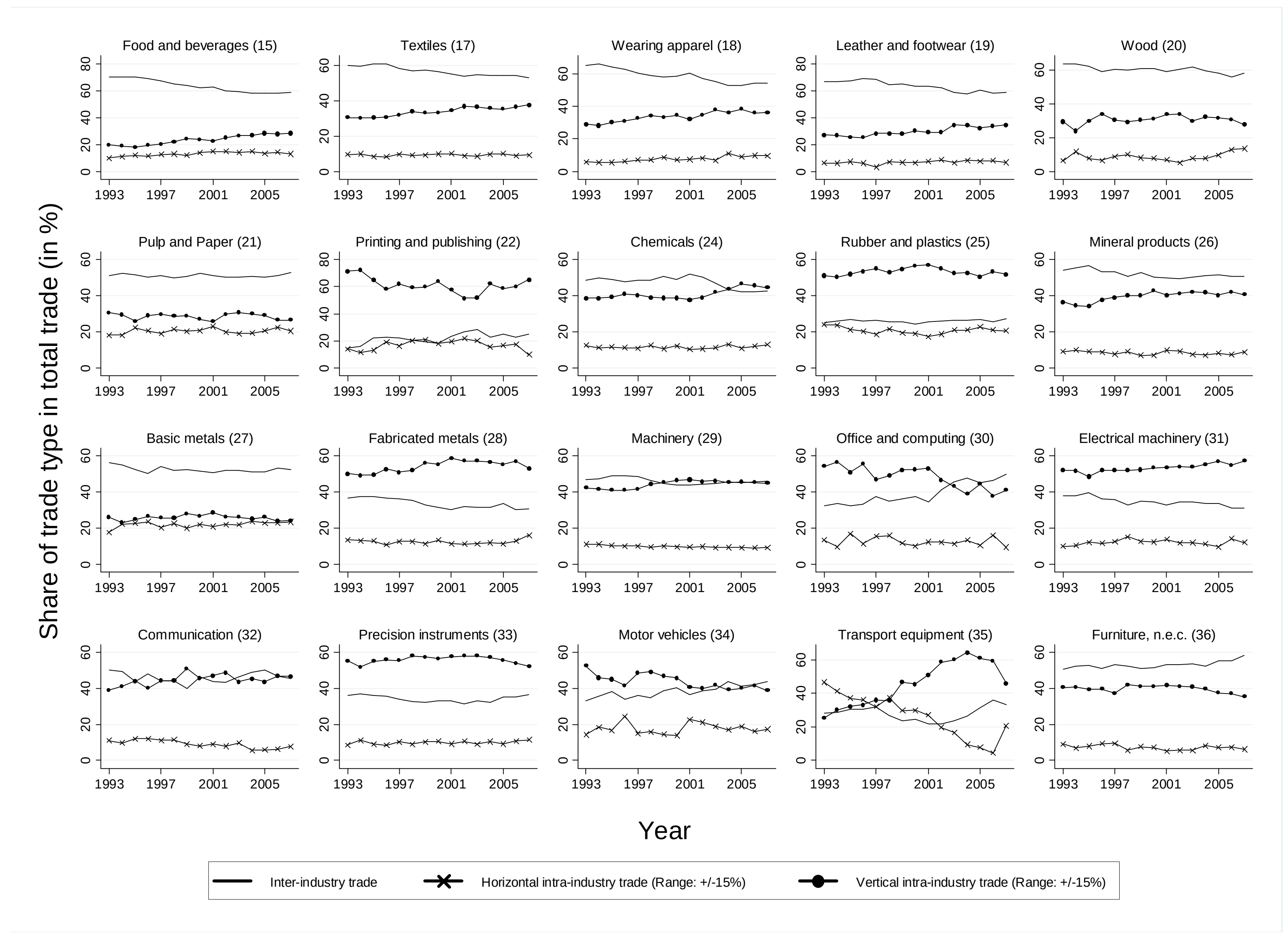
This section evaluates the role of VIIT in German manufacturing trade by industrial sector. Figure 11 presents the evolution of inter-industry trade, VIIT, and HIIT in trade with all 45 partner countries included in analysis for each of the 20 manufacturing industries. Figure 12 illustrates the development of trade flows for German trade with advanced countries, and Figure 13 with newly industrialising economies.

The figures indicate that the share of VIIT in total trade differs significantly across industries and that it developed unevenly across industries between 1993 and 2007. Differences regarding the relative importance and the development of VIIT can also be observed with respect to the stage of development of the partner country. As a comparison of Figure 11 and 12 presupposes, the pattern of trade in most industries is determined by trade with advanced countries. This result is not surprising. Despite some slight decreases since 1993, the share of trade with advanced trading partners still made up 71% of total German trade in 2007. Figure 12 shows that German trade patterns with advanced nations turned out to be relatively stable in a large number of industries between 1993 and 2007. Beyond that, the German trade relationship with advanced countries largely appeared to be of an intra-industry type with VIIT as the dominant form of two-way trade. Exceptions were the pulp and paper and the basic metals industry, where VIIT and HIIT showed similar levels.

Regarding level and development of German VIIT with advanced partner countries, high and fairly stable levels (of more than 50%) could be observed in industries such as rubber and plastics, fabricated metals, mechanical and electrical machinery, as well as precision instruments. By contrast, relatively low and stable levels (of less than 40%) over time have been detected in trade of wood, pulp, and paper as well as basic metals. Some industries also experienced a significant expansion of trade in qualities between 1993 and 2007. This expansion ranged from increases of around 9 percentage points in the production of food and beverages, apparel, and communication equipment to 12 percentage points in the textile industry. There were even remarkable rises of 15 and 40 percentage points in the leather and footwear industry and the transport equipment industry, respectively. In office and computing and motor vehicles, the share of VIIT shows a tendency to decline over time.

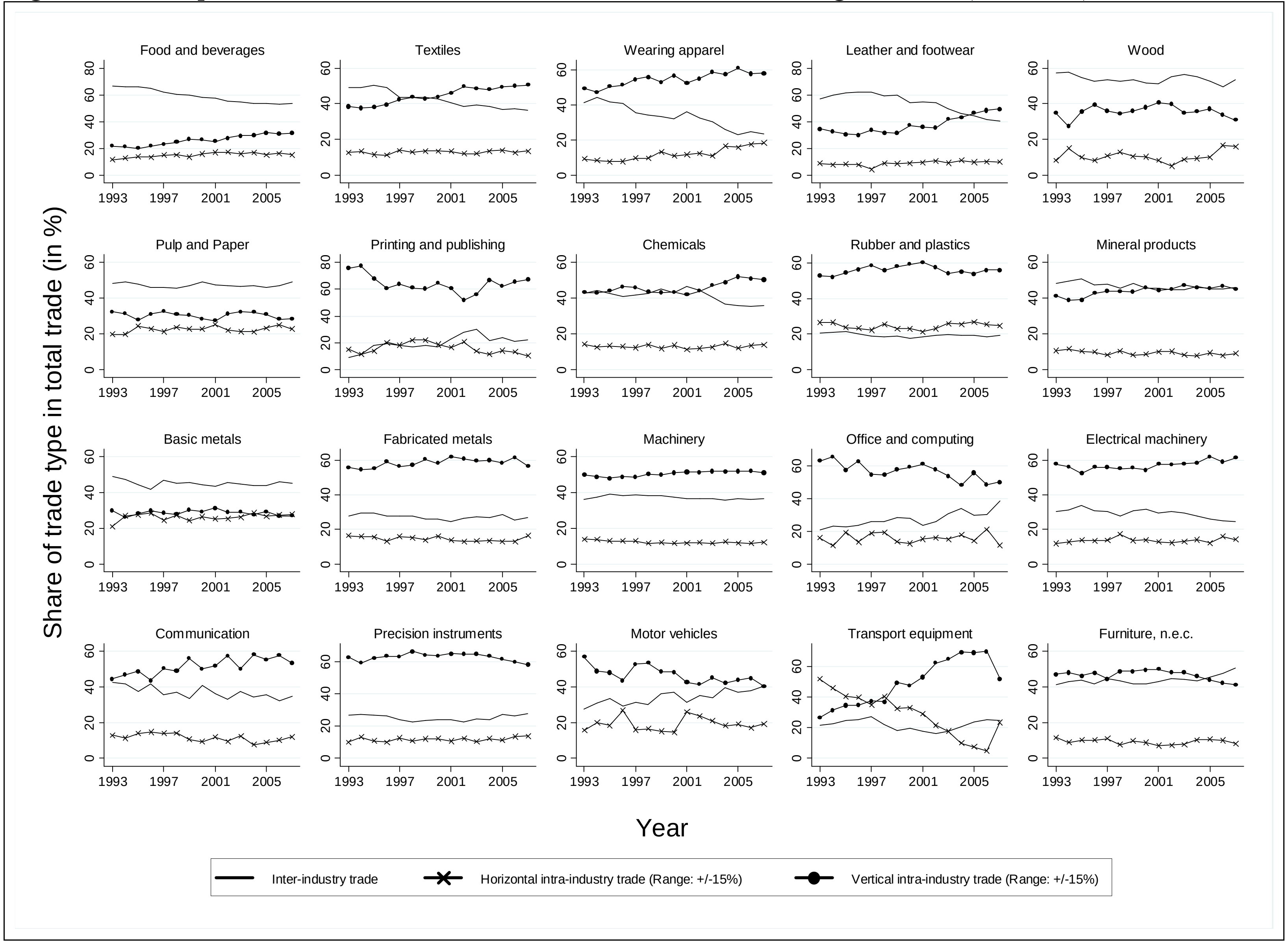
In contrast to trade with advanced countries, traditional one-way trade still dominated German trade relationships with newly industrialising countries in most sectors. As delineated in Figure 13, however, German trade patterns with these countries evolved dynamically. For a large number of manufacturing industries, the share of VIIT in total trade showed a clear upward trend between 1993 and 2007 at the expense of inter-industry trade whereas HIIT shares remained constant. This observation reflects the impressive catching-up process of emerging countries within product groups. Strong and nearly constant increases of VIIT could be observed in sectors such as mechanical and electrical machinery, fabricated metals, and precision instruments. In these sectors, the share of VIIT rose by approximately 18 percentage points, reaching levels of up to 50% in total trade in the production of fabricated metals and electrical machinery. This development implies that emerging market economies are gradually entering those markets that were prior domains of industrial countries and starting to produce more sophisticated goods. Despite these remarkable changes, the share of trade with these countries in total German manufacturing trade is still relatively small. Between 1993 and 2007, it grew from approximately 18% to 29%.

Figure 11: Trade patterns in German manufacturing industries (1993-2007)



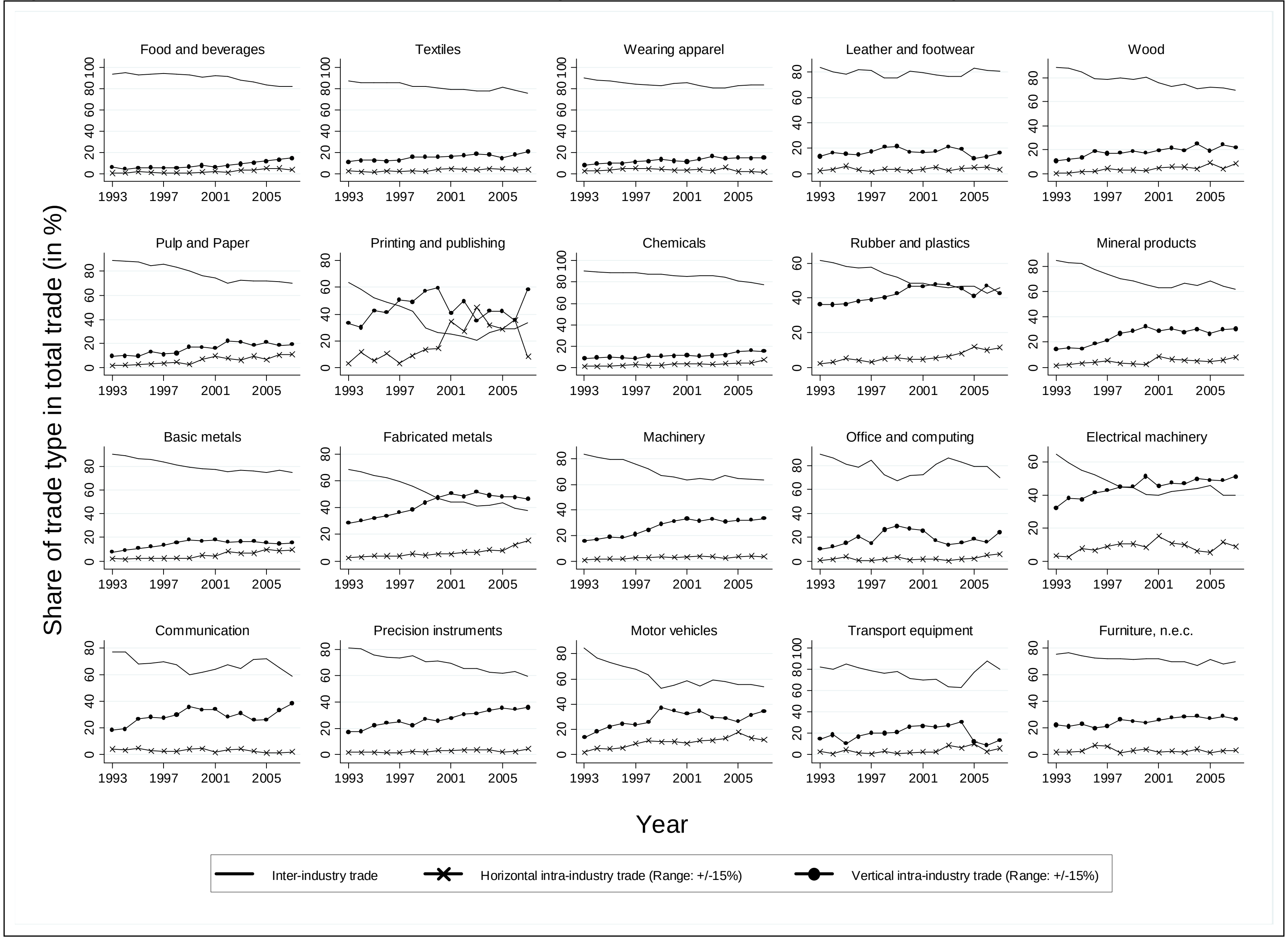
Source: *Comext* Database. Note: Calculation includes all 45 partner countries listed in Annex 1.

Figure 12: Trade patterns with advanced countries in German manufacturing industries (1993-2007)



Source: *Comext* Database. Note: Calculation includes 20 advanced partner countries listed in Annex 1.

Figure 13: Trade patterns with newly industrialising countries in German manufacturing industries (1993-2007)



Source: Comext Database. Note: Calculation includes 25 newly industrialising partner countries listed in Annex 1.

Table 9 delivers some insight on Germany's specialisation pattern in terms of quality within sectors. The table depicts the share of high- and low-quality exports in German VIIT for each industry in 1993 and 2007. Once again, there are significant differences between partner countries. In many industries, Germany's overall competitive position is determined by trade with advanced partner countries. For 1993, Table 9 shows for a majority of industries that Germany had a strong market position in the high-quality segment in trade with these countries. With a high-quality market share of roughly 76% and 72%, respectively, competitive advantage was most pronounced in trade of motor vehicles and apparel. Only in trade of transport equipment, office and computing products, food and beverages, and furniture, high-quality shares were much lower than 50%. Data for 1993 also reveals that German high-quality shares were much lower in VIIT with advanced partner countries than with emerging markets, except in trade with apparel. Once more, this observation confirms the plausible assumption that quality competition is more severe in trade with advanced countries than with emerging markets. In trade with newly industrialising countries, Germany concentrated on the provision of top-quality goods in all industries. Mostly, the share of high-quality exports was well above 60%. In trade with rubber and plastics, wood, and fabricated metal products, it even amounted to over 90%.

Between 1993 and 2007, quality competition increased considerably. In many industries, German companies had to cede high-quality market shares to competitors in advanced countries throughout this time. Exceptions can be observed in trade of office and computing machinery, electrical machinery, and other transport equipment where substantial gains in the high-quality segment could be achieved. Losses in the high-quality segment have been most pronounced in trade with apparel and printing and publishing products. In 2007, German high-quality shares in VIIT with advanced countries amounted to around 50% in nearly half of the industries. Values of much over 50% were recorded in trade with leather products, basic metals, mechanical and electrical machinery as well as motor vehicles, other transport equipment and furniture. By contrast, shares of much less than 50% could be observed in trade with food and beverages, wearing apparel, wood as well as printing and publishing products.

Table 9: Quality structure in German vertical intra-industry trade by sector (1993 and 2007)

	1993						2007					
	All countries		Advanced countries		Newly Industrialising countries		All countries		Advanced countries		Newly Industrialising countries	
Industry	VIIThigh[1]	VIITlow[2]	VIIThigh	VIITlow	VIIThigh	VIITlow	VIIThigh	VIITlow	VIIThigh	VIITlow	VIIThigh	VIITlow
Food products, beverages	42.71	57.29	42.33	57.67	50.00	50.00	43.14	56.86	42.46	57.54	49.62	50.38
Textiles	61.63	38.37	59.46	40.54	79.85	20.15	57.28	42.72	49.13	50.87	60.32	39.68
Wearing apparel, fur	70.94	29.06	72.04	27.96	59.41	40.59	37.66	62.34	39.25	60.75	28.92	71.08
Leather products, footwear	61.64	38.36	60.18	39.82	68.63	31.37	51.93	48.07	57.03	42.97	46.26	53.74
Wood, products of Wood	51.60	48.40	48.61	51.39	91.27	8.3	42.70	57.30	39.00	61.00	65.37	34.63
Pulp, paper	59.28	40.72	58.90	41.10	76.04	23.96	52.49	47.51	51.51	48.49	58.84	41.16
Printing, publishing	62.95	37.05	62.41	37.59	76.81	23.19	40.46	59.54	42.35	57.65	30.13	69.87
Chemicals	51.87	48.13	51.61	48.39	60.62	39.38	52.64	47.36	52.47	47.53	55.22	44.78
Rubber, plastics	59.73	40.27	57.12	42.88	91.17	8.83	57.72	42.28	51.03	48.97	79.25	20.75
Mineral products	58.11	41.89	57.16	42.84	74.49	25.51	53.04	46.96	47.73	52.27	61.08	38.92
Basic metals	57.66	42.34	56.45	43.55	83.12	16.88	63.39	36.61	60.86	39.14	78.05	21.95
Fabricated metals	62.92	37.08	59.51	40.49	92.44	7.56	66.86	33.14	54.35	45.65	78.36	21.64
Machinery and equipment	69.18	30.82	63.57	36.43	88.20	11.80	68.80	31.20	63.21	36.79	86.21	13.79
Office and computing	42.81	57.19	41.61	58.39	81.86	18.14	51.95	48.05	47.81	52.19	69.98	30.02
Electrical machinery	52.40	47.60	49.71	50.29	72.17	27.83	66.26	33.74	59.74	40.26	79.67	20.33
Radio-, TV-, communication	54.50	45.50	53.14	46.86	65.37	34.63	55.59	44.41	49.99	50.01	66.77	33.23
Precision instruments	57.67	42.33	56.59	43.41	74.64	25.36	57.91	42.09	52.23	47.77	81.66	18.34
Motor vehicles	76.05	23.95	75.72	24.28	89.07	10.93	66.50	33.50	70.95	29.05	46.14	53.86
Other transport equipment	32.95	67.05	29.77	70.23	84.00	16.00	78.45	21.55	80.65	19.35	38.75	61.25
Furniture, n.e.c.	47.00	53.00	43.23	56.77	77.00	23.00	58.14	41.86	60.54	39.46	48.54	51.46

Source: *Comext* Database; author's calculations. Notes: [1] Export share of high quality goods (in %); [2] Export share of low quality goods (in %). The formula to calculate the share of high- and low-quality VIIT has already been presented in Table 8.

Particularly striking are the changes in German high-quality market shares in trade with newly emerging markets. Apart from trade in electrical machinery, radio and communication equipment as well as medical and precision instruments where German companies were able to expand their share in the upper-market segment, Germany lost high-quality shares in almost all sectors between 1993 and 2007. With losses of over 40 percentage points, German companies were especially hard hit in trade of printing and publishing products, transport equipment and motor vehicles. Despite these losses, though, Germany largely defended its position in the high-quality segment in trade with emerging economies. In a majority of sectors, high-quality shares continued to exceed 50% in 2007. Particularly large shares (of 80% or more) could be observed in trade of machinery and equipment, precision instruments, electrical machinery as well as rubber and plastics.

Compared to 1993, data show that German high-quality shares continued to be higher in trade with emerging markets than in trade with advanced partner countries in a vast majority of industries in 2007. Exceptions are trade with wearing apparel and leather, printing and publishing products, furniture, motor vehicles and other transport equipment where the opposite can be observed. Especially the observation that newly industrialising countries exhibit higher quality varieties in the production of motor vehicles and transport equipment might be surprising at first sight. However, German VIIT with emerging markets constituted a much smaller fraction in total VIIT in these sectors than VIIT with advanced countries. Closer inspection of the data for the motor vehicles industry furthermore revealed that German VIIT with emerging markets comprised a much smaller range of products than VIIT with advanced countries. In addition, the bulk of German VIIT with industrialising economies consisted of the exchange of car parts whereas VIIT with advanced countries largely comprised finished motor vehicles. Hence, newly industrialising countries are currently concentrating on a restricted number of intermediate products rather than on the supply of complex final goods in this sector. Substantial FDI flows from advanced countries during recent decades and the transfer of technical know associated with it have most likely contributed to this development by enabling these countries to climb up the quality ladder in the production of intermediate goods.

In total, data on the quality structure of German VIIT exports suggest that much stronger declines in German high-quality shares could be registered over time in sectors predominantly employing low-skilled workers (e.g., apparel or leather industry). Accordingly, the pressure to upgrade product quality tends to be more severe in these sectors. On the contrary, Germany largely defended and in some cases even expanded its premium-quality markets shares in more skill-intensive sectors such as electrical and mechanical machinery, chemicals, or precision instruments. Germany's comparative advantage in the upper-market segment in these industries is also reflected in higher unit values disparities (see Annex 10). In these sectors it is easier for companies to differentiate themselves from competitors by shifting core activities from the manufacturing of standardised products to the production of high-quality niches and the provision of complementary services (e.g., offering technical assistance after sale) with a relatively low elasticity of substitution. In turn, the possibilities to achieve further breakthroughs and to develop completely new products are much more limited in industries such as apparel or leather where many "new" products have very close competitive substitutes.

