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Trade and qualification

Linking qualification needs to Germany's export flows

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Abstract

Foreign markets determine success and failure of those industries that have become reliant on foreign demand, impair the demand for employment and invoke changes in occupational fields and qualification requirements. This paper aims to disclose the direct and indirect influence of major trading partners on Germany's production, employment, and qualification needs. It projects the effects by using the dynamic macro-econometric input-output model INFORGE. Industrialised economies are the most important determinants for employment in the manufacturing industries. Business-related services are highly indirectly affected. The growth impact of industrialised nations is declining while BRICS nations are gaining momentum. A shift towards higher qualification needs can be observed.

Zusammenfassung

Ausländische Märkte bestimmen über Erfolg oder Misserfolg von Branchen, die von der Auslandsnachfrage abhängig geworden sind, beeinträchtigen die Arbeitsnachfrage und verändern Berufs- und Qualifikationsanforderungen. Dieses Papier untersucht die direkten und indirekten Einflüsse der wichtigsten Handelspartner auf die Produktion, die Beschäftigung und den Qualifikationsbedarf in Deutschland. Zur Quantifizierung dieser Effekte wird das dynamische makro-ökonometrische Input-Output-Modell IAB/INFORGE verwendet. Die hochentwickelten Industrieländer sind die wichtigsten Determinanten für die Beschäftigung im Verarbeitenden Gewerbe. Unternehmensbezogene Dienstleistungen sind nur indirekt betroffen. Das Wachstum der Industrienationen ist jedoch rückläufig, während die BRICS Staaten an Dynamik gewinnen. Eine Verschiebung hin zu höheren Qualifikationsanforderungen konnte beobachtet werden.
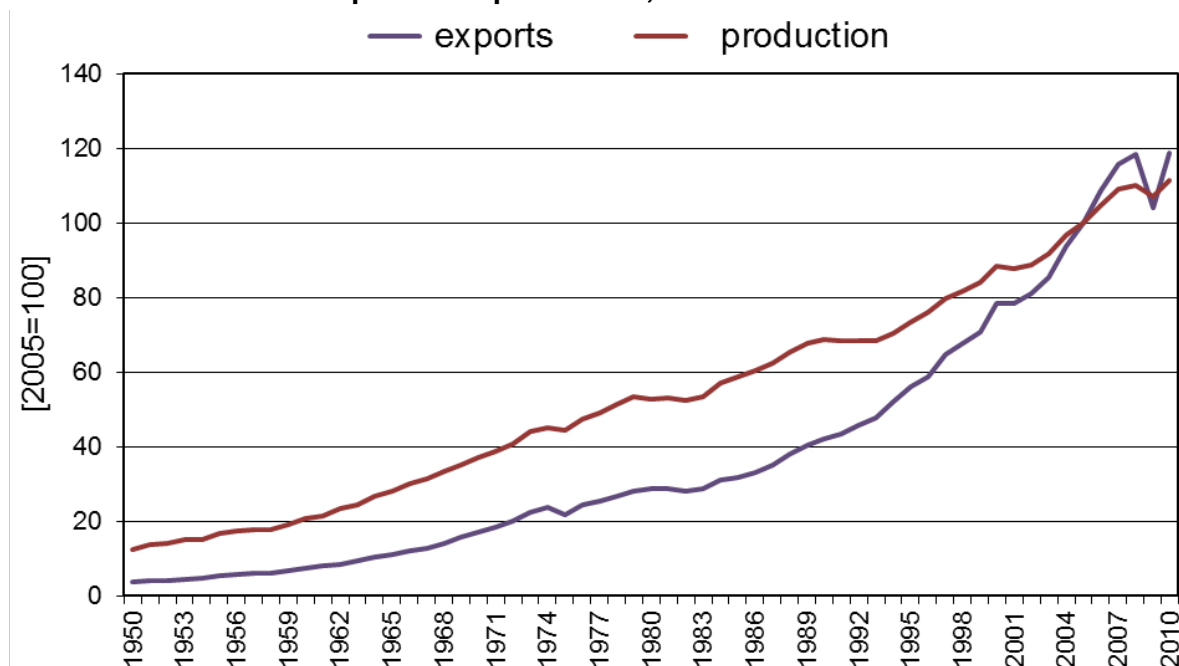
1 Introduction

Studies on foreign trade and its economic impacts are numerous. Since Ricardo (1817), it is standard economic thinking that international division of work is welfare enhancing even if a country shows comparative disadvantages in the production of all goods. Based on that, free trade has been seen as superior to protectionism although later studies e.g. Samuelson (2004) relativised Ricardo by showing constellations when international division of work can also lead to a permanent loss in welfare. Nevertheless, accompanied by the institutional setting of the General Agreement on Tariffs and Trade (GATT) in the wake of the Second World War, the world experienced a fast increase of total trade. Between 1950, two years after GATT came into force, and 2010, fifteen years after the set-up of the GATT's successor the World Trade Organization (WTO), world merchandise exports increased on average by 6% per year, while world merchandise production only increased by 3.7% p.a. [1]

Graph 1
World merchandise in exports and production, 1950-2010

Source: www.wto.org.

For Germany, the trade channel has become one of the major contributors to economic growth. In the last years, studies on foreign trade in Germany concentrated mostly on the analysis of the phenomenon of the "bazaar economy" that was first introduced to the German economy by Sinn (2005). Whereas some studies concentrated more on the international comparison of export-induced performances (Ahlert 2012, Brautzsch/Ludwig 2005), others tested the bazaar-hypothesis (Kfw 2004) or extended the analysis by its effect on the labour market (IMK 2008). All studies are

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[1]   Data taken from the webpage of the World Trade Organisation – www.wto.org.

based on the application of input-output tables as they differentiate between intermediate and final, direct and indirect as well as between domestic and imported goods and services.

Different to most other studies, Prognos (2011) has connected German exports to major trading partners of Germany and measured their direct and indirect impact on Germany's economic performance in terms of production and employment. The paper at hand aims to extent this analysis in two important fields.

1. First, this paper applies a dynamic econometric input-output-model which produces a long-term projection and hence enables to look at future changes in export structures and its effects on the domestic economy.

2. Second, this paper enhances the employment analysis by connecting employment by industries to occupational fields and qualification levels.

The analysis is conducted by applying input-output analysis on a dynamic macro-econometric forecasting and simulation, single-country model. The applied methodology is introduced in more detail in the following chapter. Then, the structure of Germany's export relations is identified. Following-up, the export-induced effects on production, employment, occupation and qualification are presented. The paper closes with a summary and implications of the results.
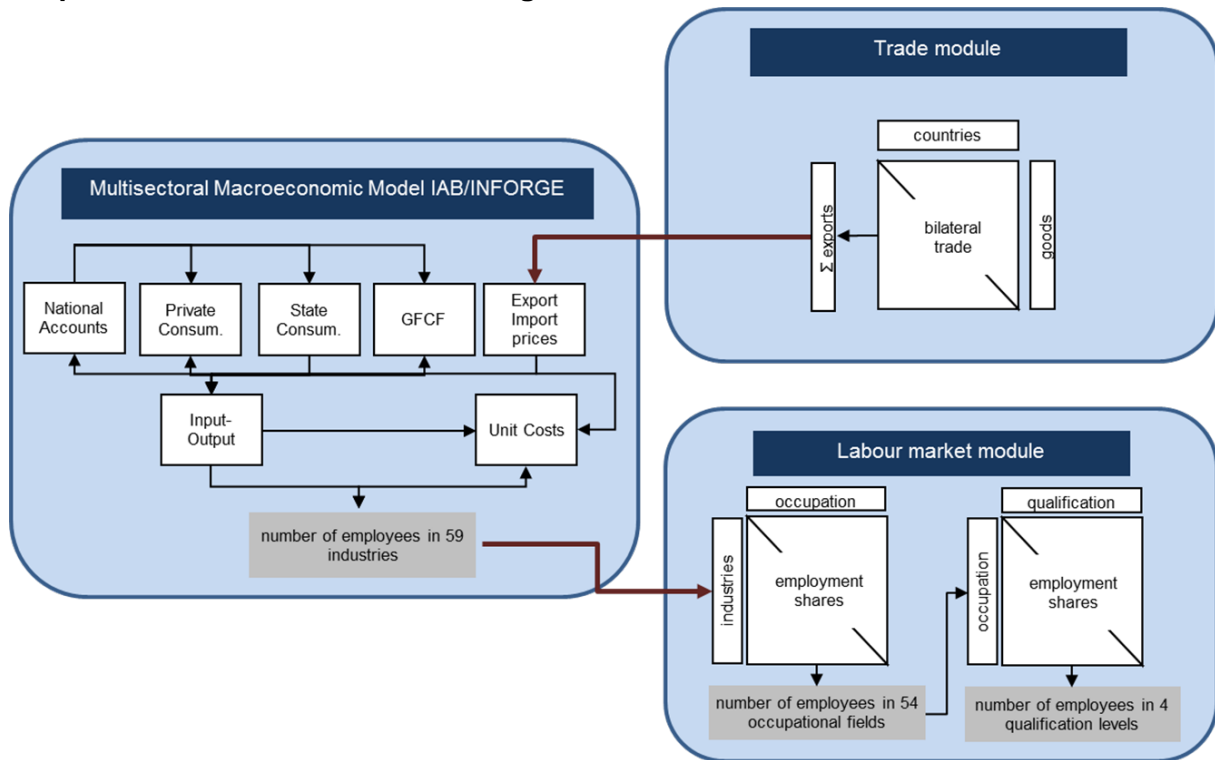
2 Methodology

2.1 The Modelling Framework

This paper uses a modelling approach that extends the dynamic macro-econometric input-output model INFORGE (Maier et al. 2013, Ahlert et al. 2009) in two economic areas: First, German exports are linked to and determined by a trade module that explicitly considers bilateral trade by countries and by products. Second, the labour market is extended by a labour demand module that converts employment by economic industries to employment by occupational fields and qualification levels.[2] Figure 1 shows an overview of the modelling framework. The economic core of the model including the trade module is represented by the macroeconomic IAB/INFORGE model. Whereas the IAB/INFORGE model itself is basically constructed as a bottom-up model, the overall modelling framework follows a top-down approach with no feedbacks from employment by occupational fields and/or employment by qualification levels. In the subsequent sectors, the macroeconomic IAB/INFORGE model and its trade module are described in detail followed by the specification of the transformation of employment to occupational fields and qualification levels.

