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Export induced qualification needs

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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. Industrialized economies are the most important determinants for employment in the manufacturing industries. Business-related services are highly indirectly affected. The growth impact of industrialized nations is declining while BRICS nations are gaining momentum. A shift towards higher qualification needs can be observed.

Keywords: *Projection; labour demand; occupational field; qualification level; modelling; international trade; input-output analysis*

1. Introduction

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. This extents other studies on German foreign trade that concentrated on the international comparison of export-induced performances (Ahlert 2010, Brautzsch & Ludwig 2005), on the bazaar-hypothesis (Sinn 2005, Kfw 2004, IMK 2008). Prognos (2011) has linked German exports to major trading partners and measured their direct and indirect impact on Germany's

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economic performance in terms of production and employment. All studies are 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.

The paper at hand extends the analysis on foreign trade in Germany in two important fields. First, a dynamic econometric input-output-model is applied which produces a long-term projection and hence enables to look at future changes in trade structures and its effects on the domestic economy. Second, the employment analysis is extended by connecting employment by industries to occupational fields and qualification levels.

The paper is structured as follows: First, the methodology applied in this paper is introduced. Then, 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 multisectoral macroeconomic model INFORGE

This paper uses a modeling approach that extends the dynamic macro-econometric input-output model INFORGE (**In**terindustrial **For**ecasting **Ge**rmany) in two important 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 labor market is extended by a labor demand module that converts employment by economic industries to employment by occupational fields and qualification levels.

INFORGE 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 (Mönnig 2013, Maier et al. 2013, Ulrich et al. 2012, Barker et al. 2011, Lindenberger 2010). The model belongs to the INFORUM family of modeling (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 over 59 industries. Each individual sector is embedded within the economic context and 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, the distribution of income, and the redistribution effects of the state and the usage of income for goods. Input-output tables are fully implemented in the national accounts (Ahlert et al. 2009). Both datasets are complemented with additional official data for improving the identification for gross fixed capital formation, private consumption, state consumption and foreign trade. Labor market specifics are consistently embedded in the macroeconomic context through output and unit costs. The applied model follows the school of evolutionary economics (Nelson & Winter 1982) as features like technological change, imperfect competition and interdependencies, or partially sticky prices are standard characteristics. INFORGE solves simultaneously and is dynamic over time. Parameters and their elasticity values are estimated econometrically with given time series for a large number of variables.

Integral element of input-output-modeling is the determination of intermediate demand between industries. Input coefficients represent the relation of intermediate demand to total production. In 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) for 59 industries (subscript i) is determined. The subscript t indicates time dependency, as in all subsequent equations, too.

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

[1]

The labor demand function depends on the number of hours employees work. Working hours are determined by sector-specific production. In some industries real wages are also influential. Average earnings are determined by using a Phillips curve approach: average earnings by industry depend on tariff wages (e.g. in machine construction) and on sector-specific productivity. Finally, the number of employees (*e*) in 59 industries is derived by definition, dividing the number of working hours (*h*) by working time per year and head (*hy*). The latter is preset exogenously.

$$e_{i,t} = {h_{i,t}} \Big/ {hy_{i,t}} \qquad [2]$$

Exports are driven by world trade dynamics for German goods which are modeled 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 structures 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, the European Commission and the International Energy Agency. The import share (*impq*) is calculated for each country. The ratio is assumed to remain constant over time. The development of imports (*impf*) for each country/region (subscript *cc*) is specified by the economic growth path of each trading partner.

$$impf_{cc,t} = {impq_{cc,t}} \Big/ {100} * gdpf_{cc,t} \qquad [3]$$

Bilateral trade matrices (*BTX*) 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.

$$impqd_{cc,t} = {\sum_{g} \left(BTX_{g,cc,t} \right)} \Big/ {impf_{cc,t}} \qquad [4]$$

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 (subscript *g*) by using the export shares on total export demand taken from the bilateral trade matrices (*BTXQ*). In the baseline scenario, these shares remain constant as well.

$$BTX_{g,cc,t} = {BTXQ_{g,cc,t}} \Big/ {\left(impqd_{cc,t} * impf_{cc,t} \right)} * 100 \quad [5]$$

The sum over all countries (*exnsv*) is then used to estimate German exports (*x*) by 59 product groups (subscript *j*).

$$x_{j,t} = x_{j,t} \left(exnsv_{g,t} \right) \quad [6]$$

2.2. Modeling occupation and qualification

On the occupational level the classifications of the BIBB 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. On the qualification level a differentiation was made on four levels, in line with the ISCED classification. The data on occupational fields and qualifications is based on long time series (1996 to 2008) from the micro census. Whereby the total number of employees is given from the national accounts, the data from the micro census is used to allocate the number of employees in industrial sectors to occupational fields and qualification levels. 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). In the projection, these shares are extrapolated with logistic time trends. The implicit assumption is that observable developments in the past can be transferred to the future. Variations from a long-term monotone trend are considered as random. For each share (p) there will be a long-term saturation level (a) which will be approached asymptotically by p. However, two conditions must hold: a can only have a value between 0 and 1, and they must add up to 1 in every industrial sector or occupational field at all times. Thus, by taking these restrictions into account, 54 trends are calculated for each of the 59 industrial sectors, and five trends for each of the 54 occupational fields.