However, in some supposedly non-competitive import competing sectors such as textiles, rubber, and basic and fabricated metals, German companies were able to preserve their market position in the high-quality segment to some extent despite a massive rise in competition. How German companies managed to resist international competition by specialising in high-quality niche products within these sectors will be elaborated in detail in Section 6.3 for the specific case of the textile industry. The section will also examine how the pressure to upgrade product quality might have been to the detriment of low-skilled workers.

6.2.3 Central insights

Investigation of trade flows has shown that German trade patterns are to a large extent determined by trade with advanced countries. The observation that trade with these countries predominantly consists of intra-industry trade is in line with the predictions of trade theory. However, contrary to earlier theoretical predictions, German intra-industry trade with advanced countries is more dominated by the exchange of varieties with different quality than by the exchange of varieties of similar quality. This insight carries an important implication.

Based on the assumption that trade between advanced countries largely consists of HIIT, the influence of trade between advanced countries on skill composition was long considered to be negligible. The preeminence of VIIT, however, suggests that German trade with advanced countries might affect the demand for skills through this channel.

As regards German trade relationship with newly industrialising countries, inter-industry trade continues to be the dominant form of German trade with these countries. Nevertheless, a rising percentage of trade with these countries has become intra-industry trade. Hence, German foreign trade with emerging markets can less and less be explained by the traditional Heckscher-Ohlin model. From the analysis of intra-industry trade flows, two major insights emerge. First, it can be conjectured that emerging markets are gradually entering those product categories which have been prior domains of industrial countries, e.g. in the production of mechanical and electrical machinery or precision instruments. Thus, whereas in the earlier stages of development, low-skilled labour abundant countries export primarily labour-intensive commodities and import capital intensive goods to restructure and modernise their economy, these countries shift from inter-industry to intra-industry trade at a certain stage of industrial development by upgrading their product mix. Among others, this is achieved through technological upgrading (in many cases fostered by FDI of advanced countries) and simultaneous improvement of the qualification of the labour force. In many cases, production is initially characterised by the imitation of advanced countries' products (e.g., Grossman and Helpman, 1991).

Second, although emerging countries increasingly export the same bundle of products as Germany, they currently tend to focus on the lower-quality segments in a majority of industries. Nonetheless, some newly industrialising economies (especially from Eastern Europe) have already gained sufficient experience and knowledge in business activities (e.g., in investment, production, engineering, R&D, etc.) to climb up the quality ladder within some selected product groups. They have also started to produce more sophisticated goods. This development cannot only be observed in trade with traditional unskilled-labour intensive products such as apparel or leather but also in trade with more knowledge-intensive commodities such as motor vehicles and transport equipment.

All in all, there has been tremendous growth in the exchange of varieties of individual products during the last two decades. The growing share of intra-industry trade suggests that countries rarely specialise at an industry level but rather on an array of products within industries. The remarkable increase in the share of VIIT in German trade implies that quality competition has become more severe. As a consequence of increased quality competition, Germany lost high-quality shares in a range of industrial sectors, particularly in sectors that employ a large amount of low-skilled workers. In other sectors, however, German companies were able to manifest their position in the export of upper-market products. This development could mostly be observed in skill-intensive sectors but was also recorded in some traditional unskilled-labour intensive branches. Regarding the labour market impact of growing quality competition in international trade, results suggest that the pressure to upgrade product quality and hence the distributional consequences of VIIT should be higher in trade with advanced partner countries because VIIT with newly emerging markets still plays a relatively small role.

6.3 Vertical intra-industry trade in the textile industry

This section carries out a more detailed evaluation of trade flows in the textile industry. The textile industry provides a very interesting case for analysing industrial trends in the age of globalisation. It represents a traditional labour-intensive sector that has been exposed to massive competition in international trade and, at the same time, has undergone severe structural changes. It also serves as a good example of how an industry might react to increased international rivalry by restructuring production and repositioning itself in terms of product quality and innovation. Moreover, the textile industry provides essential insights on the various mechanisms operating through trade and technical change, how these forces are linked with one another, and how they may affect the skill structure of employment. In fact, this industry demonstrates in an impressive manner the complexity of the subject under consideration.

The output of the textile industry can be broadly separated into two branches: home textiles and technical textiles. The production of home textiles comprises products such as curtains, bed linen, carpets, and furniture textiles. Technical textiles might have different purposes and can be used in the industrial sector (e.g., packaging textiles, dust filters, conveyor belts) as well as for sports and leisure activities (e.g., outdoor-clothing with properties like mosquito- or tick protection). The functional aspect of these kinds of textiles is more important than the fashion aspect.[41]

As its main supplier, the textile industry is closely linked to the apparel industry. Both sectors have many aspects in common. In particular, they represent traditional labour-intensive sectors where specialisation in products that offer superior quality has been one essential part of the competition strategy, allowing them to escape from cost competition and to assert themselves in times of increased international market rivalries. In the textile industry, companies have specialised in the supply of high-quality home textiles and knowledge-intensive technical textiles. In the apparel sector, companies have abandoned standard clothing and instead specialised in high-quality fashionable garments. However, investigation of trade flows in Section 6.2 showed that while German textile producers were able to strengthen their global position in the high-quality segment, German apparel companies lost significant shares in the provision of upper-market clothing. The current section is implicitly concerned with the reasons for textile companies' success.

In the following, the evolution of production and employment in the textile industry is briefly sketched out within the context of growing international competition. To compare trends in production and employment, data are also presented for the apparel industry. Afterwards, German textile industry trade patterns are evaluated. Finally, information on the evolution of trade flows is linked to figures on the evolution of skill demand in the textile industry.

[41] Verband der Nordwestdeutschen Textil- und Bekleidungsindustrie e.V. (2011).

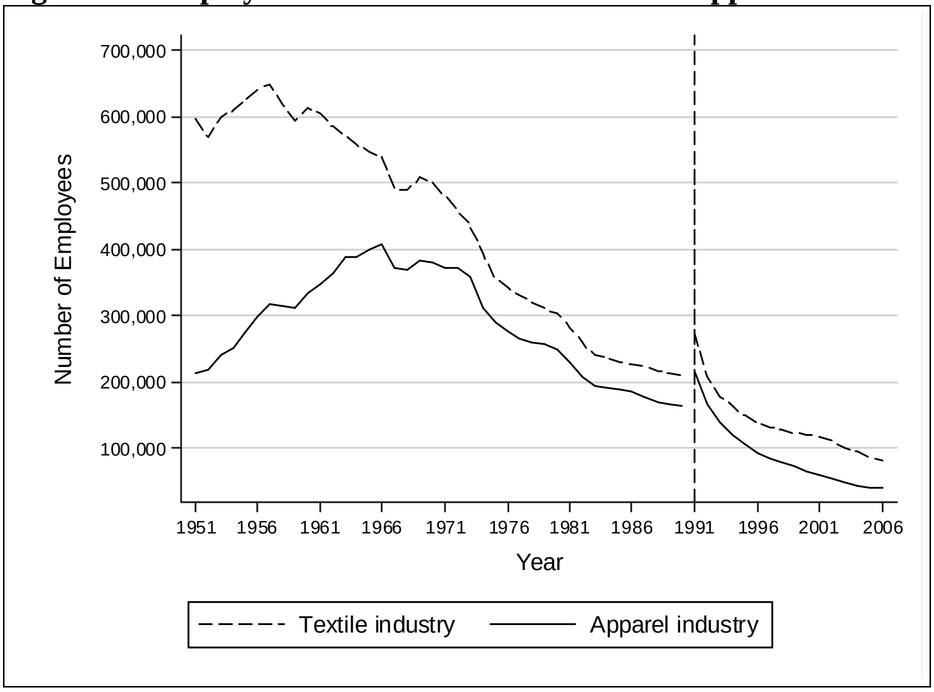
6.3.1 Structural changes in the textile industry

Like the apparel industry, the textile industry is one of the oldest and most traditional industries in Germany. In fact, its history goes back to the Middle Ages, and as a key driver of the industrial revolution in the 19th century, the industry was a major source of employment. In addition, weaving and spinning were one of the first branches where industrial fabrication technologies were implemented, in this case to satisfy rising demand for textiles and clothing (Hoffmann, 1966). More recently, affected by increased international integration and technological progress, German textile and apparel industries have undergone substantial structural changes since the 1960s. The process of restructuring was reflected in sizable employment cuts, company closures, and a significant decline in production (Junkers, 2007).

During the Second World War, both industries were weakened by the massive destruction of production facilities and further affected by the interruption of world trade. Thereafter, they experienced first a strong industrial expansion due to increased demand for clothing during the War period and then a rebuilding of production facilities with modern production technologies (Junkers, 2007). In the course of this upswing, employment increased considerably. Figure 14 portrays the development of employment separately for the textile industry and the apparel industry between 1951 and 2006.[42] The textile and the apparel industry reached a post-war employment peak in 1957 and 1966, respectively, recording 647,967 and 408,077 employees, respectively. Like the apparel industry, the textile industry has been an important industrial branch in Germany at that time. Both industries accounted for 13% of total manufacturing employment in 1960 (Schneider, 2004).

[42] Data from 2007 onwards are not reported here as they cover enterprises with 50 and more employees, compared to data from before 2007, which comprises companies with 20 and more employees. Since the textile and apparel industries are dominated by small- and middle-sized companies, these changes in the reporting sample might deliver misleading results.

Figure 14: Employment in the German textile and apparel industries (1951-2006)



Source: Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.1.1; author's illustration. Notes: 1) Figures between 1951 and 1990 refer to the former federal territory of western Germany. Data from 1951 to 1976 are classified according to the IB and data between 1977 and 1990 follow the German SYPRO. 2) Figures for 1991 and later include eastern and western Germany. Data between 1991 and 2003 are delimited according to WZ 93-statistical frame and data from 2003 onwards according to WZ 2003. 3) In 1997 and 2002 there has been an extension of the reporting sample.

However, starting around the 1960s, both industries experienced a steady decline in scale. This downturn became more pronounced during the 1970s and 1980s. Between 1970 and 1990, each industry recorded an employment loss of about 60%. Furthermore, the declining trend in the West German industries did not come to a halt after German reunification. At that time, the trend also devolved into eastern Germany, where textile companies had been sealed off from the world market for several decades and were thus severely behind their West German counterparts in terms of fashion and quality (Breitenacher et al., 1991).[43] After 1991, both industries were once again confronted with substantial job reductions in both parts of Germany. With employment losses of roughly 70% (from 274,658 to 82,638) between 1991 and 2006, though, the textile industry has been less affected than the apparel industry during the same period, with decreases of about 80% (from 216,636 to 41,001). In 2006, both

[43] Eastern German textile and apparel companies had severe difficulties in adapting to the abruptly changing market conditions. Being exposed to international competition resulted in numerous company closures and significant employment losses in eastern Germany after reunification. This process was amplified by the difficult economic situation in the early 1990s (Breitenacher et al., 1991).

industries accounted for roughly 2% of total manufacturing employment.[44] Textile and apparel production is nowadays mainly located in western Germany. The Ruhr region in North Rhine Westphalia is one of the main centres, holding a share of 27.8% of total German textile and apparel employment in 2005. Other major textile and apparel centres can be found in Bavaria (23.7%), Baden-Wuerttemberg (23.6%), Lower Saxony (6.4%), and Hesse (3.7%). In eastern Germany, textile and apparel production is concentrated in Saxony (9.7%) (Gesamttextil, 2006).

As with employment, the number of textile and apparel companies diminished considerably in recent decades. Between 1951 and 2006, the number shrank from 4,208 to 922 in the textile industry. However, the textile industry has been less affected than the apparel industry, where the number of companies declined from 3,181 to 415.[45] This development can only partly be ascribed to the increased merging activity among firms (Adler, 2004). Although there has been some tendency toward the creation of larger enterprises in order to achieve economies of scale and to increase market shares, the industry predominantly comprises small- and medium-sized businesses. According to the German Federal Statistical Office, 95% of the textile companies and 93% of apparel companies had less than 250 employees in 2010.[46] In the same year, small- and middle-sized textile companies generated 73% of total industry turnover compared to 58.5% in the apparel industry. Hence, in the textile industry, small- and medium-sized enterprises continue to realize a large portion of the turnover rate.[47] This development is less pronounced in the apparel industry, where large-scale enterprises play a greater role in generating turnover.

Figure 15 depicts the development of net production in the textile industry between 1991 and 2008. Throughout this period, the textile industry recorded a steady decline in production. In 1991, production in the textile industry was around 50% higher than production in 2000. As of 2008, production has dropped down to 80% of its value in 2000. Apparently, production losses were more severe in the early years after reunification and slowed down to some extent in the second half of the 1990s. The development in the textile sector appears to be in contrast

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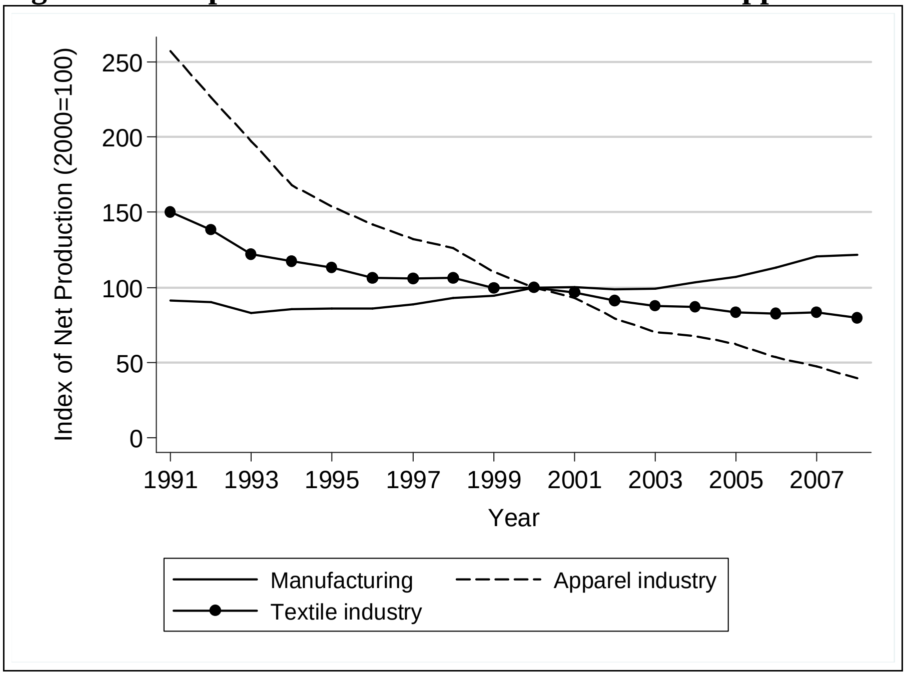
[44] Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.1.1.
[45] Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.1.1.
[46] Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.2.1.
[47] Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.2.1.

to the overall trend in German manufacturing. The index of net production for the manufacturing sector as a whole shows a nearly gradual rise in output between the time periods under consideration. However, the textile industry was less hard hit in terms of production than the apparel industry.

Figure 15: Net production in the German textile and apparel industries (1991-2008)



Source: Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 2.1; author's illustration.
Note: Data refer to unified Germany and are classified according to WZ 2003.

There is hardly any doubt that increased international competition and the emergence of new textile and apparel centres in less-developed countries have contributed to the above described development (e.g., Grömling and Matthes, 2003; Schneider, 2004). In fact, participation of less-developed countries in textile and apparel trade increased substantially around the 1970s, when many industrialised countries recorded significant downward movements in employment and production in these sectors. Due to the labour-intensive production methods applied and the relatively low requirement for technical know-how, both industries provided increased opportunities for emerging economies to start the process of industrialisation (Junkers, 2007). Between 1967 and 1974, for instance, the market share of major, less-developed producers in world trade increased from 15.4% to 18.6% in the textile industry and from 17.8% to 31.8% in the apparel industry (Schmid and Philips, 1980). Favoured by low labour costs and raw material reserves, mainly newly industrialising nations from Asia increased competition among advanced textile and apparel producers during this time (Junkers, 2007).[48]

In the following decades, less-developed countries were able to further strengthen their position in the world market of textiles and apparel, despite protectionist measures imposed by industrialised countries and embodied in the Multi-Fibre Agreement (MFA) (Nordås, 2004). The MFA regulated trade in textiles and apparel from 1974 to 2004, having been implemented on the initiative of developed countries to prevent imports from emerging countries from disrupting domestic markets in industrialised countries, by imposing quotas on exports of yarn textiles and apparel. However, the complex quota system of the MFA left loopholes for emerging markets to bypass the agreement (i.e., by shifting production to products that have not been subject to the MFA). Advanced countries could only partly tackle this problem by further tightening the agreement and encompassing additional countries and products into the system (Grömling and Matthes, 2003). All in all, the agreement was considered to have restricted imports from less-developed countries by a lower margin than expected (e.g., for Germany, see Spinanger and Piatti, 1994). It is also agreed upon that the textile industry in advanced countries has been less well protected by the agreement than the apparel industry (e.g., for Germany, see Schöppenthau et al., 2002). Starting in 1995, the MFA was replaced by the Agreement on Textiles and Clothing (ATC), under which quantitative restrictions have been gradually reduced. On January 1, 2005, the MFA (ATC) expired with the cancelling of total quotas. The expiration resulted in a growth of imports of advanced countries from low-wage economies (Nordås, 2004).

Despite these developments, Germany is nowadays still a major actor in the world trade of textiles. Table 10 depicts the ranking of top ten exporters and importers of textiles for 1980 and 2007.[49] Apparently, Germany was able to defend its position as a major supplier of textiles between 1980 and 2007, reaching the number three rank in 2007 with a share of 6.69%. Similar to other advanced countries, though, Germany has been confronted with

[48] Despite low labour costs, the competitive advantage of less-developed countries has been further enhanced by lower taxes and duties, longer working hours and machine-run times, lower regulations, and fewer requirements (e.g., for environmental protection) (Ahlert and Dieckheuer, 1994; Grömling and Matthes, 2003).
[49] Although data were already available for the year 2009 at the time this study had been conducted, data for 2007 have been chosen to prevent misleading results that might have been caused by the financial crisis of 2008 and 2009.

considerable losses in export shares over time. Meanwhile, less-developed countries have gradually expanded their influence on the world market. In 2007, China headed the rankings of the largest exporters, holding a share of 23.21% in world exports of textiles. Compared to 1980, when the country occupied the eighth place with a share of 4.62% in textile exports, China tremendously caught up in terms of ranks and shares. Other major, less-developed suppliers of textiles nowadays are Hong Kong, Turkey, India, South Korea, and Taiwan. All of these countries have improved in rank and gained additional market shares between 1980 and 2007. The remaining ranks in the list of top exporters are filled by advanced Western European countries and the U.S. Among these countries, Italy takes a leading role, ranking second in the supply of textiles in 2007. The list of top importers is primarily occupied by industrialised countries. In this regard, Germany once again belongs to the leading importers of textiles. With a share in world imports of 5.59%, it ranked third and was only topped by the U.S. and China.

Table 10: Top ten textile-trading nations (1980 and 2007)

Top ten exporters of textiles (share in % and rank)					Top ten importers of textiles (share in % and rank)				
	2007		1980		Country	2007		1980	
Country	Rank	Share	Rank	Share		Rank	Share	Rank	Share
China	1	23.21	8	4.62	USA	1	9.46	6	4.46
Italy	2	6.89	3	7.56	China	2	6.54	16	1.93
Germany	**3**	**6.69**	**1**	**11.45**	**Germany**	**3**	**5.59**	**1**	**12.06**
Hong Kong	4	5.56	12	3.22	Hong Kong	4	5.33	4	5.21
USA	5	5.15	4	6.83	Italy	5	3.68	5	4.60
South Korea	6	4.30	10	4.02	France	6	3.46	2	7.23
India	7	4.07	14	2.38	United Kingdom	7	3.28	3	6.25
Taiwan	8	4.03	11	3.23	Japan	8	2.47	8	3.02
Turkey	9	3.70	30	0.62	Turkey	9	2.36	59	0.14
Belgium	10	3.55	5	6.46	Mexico	10	2.22	51	0.23

Source: WTO Statistics Database; author's illustration.

6.3.2 Specialisation patterns in the textile industry

During the last decades, increased international competition led to a reorientation of German textile companies regarding the production and provision of textiles. In competition with emerging markets, local producers were obviously hampered by high labour costs. As a reaction to cheap imports from unskilled-labour-abundant countries, domestic textile companies were initially partly able to compensate for this disadvantage through productivity increases (Adler, 2002; 2004). Cost reductions have been achieved through technological upgrades of production equipment and improvements in training and management activities, which led to the gradual optimisation of production processes since the late 1970s.

Figure 16 shows the development of the sector's gross investments expressed as a share of turnover between 1976 and 2007.[50] During this time, investment activities in the textile industry were much higher than in the apparel industry. In the latter, much less scope has been left for further efficiency increases, considering that essential components of apparel production such as tailoring, sewing and ironing are labour-intensive processes where possibilities to automate production are restricted due to the characteristics of the materials processed (Spinanger and Piatti, 1994). In fact, technical improvements and the substitution of primarily low-skilled labour by machines have made the textile industry much more capital- and high-technology-intensive than the apparel industry (Adler, 2004). Quite remarkable is the strong increase of investment during the 1980s, with the textile industry reaching an investment peak of 5.5% in 1990. Following the common trend in German manufacturing, investments in the textile industry experienced a sharp decline at the beginning of the 1990s. Thereafter, they remained relatively stable until the end of the 1990s, when they recorded another downturn. Since 2002, however, capital investments once again show a rising tendency.

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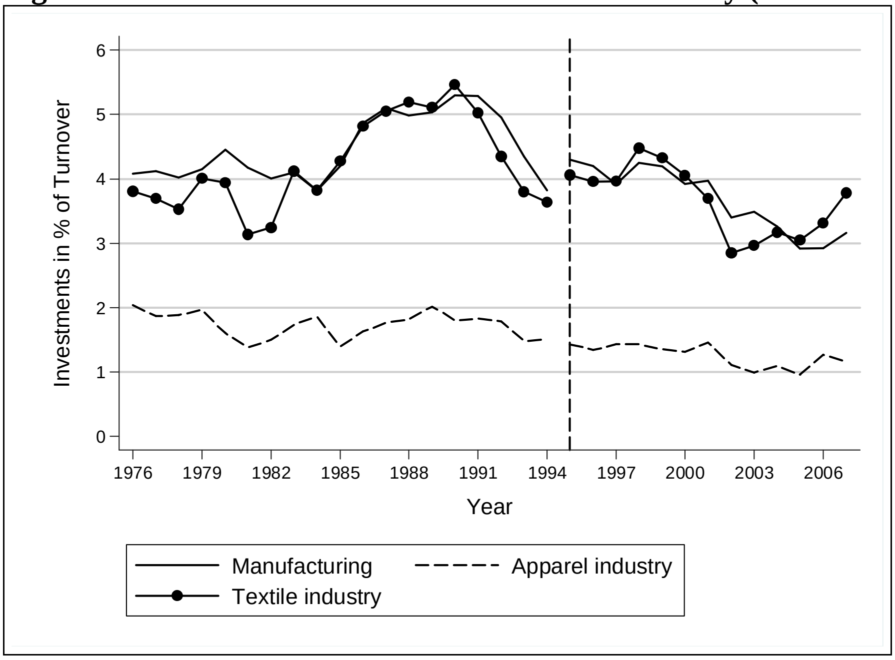
[50] As noted in Section 3.2, data on capital stock would be more appropriate to picture capital accumulation and technological progress. However, due to the limited availability of longer time series on capital stock data, the study instead draws upon data on gross investments expressed as a share of turnover.

