

GED Study

Brexit and German-British Production Chains

A Sector-Level Analysis of Value Chains

Short study

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A Sector-Level Analysis of Value Chains for the Year 2017

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Executive Summary

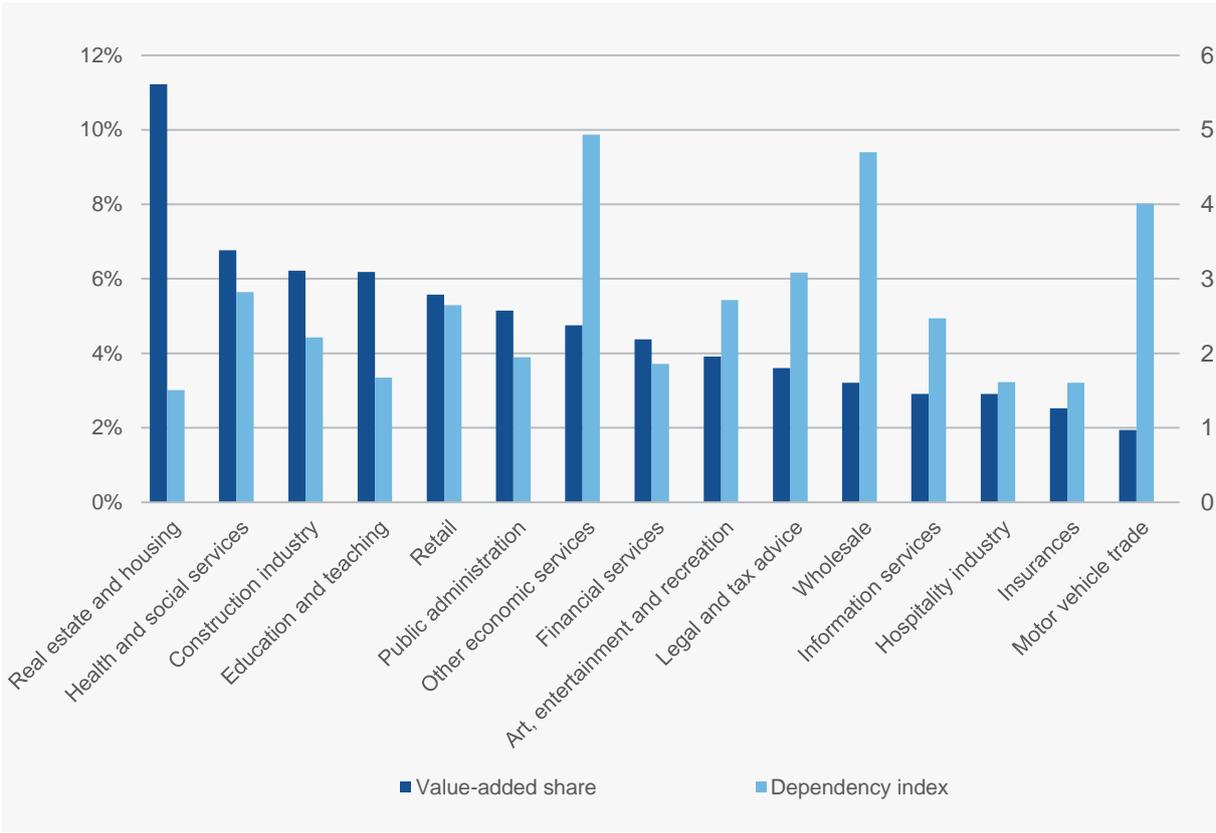
What is value-added trade and why is trading with added value important? Value-added refers to the additional value created by a production step. The sum of the value-added of all production steps is equal to the final value of the product. The value created in a specific country as part of an international production chain can be measured. It is also possible to measure the value-added content in imports and exports of intermediates between different countries. These exports and imports are also referred to as trade in value-added or value-added trade. Intermediates trade merely captures the final value-added step and additionally assigns all value-added contributions of previous steps to the supplier of intermediates. In an international comparison, countries with a low value-added share in trade are typically countries where simple assembly of intermediate products is carried out.

What is the volume of value-added trade between Germany and the United Kingdom? Looking at total trade, Germany imports 115 billion euro worth of goods and services from the United Kingdom, including more than 50 percent intermediates. The United Kingdom imports 70 billion euro worth of goods and services, including around two thirds intermediates. Looking at value added alone, both the United Kingdom and Germany import EUR 50 billion worth of goods and services from each other's partners.