In equation *[7]*, p represents the share of labor in 54 occupational fields (subscript m) in 59 industrial sectors (subscript i) with a and b as the parameters to be estimated.

$$p_{i,m,t} = \frac{\left(1 + \exp\left(a_{i,m} + b_{i,m} * t\right)\right)^{-1}}{\sum_{m=1}^{54} p_{i,m,t}} \quad [7]$$

In equation *[8]*, q represents the share of labour with 5 qualification levels (subscript k) in 54 occupational fields (subscript m) with a and b as the parameters to be estimated.

$$q_{m,k,t} = \frac{\left(1 + \exp\left(a_{m,k} + b_{m,k} * t\right)\right)^{-1}}{\sum_{m=1}^{5} q_{m,k,t}} \quad [8]$$

2.3. Design of the 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 *[6]* is used.

$$y_t^x = \left(I - A_t\right)^{-1} \cdot x_t \quad [9]$$

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

$$e_t^x = b * (I - A_t)^{-1} \cdot x_t \quad \text{[10]}$$

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 of export-induced production and employment can be determined equal to equation *[9]* and *[10]* 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 *[9]* and *[10]* by country specific exports (x^{cc}).

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 *[10]*. Total effects on occupational level (e^{xp}) are measured by using employment effects by industrial levels (e^x) multiplied with the estimated share matrix P.

$$e_{m,t}^{xp} = e_{i,t}^x * P_{m,i,t} \quad \text{[11]}$$

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

$$e_{k,t}^{xq} = e_{m,t}^x * Q_{k,m,t} \quad \text{[12]}$$

3. Export-induced performances – status quo and forecast until 2025

In this chapter, the results of the projection are shown for a selected number of years. The analysis described in chapter 2.3 is designed to show only gross effects on production and employment. The net effects of this analysis are lower as the effects of imports are considered as well. The analysis concentrates on the disclosure of structural changes initiated by exports and not on the explicit figures within a certain year.

3.1. Aggregate export-induced production and employment

Direct and indirect, export-induced production and employment in total and by regions are shown in Figure 1. They illustrate 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. 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 decade, 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 dull labor market.
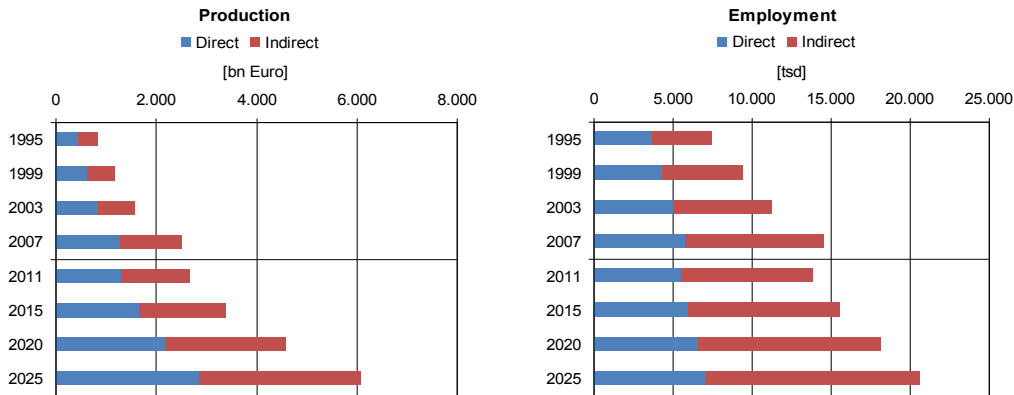
Figure 1: gross effects of aggregate production and employment

With respect to different regions, the developments in the past and in the future differ considerably. The Eurozone, NAFTA and BRICS account for around 60% of total export-induced gross production and gross employment. The Eurozone contributes the strongest share on export-induced (gross) production and employment. Having already started in the past, the Eurozone faces a declining share on export-induced production and employment. The same is true for the NAFTA region. 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%. Hence, 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.

3.2. Export-induced production and employment on industrial level

On industrial level, 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. Motor vehicle production will reduce its export-dependency in comparison.