Figure 16: Investments in the German textile industry (1976-2006)



Source: Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.2.1; author's calculations. Notes: 1) Data capture gross investments in buildings, plants and machines as a share of industry turnover. 2) Figures between 1976 and 1994 refer to the former federal territory of western Germany. These data are classified according to the German SYPRO. 3) Figures for 1995 and later include eastern and western Germany. Data between 1995 and 2002 are delimited according to WZ 93-statistical frame and data from 2003 onwards according to WZ 2003.

Throughout the years, production techniques in the textile industry became more efficient. Yet, the possibilities to compete in prices through higher productivity were limited. Global integration made it easier for emerging producers to draw upon comparable production methods through the import of foreign advanced production equipment or through FDI of advanced countries. This, in turn, enabled them to produce at comparable technical productivity but at much lower labour costs (Adler, 2004). To distinguish themselves from more cost-effective competitors, textile companies in Germany gradually upgraded their product mix (e.g., Spinanger and Piatti, 1994; Schneider, 2004). This has been achieved in several ways.

On the one hand, there has been a specialisation in fashionable high-end home textiles (e.g., Spinanger and Piatti, 1994; Schneider, 2004). Instead of significant price reductions, there has been a persistent improvement in product quality, with German products being rather an alternative to than a substitute for cheaper products offered from abroad. On the other hand, companies increasingly concentrated on the technical aspects of textiles through the usage of new fibre composite materials and innovative production technologies. This strategy has either been pursued by the development of new kinds of sophisticated textile products with special physical, chemical or functional characteristics that substitute non-textile products or by adding special characteristics to existing textile products (Schneider, 2004). Examples of technical textiles are geotextiles (e.g., drainage mats) or construction textiles (e.g., textile-reinforced concrete) deployed for the isolation or air conditioning of buildings, for drainage and water storage, or for tunnel and bridge construction. Other examples are filters, safety belts, and airbags that are utilised in the automobile sector. In the medical sector, high tech textile implants and prostheses are utilised to improve the comfort and health care function of products. Finally, outdoor clothing with UV-protection that can be used for leisure activities represents another example.[51]

This specialisation in the development and provision of fashionable home textiles as well as innovative technical textiles has furthermore been accompanied by the reduction of industrial mass production and an increase in small-scale production of customised parts. In doing so, German enterprises have focused on the satisfaction of individual customer needs reflected in individual designs and applications (Gesamttextil, 2006).

As regards the relative importance of home textiles and technical textiles, it can be observed that during the 1990s, production within the textile industry gradually shifted from traditional home textiles toward high-tech- and multifunctional textiles. The share of technical textiles in total German textile production has been growing steadily, amounting to roughly 40% in 2005. The market share of technical textiles reached 57% in this year (Forschungskuratorium Textil e.V., 2006). Due to a growing focus on technical textiles, the textile industry has become more R&D-intensive. The share of R&D expenditure in value added in this sector increased from 2.3% 1995 to 3.8% in 2006. Although this share is still relatively small compared to other knowledge-intensive German industries such as the communication equipment industry (28.9%), the automobile industry (17.9%), and the chemical industry (14.2%), an increase in innovative activities can be realised in the textile sector.[52]

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[51] Verband der Nordwestdeutschen Textil- und Bekleidungsindustrie e.V. (2011).
[52] Our own calculations on the basis of Anberd Database (OECD) and Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.3.

The gradual shift toward technical textiles can be attributed to two major factors. First, competition in the field of fashion has increased massively during the recent decades. This process has been fostered by the abolishment of quotas on textile and apparel (Adler, 2004; Kucera and Milberg, 2003). Compared to the provision of high-quality fashion textiles, where the possibilities of competitors to learn quickly are high, it is much more difficult to imitate complex technical textiles and to catch-up in terms of innovation and quality in this area. Accordingly, specialisation in technical textiles has facilitated the maintenance of an internationally competitive position in this market. The competitiveness of German companies in the provision of high-tech fibres and innovative textiles is strengthened by the industry's close linkage to other high-tech industries, such as the automobile industry, the electrical and mechanical engineering industries, the medical technology sector, and producers of environmental or safety technology. This network provides a fertile climate for the development of new and innovative products (Adler, 2004). Second, the world market for technical textiles is assumed to realise significant growth rates in the upcoming years. Newly industrialising economies in particular offer huge market potential due to large investments in infrastructure and buildings (Gesamttextil, 2011). Consequently, specialising in the provision of "intelligent textiles" is likely to turn out to be a profitable investment strategy.

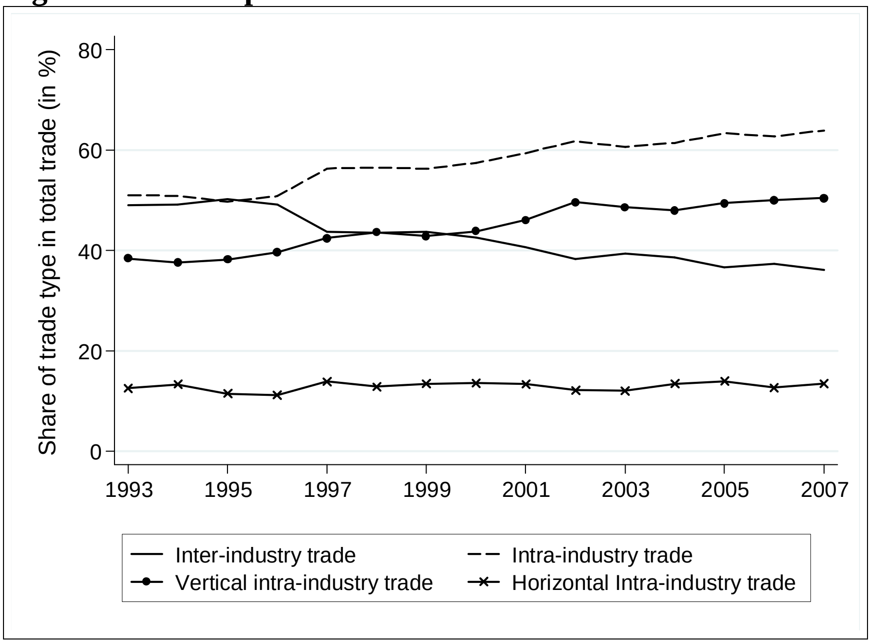
It is worth noting that the production of sophisticated first-rate textiles has largely remained in Germany. This is in contrast to the development observed in the apparel industry, where domestic producers more and more frequently availed themselves of the opportunity to move labour-intensive stages of production abroad. In fact, apparel production has been gradually relocated to low-wage countries, initially to Southern European countries and later to Eastern Europe, Asia, North Africa, and Turkey, with outsourcing activities becoming particularly distinct during the 1990s (Dispan, 2009). High-quality German clothing is nowadays to a large extent not produced in Germany. Domestic companies have rather focused on the human-capital-intensive stages of the value chain, such as the creation of designs and models, engineering, planning, management, marketing, and logistics. These production stages are subject to continual optimisation. The few manufacturing facilities that remained in Germany largely serve for the preparation of sampling, last-minute or special orders, and small series production (Adler, 2004; Dispan, 2009).

In the textile industry, shifting production abroad to take advantage of lower labour costs is less attractive because of higher capital expenditures (Schneider, 2004). Moreover, production methods in the textile sector are more complex than in the apparel industry (Schöppenthau et al., 2002). This may explain why outsourcing activities in the textile industry have been less pronounced (e.g., Geishecker, 2006). However, as Adler (2004) presumes, the textile industry might follow the apparel industry with some time delay in this regard.

6.3.3 Evolution of trade patterns in the textile industry

As in many other industries, trade patterns in the textile industry evolved very dynamically during the recent decades. Figure 17 illustrates the evolution of German textile trade patterns with advanced trading partners between 1993 and 2007. Through this period, competition within product groups increased significantly. The share of intra-industry trade made up around 50% in the early 1990s and grew nearly constantly thereafter, reaching 64% in 2007. This increase in intra-industry trade can almost entirely be attributed to the increased exchange in products of different qualities, as the development of VIIT indicates. In 2007, the share of the total trade enjoyed by VIIT was slightly above 50%.

Figure 17: Trade patterns in German textile trade with advanced countries (1993-2007)



Source: *Comext* Database; author's calculations.

Table 11 presents the development of trade flows for major sub-sectors of the textile industry in 1993 and 2007. Apparently, the pattern of German trade with advanced trading partners differed across sub-industries. In 1993, the share of intra-industry trade was above 50% in nearly half of the industries. High shares of two-way trade could be observed in the trade of textiles for furniture, medical and surgical furniture, etc. (88%), articles for technical use, etc. (68%), and cotton (68%), whereas low shares were prevalent in trade of wool, fine and coarse animal hair, etc. (31%), and articles of apparel and clothing accessories (39%). Despite the figure on trade of wool, fine and coarse animal hair, etc., intra-industry trade was dominated by VIIT.

Between 1993 and 2007, trade flows developed uneven across industries. Half of the industries recorded a significant increase in intra-industry trade. In the trade of articles of apparel and clothing accessories, two-way trade increased by 35 percentage points. High increases could also be observed in the trade of man-made filaments (26 percentage points) and special woven fabrics, tufted textile products and lace, etc. (22 percentage points). The strongest declines in intra-industry trade were registered in the trade of silk (15 percentage points), articles for technical use etc. (11 percentage points), and cotton (9 percentage points). Ten out of 14 industries experienced a rise in VIIT, indicating an increase in quality competition within product groups. In 2007, two-way trade was well above 50% in most of the sub-industries and became most pronounced in the trade of textiles for furniture, medical and surgical furniture, etc. (80%), special woven fabrics, tufted textile products and lace, etc. (80%), as well as articles of apparel and clothing accessories (74%). By contrast, two-way trade was of minor importance in the exchange of wool, fine and coarse animal hair, etc. (29%), as well as silk (30%). VIIT continued to play an overwhelming role within intra-industry trade.

Table 11: Trade patterns in German textile trade with advanced countries by sub-industry (1993 and 2007)

	1993					2007				
Industry	**Trade vol. (in 1,000 ECU)**	**OWT**	**TWT**	**VIIT**	**HIIT**	**Trade vol. (in 1,000 EUR)**	**OWT**	**TWT**	**VIIT**	**HIIT**
Silk	145,737	55.67	44.33	39.26	5.07	79,061	70.38	29.62	27.94	1.68
Wool, fine and coarse animal hair; yarn and fabrics of horsehair	1,220,447	69.46	30.54	13.73	16.81	606,555	71.25	28.75	15.48	13.28
Cotton	1,529,933	32.38	67.62	46.72	20.89	888,063	41.35	58.65	41.95	16.69
Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn	141,804	65.83	34.17	26.22	7.94	90,663	59.81	40.19	39.41	0.78
Man-made filaments	1,399,599	59.31	40.69	28.46	12.23	963,556	33.51	66.49	55.62	10.87
Man-made staple fibres	1,605,179	42.34	57.66	41.16	16.50	704,474	46.79	53.21	38.10	15.10
Wadding, felt and nonwovens; special yarns; twine, cordage, rope and cable and articles thereof	1,341,930	52.57	47.43	40.98	6.45	1,866,730	35.10	64.90	51.60	13.30
Carpets and other textile floor coverings	961,608	46.48	53.52	45.17	8.35	859,606	39.89	60.12	55.61	4.49
Special woven fabrics; tufted textile products; lace; tapestries; trimmings; embroidery	506,782	42.21	57.79	45.47	12.21	384,294	20.54	79.46	60.67	18.79
Articles for technical use, of textile materials; impregnated, coated, covered or laminated textile fabrics	862,667	32.33	67.67	49.57	18.10	1,506,097	43.40	56.60	44.53	12.07
Knitted or crotcheted fabrics	733,427	43.99	56.01	43.92	12.09	662,522	36.09	63.91	51.05	12.86
Articles of apparel and clothing accessories, knitted or crocheted	2,355,936	60.78	39.22	34.07	5.15	2,167,348	25.59	74.41	58.14	16.27
Other made up textile articles; sets; worn clothing and worn textile articles; rags	781,663	37.68	62.32	50.66	11.66	1,330,722	27.54	72.46	60.38	12.08
Furniture; medical and surgical furniture; bedding; mattresses, mattress supports etc.	165,892	11.82	88.18	48.99	39.20	241,936	19.65	80.34	68.58	11.76
Total	13,766,875	49.02	50.98	38.41	12.57	12,546,922	36.09	63.91	50.45	13.46

Source: *Comext* Database; author's calculations. Notes: 1) Trade volume is calculated as the sum of German exports and imports for each sub-industry. 2) OWT = one-way trade/inter-industry trade; TWT = two-way trade/intra-industry trade; HIIT = horizontal intra-industry trade; VIIT = vertical intra-industry trade. 3) Range between export and import unit values used to distinguish between VIIT and HIIT is +/- 15%.

Table 12 reports data on Germany's quality positioning in VIIT with advanced partner countries by major sub-industries. In half of the industries, Germany had a competitive advantage in the high-quality segment in 1993, reaching upper-market export shares of up to 88% in VIIT of carpets and other textile floor coverings. By contrast, very low high-quality market shares were realized in trade of other vegetable textile fibres, etc. (24%) and in trade of silk (28%). By 2007, Germany had lost upper-market shares in all (quantitatively) important product categories, namely articles of apparel and clothing accessories, etc., wadding, felt and nonwovens, etc., other made-up textile articles etc. and man-made filaments. An exception is trade of articles for technical use, etc., where Germany was able to expand its market share in the high-quality segment. In 2007, Germany specialised in the high-end segment in half of its industries. The largest shares of high-quality exports were recorded in trade of carpets and other textile floor coverings (85%), other vegetable textile fibres etc. (64%) and articles for technical use etc. (62%). In these sectors, price disparities between varieties exported by Germany and by its competitors tended to be higher than in other industries, as a comparison of unit value ratios suggests. On the other hand, low high-quality shares prevailed in trade of textiles for furniture, medical and surgical furniture, etc. (20%), articles of apparel and clothing accessories etc. (40%), and knitted or crocheted fabrics (42%).

This result supports the aforementioned tendency of Germany to specialise in home textiles with superior quality, primarily for private use, and in sophisticated technical textiles for industrial use. In particular, Germany's competitive edge in the technical aspect of textile production has been increasingly emphasised in the literature (Hausding and Cherif, 2008). However, the strategy of shifting production from traditional home textiles to knowledge-intensive technical textiles has been followed by several other advanced countries (Adler, 2004**)**. In this regard, Hausding and Cherif (2008) highlight the fact that, together with the U.S. and Japan, Germany maintains a leading position in the field of knowledge-intensive textiles worldwide. Inspection of trade data for 2007 has unveiled that Germany maintained a competitive head start in the provision of premium-quality technical textiles in trade with the U.S. as well as other major trading partners. The opposite can be observed for Japan, as well as for the U.K.

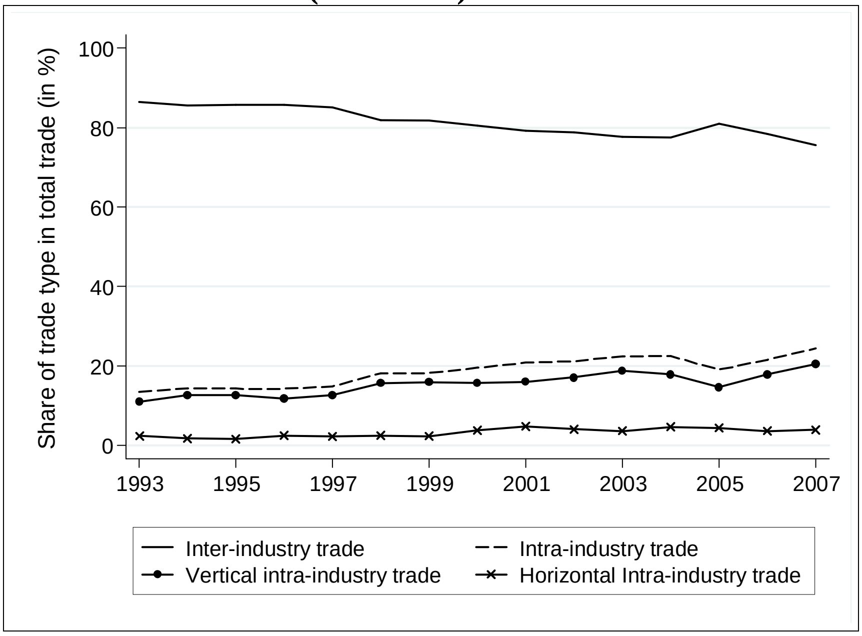
Table 12: Quality structure in vertical intra-industry textile trade with advanced countries (1993 and 2007)

	1993			2007		
Industry	**VIIThigh**	**VIITlow**	**Average UV ratio**	**VIIThigh**	**VIITlow**	**Average UV ratio**
Silk	28.25	71.75	0.84	59.82	40.18	1.66
Wool, fine and coarse animal hair; yarn and fabrics of horsehair	41.20	58.80	1.11	58.51	41.49	1.29
Cotton	39.32	60.68	1.07	50.44	49.56	1.24
Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn	24.09	75.91	1.00	63.98	36.02	1.82
Man-made filaments	50.74	49.26	1.26	46.82	53.18	1.38
Man-made staple fibres	52.10	47.90	1.17	54.54	45.46	1.38
Wadding, felt and nonwovens; special yarns; twine, cordage, rope and cable and articles thereof	58.78	41.22	1.26	45.01	54.99	1.15
Carpets and other textile floor coverings	88.14	11.86	1.81	84.81	15.19	1.76
Special woven fabrics; tufted textile products; lace; tapestries; trimmings; embroidery	67.32	32.68	1.58	55.28	44.72	1.46
Articles for technical use, of textile materials; impregnated, coated, covered or laminated textile fabrics	51.22	48.78	1.34	62.01	37.99	1.45
Knitted or crotcheted fabrics	57.02	42.98	1.10	42.34	57.66	1.05
Articles of apparel and clothing accessories, knitted or crocheted	86.83	13.17	1.86	40.34	59.66	1.19
Other made up textile articles; sets; worn clothing and worn textile articles; rags	51.91	48.09	1.28	50.70	49.30	1.34
Furniture; medical and surgical furniture; bedding; mattresses, mattress supports etc.	77.72	22.28	1.67	19.93	80.07	0.84
Total	59.46	40.54	1.37	49.13	50.87	1.30

Source: *Comext* Database; author's calculations. Note: The formula to calculate the share of high and low quality VIIT as well as the average unit value ratio has already been presented in Table 8.

Figure 18 portrays the development of trade flows for German trade with less-developed countries. The enormous share of inter-industry trade implies that Germany continues largely to exchange products with these countries, which do not directly compete with one another. However, the share of two-way trade and, hence, the exchange of products in the same product category increased substantially between 1993 and 2007. Starting from 13.5% in 1993, data show a gradual rise to 24.5% in 2007. Throughout this period, VIIT accounted for the lion's share of intra-industry trade. Particularly worth noting is the increase of (vertical) intra-industry trade in 2005, when the MFA (ATC) expired.

Figure 18: Trade patterns in German textile trade with newly industrialising countries (1993-2007)



Source: *Comext* Database; author's calculations.

Table 13 depicts German trade patterns with emerging markets for major textile sub-industries. In 1993, the share of intra-industry trade was much below 50% in all industries. In trade of furniture, medical and surgical furniture textiles, etc., Germany evinced the highest share of two-way trade (23%). In many industries, intra-industry trade consisted of trade in vertically differentiated products while trade in horizontally differentiated products was negligible. Until 2007, this picture hardly changed, although the share of two-way trade increased in all sub-industries, except in trade of silk. To a large extent, the increase in intra-industry trade can be attributed to an expansion in VIIT. In 2007, the highest share of two-way trade occurred once again in trade of furniture, medical and surgical textiles, etc. (36%), whereas the smallest share of intra-industry trade could be observed in the trade of wool, fine and coarse animal hair, etc. (6%). Except in the trade of carpets and other textile floor coverings, where the share of VIIT and of HIIT was roughly balanced, intra-industry trade predominantly comprised the exchange of different qualities.

Table 13: Trade patterns in German textile trade with newly industrialising countries by sub-industry (1993 and 2007)

	1993					2007				
Industry	**Trade vol. (in 1,000 ECU)**	**OWT**	**TWT**	**VIIT**	**HIIT**	**Trade vol. (in 1,000 EUR)**	**OWT**	**TWT**	**VIIT**	**HIIT**
Silk	87,164	96.15	3.85	3.78	0.07	65,328	96.76	3.24	3.24	0
Wool, fine and coarse animal hair; yarn and fabrics of horsehair	449,197	84.30	15.70	14.33	1.37	599,229	75.98	24.02	15.78	8.24
Cotton	598,546	80.92	19.08	16.48	2.61	769,575	74.36	25.64	21.48	4.16
Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn	44,429	94.03	5.97	5.82	0.15	62,789	80.52	19.48	18.56	0.93
Man-made filaments	514,197	90.96	9.04	8.34	0.69	671,565	73.50	26.50	21.74	4.76
Man-made staple fibres	655,066	86.09	13.91	13.27	0.64	557,313	67.65	32.35	29.35	2.99
Wadding, felt and nonwovens; special yarns; twine, cordage, rope and cable and articles thereof	258,445	86.24	13.76	13.11	0.64	681,473	71.68	28.32	27.36	0.96
Carpets and other textile floor coverings	372,576	94.59	5.41	4.76	0.66	369,057	71.44	28.56	14.13	14.43
Special woven fabrics; tufted textile products; lace; tapestries; trimmings; embroidery	156,566	83.28	16.72	12.39	4.33	302,139	70.24	29.76	28.61	1.15
Articles for technical use, of textile materials; impregnated, coated, covered or laminated textile fabrics	197,369	85.20	14.80	9.45	5.35	701,097	74.64	25.36	22.23	3.13
Knitted or crotcheted fabrics	215,838	81.58	18.42	12.25	6.17	462,677	70.31	29.69	23.70	5.99
Articles of apparel and clothing accessories, knitted or crocheted	1,311,342	88.50	11.50	8.53	2.98	1,933,939	85.32	14.68	11.78	2.90
Other made up textile articles; sets; worn clothing and worn textile articles; rags	642,841	84.02	15.98	11.06	4.92	1,721,435	76.90	23.10	19.75	3.35
Furniture; medical and surgical furniture; bedding; mattresses, mattress supports etc.	74,605	76.59	23.41	23.23	0.18	329,546	64.14	35.86	33.80	2.06
Total	5,589,795	86.54	13.46	11.04	2.42	9,319,706	75.55	24.45	20.53	3.92

Source: *Comext* Database; author's calculations. Notes: 1) Trade volume is calculated as the sum of German exports and imports for each sub-industry. 2) OWT = one-way trade/inter-industry trade; TWT = two-way trade/intra-industry trade; HIIT = horizontal intra-industry trade; VIIT = vertical intra-industry trade. 3) Range between export and import unit values used to distinguish between VIIT and HIIT is +/- 15%.