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[2] Compare also www.qube-projekt.de.

Figure 1
Simplified Illustration of the Modelling Framework

2.1.1 The multisectoral macroeconomic model IAB/INFORGE

The IAB/INFORGE-model has been developed by the Institute of Economic Structures Research (GWS) and has been tested in numerous applications in the field of research and policy analysis (Ulrich et al. 2012, Barker et al. 2011, Lindenberger 2010). The model belongs to the INFORUM family of modelling (Almon 1991) that rests on two basic fundamentals: Bottom-up construction and total integration. The former indicates that each industrial sector is modeled individually and that macroeconomic variables are calculated through explicit aggregation. This approach ensures that each individual sector is embedded within the economic context and that industrial interdependencies are explicitly incorporated and used to explain economic interaction. The latter describes a complex and simultaneous solution which takes into consideration inter-industrial dependence as well as the distribution of income, the redistribution effects of the state and the usage of income for goods. Thus, the input-output tables are fully implemented in the national accounts (Ahlert et al. 2009, Distelkamp et al. 2003). Both datasets are specified for improving the identification for gross fixed capital formation, private consumption, state consumption and foreign trade. Labour market specifics are consistently embedded in the macroeconomic context through output and unit costs. Macroeconomic indicators are determined by aggregation of 59 industries.

INFORGE solves simultaneously, is dynamic over time and is described by non-linear functions. Its basic dataset consists of input-output-tables and national accounts. The applied model in this paper follows the school of evolutionary economics (Nelson/Winter 1982) as features like technological change, imperfect competi-

tion and interdependencies, or partially sticky prices are standard characteristics. In INFORGE, parameters and their elasticity values are estimated econometrically with given time series for a large number of variables.

An integral element of input-output-modelling is the determination of intermediate demand between industries. Input coefficients represent the relation of intermediate demand to total production. In IAB/INFORGE technological change is identified by applying variable input coefficients. They are endogenously determined by relative prices and time trend. Using the Leontief-inverse (I-A)$^{-1}$ – with A as input coefficient matrix and I as identity matrix – and multiplying it with final demand (fd), gross production (y) by 59 industries is given. In the following equations the notations are as follows: Lower case letters are vectors, upper case letters are either times series or matrices. The dimension of vectors and matrices are indicated with subscripts. The subscript t indicates time dependency.

[1] $y_t = \left(I - A_t\right)^{-1} \cdot fd_t$

In many macroeconomic models, private consumption is based on the almost ideal demand system (AIDS) approach (e.g. Kratena/Wüger 2006), which allows for the estimation of consumption structures according to utility maximization behaviour and consequently does build upon the assumption of a representative individual (Deaton/Muelbauer 1980). Different to this approach, INFORGE estimates consumption patterns by 41 purposes of use (c) as a function of real disposable income (Y/P) and relative prices (p/P). For some consumption purposes, trends (T) as proxy for long-term change in consumption behaviour or demographic indicators (DI) like households or different age groups are used as explanatory variables.

[2] $c_{l,t} = c_{i,t}\left(Y_t / P_t, p_{l,t} / P_t, T_t, DI_t\right)$ $\qquad\qquad$ $l \in [1,...,41]$

INFORGE differentiates between ten classifications of the functions of governments for modelling state expenditures as final consumption. 80% of total expenditures are due to four government functions alone: (i) public administration, (ii) education, (iii) health and (iv) social welfare. Driving forces for state consumption are disposable income of the government (YG), employment (E) as well as demographic change (B).

[3] $g_{k,t} = g_{k,t}\left(YG_t, E_t, B_t\right)$ $\qquad\qquad$ $k \in [1,...,10]$

Gross fixed capital formation is the result of separate modelling of production investment (including other investments in equipment) and building investment. Production investments (i) by 59 industries are determined by industrial production (y). In some industries time lags are explicitly considered.

[4] $i_{i,t} = i_{i,t}\left(y_{i,t}, y_{i,t-1}\right)$ $\qquad\qquad$ $i \in [1,...,59]$

Prices are estimated econometrically. Basic prices (p) which are decisive for entre-preneurs are the result of unit costs (uc) and mark-up pricing. The extent to which mark-up pricing can be realised depends on the market form prevailing in specific industrial sectors. In industries with monopolistic structures, mark-up pricing is easi-er to realize than in competitive industrial structures. Industries that are strong in exports also have to consider import prices (pim) as they are exposed to foreign competitors as well.

[5] $\quad p_{i,t} = p_{i,t}\left(uc_{i,t}, pim_{i,t}\right)$ $\qquad\qquad\qquad i \in [1,...,59]$

The labour demand function depends on the number of hours employees work (vol-ume of work). This approach depends on two important observations: First, a vol-ume-based approach to labour demand considers the growing importance of part-time employees; second, labour policy instruments such as short-time work can be explicitly addressed. Working hours (h) are determined by sector-specific production (y). In some industries real wages (ae/p) are also influential.

[6] $\quad h_{i,t} = h_{i,t}\left(ae_{i,t} / p_{i,t}, y_{i,t}\right)$ $\qquad\qquad\qquad i \in [1,...,59]$

Average earnings are determined by using a Phillips curve approach. Accordingly, average earnings by industry (ae) on the one hand depend on tariff wages (AE) (e.g. in machine construction) and on the other hand on sector-specific productivity (y/h).

[7] $\quad ae_{i,t} = ae_{i,t}\left(AE_{t}, y_{i,t} / h_{t}\right)$ $\qquad\qquad\qquad i \in [1,...,59]$

Finally, the number of employees (e) is derived by definition, dividing the number of working hours (h) by working time per year and head (hy). The latter is preset exog-enously.

[8] $\quad e_{i,t} = h_{i,t} / hy_{i,t} \cdot 1000$ $\qquad\qquad\qquad i \in [1,...,59]$

2.1.2 The Trade Module: Determining Exports

In INFORGE, world trade itself is handled as an exogenous factor but with a more sophisticated modelling approach than normally observed at stand-alone, single-country models. In the trading partner economies, feedback effects via wage, price or volume adaptation are not considered. Exports are driven by exogenously given world trade dynamics for German goods which are modelled in two dimensions: By goods and services and by export demanding countries. This allows accounting for diverging speeds in economic developments as well as for different demand struc-tures by countries.

Starting point in INFORGE are the economic forecasts (gdpf) for 54 countries and two regions (OPEC and Rest of World) taken from the International Monetary Fund[3],

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[3]   World Economic Outlook Database of the International Monetary Fund (IMF).

the European Commission[4] and the International Energy Agency[5]. The import share (impq) is calculated for each country. The ratio is assumed to remain constant over time. The development of imports (impf) is specified by the economic growth path of each trading partner.

[9] $\quad impf_{cc,t} = impq_{cc,t}/100 * gdpf_{cc,t}$ $\hspace{3cm} cc \in [1,...,56]$

Bilateral trade matrices[6] (TRAD) for Germany are applied to determine the share of Germany in each country's import function (impqd). In the baseline scenario, these shares remain constant. This implies that Germany can remain its strong international position within the import portfolio of its export partners, but it is not in the position to expand its impact further.

[10] $\quad impqd_{cc,t} = \sum_g \left(TRAD_{g,cc,t}\right)/10000 /impf_{cc,t} \hspace{1cm} cc \in [1,...,56], g \in [1,...,43]$

Total export demand for German products can be derived by multiplying the import shares (impqd) with the projected import demand (impf) of each economy. The total export demand is distributed to 43 categories of goods by using the export shares on total export demand taken from the bilateral trade matrices (TRADQ). In the baseline scenario, these shares remain constant which means that Germany's exporting partners do not change their product demand structure towards Germany.

[11] $TRAD_{g,cc,t} = TRADQ_{g,cc,t}/100 * \left(impqd_{cc,t} * impf_{cc,t} *10000\right)$

$\hspace{1cm} cc \in [1,...,56], g \in [1,...,43]$

The sum over all countries (exnsv) is then used to estimate German exports (x).

[12] $\quad exnsv_{g,t} = \sum_{cc} \left(TRAD_{g,cc,t}\right)/1000000 \hspace{2cm} cc \in [1,...,56], g \in [1,...,43]$

[13] $\quad x_{j,t} = x_{j,t}\left(exnsv_{g,t}\right) \hspace{4cm} cc \in [1,...,56], g \in [1,...,43]$

2.1.3 Modelling Occupation and Qualification

On the occupational level the classifications of the BIBB[7] occupational fields (Tiemann et al. 2009) are applied: They consist of 54 occupational fields which show comparable job characteristics and industry dominance when grouped at the level of occupational categories (3-digit codes from the official German classification of occupations 1992 (KldB 92)). On the qualification level a differentiation was made on

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four levels, in line with the ISCED classification. The data on occupational fields and qualifications is based on long time series from the micro census, which is a one per cent sample of the total population and provides results for the entire range of employment (including the self-employed, assistants, civil servants and soldiers). However, only the respective structures (percentages) from the micro census are used for the final results, as the data on the employed from the IAB/INFORGE model which is taken as a starting point is based on the benchmark figures from the national accounts.