Direct and indirect export-induced employment for the year 2007 and 2025 is given for the fifteen largest industries in the following two pictures (Figure 2). Business-related services display the largest number of export-induced employees in 2007, followed by far by machinery and automobile industry. 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.
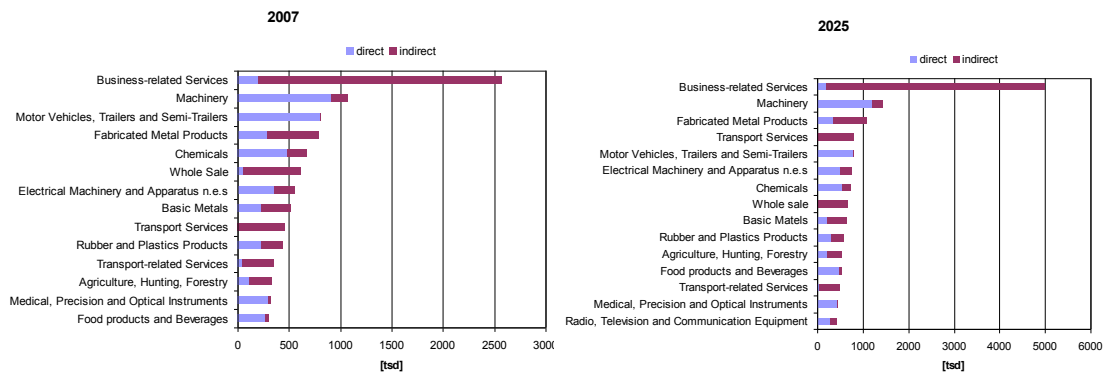

Figure 2: export-induced employment (gross) by products

The major export products of Germany are industrial products. The highest export shares hold automobiles, machinery and equipment and chemical products. All three product categories illustrate the same tendency as outlined before: 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.

3.3. 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 fifteen most affected occupations in Figure 3. By far, clerical work is the field which mostly relates to export flows. Although the direct and indirect channel is the strongest one compared to all other occupations, the indirect effects more than double the direct effects. This strong 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.
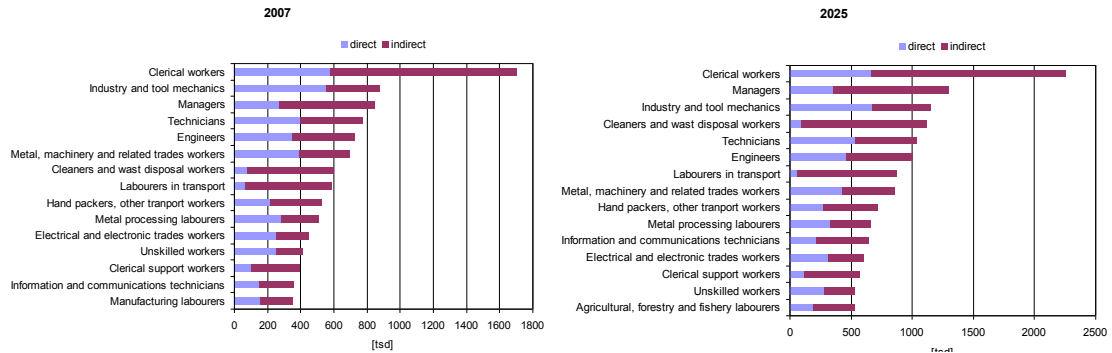

Figure 3: export-induced employment (gross) – by occuption

Looking at the regional influence, 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.

3.4. Export-induced employment by qualification

Export-induced employment by qualification levels is shown in Figure 4. The most important qualification needed to match export-induced employment demand is now and in future the ISCED level 3b and 4. 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) are similar to higher and tertiary education levels (ISCED 5a and 6). The development until 2025 displays that qualification needs generally remain the same. But it becomes evident that higher qualification increasingly matters with respect to export-induced employment. Higher education increases faster than other ISCED levels.
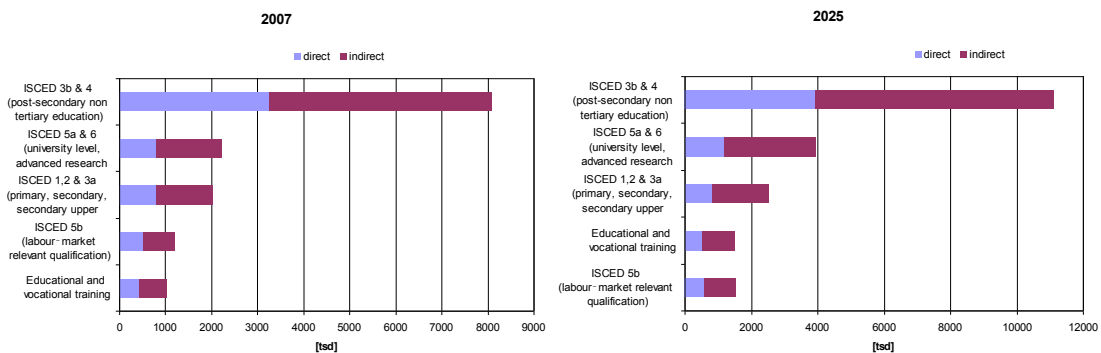
Figure 4: export-induced employment (gross) – by qualification

The Eurozone is the dominant driver on all four 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.

4. Summary and conclusion

In the past, Germany has become reliant on the trade channel as one of the major contributor 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 economy. 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 included in the observation, 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 far less but also strongly demanded occupations. Occupations with executive functions are becoming increasingly dominant. 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. In the future, a stronger shift towards higher qualification needs can be observed: The demand for higher education is increasing faster than other ISCED levels, although the dominance of the practice-oriented qualification levels remain.

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 and higher education. For policy implication, the trade effect on employment should not be underestimated. A shift towards a stronger domestic growth impact 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.

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. 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.

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