Table 14 reveals that the share of premium-quality exports dominates German VIIT with emerging countries. With the exception of trade in carpets and other textile floor coverings as well as articles of apparel and clothing, German high-quality shares were far above 50% in 1993. In half of the industries, premium-quality shares reached even higher than 90%. Until 2007, however, emerging markets were able to gain market shares in almost all high-quality segments, except in trade of other vegetable textile fibres etc., carpets and other textile floor coverings, where Germany was able to expand its high-quality shares over time. German losses have been most substantial in trade of man-made filaments, articles for technical use, etc., and other made-up textile articles, etc., where high-quality shares decreased by 30 percentage points or more. Heitger et al. (1999) remarked that trade protection of industrial countries might have favoured quality upgrading in less-developed countries. Some of these countries have reacted to quantitative restrictions on imports imposed by industrial countries through improvements in quality. Nevertheless, Germany continued to realise a strong competitive advantage in the export of first-rate quality in a vast majority of sectors. This was most pronounced in wool, fine and coarse animal hair, etc. (94%), silk (91%), and textiles for furniture, medical and surgical furniture, etc. (91%).

The development in the technical textile sector deserves particular attention. Although newly industrialising countries are still behind major advanced technical textile producers, they have caught up in terms of quality and product innovation in this sector. According to Hausding and Cherif (2008), these efforts can especially be observed in China, which is recently underway to gradually enter the market for more sophisticated textile commodities. During the last years, the country has substantially increased its R&D employment and investment activities in textile production, carrying out new fibre research and the like. Similar efforts can be observed in India and Turkey (Hausding and Cherif, 2008). For India and Turkey, this observation can also be backed up with data on trade flows. Between 1993 and 2007, Germany had to concede market shares in the high-quality segment of technical textiles to these countries. By contrast, China was not able to move out from its position as a provider of low-technology textiles during the same period. All in all, however, Germany clearly specialises in the technologically advanced segment when trading technical textiles with China, Turkey, and India. This picture can also be confirmed for the majority of other emerging trading partners. However, a number of Central and Eastern European trading partners - especially Slovenia, Slovakia, and the Czech Republic – managed to climb up the quality ladder and to take over market shares in the high-quality segment.

Table 14: Quality structure in vertical intra-industry textile trade with newly industrialising countries (1993 and 2007)

	1993			2007		
Industry	**VIIThigh**	**VIITlow**	**Average UV ratio**	**VIIThigh**	**VIITlow**	**Average UV ratio**
Silk	92.12	7.88	1.59	91.20	8.8	2.71
Wool, fine and coarse animal hair; yarn and fabrics of horsehair	97.25	2.75	1.58	93.58	6.42	1.49
Cotton	68.56	31.94	1.87	67.73	32.27	1.66
Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn	77.84	22.16	1.69	86.66	13.34	2.55
Man-made filaments	97.36	2.64	2.22	61.47	38.53	3.15
Man-made staple fibres	94.17	5.83	2.68	69.73	30.27	1.83
Wadding, felt and nonwovens; special yarns; twine, cordage, rope and cable and articles thereof	94.83	5.17	3.72	67.24	32.76	2.99
Carpets and other textile floor coverings	25.99	74.01	1.09	42.64	57.36	1.43
Special woven fabrics; tufted textile products; lace; tapestries; trimmings; embroidery	85.20	14.80	3.39	82.15	17.85	2.78
Articles for technical use, of textile materials; impregnated, coated, covered or laminated textile fabrics	98.15	1.85	3.98	62.62	37.38	2.39
Knitted or crotcheted fabrics	89.35	10.65	2.17	62.51	37.49	4.04
Articles of apparel and clothing accessories, knitted or crocheted	35.57	64.43	1.68	21.50	78.50	1.95
Other made up textile articles; sets; worn clothing and worn textile articles; rags	79.94	20.06	1.92	50.16	49.84	1.09
Furniture; medical and surgical furniture; bedding; mattresses, mattress supports etc.	99.21	0.79	1.52	90.94	9.06	1.38
Total	79.85	20.15	2.14	60.32	39.68	2.13

Source: *Comext* Database; author's calculations. Note: The formula to calculate the share of high and low quality VIIT as well as the average unit value ratio has already been presented in Table 8.

Quite remarkable is the observation that, in 2007, the Germany high-quality share in VIIT of technical textiles with newly emerging markets (62.62%) nearly equalled the high-quality share in trade of technical textiles with advanced countries (62.01%) (see Table 12 and Table 14). This result might be surprising at first sight. However, compared to VIIT of technical textiles with advanced partner countries, German VIIT with newly emerging markets comprises a much smaller number of products. Apparently, emerging markets are focusing on a relatively limited range of products and are gradually trying to shift production from down-market commodities toward the production of goods with superior quality. The exchange of quality differentiated technical textiles with emerging markets also constituted only a small fraction of total VIIT of technical textiles. All in all, the main competitors of German textile producers continue to be found in Western Europe, the U.S. and Japan, rather than elsewhere in Asia or in other emerging regions.

6.3.4 Consequences for skill demand

The textile industry in Germany refutes the prediction of traditional trade theory that after trade liberalisation there is a concentration of economic activity in a limited number of industries and an abandoning of other industries. Although this industry has suffered from a substantial shrinkage, a range of companies managed to persist despite massive international competition. Modern production in the textile industry is characterised by the provision of quality-intensive, innovative, and individualised products, rather than “mundane” labour-intensive products.

The strategic activities needed to stay a global player have also had distributional impacts (e.g., for Germany, see Spinanger and Piatti, 1994). The shift toward the production of sophisticated technical textiles with special functions has made the provision of textiles more research-, capital-, and high-technology-intensive. A growing number of jobs require creativity, the flexibility to produce new products and ideas, organisational competence, and communication skills (Adler, 2004). Accordingly, the competitiveness of the textile industry is nowadays to a large extent dependent on the existence of qualified employees. By contrast, the demand for low-skilled, less-adaptable workers has receded as certain skills have become redundant. Beyond that, job profiles for the remaining manual jobs have changed since the persistent pressure to upgrade product quality has increased the need for professional craft skill. These changes in employment trends are also reflected in the data. Between 1980 and 2000, the wage bill share of blue collar workers declined from 66.9% to 56.9% (Adler, 2004).

How much the shift towards the production of high-quality products has contributed to intra-industry skill upgrading is, however, difficult to determine. Along with product differentiation, the introduction of high-tech production techniques and the automatisation of the production process as well as the relocation of production have been steps to cope with changing competitive conditions. Thus, the exact contribution of product quality upgrading to changes in the structure of employment is difficult to identify. The interaction between these forces makes empirical analysis particularly challenging.

7. Skill upgrading in German manufacturing: Within or between industries?

The previous chapter has brought to light the increased significance of quality competition in German trade. It elaborated on how German companies have resisted competition through product quality upgrading and specialisation in high-quality niches. Using the textile industry as an example, it was further shown how the specialisation in certain quality segments has been interacting with other forces that may explain the declining demand for jobs that require a low level of qualification.

This chapter analyses the process of skill upgrading in German manufacturing in greater detail. Specifically, it aims to reduce the number of potential forces that might have been responsible for the shift toward high-skilled workers observed in recent decades. Chapters 3 and 4 demonstrated that, in addition to trade in quality differentiated products (i.e. VIIT), traditional inter-industry trade, international outsourcing, and SBTC might provoke severe reallocations of resources. One important detail is the fact that these forces differ with respect to their occurrence. While VIIT, international outsourcing, and SBTC are assumed to change the labour composition of skills within industries, inter-industry trade is expected to affect labour composition between industries, causing shrinkage of industries that employ a large number of unskilled workers and an expansion of industries that employ a large number of skilled workers.[53] Consequently, the focus of analysis will be on whether the shift toward skilled workers occurred primarily within or between industries.

In the following, Section 7.1 introduces the methodology used to decompose changes in production workers' share of employment and wage bill. Section 7.2 describes the data and Section 7.3 presents and discusses the results.

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[53] For the sake of completeness, it should be pointed out that, in addition to the expansion of inter-industry trade, other potential forces might trigger the reallocation of resources between sectors. The size of a branch might be affected by changes in the demand for goods, e.g., if the demand shifts from manufacturing goods toward services. Moreover, structural changes between sectors might be fostered by sector-biased technical change, as pointed out in Section 3.2.2, which is supposed to provoke a shift in production toward human capital-intensive sectors. In the literature, however, inter-industry trade is still considered to be the major force behind the between-industry shift (Chusseau et al., 2008).

7.1 Methodology

The decomposition analysis conducted in this chapter is based on seminal contributions by Berman et al. (1994). They broke down the overall decline in production workers' share of total employment into two components: one that reflects the shift in demand for low-skilled workers across industries (the *between* component) and another that can be associated with the shift from low-skilled toward high-skilled workers within industries (the *within* component). Thereby, the change in the aggregate share of low-skilled workers in the total manufacturing employment is decomposed into the two terms according to the following formula:

$$\Delta S^{LS} = \sum_{i=j}^{n} \Delta h_i \overline{S}_i^{LS} + \sum_{i=j}^{n} \Delta S_i^{LS} \overline{h}_i \qquad (2)$$

where ΔS^{LS} is the overall change in the share of low-skilled labour, $S_i^{LS} = L_i^{LS} / L_i$ denotes the proportion of low-skilled workers in industry i, and $h_i = L_i / L$ represents the employment share of industry *i* in total manufacturing employment. An overbar indicates the average over the period under consideration. The first term on the right side refers to the change in employment across or between industries (the *between* component), and the second term is attributed to the allocation of employment within industries (the *within* component) (Berman et al., 1994).

For Germany, a similar methodology has been applied by Berman et al. (1998) and Geishecker (2006), who examined the process of skill upgrading in German manufacturing during the 1970s and 1990s, respectively. Both studies concluded that the shift away from unskilled to skilled workers has been due mainly to within-industry changes. Using data on production and non-production workers from the United Nations General Industrial Statistics Database, Berman et al. (1998) attributed 93% of the total decline in production workers' share of employment between 1970 and 1980 to a reallocation of employment within industries.[54] Analysing data on production and non-production workers provided by the German Federal Statistical Office, Geishecker (2006) found that, from 1991 to 2000, within-

[54] Berman et al. (1998) reported similar tendencies for a large number of industrial countries during that time.

industry changes have been entirely responsible for the process of skill upgrading. Since the shift toward non-production workers within industries has been slightly countervailed by a positive between-industry shift toward low-skilled labour-intensive industries, the overall drop in production workers' employment share during that time has been smaller than the within-industry shift.

7.2 Data

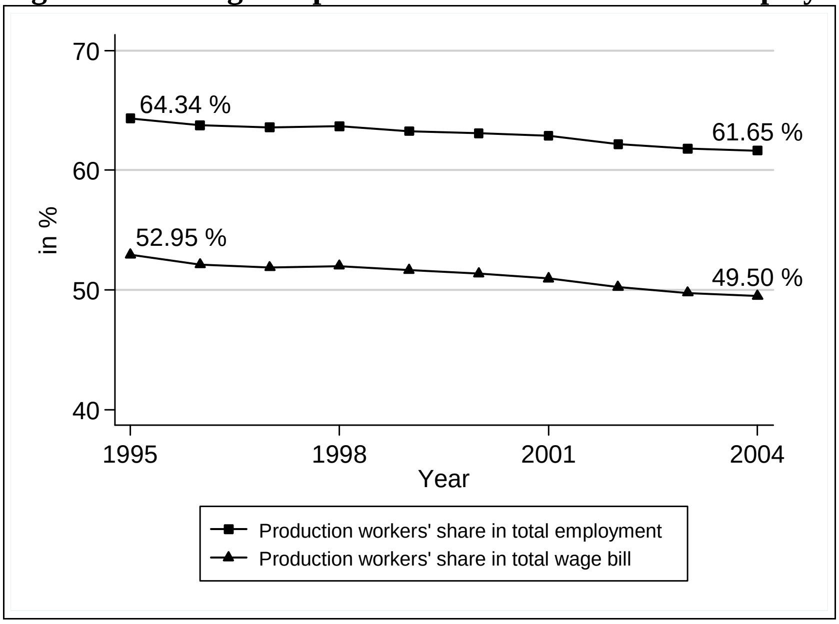
To analyse the process of skill upgrading in German manufacturing, the present study draws upon aggregated employment and wage data for German manufacturing provided by the German Federal Statistical Office (Fachserie 4, Reihe 4.1.1). The German Federal Statistical Office groups data into data for wage earners and data for salaried employees. This distinction roughly corresponds to the often-used differentiation between production and non-production workers or blue- versus white-collar workers, respectively. Obviously, the distinction between production and non-production workers is only a crude approximation of the differentiation between low-skilled and high-skilled labour and is based on the assumption that all production workers are low-skilled and all non-production workers are high-skilled. However, some production work might be highly skilled (e.g., that of a production manager) and some non-production work might be completely unskilled (e.g., that of a doorman). Nevertheless, it should be unquestionable that the share of genuinely unskilled work is much higher among manual jobs than among non-manual jobs. Furthermore, this broad separation of skill groups is very often applied in the literature (e.g., Berman et al., 1994, 1998; Machin and Van Reenen, 1998; Paqué, 1999; Head and Ries, 2002).

The decomposition analysis covers 20 out of 23 (two-digit) manufacturing industries listed in Annex 2. Three industries, namely the tobacco, coke, and refined petroleum, as well as the recycling industry, have been excluded from the analysis, as they have also been eliminated from the econometric study in Chapter 8 for several reasons (see Chapter 8). The focus of analysis is on the period from 1995 to 2004 to ensure comparability with the econometric analysis in Chapter 8, which also focuses on this period. Additionally, the data refer to the unified Germany since separate time series data for eastern and western Germany are not available for the period under consideration.

7.3 Results

After the data on production and non-production workers have been analysed, the results reveal that the process of skill upgrading persisted between 1995 and 2004. As Figure 19 illustrates, the share of production workers in total manufacturing employment decreased from 64.34% to 61.65% (by 2.69 percentage points) during that time. Similarly, the wage bill share declined from 52.95% to 49.50% (by 3.45 percentage points).

Figure 19: Changes in production workers' share of employment/wage bill (1995-2004)



Source: Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.1.1; author's calculations.

In the next step, the decline in production workers' employment and wage bill share, respectively, has been decomposed according to the aforementioned formula. The decomposition analysis for German manufacturing between 1995 and 2004 basically confirms the findings of previous studies. The results are presented in Table 15. The message of the table is quite unambiguous: there is strong evidence for substantial skill upgrading within industries. In total, the share of production workers dropped by 2.69 percentage points. This reduction has been due to a sizable fall in production workers' share within industries (-2.91 percentage points), which was marginally compensated for by a small shift toward unskilled labour-intensive industries, as the positive between component change suggests (+0.22 percentage points).

The same calculation can be done using production workers' share of the total wage bill instead of production workers' share of total employment. In doing so, it can account for the observation that the decline in the relative demand for less-skilled workers in Germany has been reflected in both declining relative employment and relative wages during that time. Data on industry payments can also be taken from the German Federal Statistical Office. The results of this analysis reveal that, regarding the relative magnitude of the within and between component, the pattern is quantitatively similar (Table 15). Between 1995 and 2004, production workers' share of the wage bill decreased by 3.45 percentage points. This decline can be ascribed to a within-industry shift of -3.81 percentage points, which was slightly compensated for by a between-industry shift of +0.36 percentage points.

Table 15: Decomposing changes in production workers' employment and wage bill share (1995-2004)

Employment			Wage bill		
Total	Between	Within	Total	Between	Within
- 2.69	0.22	-2.91	- 3.45	0.36	- 3.81

Source: Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.1.1; author's calculations.

As depicted in Table 16, the substitution of non-production workers for production workers within industries is not restricted to specific sectors but can be observed in almost all manufacturing industries. Nevertheless, skill upgrading seems to be concentrated. Some branches experienced a stronger decrease in production workers' employment share than others. The industries that have been primarily responsible for the within-industry decline in production workers' share of total employment between 1995 and 2004 have been the motor vehicle industry (-0.56 percentage points), the machinery industry (-0.47 percentage points), the radio, TV, and communication equipment industry (-0.28 percentage points), printing and publishing (-0.28 percentage points), and the electrical machinery industry (-0.26 percentage points). These are also the top contributors if production workers' share of the total wage bill rather than employment is considered.

Table 16: Within-industry contribution to the decline of production workers' employment and wage bill share (in percentage points) (1995-2004)

Industry	**Employment**	**Industry**	**Wage bill**
1. Motor vehicles	- 0.565	1. Motor vehicles	- 0.800
2. Machinery	- 0.472	2. Machinery	- 0.701
3. Radio, TV and communication	- 0.285	3. Printing and Publishing	- 0.359
4. Printing and Publishing	- 0.280	4. Radio, TV and communication	- 0.294
5. Electrical Machinery	- 0.259	5. Electrical Machinery	- 0.293
6. Wearing Apparel	- 0.195	6. Mineral Products	- 0.208
7. Chemicals	- 0.188	7. Chemicals	- 0.200
8. Other transport equipment	- 0.178	8. Other transport equipment	- 0.185
9. Medical, precision and optical instruments	- 0.180	9. Medical, precision and optical instruments	- 0.181
10. Mineral products	- 0.156	10. Wearing Apparel	- 0.137
11. Furniture n.e.c.	- 0.089	11. Furniture n.e.c.	- 0.102
12. Rubber and plastic products	- 0.043	12. Rubber and plastic products	- 0.073
13. Leather products and footwear	- 0.040	13. Fabricated Metal products	- 0.072
14. Wood	- 0.030	14. Basic metals	- 0.060
15. Textiles	- 0.027	15. Wood	- 0.045
16. Pulp and Paper	- 0.026	16. Pulp and Paper	- 0.041
17. Basic metals	- 0.013	17. Leather products and footwear	- 0.037
18. Food products and beverages	0.033	18. Textiles	- 0.030
19. Office and computing machinery	0.036	19. Food products and beverages	0.026
20. Fabricated Metal products	0.043	20. Office and computing machinery	0.047
Total	**-2.91**	**Total**	**- 3.81**

Source: Statistisches Bundesamt (Curr. Iss.), Fachserie 4, Reihe 4.1.1; author's calculations.

The predominance of the within-industry shift has several implications for empirical analysis. The first implication concerns the commodity structure of German manufacturing and the pattern in international trade. In this regard, the results suggest that Germany has specialised in selected products within a large range of manufacturing industries rather than completely specialised in specific industrial branches as a reaction to competitive pressure from abroad. The second implication refers to the different forces that might have been responsible for changes in the skill structure of employment. The large within-industry shift clearly implies that increased trade in different qualities, international outsourcing, and technological progress are among the prime suspects.

8. Trade in qualities and skill demand in German manufacturing

The descriptive analysis in the preceding chapter has provided evidence for the continuation of skill upgrading in German manufacturing between 1995 and 2004. The insight that the within component clearly dominates the picture confirms the assumption to focus on factors that affect the employment structure within industries when explaining the change in the relative demand for skills. This chapter investigates empirically to what extent quality competition and Germany's subsequent specialisation in high-quality niches has favoured skill upgrading in German manufacturing. Special emphasis will be put on separating the effect of VIIT on skill demand from major other forces at work, namely SBTC and international outsourcing. The analysis contributes to the existing literature on trade and employment in several ways: first, it provides some evidence on the linkage between quality competition in international trade and the demand for skills in industrial countries. Considering that studies on this linkage are scarce, the present study delivers an essential contribution to the existing literature. Second, it explicitly deals with the potential labour market impact of trade between advanced countries. This issue has hardly received attention in the empirical literature that primarily concentrates on the effect of advanced countries' trade with developing countries.

The remainder of this chapter is structured as follows. Section 8.1 derives the econometric model. Afterwards, Section 8.2 describes the estimation approach in more detail before Section 8.3 explains the dataset used for analysis. Section 8.4 presents and discusses the econometric results. Section 8.5 concludes the empirical analysis by discussing its limitations.

8.1 Econometric model

To quantify the impact of VIIT on the labour market and, specifically, the relative demand for low-skilled workers within industries, a translog cost function approach based on the work of Berman et al. (1994) and Feenstra and Hanson (1996a, 1996b) is employed. The starting point for deriving the econometric model is an arbitrary aggregated production function for each industry *i*:

$$Y_i = Y(L_i^{LS}, L_i^{HS}, K_i, T_i) \qquad (3)$$

where for each industry i, Y denotes industry's output which is produced with a range of homogenous inputs. L_i^{LS} and L_i^{HS} denote the amount of low-skilled labour and high-skilled labour, respectively. K_i represents the capital stock of industry i and T_i is a time variable that is included to allow the structure of production to vary over time. Basically, T_i can also be interpreted as a technology parameter that captures changes in technical efficiency.

It is assumed that there are two variable factors of production, namely high-skilled and low-skilled workers. The capital- and technology stock are considered as a quasi-fixed input, implying they are fixed in the short run, but may differ from their long-run equilibrium. It is further assumed that the isoquants of the production functions are convex and that firms seek to maximise profits. Following, for each industry a variable unit cost function dual to (3) exists:

$$CV_i = CV(Y_i, W_i^{LS}, W_i^{HS}, K_i, T_i) \quad (4)$$

where for each industry i, CV_i reveals variable cost. W_i^{LS} and W_i^{HS} represent the wage rates for low-skilled and high-skilled workers, respectively.