On the basis of data from the micro censuses from 1996 to 2008 we generate the information how many people were employed in each occupational field in each industrial sector, and how many of those employed in each occupational field had which kind of qualification. This gives rise to shares which reflect the distribution of occupational fields in the economic sector for each year (share matrix P), and the configuration according to the highest qualification for each occupational field (share matrix Q).

To forecast the future labour demand, these shares are extrapolated in time as trends. Variations from a long term monotone trend are considered as random. For each share $o_i(t)$ there will be a long term saturation level a^*i which will be approached asymptotically by $o_i(t)$. However, it must be noted that (1.) a^*i can only have a value between 0 and 1, and (2.) they must add up to 1 in every industrial sector or occupational field at all times. Thus, by taking the above restrictions into account, 54 trends are calculated for each of the 59 industrial sectors, and five trends for each of the 54 occupational fields.

After a series of analyses it was shown that logistic trend extrapolation delivered the most sustainable results for the problem area at hand. With regard to logistic trend estimation, it is assumed that the estimated shares asymptotically approach a saturation level. At the same time it is warranted that both conditions mentioned above are met by the selected estimation procedure.

$$[14] \quad o_{n,i,t} = \frac{\left(1 + \exp\left(a_{n,i} + b_{n,i} * t\right)\right)^{-1}}{\sum_{n=1}^{54} o_{n,i,t}} \qquad\qquad n \in [1,...,54], i \in [1,...,59]$$

Here $p_{n,l,t}$ represents the share of labour in occupational field (n) within industrial sector (i) at time (t) with $a_{n,i}$ and $b_{n,i}$ as the parameters to be estimated.

Accordingly, the formula for the qualification shares is as follows:

$$[15] \quad q_{m,n,t} = \frac{\left(1 + \exp\left(a_{m,n} + b_{m,n} * t\right)\right)^{-1}}{\sum_{m=1}^{5} q_{m,n,t}} \qquad\qquad m \in [1,...,5], n \in [1,...,54]$$

$q_{m,n,t}$ represents the share of labour with qualification level (m) in occupational field (n) at time (t) with $a_{m,n}$ and $b_{m,n}$ as the parameters to be estimated.

2.2 Design of Analysis

The calculation of export-induced direct and indirect production and employment belongs to standard input-output-analysis (Holub/Schnabl 1994). Similar to equation [1], the determination of export-induced production (y^x) needs the Leontief-inverse $(I-A)^{-1}$ but instead of multiplying it with total final demand, only the export vector (x) of equation [13] is used.

[16] $\quad y_t^x = (I - A_t)^{-1} \cdot x_t$

Export-induced employment (e^x) is retrieved by multiplying the employment coefficient (b) left-hand-sided with the Leontief-Inverse and the export vector.

[17] $\quad e_t^x = b * (I - A_t)^{-1} \cdot x_t$

The total of export-induced production and employment can be separated into directly and indirectly induced effects. Indirect effects are initiated by inter-industrial production relations and are in general higher in those industries that function as component supplier for other industries. Direct effects are stronger in those industries that produce final products for consumers. Direct effects of export-induced production and employment can be determined equal to equation [16] and [17] by using the diagonal elements of the Leontief-Inverse (Holub/Schnabl 1994).

In order to determine country specific impulses, total export (x) has to be replaced in equation [16] and [17] by country specific exports (x^{cc}).[8]

Country-specific, export-induced, direct and indirect effects on employment by occupational fields and qualification levels are elaborated after the effects on total employment and employment by industrial levels are generated according to equation [17]. Total effects on occupational level (e^{xp}) are measured by using employment effects by industrial levels (e^x) multiplied with the estimated share matrix O.[9]

[18] $\quad e_t^{xp} = e_t^x * O_{n,i,t}$ $\qquad\qquad\qquad n \in [1,...,54], i \in [1,...,59]$

Accordingly, employment effects on qualification levels (e^{xq}) are retrieved by applying the share matrix Q.

[19] $\quad e_t^{xp} = e_t^x * Q_{m,n,t}$ $\qquad\qquad\qquad m \in [1,...,5], n \in [1,...,54]$
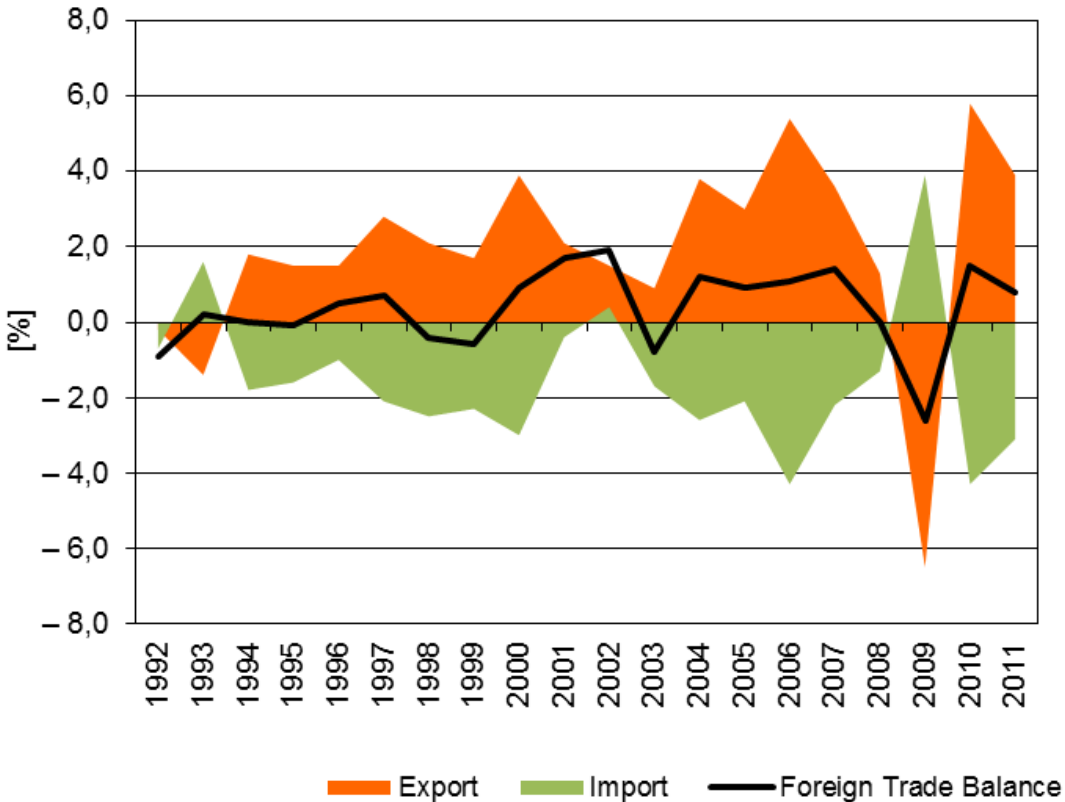
3 Germany's trade in exports

The growth contribution of exports in Germany, as shown in Graph 2, was mostly positive and dominating to the other determinants of GDP in the past. But in 2009,

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[8] Refer back to chapter 2.1.2 for the calculation and integration of German exports by 54 countries and 2 regions in INFORGE.

[9] The share matrix P and its forecasting approach were explained in chapter 2.1.3.

the vulnerability of the German economy due to its strong exposure to foreign trade became more than evident with a decline in real GDP of -5.1%. The negative growth impact of exports reached the level of -6.5%. Within one year, the recovery process, initiated by worldwide stimulus packages of estimated 2,000 billion USD, let to a strong economic upswing that persisted until 2011. Again, the export channel was the major driving force to this development.

Graph 2
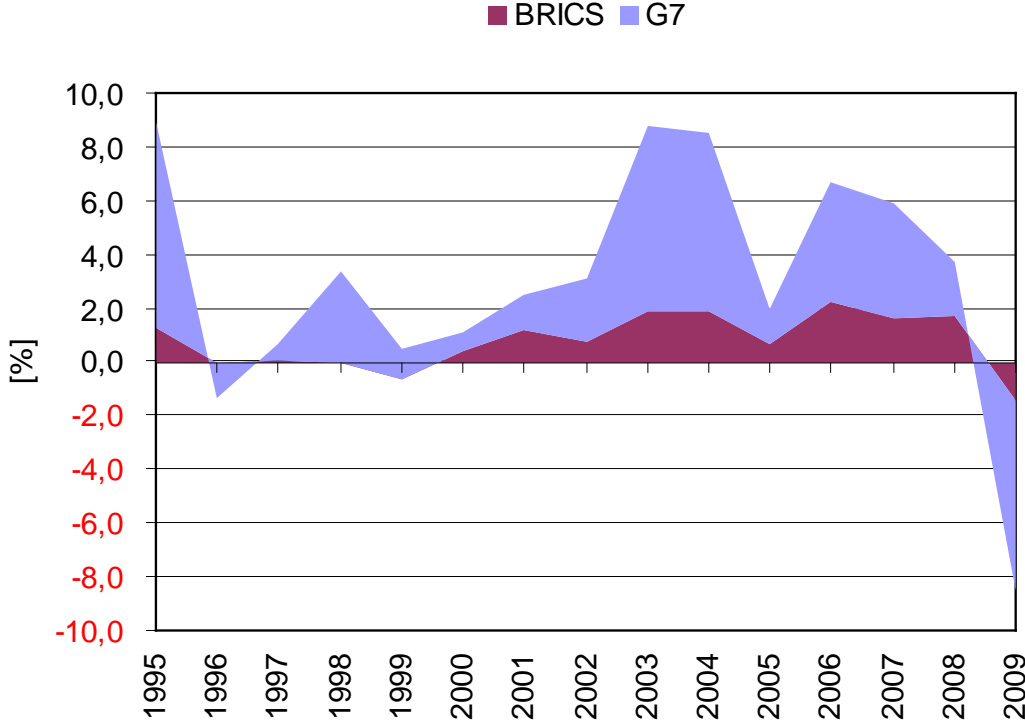**Growth impact to GDP, 1992-2011**

Source: German Federal Statistical Office.