Which German sectors are (in absolute terms) most active in value-added trade with the United Kingdom? For Germany, the main industries exporting value-added into the United Kingdom are business services (4.2 billion), wholesale trade (3.8 billion), pharmaceuticals (3.6 billion), automotive (3 billion) and chemicals (2.9 billion). The most important sectors importing British value added into Germany are also the automotive industry (4.9 billion) and mechanical engineering (2.6 billion), but also construction (2.6 billion), the food industry (2.1 billion) and mining (1.9 billion). In relative terms, pharmaceuticals, metal work, coking, other vehicle construction and chemistry are the German sectors with the strongest dependency on the British economy.

Which British sectors are (in absolute terms) most active in value-added trade with Germany? For the United Kingdom, the most important export sectors of value added into Germany are wholesale trade (2.9 billion), legal and tax consultancy (2.9 billion), business services (2.8 billion), mining (2.7 billion) and financial services (1.9 billion). The most important import sectors of value added from Germany are healthcare (10.1 billion), automotive (5 billion), construction (4.7 billion) and public administration (3.8 billion). In relative terms, chemistry, metal work, mining and the automotive industry show the highest degree of dependency on the German economy.

What does Brexit mean for value-added trade between the United Kingdom and the EU and Germany? For the United Kingdom Brexit will change trade relations not only with Germany but the entire EU. The level of value added contributions from the EU in British products is much higher than the content of German value added in British goods. Similarly, the demand for British value added and final products from the EU is substantial. This implies a much higher need of adjustment. For the most important British sectors, it is highest in business services, wholesale, motor trade and legal and tax consultancy.



Comparison of the value added share by industry in the United Kingdom and a dependency index which measures to what extent a British sector is linked to the German economy through value added trade. The figure is identical to Figure 21 on page - 34 -.

Summary

The United Kingdom is a key trading partner for the German economy and the withdrawal of the United Kingdom from the European Union is therefore likely to have a significant impact on economic relations between the two countries. In addition to trade in end products, trade in intermediate inputs is also of major importance. Intermediate exports include value added from the exporting country as well as from "upstream" foreign countries. For trading partners, the value added that is traded is particularly relevant, as it often cannot simply be substituted by value added from other countries. The consequences of Brexit for the German-British trade partnership can hardly be assessed until the withdrawal procedure has been finally determined. However, in order to quantify and assess which industries in Germany and the United Kingdom would be affected by Brexit and to what extent, it is important to first determine the current value-added relationships.

The present study uses data from the World Input-Output Database (WIOD). The results for 2017 show that Germany and the United Kingdom trade substantial value added, but less than the figures for wholesale trade suggest. Accordingly, part of the value added contained in the traded intermediate inputs comes from other countries along the value chain. While trade in intermediate consumption from and to industry sectors in Germany recently accounted for a substantial share (up to three quarters) of total intermediate consumption trade between the two countries, the share of traded value added from and to industry sectors in German industry was just under half of the total value added traded. By contrast, the share of intermediate consumption traded from and to industries of the German services industry accounted for around a quarter of the total intermediate consumption traded, while the value-added share traded from and to industries of the German services industry accounted for a good half of the total value added traded. The ratios between traded intermediate consumption and value added in industry and services are very similar in the United Kingdom, although less pronounced. Accordingly, industry in Germany, as in the United Kingdom, partly serves as a trading platform for value added from third countries, while service industries from Germany and the United Kingdom indirectly trade value added via third countries.

In 2017, the *motor vehicle construction* and *mechanical engineering* industries were significantly involved in value-added trade with the United Kingdom. *Chemistry, pharmaceuticals* and *electronics* also imported and exported substantial value added to the United Kingdom. In addition, the German service industries *other economic services*, *wholesale trade* and *real estate and housing* also traded to a significant extent. The majority of these industries are essentially linked to the United Kingdom through value-added exports. Others, such as the *food products industry*, *public administration* or the *coking plant*, are heavily dependent on value-added imports from the UK.

In the United Kingdom, the *health and social services* industry was by far the driving force behind value-added trade with Germany in 2017, followed by *motor vehicle construction*, *construction* and *wholesale*. With a few exceptions such as *other economic services*, *legal and tax advice*, *mining* and *financial services*, enterprises in the United Kingdom were the main recipients of value-added exports from Germany.