For an empirical implementation, an appropriate functional form of the cost function in (4) has to be specified. Following major preceding studies (e.g. Berman et al., 1994), the variable cost function is approximated by a translog cost function as originally suggested by Brown and Christensen (1981). The translog function can be considered as a second-order Taylor's approximation in logarithms to an arbitrary (twice-differentiable) cost function with variable and quasi-fixed input factors. Using this specification is appealing from an empirical point of view since it does not impose *ex ante* restrictions on the production structure, e.g. with respect to homotheticity, homogeneity, and unitary elasticities of substitution. The cost function takes the following form:

$$\ln CV_i = \alpha_0 + \alpha_Y \ln Y_i + \frac{1}{2}\alpha_{YY}(\ln Y_i)^2 + \alpha_K \ln K_i + \frac{1}{2}\alpha_{KK}(\ln K_i)^2 + \alpha_{LS} \ln W_i^{LS} + \alpha_{HS} \ln W_i^{HS}$$
$$+ \frac{1}{2}\alpha_{LSLS}(\ln W_i^{LS})^2 + \frac{1}{2}\alpha_{LSHS} \ln W_i^{LS} \ln W_i^{HS} + \frac{1}{2}\alpha_{HSHS}(\ln W_i^{HS})^2 + \frac{1}{2}\alpha_{HSLS} \ln W_i^{HS} \ln W_i^{LS}$$
$$+ \alpha_{YLS} \ln Y_i \ln W_i^{LS} + \alpha_{YHS} \ln Y_i \ln W_i^{HS} + \alpha_{KLS} \ln K_i \ln W_i^{LS} + \alpha_{KHS} \ln K_i \ln W_i^{HS} + \alpha_{YK} \ln Y_i \ln K_i$$
$$+ \alpha_T T_i + \frac{1}{2}\alpha_{TT} T_i^2 + \alpha_{TY} T_i \ln Y_i + \alpha_{TK} T_i \ln K_i + \alpha_{TLS} T_i W_i^{LS} + \alpha_{THS} T_i W_i^{HS} \qquad (5)$$

where $\alpha_{HSLS} = \alpha_{LSHS}$ is assumed for symmetry reasons. To be well behaved, the translog cost function must be homogenous of degree one in prices. This implies that, for a fixed level of output, total cost must rise proportionally when all prices increase proportionally. For this condition to hold, the following restrictions are imposed on the equation (5):

$$\alpha_{LS} = 1 - \alpha_{HS}$$
$$\alpha_{HSHS} + \alpha_{HSLS} = \alpha_{LSLS} + \alpha_{LSHS} = 0$$
$$\alpha_{YLS} + \alpha_{YHS} = \alpha_{KLS} + \alpha_{KHS} = \alpha_{TLS} + \alpha_{THS} = 0 \qquad (6)$$

In a next step, an industry *i*'s demand for low-skilled workers can be obtained. According to Shephard's lemma (1953), the partial derivative of the variable cost function with respect to the price of a certain variable factor yields the demand equation for this factor. Due to the logarithmic form of the variable cost function, differentiation delivers the share of this factor in total variable costs. For low-skilled workers, we obtain the following factor share equation:

$$\frac{\partial \ln CV_i}{\partial \ln W_i^{LS}} = \frac{\partial CV_i}{\partial W_i^{LS}} \frac{W_i^{LS}}{CV_i} = \frac{L_i^{LS} W_i^{LS}}{CV_i} = WS_i^{LS} \qquad (7)$$

with WS_i^{LS} representing the cost share of low-skilled workers in the total wage bill of industry *i*. This cost share can be interpreted as a composite measure of the relative demand for less-skilled workers, reflecting not only relative employment but also relative factor prices (Geishecker, 2004). Using this cost share as the independent variable can account for the observation that the decline in the relative demand for less-skilled workers in Germany might have been reflected either through declining relative employment or relative wages. Differencing (5) with respect to the wage of low-skilled workers yields:

$$
\begin{aligned}
WS_i^{LS} &= \alpha_{LS} + \alpha_{LSLS} \ln W_i^{LS} - \alpha_{LSLS} \ln W_i^{HS} + \alpha_{YLS} \ln(Y_i) + \alpha_{KLS} \ln(K_i) + \alpha_{TLS} T_i \\
&= \alpha_{LS} + \alpha_{LSLS} \ln\left(\frac{W_i^{LS}}{W_i^{HS}}\right) + \alpha_{YLS} \ln(Y_i) + \alpha_{KLS} \ln(K_i) + \alpha_{TLS} T_i \qquad (8)
\end{aligned}
$$

with W_i^{LS} / W_i^{HS} denoting the relative wage rate of low-skilled and high-skilled workers in industry *i*.

As already pointed out by Feenstra and Hanson (1996a, 1996b), including only factors derived from the traditional cost function might not capture all determinants influencing an industry's demand for unskilled labour. Therefore, in the empirical application of the above model further variables are added to the wage bill share equation, namely an indicator for the outsourcing activities of each industry and an indicator reflecting the pressure to upgrade product quality:

$$
\begin{aligned}
WS_{it}^{LS} &= \beta_0 + \beta_1 \ln\left(\frac{W_{it}^{LS}}{W_{it}^{HS}}\right) + \beta_2 \ln(Y_{it}) + \beta_3 \ln(K_{it}) + \beta_4 T_{it} \\
&\quad + \beta_5 \ln(OUTS_{it}) + \beta_6 \ln(VIIT_{it}) + \beta_7 D_t + v_{it} \qquad (9)
\end{aligned}
$$

where *t* refers to specific years. The variable $OUTS_i$ reflects international outsourcing in industry *i* and $VIIT_i$ is the share of trade in quality differentiated products in total trade of industry *i*. D_t is a set of year dummies which accounts for secular changes of single time periods that are common to all industries and affect the demand for skills from one year to another (e.g. common macroeconomic effects, structural changes) but are not explicitly modelled. Finally, the error term v_{it} accounts for unobserved factors that affect the demand for skills within industries.[55]

[55] To fit the model better to the data, the variables measuring outsourcing ($OUTS_i$) and trade in quality differentiated products ($VIIT_i$) also enter regression in logarithmic form.

One empirical challenge is to proxy for SBTC denoted as T_i in equation (9). As emphasised in Section 3.2, the mechanisms through which SBTC operates are complex and a clear theoretical foundation for SBTC is missing. For this reason, there is no commonly agreed-upon method how to measure SBTC empirically. In the literature, several attempts have been made. Some studies intended to estimate technical change directly, including a measure for growth in total factor productivity in regression (e.g., Lawrence and Slaughter, 1993; Leamer, 1997). According to traditional growth theories, technical change reflects the part of productivity growth that cannot be explained by the growth of inputs. From an econometrical point of view, technical change is then the coefficient of the time trend in a neoclassical linear homogenous production function of each industry. However, since the time trend is a residual that captures several factors, it might also control for other determinants which do not necessarily reflect technical change (Heitger and Stehn, 2003). Beyond that, problems might arise when adding this term to regression (9) since it is most likely highly correlated with the capital variable. Another way of capturing the impact of technological progress is to proxy its influence by adding technology related indicators to the estimated equation, i.e. explanatory variables that are assumed to trigger technical change such as R&D intensity (e.g., Machin and Van Reenen, 1998), the number of computers in service (e.g., Autor et al., 1998), or physical capital (e.g., Berman et al., 1994; Acemoglu, 2002).

The present study follows the latter approach by adding an appropriate technology-related variable to the regression analysis to proxy technical change. For this purpose, the capital variable (K_i) has been split up into two components, namely buildings and plants (P_i) and equipment (E_i). Particularly the equipment variable (E_i) that comprises machinery and other assets (e.g. assets of an immaterial nature such as software programs) is supposed to capture the impact of technical change. The rationale behind this approach is that economic theory has attached great importance to the role of capital in technical change, as mentioned in Section 3.2 (see also Papaconstantinou et al., 1996). In fact, capital stock provides essential information on the state of technology since many innovations are embodied in capital goods such as machinery. In addition, the skill bias of technical change is supposed to be closely linked to the mechanisation of the production process since unskilled workers can be substituted more easily for machines and robots. The remaining industry-specific impact of technical change that is not absorbed by the equipment variable is captured by the industry specific error term, v_{it}. In addition, the constant term and the set of time dummies capture changes in technical efficiency that are common to all industries. Replacing the capital variable (K_i) in regression (9) yields the following equation:

$$WS_{it}^{LS} = \beta_0 + \beta_1 \ln\left(\frac{W_{it}^{LS}}{W_{it}^{HS}}\right) + \beta_2 \ln(Y_{it}) + \beta_3 \ln(P_{it}) + \beta_4 \ln(E_{it})$$

$$+ \beta_5 \ln(OUTS_{it}) + \beta_6 \ln(VIIT_{it}) + \beta_7 D_t + v_{it} \qquad (10)$$

When estimating equation (10), endogeneity problems might arise since relative wage rates (W_i^{LS} / W_i^{HS}) might not necessarily be exogenous. In fact, wages and the relative demand for unskilled labour might be determined simultaneously, which in turn implies biased coefficients. Despite prevailing wage coordination in German manufacturing industries, this problem cannot be ruled out (Geishecker, 2006). Thus, following previous studies (e.g., Berman et al., 1994; Geishecker, 2006) relative wages are omitted from regression. If we assume that the relative price of low-skilled to high-skilled labour does not vary across industries, the exclusion of relative wages from regression will only affect the constant term (Berman et al., 1994). Alternatively, annual changes in the wage levels faced by all industries might be absorbed by the time dummies. Dropping the relative wage from (10) delivers:

$$WS_{it}^{LS} = \beta_0 + \beta_1 \ln(Y_{it}) + \beta_2 \ln(P_{it}) + \beta_3 \ln(E_{it})$$

$$+ \beta_4 \ln(OUTS_{it}) + \beta_5 \ln(VIIT_{it}) + \beta_6 D_t + v_{it} \qquad (11)$$

8.2 Estimation procedure

To correctly estimate equation (11), an appropriate estimation technique has to be chosen. If we impose the restriction that the coefficients of the exogenous variables are the same across industries, data can be pooled and estimated with the Ordinary Least Square Estimation method (pooled OLS), using time-series variation as well as cross-section variation in the data.

However, one specific problem that frequently plagues panel data analysis is the presence of unobserved time-invariant individual effects that might affect the reliability of OLS estimation results. In the presence of unobserved effects, the error term v_{it} in (11) can be decomposed into two components: $v_{it} = a_i + u_{it}$, where a_i represents an unobserved time-constant industry-specific effect and u_{it} is the idiosyncratic or time-varying error representing unobserved factors that affect the skill structure of employment and that vary over time. In the literature, the unobserved time-invariant characteristic a_i is also referred to as "unobserved heterogeneity", "unobserved effect", or "fixed effect" (e.g., Wooldridge, 2002; 2009). In our specific case, it comprises all factors that affect the demand for skills within an industry that do not change over time or are roughly constant over a longer time period and that cannot be observed or identified. Since it is unobserved, it is felt through the disturbance term. Examples for unobserved industry specific characteristics in the underlying case might be productivity differences or technology differences that, for instance, cause some industries to show a permanent higher demand for skills than others.

If unobserved effects are present, the estimation of equation (11) with pooled OLS might deliver seriously misleading results. If the unobserved effect is correlated with one or more explanatory variables, estimation would suffer from "heterogeneity bias" or "omitted variable bias" since relevant variables (reflecting industry characteristics) that affect the demand for skills but cannot be observed or identified are excluded from regression. As a consequence, observations are not independently distributed across time and using pooled OLS estimation would produce biased coefficients (e.g.; Greene, 2002; Wooldridge, 2002; 2009). But even if the time-constant industry-specific effect is not correlated with any of the explanatory variables, estimation results are affected since unobserved effects most likely not only influence an industry's demand for skills in one year but also in subsequent years. This implies serial correlation in the error term, which in turn produces distorted standard errors.

To test for the presence of unobservable effects in the underlying model, a *Breusch-Pagan Lagrangian Multiplier Test* (LM) has been implemented (Breusch and Pagan, 1980). The general idea of this test is to find out whether there is a significant difference of a_i across units. The null hypothesis of the LM test states that the variance of the individual-specific (i.e.

industry-specific) component a_i of the composite error term is zero, and hence that there is no significant difference of a_i across units.[56] The test procedure is as follows: with the residuals from a pooled OLS regression (in our case on equation (11)), a LM test statistic is calculated (see Greene, 2002). Under the null hypothesis, this test statistic is distributed as chi-squared with one degree of freedom. If the test statistic exceeds a certain critical value for chi-squared with one degree of freedom, the null hypothesis is rejected, and hence a classical regression model with a single constant term is not appropriate for the data. When applying the LM test to the above model (11), the null hypothesis had to be rejected at a 1% significance level. This implies the existence of unobserved heterogeneity and the need to control for unobservable effects when estimating (11).[57] The test statistic for this as well as the upcoming diagnostic tests is reported in Annex 11.

In order to account for time-constant unobserved effects, two types of estimation approaches are usually employed: Fixed Effect Estimation (FE) and Random Effect Estimation (RE). The choice between both models is dependent on the correlation between the unobserved industry-specific effect and the explanatory variables. If there is a correlation between the time-invariant industry-specific effect and any time-varying explanatory variable, a FE model would be appropriate to prevent omitted variable bias since it allows for the correlation between both by washing out the time-invariant effect through transforming the above mentioned model by differentiation. In specific, the unobserved effect is eliminated from regression by subtracting (for each industry *i*) the value of each variable in period *t* from its average value over time. In the literature, this transformation is also referred to as *time-demeaning* (Wooldridge, 2002; 2009). After the transformation has been carried out, pooled OLS regression can be conducted using the time-demeaned variables. It is particularly noteworthy that fixed effects estimation only exploits within-group variation over time to estimate regression coefficients. In other words, the impact of an independent variable is identified through intra-industry changes using only the information contained in time-series.

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[56] Thereby it is assumed that the individual specific constant term is considered to be randomly distributed across cross-sectional units.

[57] The LM-test has been implemented in STATA in the following way: First, equation (11) has been estimated with Random Effects estimation, using the *xtreg* command and the option *re*. After that, the command *xttest0* had been implemented to conduct the LM-test. Since the p-value was much smaller than 1%, it was concluded that there is a significant difference across industries and that the null hypothesis can be rejected.

Information on the variation across industries is not used since it might reflect omitted variable bias. Therefore, the fixed effect estimator is also called the *within* estimator.

If the time-invariant industry-specific effect is not correlated with any time-varying explanatory variable, RE estimation should be applied. In RE-model, the unobserved effect a_i is assumed to be a stochastic or random variable that is similar to the idiosyncratic error u_{it}, independently and identically distributed (i.i.d.). In contrast to FE, the RE estimation technique does not eliminate the unobserved effect, since correlation with the regressors is not a problem. However, as mentioned above, there might be substantial serial correlation in the error term generating biased standard errors. This problem can be tackled by applying Generalized Least Squares Estimation (GLS) or, more commonly, Feasible Generalized Least Square Estimation (FGLS). Both methods correct for serial correlation in the error term by transforming the underlying econometric model (model (11) in our case). However, since a transformation requires information on the variance components, i.e. the variance of a_i and the idiosyncratic error u_{it}, which is usually not available, the disturbance variances have to be estimated in a first step before the econometric model is transformed and estimated in a second step. Hence, FGLS is usually applied (Greene, 2002).

If there is no correlation between the unobserved time-constant effect and one or more exogenous variables, the RE estimator delivers consistent estimates as does the FE estimator. However, compared to FE, the RE estimator is not only consistent but also efficient since it uses the information from cross-section and time-series variation (the FE estimator uses only information on time-series). Very often, however, the assumption of no systematic correlation between the unobserved individual (or industry-specific) characteristics and any of the explanatory variables is not fulfilled. In the present model, for example, more productive firms or industries might be more prone to outsourcing.

To choose between the FE and the RE model when estimating (11), and implicitly to test whether there is a correlation between the unobserved time-constant industry specific effect and the explanatory variables, a robust Hausman test suggested by Wooldridge (2002) was conducted.[58] The null hypothesis of the test is that the preferred estimation model is the random-effect model since it is efficient compared to fixed effect (as it uses information within as well as across industries), given that errors are not correlated with the regressors. The Hausman test proceeds in two steps. In the first step, the empirical model under consideration has to be estimated separately with FE and RE regression. After that, the estimated coefficients of both methods are compared with each other. If there is a significant difference between the coefficients, the assumption of no correlation between the unobserved effect and the explanatory variables is most likely not fulfilled and the FE method is preferred to RE since it delivers unbiased and consistent estimates. Applying this test to the wage bill share equation (11), the robust Hausman test reveals the FE-Model seems to be more appropriate than RE, indicating a correlation between the time-invariant industry-specific effect and some explanatory variables.[59] Hence, (11) should be estimated using the FE estimation technique.

An alternative to FE-estimation that allows controlling for the time-invariant industry-specific heterogeneity included in the error term by eliminating it from regression is using First Differences (FD). Both methods differ with respect to the transformation employed to eliminate the unobserved individual specific effect. In contrast to the time-demeaning procedure of FE regression, FD regression differences the unobserved effect away by subtracting for each industry i the value of each explanatory variable in one period from its succeeding value. Similar to FE estimation, FD-method effectively estimates the relationship between changes of variables. Consequently, we cannot draw any conclusion regarding the relationship between different levels. According to Wooldridge (2002), FD-estimation is more efficient and therefore preferred to FE-estimation in the presence of high positive autocorrelation, as is the case in this setting.[60]

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[58] In contrast to the standard Hausman test, the robust version allows for the case that the RE estimator is not fully efficient (Cameron and Trivedi, 2009).

[59] The robust Hausman test was implemented in STATA using the user-written command *xtoverid*.

[60] To determine the correlation of the residuals, pooled OLS regression on (11) was conducted and the residuals were stored. Afterwards, residuals were regressed on their lagged values. The regression results suggest a high positive serial correlation with a coefficient for the lagged residuals of 0.90.

Finally, equation (11) is estimated as a panel model applying first difference estimation, i.e. estimating a first-differenced equation with OLS. Differencing (11) yields the following model:

$$\Delta WS_{it}^{LS} = \beta_0^* + \beta_1 \Delta \ln(Y_{it}) + \beta_2 \Delta \ln(P_{it}) + \beta_3 \Delta \ln(E_{it}) + \beta_4 \Delta \ln(OUTS_{it}) + \beta_5 \Delta \ln(VIIT_{it}) + \beta_6 D_t + \varepsilon_{it} \qquad (12)$$

where Δ denotes the change from *t-1* to *t* and $\varepsilon_{it} = \Delta u_{it}$.

It should be noted that the constant term of the original model (11) is actually eliminated from regression when taking first differences. However, following previous studies in this field of research (e.g., Berman et al. 1994; Strauss-Kahn, 2003) and econometric textbooks (e.g., Wooldridge, 2002; 2009), a constant term β_0^* is included in the first difference equation. Additionally, the year dummies included in regression do not enter the equation in first differenced form. Instead, single time period dummies for the years between 1997 and 2004 are included (see Wooldridge, 2002; 2009).[61]

Although FD estimation controls for unobserved effects, it might still deliver misleading results if other assumptions of standard OLS-estimation are violated. One central assumption in standard OLS-estimations is that the error term is assumed to be independent and identically distributed (i.i.d.) over time periods and across cross-sectional units. Hence, in order to derive unbiased and efficient estimates, several diagnostic tests have been conducted to find out whether this central assumption that is frequently violated when estimating panel data models is fulfilled in the present case. Specifically, it has been tested for serial correlation, heteroscedasticity, and contemporaneous correlation among the error terms.

When error terms exhibit serial correlation, the residuals in one period are correlated with the residuals of the previous period (e.g. Auer, 2007). Serial correlation causes biased standard errors. Although the FD-estimator used to estimate equation (12) relies on the assumption that the first differences of the error terms are serially uncorrelated, serial correlation is not

[61] However, although time dummies have been included in regression at the beginning, they have finally been dropped since none of them turned out to be statistically significant.

necessarily wiped out with taking first differences. To test for serial correlation, the test procedure suggested by Wooldridge (2002) has been applied. The underlying assumption of this test is that when ε_{it} are not serially correlated, then Corr($\Delta\varepsilon_{it}, \Delta\varepsilon_{it-1}$) = – 0.5.[62] The hypothesis of no serial correlation cannot be rejected.

The i.i.d. assumption of the error term is also violated when errors are heteroscedastic, i.e. when the error terms do not have the same variance across units (e.g. Auer, 2007). An initial inspection of the data after FD-regression on equation (12) revealed that the residuals tend to vary more for smaller industries. This indicates the assumption of homoscedasticity is likely to be violated due to differing sizes of industries, implying distorted standard errors. Applying a Breusch-Pagan/Cook-Weisberg test (Pindyck and Rubinfeld, 1998) confirms the existence of heteroscedasticity. In general, this statistical test tests the null hypothesis that the variances of the errors are all equal against the alternative hypothesis that error variances are a multiplicative function of one or more variables. Testing whether the scedasticity function of the errors is dependent on one or more regressors in model (12) yields the following insights: testing the joint (simultaneous) hypothesis leads to the rejection of the null hypothesis of homoscedasticity at a 1% significance level. When testing for each regressor separately, the variables mainly responsible for heteroscedasticity could be identified. In specific, the null hypothesis had been rejected for the capital variable ($\Delta\ln(P_{it})$) at a 5% and the output variable ($\Delta\ln(Y_{it})$) at a 1% significance level, thus confirming the initial presumption that the variance of the errors tends to depend on the industry size.[63]

A third problem when estimating panel data arises when individual observations across panels are not independent of one another, i.e. errors are correlated across units. This phenomenon, also referred to as “spatial dependence”, “cross-sectional dependence”, or “contemporaneous correlation” is caused by the presence of unobserved common factors such as exogenous shocks that affect all industries. Since these factors are unobserved, their impact is felt through the disturbance term. If there is no correlation between the unobserved common

[62] The test has been performed in STATA using the command *xtserial* (Drukker, 2003).
[63] The test has been implemented in STATA using the postestimation command *estat hettest* after FD-regression on equation (12). Additionally, the option *mtest* had been implemented. This option performs multiple tests that test each component separately and then all components together.

factors and the regressors included, estimation would yield consistent, though not efficient, estimators and biased standard errors (Baltagi, 2005).

To test whether the residuals are correlated across entities in the present paper's panel data, a Pesaran CD (cross-sectional dependence) test with the null hypothesis of no cross-sectional correlation between the residuals was implemented (Pesaran, 2004). The CD test is supposed to have good small sample properties and hence seems appealing for the present data set. The general idea behind this diagnostic test is to calculate a CD test statistic that contains information on the correlation coefficient of the disturbances. Under the null hypothesis, the test statistic is asymptotically normally distributed for a sufficiently large panel. The null hypothesis is rejected if the test statistic exceeds a certain critical value. When applying this test to the data, however, the null hypothesis could not be rejected at a 5% significance level, indicating that cross-sectional dependence does not seem to be a problem in this context.[64]

To sum up, preliminary tests have detected the presence of heteroscedasticity, whereas serial correlation and contemporaneous correlation do not seem to be a problem. Since heteroscedasticity implies biased standard errors and less efficient estimates, equation (12) is estimated using FGLS estimation to obtain heteroscedasticity-consistent standard errors.[65] FGLS estimation was conducted as follows: first, regression was run on (12). Second, the residuals from this regression were stored. The stored residuals were then used to estimate a regression model for the error variance and to predict the individual error variance. Third, a linear regression on (12) has once again been performed using the information on the individual error variance to weight the data.