German foreign trade is strongly concentrated on certain regions and single econo-mies. Latest available data from 2009 show that the greatest influence on Ger-many's trade balance with a share of 80% comes from the leading industrialised economies grouped in the OECD.[10] 63% alone is determined by the countries of the European Union. By individual countries, France is the most important trading part-ner for Germany. The most important non-European economy in terms of exports are the United States with a share of 6.7% on Germany's exports. The fast develop-ing economies of the BRICS-group ask for 9.6% of German products whereof half is solely due to demand from China.

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[10]   Bilateral trade matrices of the OECD.

In Graph 3, the growth impact of the seven leading industrialised economies (G7) and the major developing economies (BRICS[11]) is shown for the period from 1995 to 2009. The G7[12] region holds a share of 40% on Germany's exports and was especially responsible for Germany's high export growth rates in early 2000. Its growth impact is declining since then, whereas the growth impact of the BRICS economies remains on a constant and steadily increasing path. The downswing in 2009 in foreign trade is mostly due to declining demand in industrialised nations.

Graph 3
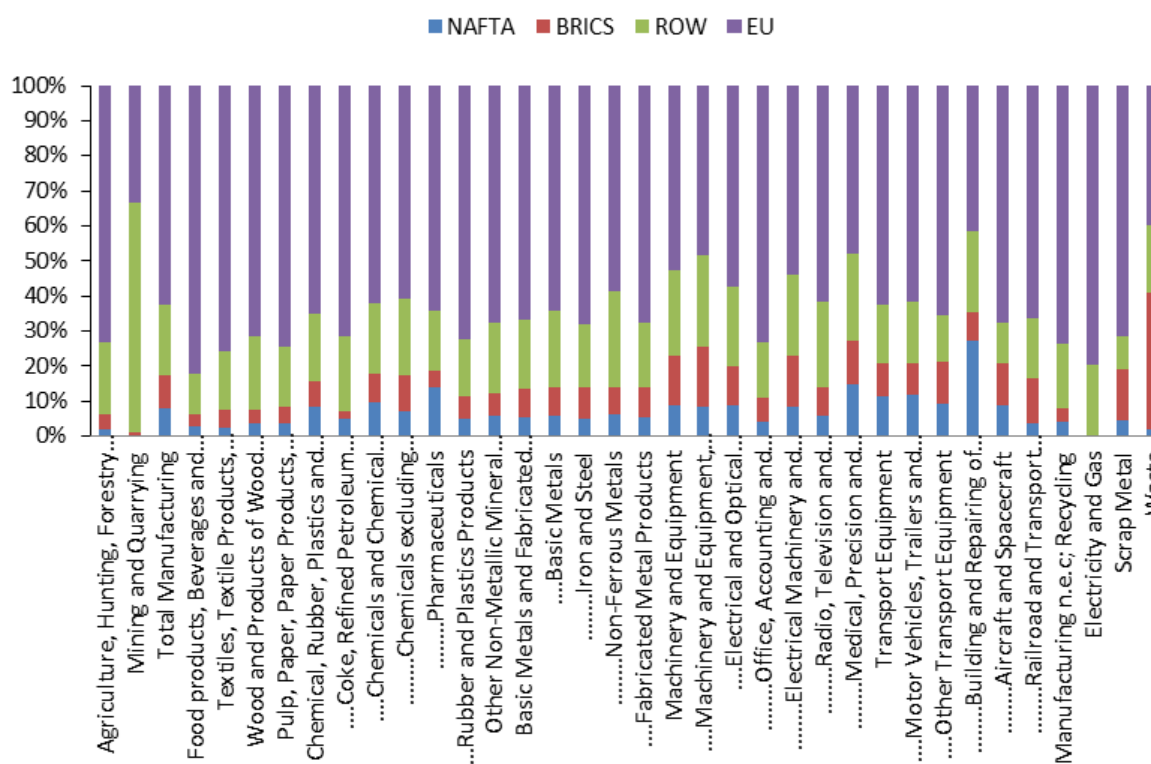**Growth impact of G7 and BRICS on Germany's exports , 1995-2009**

Source: OECD Bilateral Trade Matrices – own calculations.

On product level, the same dominant export structure is evident (Graph 4). Except for machinery equipment and waste, the demand from non-OECD economies exceeds 20% (compare Graph 4).

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[11] Brazil, Russia, India, China, South Africa
[12] The G7-group comprises Germany, the USA, Japan, UK, Canada, France and Italy.

Graph 4
Exports by products and regions of destination 2009[13] [14] [15]

Source: OECD Bilateral Trade Matrices – own calculations.

4   Export-induced Impacts - Status-Quo and Forecast until 2025

In the subsequent chapters, the results of the forecast are shown for a selected number of years. The results have to be interpreted according to their underlying methodology. The analysis described in chapter 2.2 is designed to show only the gross effects on production and employment. The net effects of the analysis are lower as the containing effects of imports are considered. Further, the analysis concentrates foremost on the disclosure of structural changes initiated by exports over time and less on the explicit figures within a certain year. The country-specific, export-induced changes are aggregated and limited to three regions: BRICS, NAFTA and Eurozone. The choice of regions is due to three reasons: first, the BRICS-quintet assembles those countries with the highest speed in economic development and, simultaneously, with a comparatively high share in German exports. Second, the NAFTA region represents a country group that includes industrialized economies

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[13] The NAFTA (North American Free Trade Agreement) is a trilateral trade bloc created by the USA, Canada and Mexico.

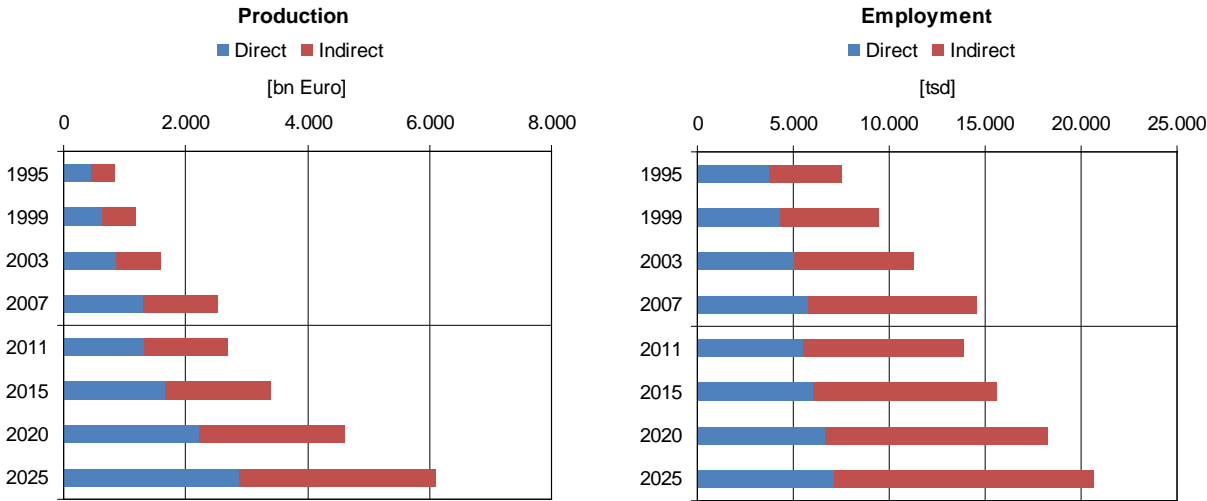[14] ROW is the abbreviation for "rest of the world".

[15] BRICS is the abbreviation of the five fast-developing countries Brazil, Russia, India, China and South-Africa.

with a high share in German exports. Third, the Eurozone covers a homogenous group of economies that are not only member of the European Union but also of the European Currency Union.