When estimating (12), we expect the following signs for the variables' coefficient: the coefficient of the variable denoting the industry's production value (Y_i) is expected to have a positive sign, assuming that the demand for low-skilled (i.e. manual) workers and hence their share in the total wage bill rises with an increase in output (Geishecker, 2004). Since capital, in general, is supposed to be more complementary for high-skilled (i.e. non-production)

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[64] The test was implemented in STATA using the postestimation command *xtcsd* and the option *pesaran* after regression on (12).
[65] Estimation has been performed with the *reg* command in STATA. To prevent any misspecification, the *robust* option has been added to the command line (Cameron and Trivedi, 2009).

workers than for low-skilled (i.e. production) workers (see Section 3.2), the coefficient of capital stock should have a negative sign.

However, we might yield a more differentiated picture on the role of capital in affecting the skill structure of employment when measuring capital separately as plants (P_i) and equipment (E_i) since the impact of both types of capital might differ (Berman et al., 1994). Whereas an increase in equipment (E_i) (i.e. machines and the like) tends to adversely affect production workers by replacing them, the impact of the construction of new buildings is less clear and, in addition, not elaborated theoretically. Intuitively, additional plants and buildings might affect the relative demand for production worker negatively when appearing in the form of office and administration centres or R&D departments and positively in the form of production factories.

The sign of the coefficient for variable $OUTS_i$ that measures international outsourcing is ambiguous from a theoretical point of view as expounded in Section 4.2. When predicting the sign of the outsourcing variable, another difficulty arises from the fact that the study draws upon data provided by the Federal German Statistical Office to measure outsourcing. These data suffer from one shortcoming: they do not distinguish between outsourcing activities of German firms in emerging markets and in other advanced countries. However, with respect to the effect of outsourcing stages of the production to advanced partner countries on the skill structure of employment which might be motivated by factors other than differences in factor costs such as economy of scale effects, synergy, or learning effects (see Section 4.1), we have very little prior knowledge.

Finally, an expansion of VIIT is perceived to reduce the share of the production worker's wage bill in the total wage bill, implying a negative coefficient for the $VIIT_i$ variable. To check for potential differences regarding the distributional impact of quality competition with industrial advanced and newly industrialising countries, German VIIT with both kinds of trading partners is considered separately in a second regression.

Last but not least, to account for the possibility that the independent variables' impact on the skill structure of employment might not be instantaneous, one-period lags of all variables have been included in a third regression. Particularly in the case of VIIT, two- and three-period lags have been introduced in regression at the beginning to consider that the reallocation within firms due to increased quality competition takes some time. Since none of them has been statistically significant they have been dropped from the regression.

8.3 Data

The econometric estimation is based on two-digit industry level data for 20 out of 22 manufacturing industries (15-36) of unified Germany for which data are available. Data are classified according to the WZ 2003. The industries are listed in Annex 2. Two out of the 22 industries were excluded from analysis, namely the tobacco and the coke and refined petroleum product industry, since both industries have been detected as outlier industries exhibiting particularly high/low growth rates of VIIT share in total trade.[66]

The analysis draws upon different sources. Due to data restrictions and systematic changes in the industry classification, econometric analysis is restricted to the period between 1995 and 2004, which yields a maximum number of 200 observations. In line with the empirical analysis in Chapter 6 and 7, the data refer to unified Germany since there are no separate data available for western and eastern Germany for the time period under consideration. In this regard it should be pointed out that alternatively, data for the period between 1991 and 2000 could have been used. The main reason for not choosing this time period is that the effects of German reunification on the economy might have affected data, particularly in the earlier years of the 1990s. Accordingly, the results might be misleading.

Wages and employment. Data on industry payments and employment have been taken from the German Federal Statistical Office (Fachserie 4, Reihe 4.1.1) where they are grouped into data for production and non-production workers (see Section 7.2). Thereby, production workers (non-production workers) are supposed to comprise low-skilled workers (high-skilled

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[66] Outlier industries have been identified in STATA using the command *extremes* which lists the extremely high and extremely low values of a variable.

workers). The dependent variable that measures for each industry production workers' cost share in the total wage bill is obtained by dividing wage payments by the sum of wage and salary payments in the respective industry:

$$WS_{it}^{LS} = \frac{\left(L^{LS} * W^{LS}\right)_{it}}{(L^{LS} * W^{LS})_{it} + (L^{HS} * W^{HS})_{it}} \tag{13}$$

where WS_{it}^{LS} represents production workers' cost share in the total wage bill, $(L^{LS} * W^{LS})_{it}$ the wage payments (of low-skilled workers), and $(L^{HS} * W^{HS})_{it}$ represents the salary payment (of high-skilled workers) in industry *i* in year *t*.

Production. Annual data on industries' value of production expressed in year 2000 prices have been taken from the German Federal Statistical Office (Fachserie 18, Reihe 1.4, own calculations).

Capital Stock. Annual averages of net capital stock measured in year 2000 prices are also provided by the German Federal Statistical Office (Fachserie 18, Reihe 1.4). Capital stock data can be obtained as an aggregate or separately (i) as buildings and plants and (ii) as equipment that comprises machinery and other assets (e.g. immaterial assets such as software programs).

Outsourcing. To measure German outsourcing activities, the study draws upon the input-output tables of the German Federal Statistical Office (Fachserie 18, Reihe 2). The input-output tables are part of the national account data and provide annual information on the inter-industry relation of German two-digit sectors among each other and with the rest of the world. These *input-output* tables record for each specific industry *i* the amount of goods and services that are obtained from other sectors and that are used as intermediate inputs in industry *i*'s production. In other words, they offer information about the *inputs* in one sector being the *outputs* in another sector. The value of intermediate inputs is recorded in current prices and is provided separately for domestically produced and imported intermediate inputs. One drawback of the data is, however, that it is not possible to distinguish imported intermediate inputs by the countries from which they were imported. Thus, the outsourcing activities of German firms in industrialised countries cannot be separated from those in emerging markets. Data on imported intermediate inputs are adjusted to year 2000 prices using the price index for imported manufacturing goods (Fachserie 17, Reihe 8.1).

It should be pointed out that relying on the import content of intermediate consumption allows for the distinction between the two-way trade of products and the international division of production. To measure international outsourcing, the present study relies upon major preceding studies (e.g., Feenstra and Hanson, 1996a, 1996b, and 1999). Usually, a narrow and a broad definition of outsourcing are distinguished. Both concepts mainly differ with respect to the presumption whether an industry's outsourcing activity is only captured by its import of intermediate goods from the same industry abroad (narrow definition) or whether imported intermediate inputs from all industries abroad should be considered (broad definition).

In studies where the narrow measure of outsourcing is used (e.g., Feenstra and Hanson, 1999), outsourcing should predominantly be understood as the result of a company's make-or-buy decisions. In particular, an appropriate measure of outsourcing should reflect the idea that foreign sourcing offers a possibility for domestic firms to increase efficiency by transferring some activities involved in the making of a product abroad. Feenstra and Hanson (1999) argued that in the automobile industry, for instance, the import of components or assembly from abroad can be considered as outsourcing since firms may otherwise have produced these inputs internally. Instead, the import of steel for the production of automobiles would not capture very well the idea of outsourcing since the domestic automobile industry would not have performed steel production by itself anyway. In this case, there is rather a replacement of domestic by foreign suppliers which reflects more international competition in "final" goods than outsourcing activities. Nevertheless, the broad concept of outsourcing where the total sum of intermediate inputs from abroad is considered in the calculation of the outsourcing measure is very often employed in the literature (e.g., Campa and Goldberg, 1997; Geishecker and Görg, 2008).

In the present study, however, the narrow concept has been applied since the potential impact of competition in "final" goods on domestic producers (and, hence, wages and/or employment) is supposed to be captured by the VIIT variable. The index used to construct the narrow measure builds upon the index suggested by Feenstra and Hanson (1999) and its modifications by Geishecker and Görg (2008). Specifically, the index is calculated as the value of an industry *i*'s imported goods from the same industry abroad as a share of the domestic industry's production value:

$$OUT_{it}^{narrow} = \frac{IMP_{i^*t}}{Y_{it}} \tag{14}$$

where for each time period *t*, IMP_{i^*t} represents imported intermediate inputs from foreign industry *i** and Y_{it} denotes the production value of domestic industry *i*.

Trade flows. Data on trade flows are taken from the *Comext*-Database (EUROSTAT), where annual data are provided on a disaggregated eight-digit level (Combined Nomenclature). For a detailed description of the data it is referred to Section 6.1. The methodology adapted to calculate the share of $VIIT_i$ in industry *i*'s total trade is described in Chapter 5**.**

8.4 Results and discussion

The results of the FD-regression are presented in Table 17 (regressions (a)-(d)). The output variable (*Y*) has the expected positive sign, but only its immediate impact is statistically significant. The effect of capital in the form of buildings or plants (*P*) on the relative demand for production workers is ambiguous. Whereas the instant impact is positive, the delayed impact is negative. However, in most regressions neither the immediate nor the lagged variables are statistically significant. When measured as equipment (*E*), capital always has a negative coefficient and its immediate impact is statistically significant in nearly all regressions. In contrast, the lagged impact is never statistically significant.

Table 17: Regression results

Dependent Variable: ΔWS_t^{LS}								
	Range: 15%[1]				Range: 25%[2]			
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
$\Delta\ln(Y)_t$	6.016***	5.973***	5.098***	4.904***	5.793***	5.741***	5.249***	4.991***
$\Delta\ln(Y)_{t-1}$			1.567	1.351			1.369	1.551
$\Delta\ln(P)_t$	2.902	3.342	7.285	9.221**	3.906	5.638	10.32**	9.382*
$\Delta\ln(P)_{t-1}$			- 1.915	- 2.513			- 1.740	- 1.494
$\Delta\ln(E)_t$	- 4.387**	- 3.740*	- 4.466	- 5.045*	- 5.382**	- 5.564**	- 5.933**	- 5.395*
$\Delta\ln(E)_{t-1}$			- 1.896	- 1.822			- 1.541	-2.071
$\Delta\ln(OUT)_t$	- 0.068	- 0.065	- 0.122	- 0.186	- 0.059	- 0.048	- 0.165**	- 0.145
$\Delta\ln(OUT)_{t-1}$			- 0.231	- 0.193			- 0.266	- 0.203
$\Delta\ln(VIIT)_t^{ALL}$	- 1.579**		- 1.611*		- 1.082**		- 0.677	
$\Delta\ln(VIIT)_{t-1}^{ALL}$			- 0.745				0.280	
$\Delta\ln(VIIT)_t^{Advanced}$		- 1.856**		- 1.707**		- 1.057**		-0.879*
$\Delta\ln(VIIT)_{t-1}^{Advanced}$				0.009				0.010
$\Delta\ln(VIIT)_t^{NewlyIndus.}$		0.335		-0.094		0.115		- 0.103
$\Delta\ln(VIIT)_{t-1}^{NewlyIndus.}$				0.019				0.007
Cons	- 0.574***	- 0.564***	- 0.495***	- 0.488***	- 0.578***	- 0.551***	- 0.459***	- 0.481***
N	180	180	160	160	180	180	160	160
R^2-Adj.	0.239	0.227	0.202	0.221	0.217	0.213	0.247	0.231
VIIT contribution	4%	4.7%	4.1%	4.3%	2.3%	2.2%	0%	1.9%

Source: Author's calculations. Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. All standard errors are robust to heteroskedasticity. Dependent variable is the annual change in production workers' share in total wage bill. The time period under observation runs from 1995 to 2004. The industry subscripts *i* have been dropped in order to reduce complexity. [1] Range between export and import unit values used to distinguish between VIIT and HIIT is +/- 15%. [2] Range between export and import unit values is +/- 25%.

Although the coefficient of the outsourcing variable has a negative sign in all regressions, its impact on production workers' share in the wage bill is very small and mostly statistically insignificant. As aforementioned, we should be cautious when interpreting the coefficient of the outsourcing variable as the variable does not merely capture German outsourcing activities in less-developed countries since the data also include German trade in intermediates with other advanced countries.

The coefficient for VIIT has the expected negative sign and is statistically significant for all regressions when the immediate impact is considered. This confirms the assumption that trade in quality differentiated products and hence the pressure to upgrade product quality plays some role in determining the fortune of manual workers in Germany. When the effect of VIIT on the relative demand for skills is analysed with respect to different partner countries in a second regression, the estimated coefficient of VIIT with industrialised countries is negative and statistically significant when the instant impact is considered. In contrast, the sign of the coefficient for German VIIT with newly emerging markets is ambiguous. In addition, the coefficient is very small and always insignificant.

This result implies that even though a range of less-developed countries has started to produce more complex and sophisticated goods, the quality they produce is still too low to exhibit substantial competitive pressure on German firms. Apparently, the negative impact of VIIT on the relative demand for production workers mainly stems from trade with other advanced countries. The result is also interesting in the light of the fact that the increase of German VIIT with advanced countries has been much lower than with newly emerging markets during the time period under consideration. Whereas the share of VIIT with industrial countries only rose from 43.80% in 1995 to 47.34% in 2004, the trade with newly emerging markets increased from 18.72% to 27.70% (Table 18). In this regard, it should be once again noted that although international trade with emerging economies has increased nearly constantly during the last years, its contribution to overall trade is still relatively small compared to the share of German trade with other advanced countries. For the sample of 25 emerging market economies included in the study, German trade with newly industrialising countries made up around 19% in 1995 and grew to around 25% in 2004.

Table 18: Share of trade types in German manufacturing trade in % (1995 and 2004)

	1995				2004			
Trading partner	OWT	TWT	HIIT	VIIT	OWT	TWT	HIIT	VIIT
All countries	46.93	53.07	14.09	38.98	44.34	55.66	13.27	42.38
Advanced countries	39.55	60.45	16.65	43.80	36.77	63.23	15.89	47.34
Newly Industrialising countries	78.08	21.92	3.20	18.72	66.47	33.53	5.83	27.70

Source: *Comext* Database; own calculations. Note: OWT = one-way trade/inter-industry trade; TWT = two-way trade/intra-industry trade; HIIT = horizontal intra-industry trade; VIIT = vertical intra-industry trade. Note: Range between export and import unit values used to distinguish between VIIT and HIIT is +/- 15%.

In order to check the robustness of the results, particularly with respect to the range between export and import unit values used to distinguish between HIIT and VIIT, regressions have been performed with an alternative range of +/-25%. The results are also reported in Table 17 (regressions (e)-(h)). With respect to the statistical significance and magnitude of the variables included in regression, the results do not change markedly. Particularly the impact on production workers' share in the wage bill exerted by trade in different qualities remains statistically significant. However, it has slightly decreased with respect to its size.

Considering the fact that FD regression estimates the relationship between changes of variables, the coefficient of VIIT which takes on a maximum value of -0.0186 in Regression (b) can be interpreted as follows: in industries where the share of VIIT increased by one percent between two years, an average decline of the cost share of manual workers in the total wage bill of 0.0186 percentage points could be observed. Finally, information on the slope coefficient of VIIT can also be used to evaluate the magnitude of VIIT's impact on the overall decline of the share of production workers' wage bill in manufacturing industries between 1995 and 2004. Multiplying the estimated parameter for VIIT with the average annual growth rate of VIIT and dividing it by the average annual rate of change in production workers' cost share delivers a maximum contribution of VIIT to the decline in production workers' cost share of 4.7%.

Thus, it can be concluded that trade in different qualities appears to be of relatively small economic importance in determining the overall decline in the demand for production workers. The decrease in the wage bill share of production workers that is not explained by changes in VIIT can at least partly be ascribed to the mechanisation of the production process which, in turn, is closely linked to technical change.

One reason for the low impact of VIIT on the skill structure of employment might be ascribed to the fact that the process of restructuring within German manufacturing industries attributed to the repositioning on quality-intensive products most likely already started before 1995. In fact, Germany's reputation as a high-quality producer has been recognised and scientifically verified for several decades (e.g., Fontagné et al., 1997). Given that the impact of quality competition on skill demand depends on the quality segment of the market in which a country is positioned, it should be more severe for a low-quality than for a high-quality producer. Germany's top quality position prior to 1995 might explain why the distributional impact of an expansion in VIIT has been relatively small between 1995 and 2004.

8.5 Limitations of econometric analysis

The empirical analysis carried out in the preceding chapter has shed some light on the linkage between trade, quality competition, and skill upgrading in German manufacturing between 1995 and 2004. On the one hand, the study has thus delivered further insights on the trade-skill demand relationship in industrial countries. On the other hand, the results raise new questions and provide a basis for further research.

First, conducting empirical analysis for earlier years (i.e. the 1970s and 1980s in particular) might deliver further insights on the linkage between quality competition in international trade and skill demand. Bertschek (1995), for instance, found a positive significant effect of import competition on product and process innovations for 1,270 selected West German manufacturing firms between 1984 and 1988. Therefore, it would be of interest whether the impact of VIIT on the skill structure of employment differed for the 1970s and/or the 1980s. Unfortunately, the investigation of this issue for earlier time periods is restricted due to data availability.

Second, assuming that the coefficients for VIIT and, hence, its impact on the skill composition of employment is equal across industries is obviously suggestive. Instead, effects are likely to differ between industries since some industries are more exposed to international quality competition than others (see Chapter 6). Obviously, the same argument is valid for the impact of technical change and outsourcing. Both factors vary across industries with respect to their intensity (see Section 3.2 and 4.1), and so, most likely, does their role in affecting skill demand. In order to account for these differences in empirical analysis, an industry-by-industry approach would be useful to gather additional insights on the relative importance of each of these factors in determining intra-industry skill structure. Unfortunately, data for certain variables (e.g., for wages and employment) are either not available at all or cannot be obtained consistently at a more disaggregated level.

Third, the assumption that VIIT and SBTC are independent of each other is quite restrictive. In fact, both are most likely interrelated phenomena that stimulate each other.[67] Katsoulacos (1986) provided one possible explanation how these two forces might interact with each other. He conceived SBTC as appearing either in the form of product innovation or process innovation. Both product and process innovations are, in turn, closely related to product quality: On the one hand, many high-quality products are at the same time high-technology products (e.g. a Mercedes-Benz car) or might be produced using advanced technologies (e. g. first-rate wine[68]). On the other hand, the pressure to upgrade product quality fosters product and process innovations and therefore technical change. However, it has to be pointed out that product quality does not always have to be associated with technological innovations so strongly. High-quality porcelain, for example, is neither a high-tech product nor does its production require high-tech machines, but rather skilled manual work. Nevertheless, the insight that the difference between quality upgrading and technological innovations is not clear-cut clearly represents another obstacle for empirical analysis.

The fourth and last issue relates to data on wages and employment. Data used for analysis have been obtained from the German Federal Statistical Office where skill level is tracked by the broad type of task carried out by the worker. Clearly, the distinction between production- and non-production workers is a relatively crude approximation to the differentiation between

[67] The general interrelation between international trade and technical change had already been discussed in Section 3.2.1.

[68] For example, in wine production, temperature regulation might be conducted using high technology.

low-skilled and high-skilled labour. Using other data sources to verify the influence of trade and technical change on within-industry shifts might deliver further insights. The linked Employer-employee data set of the German Federal Employment Agency (LIAB), for instance, which combines information from German employment statistics and the IAB establishment panel, provides data on educational attainment and vocational training. This data set also allows an investigation of the determinants of employment structure within a plant. The German Socio-Economic Panel (GSOEP) contains data on earnings by occupational status. Compared to the data provided by the German Federal Statistical Office, however, both the LIAB and GSOEP deliver more limited information on industry employment.

9. Conclusions

The declining demand for low-skilled workers in Germany and in many other industrial countries has long been recognised. Yet, the debate over the forces responsible for this development is complicated and remains unresolved. This thesis shed further light on the linkage between international trade, the rapid advance of technology and the demand for skills. Specifically, it illuminated to what extent quality competition and Germany's subsequent specialisation in high-quality niches have favoured skill upgrading in the manufacturing sector. This last chapter briefly summarises the main findings in Section 9.1 and delivers an outlook on the relationship between trade openness, technical change and skill demand in Section 9.2. Finally, it provides some recommendations for public policy in Section 9.3.

9.1 Summary

Chapter 2 has shown that the reduced relative demand for low-skilled workers in the 1980s was noticeable in the disproportionally growing unemployment rate of this skill group; however, since the mid-1990s, this declining demand was also reflected through rising wage inequality. Chapters 3 and 4 addressed the extent to which this development can be attributed to the deepening of trade integration and technical progress. The excursus in the existing literature has portrayed the different channels through which trade might affect the requirement for skills. The literature review has also described the various attempts made to separate trade from technical change. Existing studies have generally attributed distributional changes to SBTC rather than to international trade. The present study has directed special focus toward tracing the linkage between VIIT (i.e., trade in qualities) and skill demand to provide an alternative explanation to technical change. The effects that this type of trade has on skill composition have received little attention from the literature thus far.

In order to examine the relevance of VIIT to German foreign trade and to quantify this trade's impact on the labour market, Chapter 5 introduced and discussed several ways to measure VIIT. Then, Chapter 6 chose one appropriate methodology to assess data from German manufacturing trade. From the investigation of trade flows in Chapter 6, two main insights emerged.

First, trade patterns underwent a perpetual changing process during recent decades and the exchange of varieties differing with respect to quality increased significantly. Nowadays, quality plays a substantial role not only in trade between Germany and newly emerging markets, but also in trade between Germany and advanced countries. The latter insight is especially interesting, as trade across advanced countries has, for a long time, been perceived to be horizontal by nature and therefore beneficial for every country and subject involved. The incidence of substantial VIIT between advanced trading partners and its potential impact on the labour market has been neglected in the empirical literature thus far, as the literature exclusively focuses on advanced countries' trade with newly industrialising markets.

Second, when competing with other countries, some German industries were more successful than others in creating a comparative advantage through high-quality standards, diversified product ranges and customisation. The pressure to upgrade product quality was found to be stronger in traditional labour-intensive industries, such as apparel or leather, where companies were confronted with considerable losses in high-quality market shares. Low innovation capacity has made these sectors particularly vulnerable to international competition. In contrast, skill-intensive industries have expanded their quality leadership in a range of sectors, such as machinery or motor vehicles. This result supports the predictions of earlier literature in so far as adjustment pressure tends to be more severe in traditional labour-intensive sectors.

In contrast to earlier literature, however, the present investigation revealed that some supposedly non-competitive import competing sectors managed to resist international competition. The dynamic development of the German textile industry delivered a striking example of how comparative advantage may shift rapidly from one activity to the next and how companies may succeed in asserting themselves in times of increased international rivalry by specialising in first-rate quality products. The textile industry also demonstrates how its specialisation in high-quality niches may go hand in hand with other forces that may affect the skill structure of employment within an industry. Along with product innovation, technical upgrading of production equipment and the relocation of production stages abroad turned out to be important strategic activities for ensuring corporate survival and for strengthening companies' positions in international markets. In this regard, there is ample scope left for further research. In order to discover whether dynamics differ between industries, future studies could conduct analyses on other manufacturing sectors. Describing detailed trends for all German manufacturing sectors was beyond the scope of this work.