4.1 Aggregate export-induced Production and Employment

Direct and indirect, export-induced production and employment in total (Graph 5) and by regions (Graph 6) are shown for a selected number of years in the following. Graph 5 illustrates that export-induced production has nearly tripled from 1995 to 2007 and will further increase until 2025 albeit to a slightly slower extent. Direct effects on production have exceeded indirect effects in the past. The ratio will change at the latest in 2020 when indirect export-induced production will be predominant. In 2007, export-induced direct production held a share of 29% on total production; by 2025, this share will substantially increase to slightly over 40%. The result indicates that on the one hand, export-induced production remains the leading factor for overall growth. And, on the other hand, intermediate production is gaining momentum as the indirect production effects are dominant in the future. The gross effects on employment also show a constant and strong upswing in directly and indirectly export-dependent workplaces. The development is slower compared to production in current prices. During 1995 and 2007, the number of export-induced employees has not even doubled. Within the next fifteen years, the development will slow down considerably but the total number of export-induced employees (gross effect) is still increasing. By the end of the projection horizon, the number of workplaces indirectly dependent on export is exceeding. The slower development on the labour market is explained by the sluggish labour market. In relation to the total number of employees, the numbers of employees directly exposed to exports amounted to 15% in 2007. Until 2025, the ratio will increase slightly to 18%.
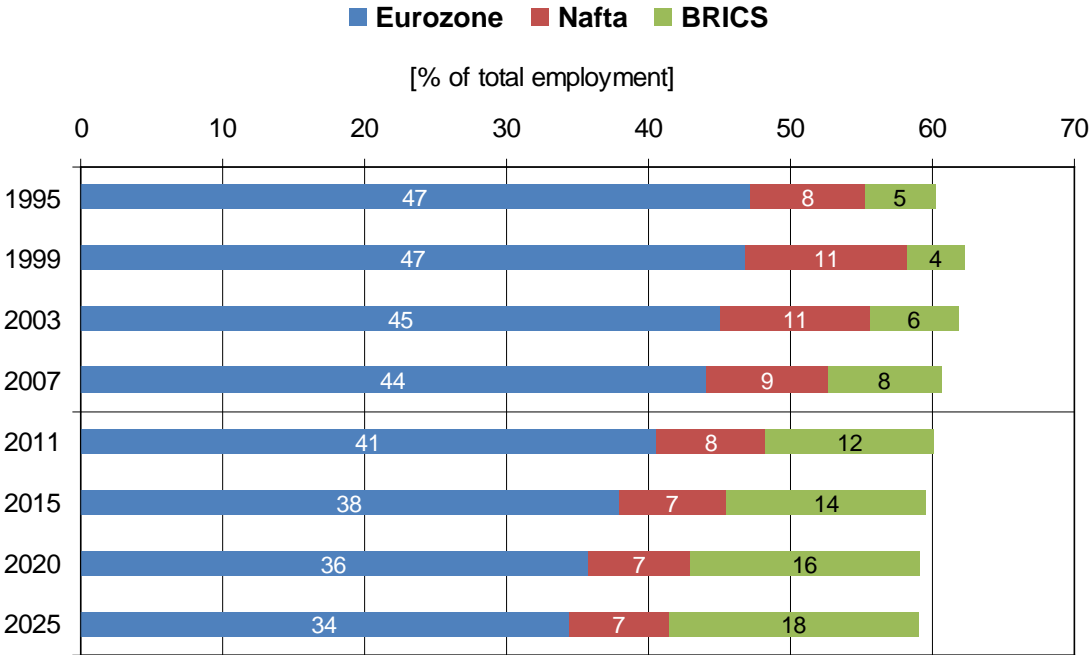
Graph 5
Export-induced production and employment (gross) – all countries

Source: Own calculations.

With respect to different regions, the developments in the past and in the future differ considerably. The Eurozone, Nafta and BRICS encount for around 60% of total export-induced gross production and gross employment. The Eurozone with presently 40% contributes the strongest share on export-induced (gross) production and employment. However, already since the late 1990s, the Eurozone faces a declining share on export-induced production and employment and, by 2025, the share will have been substantially reduced to 34%. The same is true for the NAFTA region with the USA, Canada and Mexico as leading economies. With currently 8% on total export-induced production and employment, this region experienced its greatest influence on Germany's production in the year 2000 with a share on export-induced production of 12% respectively 11% on employment. In contrast, the BRICS nations started in 1995 with a share in production and employment of 5%. Until the late 1990s, this ratio remained more or less constant but started to increase steadily in the early years of the 2nd century. By now, the export-induced production and employment share is at 12% respectively 13%. With that, the impact of the BRICS nations has already exceeded the impact of the NAFTA region and is steadily closing-up to the Eurozone. By 2025, it is projected that around 18% of export-induced production and 19% of export-induced employment is due to increasing demand for German products in the BRICS countries.

Graph 6
Export-induced employment by regions (gross)

■ **Eurozone** ■ **Nafta** ■ **BRICS**

[% of total employment]

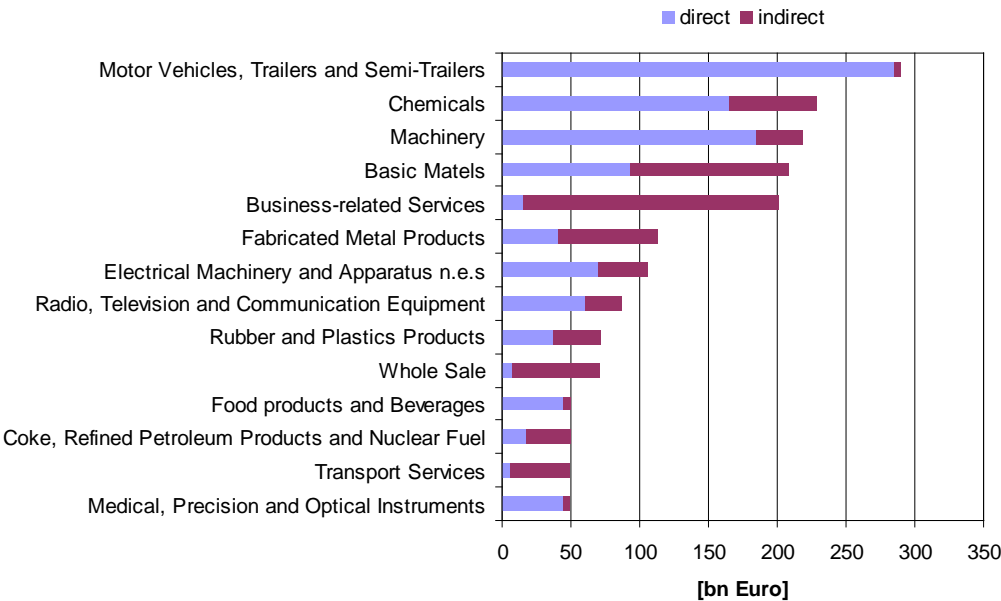| Year	Eurozone	Nafta	BRICS
1995	47	8	5
1999	47	11	4
2003	45	11	6
2007	44	9	8
2011	41	8	12
2015	38	7	14
2020	36	7	16
2025	34	7	18

Source: Own calculations.

4.2 Export-induced Production and Employment on Industrial Level

Direct and indirect export-induced production for the year 2007 and 2025 is given for the fifteen largest industries in Graph 7. Export-induced production is the largest for motor vehicles in 2007, followed by chemical products and machineries. Whereas
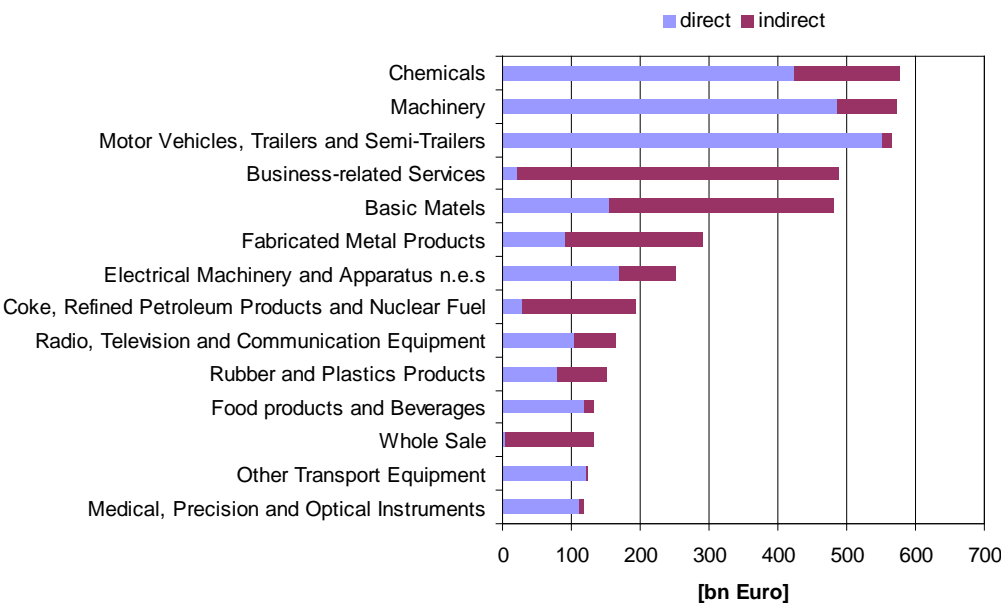
the export-induced production is by majority directly generated, the export-induced production of chemical goods is also largely motivated by indirect export demand. The same holds to a little lesser extent for machinery products. But the largest indirect effect of export-induced production is focused on business-related services. Until 2025, the production of chemical products becomes the largest industry exposed to exports, followed by machineries. Relative to the chemical and machinery industries, motor vehicle producers reduce in comparison their export-dependency. Still, the automobile industry increases also their total volume in exports.