Chapters 7 and 8 were dedicated to determining the impact of VIIT on the labour market. The decomposition analysis in Chapter 7 unveiled that the shift toward skilled labour in German manufacturing can be explained predominantly by within-industry variations. Along with SBTC and international outsourcing, VIIT has become one more potential determinant. This finding set the stage for the econometric study in Chapter 8, which deconstructed the sources of within-industry changes of the wage bill share. This chapter's analysis revealed that VIIT contributed to the labour market outcome of low-skilled workers between 1995 and 2004. However, the magnitude has been relatively small in size, with trade in qualities accounting for approximately 5% of the overall decline in production workers' cost share during that time. In contrast, more weight can be attributed to technical change. Thus, this chapter's analysis generally confirms the conclusions drawn by the existing literature. However, the novel insight derived from this analysis is that trade between advanced countries might influence the demand for skills. The present results suggest that the negative impact of vertical intra-industry trade on the production workers' wage bill share can be ascribed entirely to German quality competition with other advanced countries. The exchange of different qualities with newly emerging markets, in turn, has not increased human capital intensity within industries.

Quantifying the effect of trade or technical change on the labour market continues to be a challenge for empirical analysis, given the conceptual shortcomings, a lack of appropriate data and the complexity of the mechanisms controlling trade and technical change. Even today, the channels operating through trade and technical change are elusive to observation, and whatever evidence that studies gather is, at best, suggestive. Once more, emphasis should be placed on the fact that this thesis has only examined the manufacturing sector, so low-skilled jobs lost in this sector might be created in other sectors of the economy, first and foremost in the service sector. How far international trade might affect employment and remuneration in the service sector is the subject of another branch of research. Like the literature on manufacturing trade, the literature related to trade in services has concluded that the effect of this type of trade on the demand for less-skilled labour is modest (e.g., for Germany, see Schöller, 2007).

9.2 Outlook

Global competition poses great challenges to German enterprises. Considering the substantial spread of trade integration and the underlying dynamics of trade patterns associated with such integration, it is reasonable to assume that the pressure to be innovative and to upgrade product quality will intensify even more in the future. Through product innovation, firms will introduce new products into the market, and outdated products will disappear. This adjustment process involves the creation of new jobs and the destruction of old ones, respectively. It inevitably entails firm closure and involuntary job displacements, which comprise a particularly challenging task. New jobs may not match the old ones with respect to skill or to location.

The need for persistent innovation is supposed to further enhance firms' requirement for skills. Inversely, the labour market for less-qualified employees and for those without any qualification is expected to shrink. Indeed, a number of authors have forecasted a continuation of losses of low-skilled industrial jobs (e.g., Reinberg, 2003a; Jäger and Kohl, 2009). Nonetheless, this mainstream perspective has been increasingly questioned. More and more authors are arguing that declining employment opportunities for low-skilled workers in the manufacturing sector will (at least partly) be compensated through the creation of jobs for this skill group in other sectors of the economy, especially the service sector. The creation of low-skilled-intensive jobs in the health care sector (e.g., geriatric nurses or social workers), hotel and catering services or commercial cleaning is often highlighted in this regard (e.g., Hirsch-Kreinsen et al., 2010; Kalina and Weinkopf, 2005).

Still other recent empirical studies indicate that the number of low-skilled industrial jobs in Germany will continue to be economically relevant (e.g., Hirsch-Kreinsen, 2011; Zeller, 2005). Using data from the German Microcensus, Hirsch-Kreinsen et al. (2010) revealed a continuous decrease in the share of low-skilled jobs in the manufacturing sector during the 1990s, yet the demand for this type of work has turned out to be surprisingly stable between 2000 and 2007. They ascribed several factors to this development. First and foremost, they argued that firms' opportunities to outsource ordinary production jobs to low-wage countries or to rationalise jobs through automated production processes have become much more limited in the past few years due to organisational, technical or economical constraints. In addition, Hirsch-Kreinsen et al. (2010) emphasised that the mechanisation of production has not only removed but also created low-skilled jobs (e.g., ordinary controlling or monitoring tasks). For the production of food and beverages, rubber and plastics or metal products, for instance, manufacturers continue to employ an over proportional amount of low-skilled workers for operating machines, packing or performing other assembly work (Hirsch-Kreinsen, 2011).

Yet, this bright employment outlook for unskilled workers is overshadowed by another notable development. As Chapter 2 illustrated, the requirements for jobs traditionally considered unskilled-labour-intensive have changed (e.g. Dauser and Deisler, 2009; Jaehrling and Weinkopf, 2006; Zeller, 2002). These changes can be observed with respect to sector-specific competences (e.g. technical understanding for certain types of machinery or product knowledge), but also with respect to general competences. Regarding the latter, growing attention has been devoted to the role of transferable skills.

Zeller (2005) analysed changes in the job requirements of low-qualified employees and identified a movement from routine manual skills with low complexity toward non-routine cognitive and interpersonal skills. She highlights the growing importance of key competences, such as one's ability to integrate into a team, one's flexibility and one's ability to adapt to changes in product ranges or production processes (e.g., in the case of an urgent order), which allow the employee to work more autonomously and be less dependent on instructions. Furthermore, workers performing low-skilled jobs are increasingly expected to think and act in entrepreneurial terms. Many employers ask them to take co-responsibility for their firm's operations in order to apply means of production effectively, to ensure quality or to maintain occupational safety. Such workers are also expected to help optimise production processes and be capable of identifying and reporting technical flaws, disturbances and interruptions. In other words, workers in low-skill positions are increasingly asked to look beyond the edge of the plate and to understand internal processes (see also Jäger and Kohl, 2009).

The finding of this trend is supported by the observation that companies face difficulties attracting low-qualified employees for low-skilled work, despite the relatively high unemployment rate of this skill group (DIHK, 2006). Moreover, low-skilled jobs are often performed by workers who are formally qualified (i.e., have completed vocational education) and are thus usually overqualified for the tasks they undertake (Hirsch-Kreinsen et al., 2010). In times of economic downswings and higher unemployment rates, the labour market situation is likely to permit the recruitment of formally qualified employees for low-paid occupations. However, it is questionable whether companies will be able to pursue this strategy in the future. Demographic trends, such as the transition of the baby-boomer generation from work to retirement, are predicted to lead to a significant decline in the size of the German workforce (e.g., Bonin et al., 2007; Kalinowski and Quinke, 2010; Paqué, 2012). Due to emerging labour supply shortages, it will become more difficult for employers to attract formally qualified applicants for simple work activities.

9.3 Implications for economic policy

In light of the aforementioned global trends on the one hand and the German labour market developments on the other hand, some implications for economic policy can be drawn. In the early years of research on trade and the demand for skills, the focus of the discussion was directed toward the question of whether industrial countries should resort to protectionist measures to narrow the rising wage gap and/or to reduce the disproportionately high unemployment rates of low-skilled workers. Considering the costs and benefits of trade policy tools, such as tariffs or limits on imports, however, there has been a consensus that closing domestic markets will lead to much higher costs for society than exposing domestic firms to international competition (OECD, 2009b). These costs may involve higher expenses for households and firms, limited availability of products and services, less efficient firms, fewer jobs and outdated technology. Moreover, Germany belongs to those countries in the world that are most engaged in international trade, so protection would not be a solution, anyway. Official statistics show that in times of financial crisis, export-oriented German companies profit significantly from worldwide demand, especially from newly emerging markets (Statistisches Bundesamt, 2011). Apart from this discussion, there is overwhelming evidence that low-skilled workers compete not only with foreign labour but also with better and cheaper capital equipment.

Since global trends cannot be stopped or unravelled, economic policy should aim at reaping the gains of a changing global market while minimising the costs associated with it, such as job loss. Over the past 15 years, the German government has made several attempts to improve the employment prospects of workers in Germany with lower qualifications. A series of institutional reforms to liberalise the labour market has made the German labour market more flexible and has increased its capacity to absorb low-skilled workers. This liberalisation has been reflected in the easing of dismissal protection, changing legislation for temporary employment, abolition of collective agreements and changes in unemployment benefits, among other reforms (Eichhorst and Marx, 2009; Paqué, 2012).

To meet the rising demand for skills and to counter the shortages emerging from demographic trends and the baby-boomers' exit from the labour market, the acquisition of new skills should be the preeminent objective of an economic policy that is designed to help workers with lower qualifications to find work. In this regard, lack of education is often seen as the root of the problem of unemployment. Thus, it is common to view secondary education and vocational training as indispensable to increasing the employment opportunities for this skill group. In view of demographic changes and an ageing German society, this is a reasonable claim. However, apart from the fact that it is difficult to involve all low-qualified individuals in skill upgrading measures (either because they cannot cope with the performance requirements or they are not motivated enough), this view might be too narrow, as it considers only one side of the coin. As mentioned, globalisation and technical change have not removed the need for low-skilled work, which might require a secondary education but not necessarily the completion of vocational training. Studies predict that firms will search explicitly for lower-qualified workers in the future (e.g., Zeller, 2005).

Given that a rising number of tasks within firms is characterised by a mixture of routine jobs and activities that require additional skills, low-qualified workers should be equipped with competences that enable them to cope with changes in the profiles of rudimentary jobs. Firms could offer specific on-the-job trainings or adequate training programmes to qualify their untrained and low-skilled workers for new demands and to integrate them into modern working processes. To raise workers' productivity, the training should aim to improve practical skills, such as how to use new equipment (OECD, 2005).

In practice, the implementation of persistent education and training programs for unskilled workers is relatively limited at the time this paper was written (e.g., Dauser and Deisler, 2009). Drawing upon a survey of 321 enterprises, Dauser and Deisler (2009) identified several obstacles that prevent companies from providing continuous vocational training. According to the survey, programs for upgrading skills are considered to cause disturbances in internal processes. For example, when managers must release workers from their posts for some time, they must find ways to compensate or prevent losses in production. Furthermore, employers generally maintain that the learning potential of their workers is restricted due to either learning difficulties or a lack of motivation. Dauser and Deisler (2009) noted another impediment to the implementation of education and training programs when they found that some employers complained of the lack of appropriate regional training programs offered, for instance, by employment agencies. Last but not least, restrained investments in continuing vocational training programs might be ascribed to financial considerations, as highlighted in a study initiated by the Educational Ministers' Conference (KMK) and the Federal Ministry of Education and Research (BMBF) (KMK/BMBF, 2008).

The participation of low-skilled workers in continuing vocational training programs up to now tends to be limited, as well. The study by the KMK and the BMBF brought to light that only 9% of low-skilled workers, that is, workers without completed vocational training, participated in skill upgrading courses and trainings in 2007. With a ratio of 40%, the participation of high-qualified workers, or workers with a degree from a university or from a university of applied sciences, has been four times higher (KMK/BMBF, 2008). Apart from the lack of interest, difficulties in accessing training programs and the lack of appropriate programs for low-skilled workers might explain these disparities (Jäger and Kohl, 2009).

All in all, there is scope left to strengthen the implementation and participation of future vocational training programs. Reinberg (2003b) analysed the structure of formally non-qualified workers (i.e., workers without completed vocational training) on the basis of the German Microcensus and conjectured that only 13% of these workers do not have a school leaving certificate. In contrast, 7% are in possession of a degree from a university, 13% have a degree from a university of applied sciences and the remaining 67% completed secondary modern school. Hence, there exists some foundation to further train this group of the labour force.

Annex

Annex 1: Countries included in empirical analysis

Industrialised countries:	**Newly industrialising countries:**
Netherlands	Russia
France	Poland
Belgium	Czech Republic
Luxemburg	Hungary
UK	Romania
Austria	Lithuania
Italy	Estonia
Norway	Latvia
Switzerland	Slovenia
Sweden	Slovakia
Spain	Bulgaria
USA	Ukraine
Denmark	Turkey
Finland	Brazil
Canada	Mexico
Australia	China
Ireland	Thailand
Portugal	India
Greece	South Korea
Japan	Indonesia
	Taiwan
	Singapore
	Hong Kong
	Egypt
	South Africa
20 countries	***25 countries***

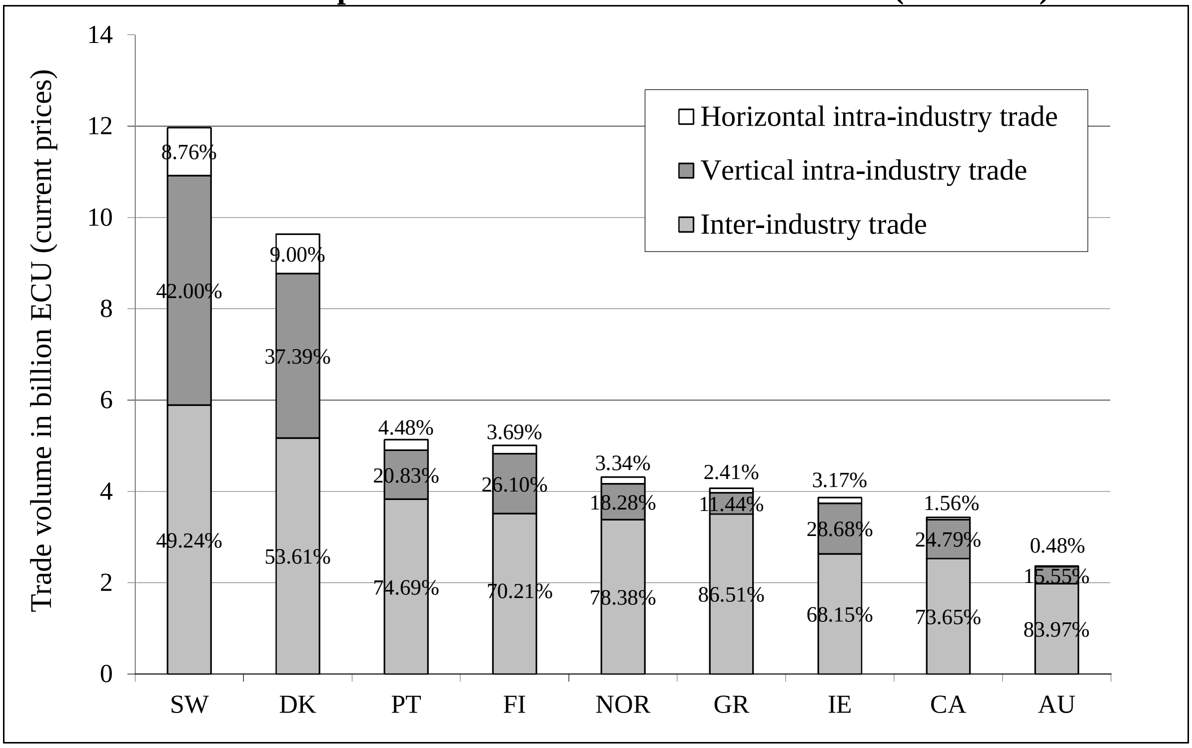
Source: author's illustration.

Annex 2: Industries included in empirical analysis

Code (WZ 2003)	Industry
15	Food products and beverages
17	Textiles
18	Wearing apparel, fur
19	Leather products and footwear
20	Wood and products of wood (furniture not included)
21	Pulp, paper and paper products
22	Printing and publishing
24	Chemicals and chemical products
25	Rubber and plastics products
26	Non-metallic mineral products
27	Basic metals
28	Fabricated metal products
29	Machinery and equipment n.e.c.
30	Office and computing machinery
31	Electrical machinery n.e.c.
32	Radio, TV and communication equipment
33	Medical, precision instruments
34	Motor vehicles
35	Other transport equipment
36	Furniture, manufacturing n.e.c.

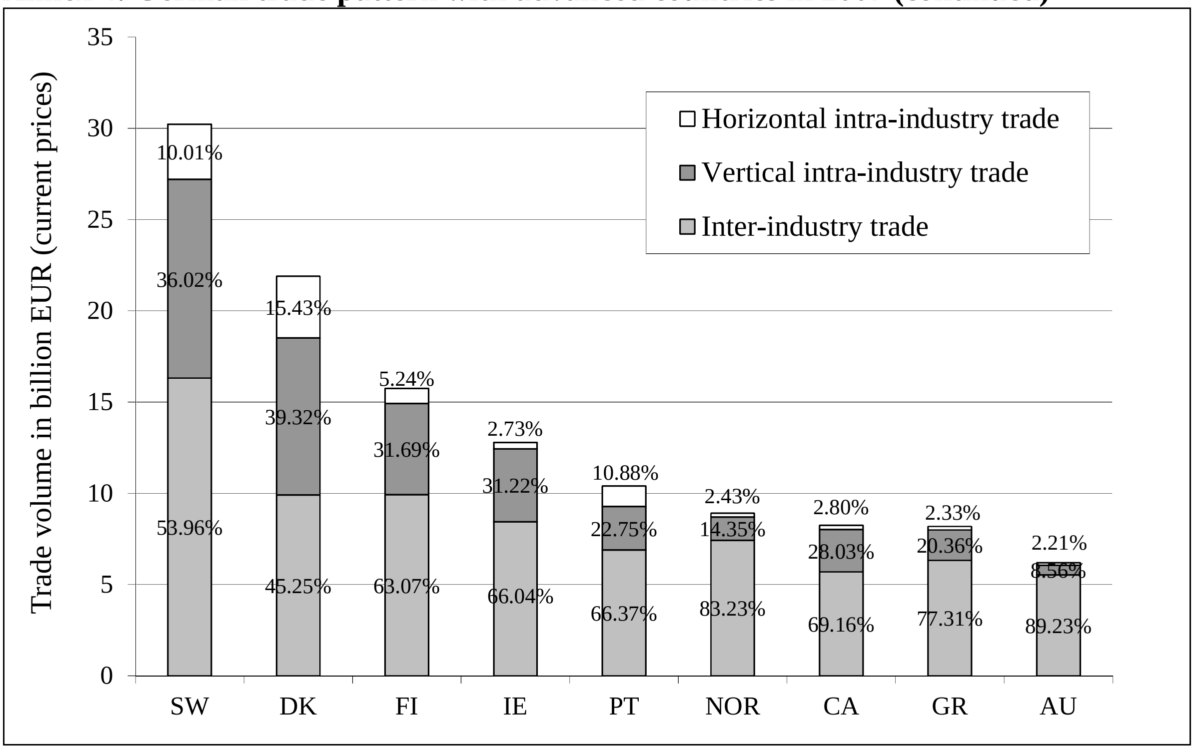
Source: Statistisches Bundesamt; author’s illustration. Notes: n.e.c .= not elsewhere classified.

Annex 3: German trade pattern with advanced countries in 1993 (continued)



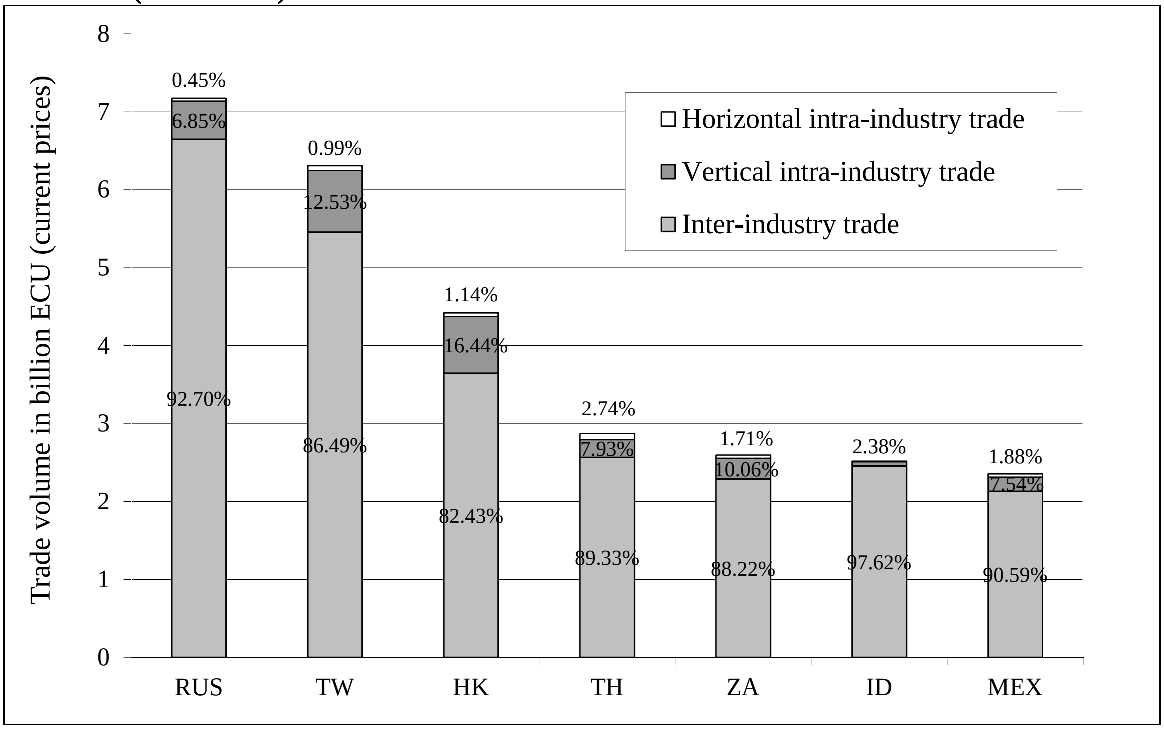
Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country. Definitions: SW = Sweden, DK = Denmark, PT = Portugal, FI = Finland, NOR = Norway, GR = Greece, IE = Ireland, CA = Canada, AU = Australia.