Graph 7
Export-induced production (gross) – by products
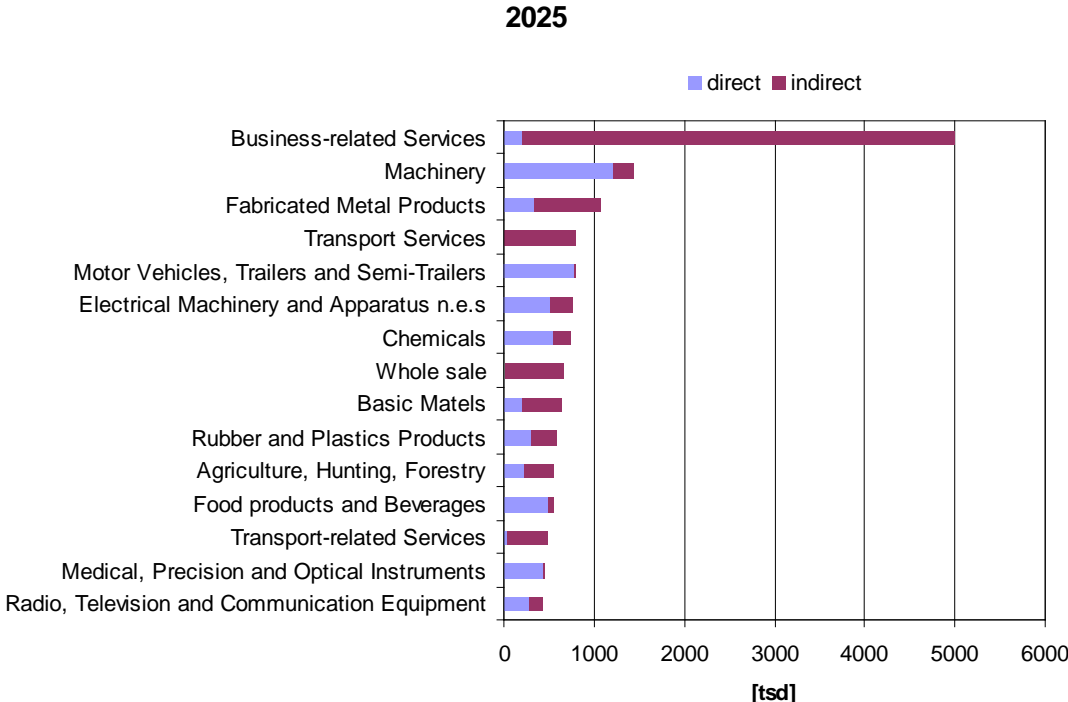
2007

2025

Source: Own calculations.
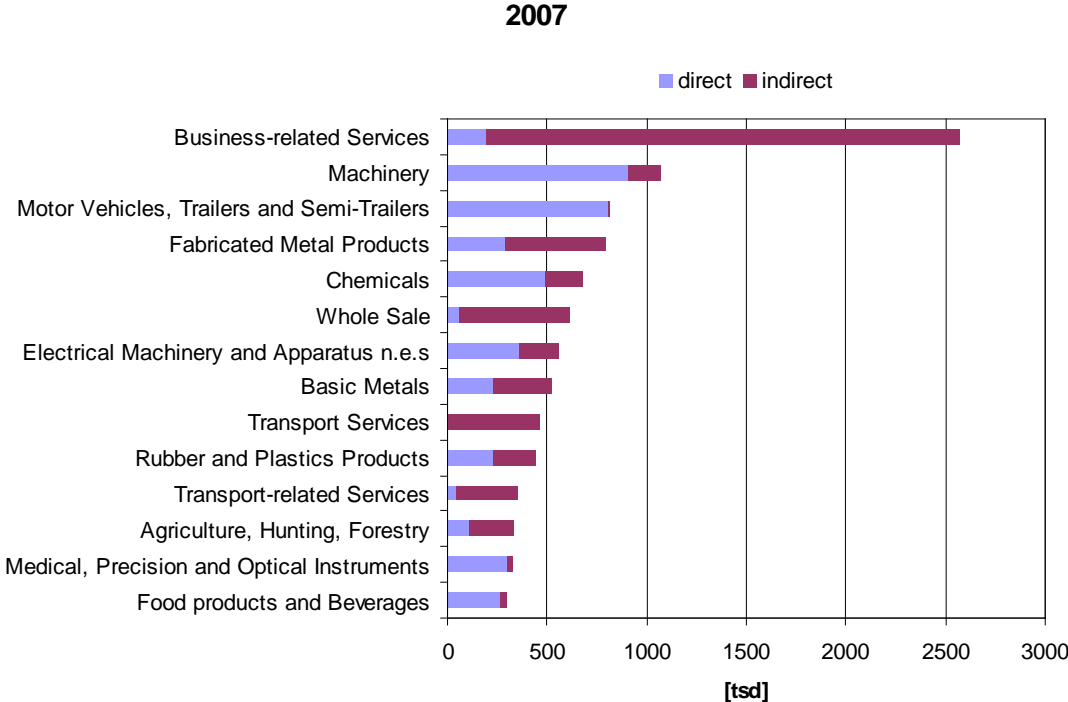
Direct and indirect export-induced employment for the year 2007 and 2025 is given for the fifteen largest industries in Graph 8. Business-related services display the largest number of export-induced employees in 2007, followed by far by machinery and automobile industry.
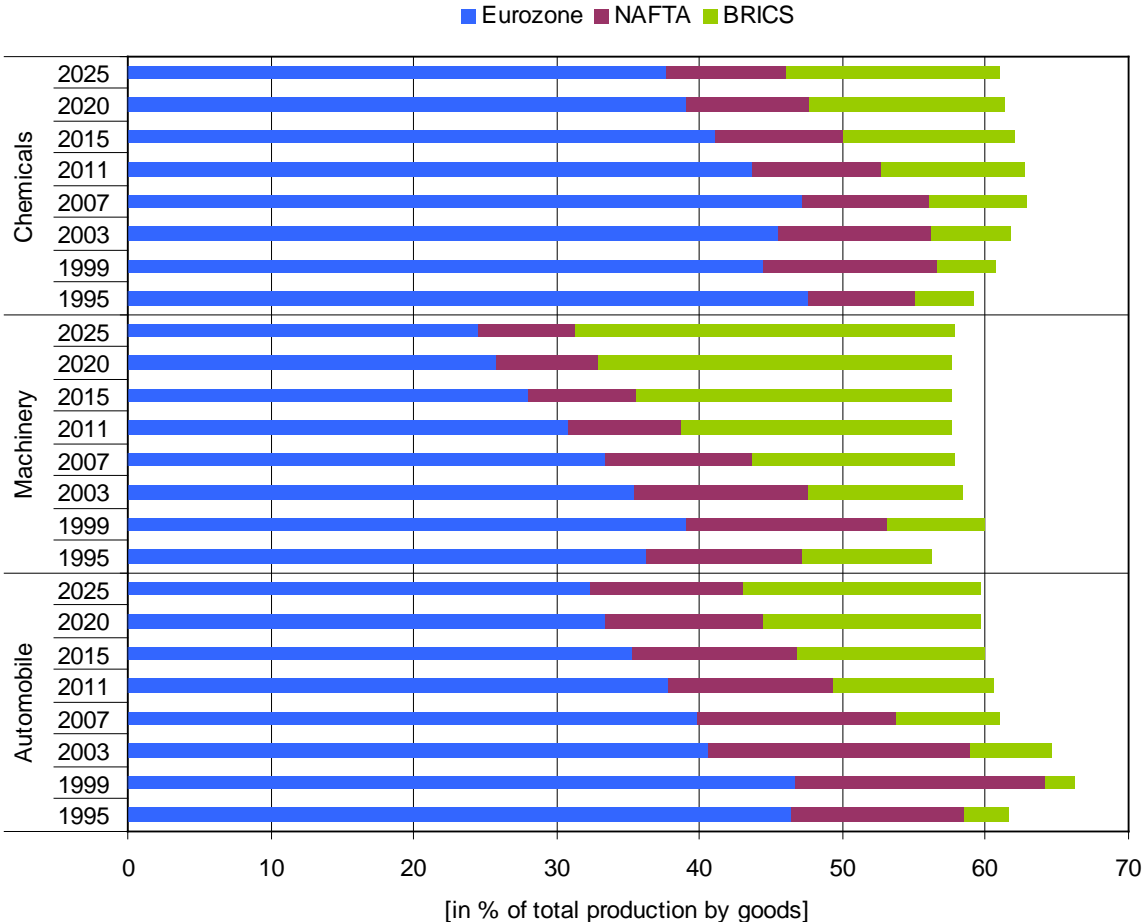
Graph 8
Export-induced employment (gross) – by products

2007

2025

Source: Own calculations.

The large number of export-induced employees in the business-related service sector is mainly due to indirect effects which emphasises the dependency of this sector to other industries. This dependency can be directly linked to the importance of labour leasing for the manufacturing industries. Other industries that reflect a high indirect dependency on exports with respect to employment are the whole sale sector, the transport sector as well as the sector related to the production of crude oil and natural gas. The export-induced employment in the motor vehicle industry is mainly directly linked to the export channel. The same holds for the food producing industry as well as the industry for medical, precision and optical instruments. Until 2025, the business-related service sector remains the industry with the largest directly and indirectly dependent workplaces. The indirect effect is even larger.

Graph 9
Export-induced production by regions and selected products

[in % of total production by goods]

Source: Own calculations.