Annex 4: German trade pattern with advanced countries in 2007 (continued)



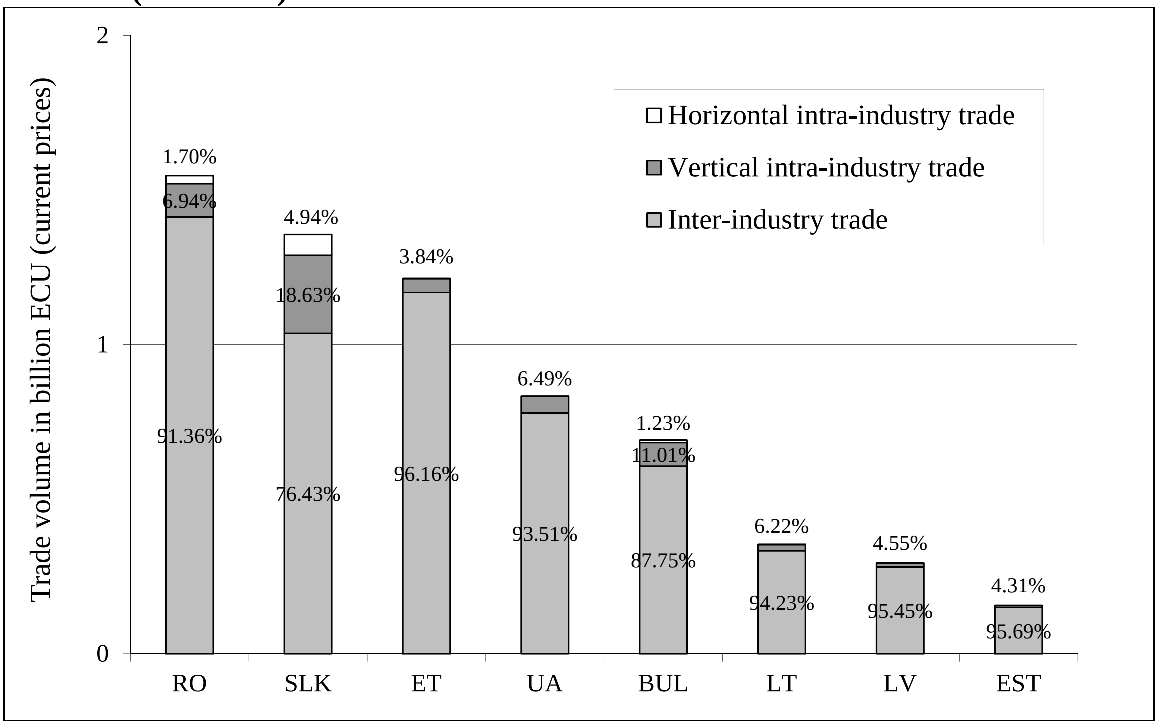
Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country.

Annex 5: German trade pattern with newly industrialising countries in 1993 (continued)



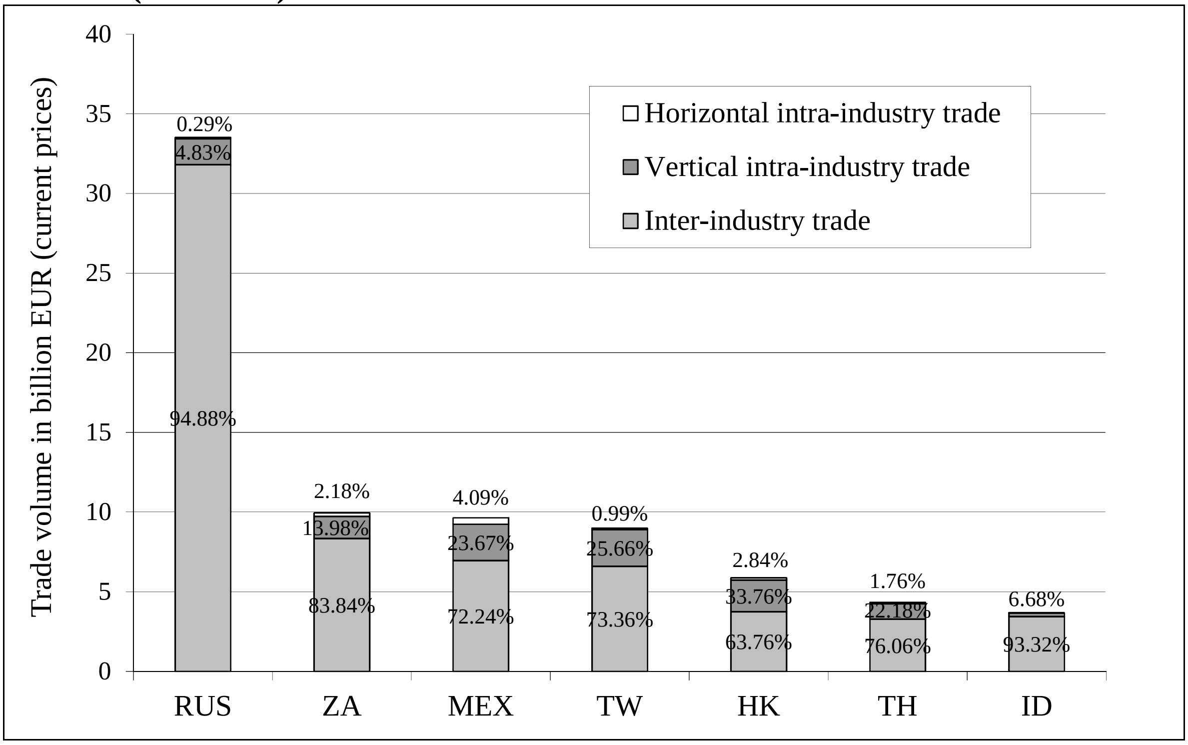
Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country. Definitions: RUS = Russia, TW = Taiwan, HK = Hong Kong, TH = Thailand, ZA = South Africa, ID = Indonesia, MEX = Mexico.

Annex 6: German trade pattern with newly industrialising countries in 1993 (continued)



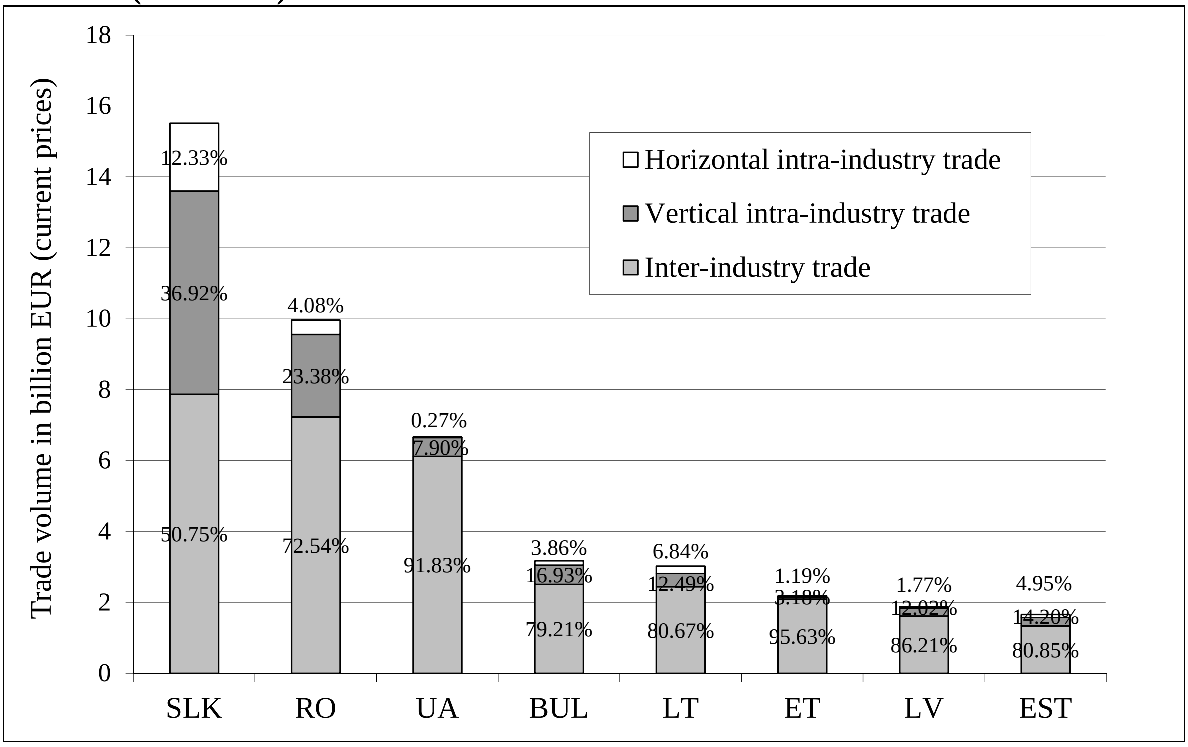
Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country. Definitions: RO = Romania, SLK = Slovakia, ET = Egypt, UA = Ukraine, BUL = Bulgaria, LT = Lithuania, LV = Latvia, EST = Estonia.

Annex 7: German trade pattern with newly industrialising countries in 2007 (continued)



Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country.

Annex 8: German trade pattern with newly industrialising countries in 2007 (continued)



Source: *Comext* Database; author's calculations. Note: Trade volume is calculated as the sum of German exports and imports for each partner country.

Annex 9: Quality structure in German vertical intra-industry trade by partner country (1993 and 2007) (continued)

		1993			2007		
	Partner Country	**VIIThigh**	**VIITlow**	**Average UV ratio**	**VIIThigh**	**VIITlow**	**Average UV ratio**
Advanced countries	Norway	65.33	34.67	1.95	39.52	60.48	1.66
	Sweden	52.86	47.14	1.39	43.39	56.61	1.38
	Denmark	50.19	49.81	1.49	44.49	55.51	1.34
	Finland	53.75	46.25	1.60	29.96	70.04	1.27
	Canada	71.51	28.49	1.76	26.95	73.05	1.46
	Australia	80.46	19.54	1.83	42.88	57.12	1.47
	Ireland	43.62	56.38	1.95	28.13	71.87	1.15
	Portugal	68.92	31.08	1.94	57.95	42.05	1.69
	Greece	47.97	52.03	1.62	47.45	52.55	1.31
Newly industrialising countries	Russia	71.99	28.01	4.20	62.92	37.08	2.68
	Romania	68.17	31.83	6.25	62.56	37.44	1.75
	Lithuania	81.91	18.09	3.73	58.51	41.49	1.95
	Estonia	84.51	15.49	3.72	53.33	46.67	1.75
	Latvia	88.76	11.24	4.48	36.73	63.27	1.86
	Slovakia	80.82	19.18	4.23	52.42	47.58	1.40
	Bulgaria	78.63	21.37	4.84	73.63	26.37	2.13
	Ukraine	83.77	16.23	6.23	91.28	8.72	4.19
	Mexico	61.07	38.93	2.27	61.53	38.47	1.49
	Thailand	71.20	28.80	2.79	82.07	17.93	6.47
	India	63.00	37.00	3.49	70.88	29.12	3.35
	South Korea	85.02	14.98	4.64	80.93	19.07	2.62
	Indonesia	62.67	37.33	8.16	59.52	40.48	5.12
	Taiwan	81.23	18.77	3.78	86.28	13.72	5.44
	Hong Kong	66.76	33.24	28.26	88.59	11.41	8.46
	Egypt	74.16	25.84	1.89	64.26	35.74	4.04
	South Africa	73.30	26.70	2.67	42.17	57.83	1.60

Source: *Comext* Database; author's calculations. Note: The formula to calculate the share of high- and low-quality VIIT as well as the average unit value ratio has already been presented in Table 8.

Annex 10: Average unit value ratio of German vertical intra-industry trade by sub-industry (1993 and 2007)

	1993			2007		
Industry	All countries	Advanced countries	Newly Industrialising countries	All countries	Advanced countries	Newly Industrialising countries
Food products, beverages	1.17	1.15	1.71	1.14	1.12	1.35
Textiles	1.45	1.37	2.14	1.49	1.30	2.13
Wearing apparel, fur	1.70	1.63	2.16	1.26	1.08	1.94
Leather products, footwear	1.59	1.37	2.56	1.35	1.27	1.67
Wood, products of Wood	1.41	1.28	2.99	1.38	1.26	1.77
Pulp, paper	1.32	1.30	2.07	1.26	1.24	1.34
Printing, publishing	1.36	1.34	1.78	1.56	1.58	1.49
Chemicals	2.24	2.21	3.14	2.82	2.78	3.43
Rubber, plastics	1.47	1.34	2.96	1.38	1.21	1.90
Mineral products	2.03	1.94	3.31	1.9	1.56	3.07
Basic metals	1.30	1.24	2.41	1.53	1.52	1.56
Fabricated metals	1.78	1.48	3.99	1.62	1.32	2.29
Machinery and equipment	1.92	1.63	5.12	2.03	1.57	3.31
Office and computing	1.27	1.18	3.94	1.43	1.13	2.55
Electrical machinery	1.52	1.38	2.41	1.75	1.55	2.09
Radio-, TV-, communication	2.21	2.12	3.03	2.84	1.50	5.18
Precision instruments	3.42	1.72	33.96	2.19	1.58	4.92
Motor vehicles	1.50	1.45	3.12	1.33	1.37	1.21
Other transport equipment	1.32	1.27	2.04	1.36	1.31	2.39
Furniture, n.e.c.	1.89	1.31	5.17	1.75	1.44	2.46

Source: *Comext* Database; author’s calculations. Notes: The formula to calculate the average unit value ratio has already been presented in Table 8.

Annex 11: Test statistics

Breusch-Pagan LM Test	chi2(1) = 870.47	Prob > chi2 = 0.000
Hausman Test	chi2(13) = 67.867	Prob > chi2 = 0.000
Wooldridge Test of Autocorrelation after taking first differences	F(1, 21) = 1.570	Prob > F = 0.224
Pesaran CD	CD test stat. = 1.935	Prob > F = 0.053
Breusch-Pagan/Cook-Weisberg Test of Heteroscedasticity:		
$\Delta \ln(P)_t$	chi2(1) = 4.02	Prob > chi2 = 0.045
$\Delta \ln(E)_t$	chi2(1) = 1.90	Prob > chi2 = 0.168
$\Delta \ln(Y)_t$	chi2(1) = 44.25	Prob > chi2 = 0.000
$\Delta \ln(OUTS)_t$	chi2(1) = 3.15	Prob > chi2 = 0.076
$\Delta \ln(VIIT)_t$	chi2(1) = 0.01	Prob > chi2 = 0.937
Simultaneous	chi2(5) = 55.87	Prob > chi2 = 0.000

Source: author's calculation. Note: The industry subscripts *i* have been dropped in order to reduce complexity.

Annex 12: Summary statistics

Variable	Nr. Obs.	Mean	St. dev.	Min.	Max.
ΔWS_t^{LS}	180	-.4905	.8587	-3.9237	2.7187
$\Delta \ln(Y)_t$	180	.0217	.0673	-.1499	.3946
$\Delta \ln(Y)_{t-1}$	160	.0196	.0701	-.1499	.3946
$\Delta \ln(P)_t$	180	-.0196	.0257	-.0699	.1651
$\Delta \ln(P)_{t-1}$	180	-.0188	.0256	-.0699	.1651
$\Delta \ln(E)_t$	180	-.0143	.0371	-.1061	.1725
$\Delta \ln(E)_{t-1}$	180	-.0139	.0361	-.1095	.1725
$\Delta \ln(OUT)_t$	180	.0147	.3257	-1.601	1.5307
$\Delta \ln(OUT)_{t-1}$	160	.0140	.3431	-1.601	1.5307
VIIT variables with Range: 15%					
$\Delta \ln(VIIT)_t^{ALL}$	180	.0126	.0633	-.1666	.2688
$\Delta \ln(VIIT)_{t-1}^{ALL}$	180	.0124	.0657	-.1666	.2688
$\Delta \ln(VIIT)_t^{Advanced}$	180	.0129	.0673	-.1592	.2861
$\Delta \ln(VIIT)_{t-1}^{Advanced}$	180	.0123	.0701	-.1592	.2861
$\Delta \ln(VIIT)_{t-1}^{NewlyIndus.}$	180	.0419	.1393	-.4116	.5731
$\Delta \ln(VIIT)_{t-1}^{NewlyIndus.}$	180	.0483	.1488	-.5954	.5731
VIIT variables with Range: 25%					
$\Delta \ln(VIIT)_t^{ALL}$	180	.0122	.0964	-.4385	.5975
$\Delta \ln(VIIT)_{t-1}^{ALL}$	180	.0156	.1036	-.4385	.5975
$\Delta \ln(VIIT)_t^{Advanced}$	180	.0126	.1040	-.4559	.6507
$\Delta \ln(VIIT)_{t-1}^{Advanced}$	180	.0159	.1128	-.4559	.6507
$\Delta \ln(VIIT)_t^{NewlyIndus.}$	180	.0368	.1481	-.4441	.6158
$\Delta \ln(VIIT)_{t-1}^{NewlyIndus.}$	180	.0424	.1569	-.6406	.6158

Source: author's calculation. Note: The industry subscripts *i* have been dropped in order to reduce complexity.

Annex 13: Correlation matrix

										VIIT variables with Range: 15%		
	ΔWS_t^{LS}	$\Delta\ln(Y)_t$	$\Delta\ln(Y)_{t-1}$	$\Delta\ln(P)_t$	$\Delta\ln(P)_{t-1}$	$\Delta\ln(E)_t$	$\Delta\ln(E)_{t-1}$	$\Delta\ln(OUT)_t$	$\Delta\ln(OUT)_{t-1}$	$\Delta\ln(VIIT)_t^{ALL}$	$\Delta\ln(VIIT)_{t-1}^{ALL}$	$\Delta\ln(VIIT)_t^{Advan.}$
ΔWS_t^{LS}	1.00											
$\Delta\ln(Y)_t$	0.342	1.00										
$\Delta\ln(Y)_{t-1}$	0.234	0.341	1.00									
$\Delta\ln(P)_t$	-0.108	-0.082	0.074	1.00								
$\Delta\ln(P)_{t-1}$	-0.029	-0.002	-0.046	0.718	1.00							
$\Delta\ln(E)_t$	-0.228	-0.062	0.164	0.746	0.459	1.00						
$\Delta\ln(E)_{t-1}$	-0.229	-0.057	-0.012	0.685	0.747	0.773	1.00					
$\Delta\ln(OUT)_t$	0.004	0.232	-0.038	0.084	0.012	0.073	0.047	1.00				
$\Delta\ln(OUT)_{t-1}$	-0.053	-0.258	0.236	0.147	0.047	0.098	0.097	-0.101	1.00			
VIIT variables with Range: 15%												
$\Delta\ln(VIIT)_t^{ALL}$	-0.120	-0.088	-0.035	-0.051	-0.115	0.095	-0.034	0.013	-0.158	1.00		
$\Delta\ln(VIIT)_{t-1}^{ALL}$	-0.056	0.077	-0.105	-0.099	-0.077	0.009	0.059	-0.047	0.031	-0.149	1.00	
$\Delta\ln(VIIT)_t^{Advanced}$	-0.151	-0.076	-0.035	-0.011	-0.109	0.127	-0.007	0.049	-0.161	0.934	-0.138	1.00
$\Delta\ln(VIIT)_{t-1}^{Advanced}$	-0.069	0.075	-0.105	-0.089	-0.044	-0.013	0.084	-0.072	0.064	-0.186	0.946	-0.192
$\Delta\ln(VIIT)_t^{NewlyIndus.}$	0.031	-0.017	0.062	-0.080	0.017	-0.054	-0.057	-0.117	-0.044	0.381	-0.084	0.084
$\Delta\ln(VIIT)_{t-1}^{NewlyIndus.}$	0.124	0.122	0.021	-0.028	-0.041	0.041	-0.034	-0.010	-0.088	0.005	0.395	0.069
VIIT variables with Range: 25%												
$\Delta\ln(VIIT)_t^{ALL}$	-0.048	-0.020	-0.098	-0.028	-0.025	-0.035	0.027	-0.007	-0.061	0.477	0.003	0.467
$\Delta\ln(VIIT)_{t-1}^{ALL}$	0.079	-0.006	-0.053	-0.043	-0.050	0.026	-0.028	-0.047	0.009	-0.007	0.492	-0.004
$\Delta\ln(VIIT)_t^{Advanced}$	-0.065	-0.021	-0.103	-0.009	-0.002	-0.019	0.057	0.017	-0.058	0.431	0.027	0.482
$\Delta\ln(VIIT)_{t-1}^{Advanced}$	0.065	-0.005	-0.056	-0.044	-0.039	-0.001	-0.026	-0.070	0.023	-0.040	0.438	-0.038
$\Delta\ln(VIIT)_t^{NewlyIndus.}$	0.007	-0.009	0.072	-0.057	-0.041	-0.049	0.091	-0.168	-0.017	0.309	-0.076	0.116
$\Delta\ln(VIIT)_{t-1}^{NewlyIndus.}$	0.157	0.107	0.020	-0.000	-0.005	0.084	0.007	0.029	-0.069	0.058	0.403	0.079

Source: author's calculation. Note: The industry subscripts *i* have been dropped in order to reduce complexity.

Correlation matrix - Continued

	VIIT variables with Range: 15%			VIIT variables with Range: 25%					
	$\Delta\ln(VIIT)_{t-1}^{Advan.}$	$\Delta\ln(VIIT)_{t}^{NewlyIndus.}$	$\Delta\ln(VIIT)_{t-1}^{NewlyIndus.}$	$\Delta\ln(VIIT)_{t}^{ALL}$	$\Delta\ln(VIIT)_{t-1}^{ALL}$	$\Delta\ln(VIIT)_{t}^{Advan.}$	$\Delta\ln(VIIT)_{t-1}^{Advan.}$	$\Delta\ln(VIIT)_{t}^{NewlyIndus.}$	$\Delta\ln(VIIT)_{t-1}^{NewlyIndus.}$
ΔWS_t^{LS}									
$\Delta\ln(Y)_t$									
$\Delta\ln(Y)_{t-1}$									
$\Delta\ln(P)_t$									
$\Delta\ln(P)_{t-1}$									
$\Delta\ln(E)_t$									
$\Delta\ln(E)_{t-1}$									
$\Delta\ln(OUT)_t$									
$\Delta\ln(OUT)_{t-1}$									
VIIT variables with Range: 15%									
$\Delta\ln(VIIT)_{t}^{ALL}$									
$\Delta\ln(VIIT)_{t-1}^{ALL}$									
$\Delta\ln(VIIT)_{t}^{Advanced}$									
$\Delta\ln(VIIT)_{t-1}^{Advanced}$	1.00								
$\Delta\ln(VIIT)_{t}^{NewlyIndus.}$	-0.052	1.00							
$\Delta\ln(VIIT)_{t-1}^{NewlyIndus.}$	0.129	-0.196	1.00						
VIIT variables with Range: 25%									
$\Delta\ln(VIIT)_{t}^{ALL}$	-0.057	0.148	0.187	1.00					
$\Delta\ln(VIIT)_{t-1}^{ALL}$	0.499	-0.025	0.103	-0.365	1.00				
$\Delta\ln(VIIT)_{t}^{Advanced}$	-0.025	-0.002	0.189	0.974	-0.348	1.00			
$\Delta\ln(VIIT)_{t-1}^{Advanced}$	0.497	-0.032	-0.037	-0.409	0.978	-0.397	1.00		
$\Delta\ln(VIIT)_{t}^{NewlyIndus.}$	-0.134	0.729	0.019	0.259	-0.066	0.068	-0.066	1.00	
$\Delta\ln(VIIT)_{t-1}^{NewlyIndus.}$	0.225	-0.073	0.778	0.172	0.233	0.213	0.061	-0.169	1.00

Source: author's calculation. Note: The industry subscripts *i* have been dropped in order to reduce complexity.

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