The major export products of Germany are industrial products. The highest export shares hold automobiles, machinery and equipment and chemical products. The following graph illustrates the share of regions on export-induced production by products.[16] All three product categories illustrate the same tendency as outlined

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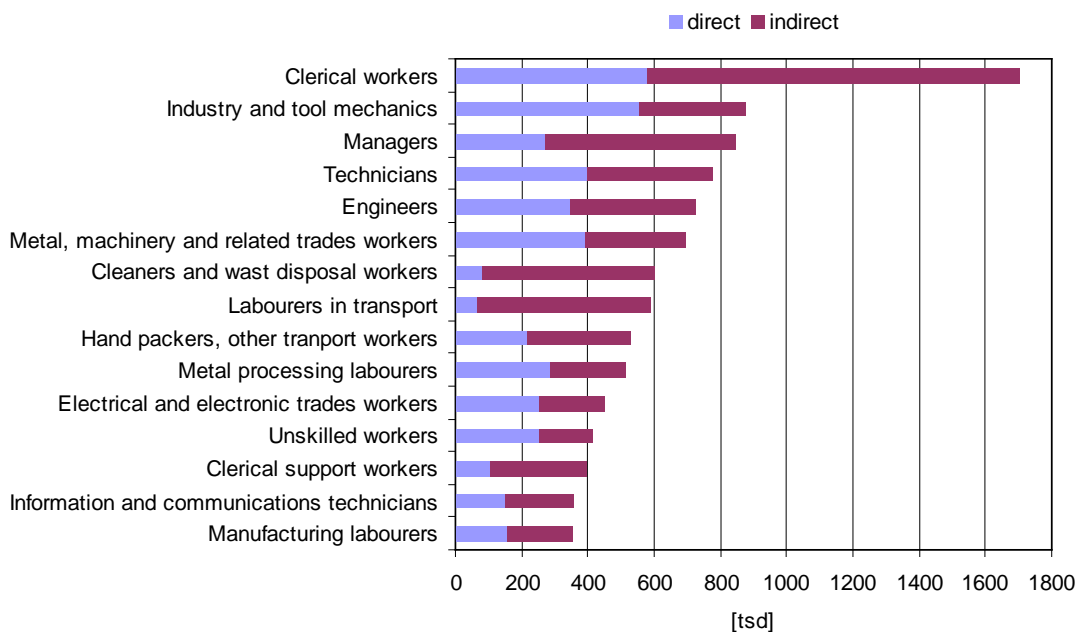[16] The figures do not show the share on total export-induced production!

above: The share of export-dependent production to the Eurozone is declining, while the share of the BRICS's export-induced production is increasing. But apart from that, the three product groups differ considerably in detail. While the chemical industry shows the highest dependency on exports into the three regions and the highest share of export-induced production by the Eurozone, the machinery industry reveals a very strong dependence of export-induced production on the fast developing economies. The automobile industry instead shows a production dependency somewhere situated between both extremes. Already today the machinery industry relies exceptionally strong on exports bound to the BRICS nations. Until 2025, the share will increase to roughly 30%, whilst in the case of automobiles or chemical products the share will increase between 15% and 20%. The automobile industry illustrates its strong dependence on the two largest car markets of the world, the USA and China. The NAFTA region has the strongest impact on automobile production but the BRICS region is gaining momentum if only recently.

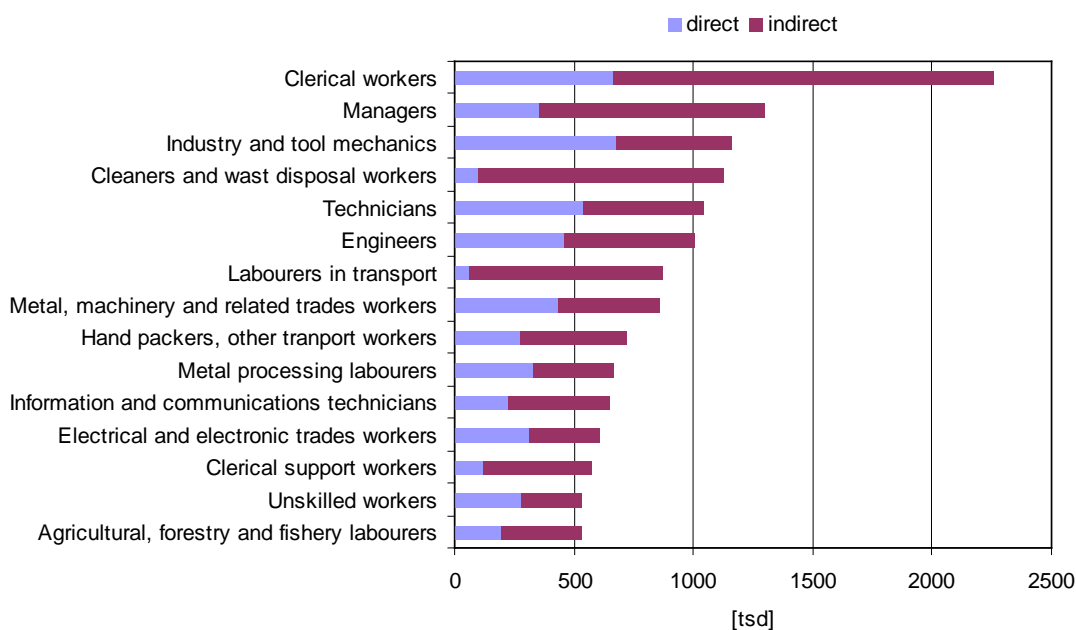## 4.3 Export-induced employment by occupation

The effects of the transmission of export-induced employment by economic sectors to export-induced employment by occupational fields are displayed for the years 2007 and 2025 for the fifteen most affected occupations in Graph 10. By far, clerical work is the field which mostly relates to export flows. This is even more remarkable, as this occupation comprises the largest number of employees: nearly 12% of all employees are grouped in this occupational field. Although both the direct and indirect channels are the strongest compared to all other occupations, the indirect effects more than double the direct effects. This significant and mostly indirect exposure to export is linked to the observation made in the previous chapter: Employment in the business-related service sector displays the strongest direct and indirect export-induced employment effect. The same holds for executive functions. The strong effects on technical occupations are the result of the high export-exposure of the manufacturing industry in total. Noticeable is the relatively strong indirect effect on labourers in transport. This accounts for the high indirect export-induced employment effects in the transport service sector.

Until 2025, export-induced employment effects by occupational fields are increasing, despite a shift in the structural composition. Occupations related to the business-related service sector and indirect effects are getting more prominent. Parallel, more service-oriented jobs are becoming more prominent like e.g. in the field of information and communication or of transport services.

Graph 10
Export-induced employment (gross) – by occupation

2007

2025

Source: Own calculations.

Looking at the regional influence in Graph 11, the Eurozone is the most important factor in all occupational fields. The indirect effect is especially significant in the field of clerical workers and managers. In the case of industry and tool mechanics and technicians, the indirect effect is comparatively small but still prominent. The export-induced employment effects by the regions NAFTA and BRICS are equally high and significantly smaller than in the Eurozone in 2007. By 2025, employment effects induced by the BRICS economies have grown much faster than the employment effects induced by the NAFTA countries.

Graph 11
Export-induced employment (gross) – by selected occupations

Source: Own calculations.

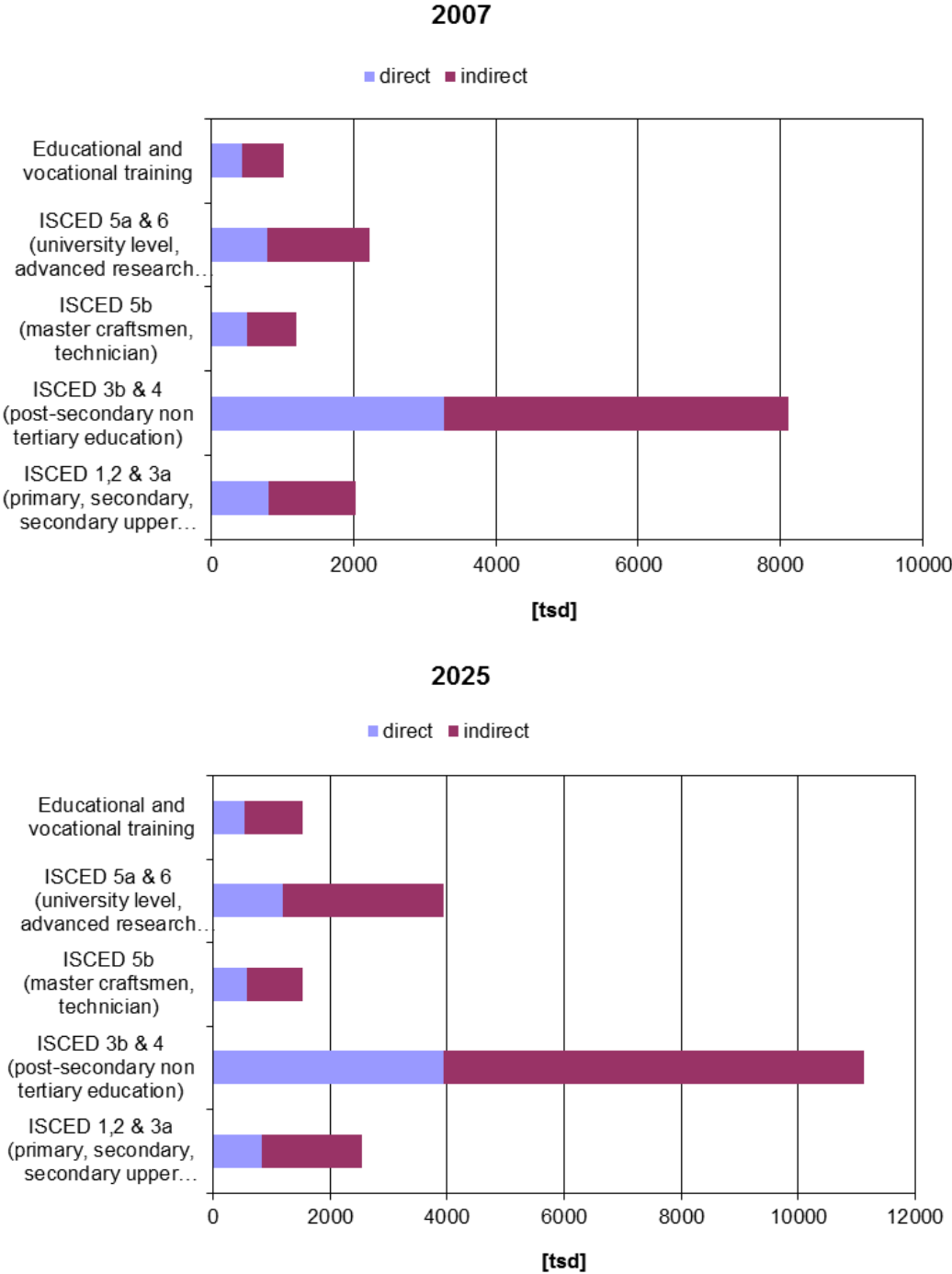## 4.4 Export-induced employment by qualification

Export-induced employment by qualification levels is shown in Graph 12. The most important qualification needed to match export-induced employment demand is now and in future the ISCED level 3b and 4.[17] This qualification level is strongly practice-oriented with a focus on vocational training. The importance of this qualification level reflects the technical and industrial orientation of the employment fields mostly affected by exports. The education of clerical workers is also categorised in this qualification level. Higher or tertiary education (ISCED 5a and 6) is far less important than expected. Employees with university degree or higher are only little exposed to export-induced employment, although the indirect effects are relatively stronger than in ISCED level 3b and 4. Presently, the export-induced effects for primary, secondary and upper education (ISECD 1, 2 and 3a)[18] are similar to higher and tertiary education levels (ISCED 5a and 6).

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[17] Individuals grouped in the category ISCED 3b have either successfully completed a vocational training programme or finished dual education (e.g. *Berufsschule*). ISCED 3b programmes are designed to provide direct access to ISCED 5b (additional practical, technical or occupational skills with a minimum duration of two years full-time equivalent at the tertiary level) like vocational schools (*Fachschulen*) or universities of cooperative education (*Berufsakademien*). ISCED 4 qualifications describe post-secondary non tertiary education and are designed for those individuals who have completed ISCED 3.

[18] This category covers all steps of basic education until secondary level (ISCED 1 and 2) and includes programmes designed to provide direct access to ISCED 5a (programmes and professions with high skills requirements) like universities. The qualification remains below Phd level.

The development until 2025 displays that qualification needs gene do not shift to a large extent. But it becomes evident that higher qualification increasingly matters with respect to export-induced employment. Higher education increases faster than other ISCED levels.

Graph 12
Export-induced employment (gross) – by qualification
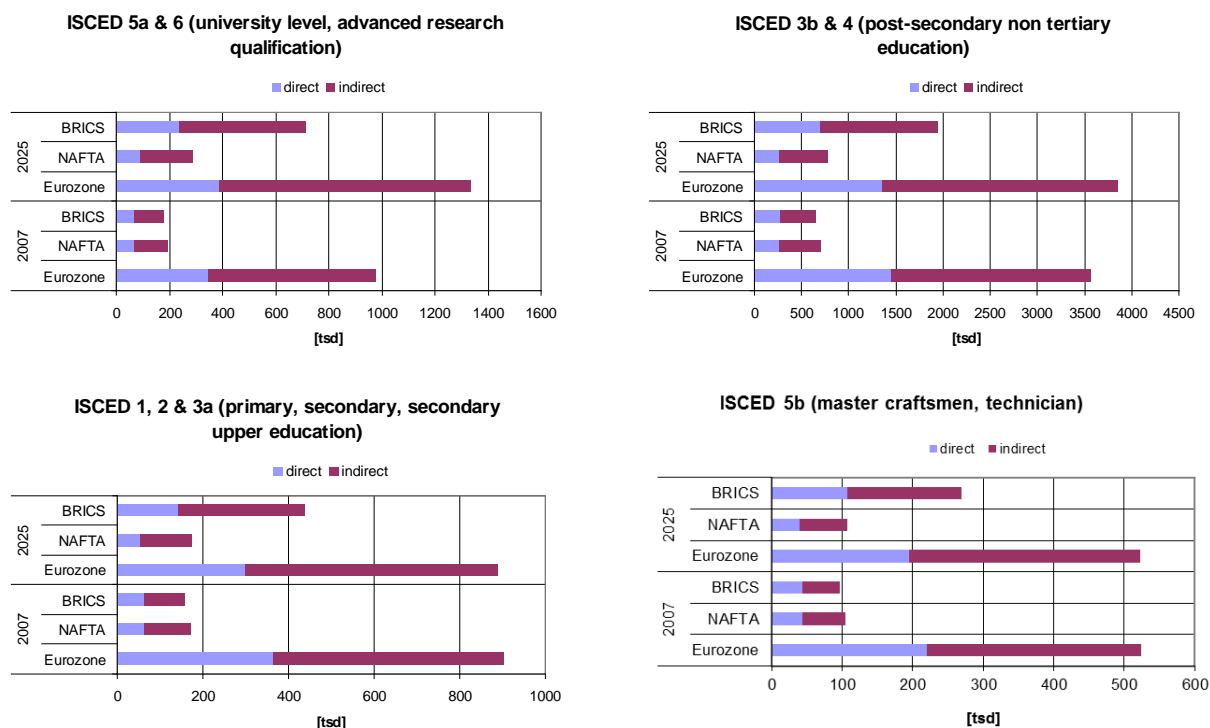
2007

2025

Source: Own calculations.

The regional effects by qualification levels are illustrated in the following graphs. Similar to the effects on occupational fields, the Eurozone is the dominant driver on all four displayed qualification levels. In the future, this prominent status remains.

But it is interesting to notice that the influence of the Eurozone on qualification levels increases especially in the more qualified ISCED levels 3b to 6 whereas the effects remain more or less constant for the lower qualification levels. In contrast, the influence arising from trade to the BRICS economies shows also impacts on lower qualification levels.

Graph 13
Export-induced employment (gross) – by selected qualifications

Source: Own calculations.

5   Summary and Conclusion

In the past, Germany has become reliant on the trade channel as one of the major contributors to economic growth – or degrowth. The 2009 recession as well as the recovery process in the years to follow was mainly driven by foreign trade developments. The German trade structure reveals that Germany's trade flows are concentrated on industrialised economies grouped in the OECD and with over 60% of total exports on the countries of the European Union. Meanwhile, the impact of the fast developing economies of the BRICS-quintet is gaining momentum. On product level, the increasing impact of the BRICS nations can already be observed at the example of machinery and equipment, where the demand from non-OECD countries exceeds 20%.

The paper at hand has applied the advantages of input-output analysis on identifying the effects of export flows on the German labour market. It has extended other works on this subject in two important fields: First, it has applied a dynamic econometric input-output-model which produces a long-term projection and hence enables to look at future changes in trade structures and its effects on the domestic econ-

omy. Second, this paper has enhanced the employment analysis by connecting employment by industries to occupational fields and qualification levels.

The results show that the dependence of domestic production and employment on export has increased significantly during the past and are expected to increase further in the future. Indirect effects are getting more and more prominent. Currently, industrialised economies are the most important determinants for employment especially in the manufacturing industries. But the growth impact is declining and the impact of the BRICS nations is getting more relevant by 2025. On industrial level, the highest employment and production effects are received in those three industries that account for roughly 40% of total exports in Germany: The car industry, machinery producers and the chemical industry. Mostly direct effects account for this result. When indirect effects are also considered, the business-related service sector becomes one of the sectors strongest exposed to exports. This demonstrates the high dependency on other export-oriented industries like the car industry through work lease. Clerical workers are the strongest and mostly indirectly effected occupation by export flows. Technicians, engineers and industry and tool mechanics are strongly demanded occupations but far less significantly exposed to exports. Occupations instead with executive functions are becoming increasingly dominant and export-exposed. With respect to formal qualification needs, the analysis shows that mainly qualification levels with a strong practice orientation (vocational training) depend highly on export flows. The importance of this qualification level reflects the technical and industrial orientation of the employment fields mostly affected by exports. Employees with university degree or higher are only little exposed to export-induced changes. But in the future, a slightly stronger shift towards higher qualification needs in export-oriented industries can be observed: The demand for higher education is increasing faster than other ISCED levels, although the dominance of the practice-oriented qualification levels remains.

The analysis shows, that Germany's export dependency has strong domestic effects on production and employment. Labour demand strongly depends on trade and stimulates especially the future demand for MINT occupations[19] and higher education. For policy implication, the trade effect on employment should not be underestimated. A shift towards a stronger domestic growth share – as suggested by for instance Peter Bofinger (2013) with his demand to lower international competitiveness via a raise in wages and salaries of up to 5% – would have implications on the specific labour demand. A less export-dependent growth path of Germany in the future would most likely lower the demand for MINT occupations and hence lower the pressure on the current discussion on skill shortages.

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[19] MINT summarises occupations related to **m**athematics, **i**nformatics, **n**atural science and **t**echnology.

The results presented are gross effects on production and employment induced by export to 54 trading countries and 2 regions. Effects initiated by import flows are not considered. Future work on this topic should encounter this effect as the results – the net effects – are expected to be smaller. Above that, encountering the import effects might also invoke substantial impacts on structural levels including industries, occupations and qualifications. Hence, the implications of a net effect analysis on industrial sectors, occupational fields and qualification levels might differ to the presented gross effects not only in height but also in its structural composition. The application of the methodology to other components of total demand would help to classify the export-induced results. Additionally, the identification of future skill shortages can only be estimated if a full-fledged labour supply forecast on occupational and educational level is included in the analysis. The expansion of the FTCS with respect to moving import quotes, could improve the impact analysis of export-induced changes. The applied status-quo assumption is likely to underestimate the described effects as exports normally grow faster than production. Further, the impact is likely to be underestimated also because indirect trade flow effects on the trading partners are not endogenized. But such effects cannot be captured by a single-country model like INFORGE. Multi-country or multi-regional macro-econometric models such as GINFORS or GRAM are more proper instruments to include reaction functions of the trading partner economies.

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