However, industries in both countries that trade significant amounts of value added are not necessarily most dependent on each other. In 2017, for example, the *mechanical engineering* industry in

Germany traded value added worth around 5 billion Euro with the United Kingdom. However, the United Kingdom was a relatively insignificant trading partner in terms of value added and final-demand production in this industry. In particular, the *pharmaceutical, chemical, metalworking, coking and other vehicle construction* industries are heavily dependent on the United Kingdom. *Motor vehicle construction*, which is the most important industry in absolute terms for value-added trade with the United Kingdom, is only moderately dependent on the United Kingdom in relation to domestic value added and production.

From the UK perspective, the *chemical, metalworking, mining, motor vehicle construction and electrical equipment* industries are highly dependent on Germany relative to domestic value added and production. Industries such as *health-care and social services, construction, wholesale trade or public administration*, which in absolute terms are most closely involved in value-added trade with Germany, are relatively unaffected by Germany.

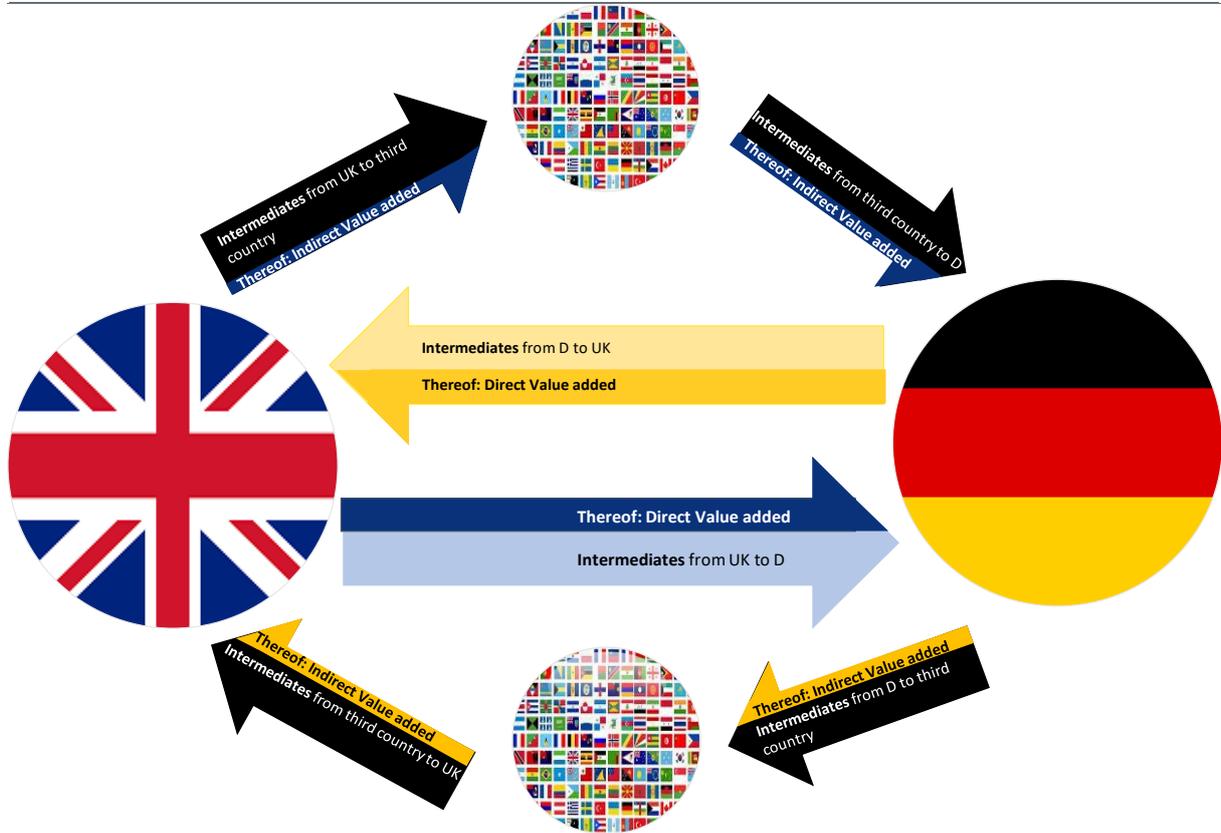
1 Introductory remarks

The economic consequences of the withdrawal of the United Kingdom from the European Union (Brexit) can currently only be determined approximately, as the concrete form of the Brexit is not clear. In particular, it is unclear how trade will develop between the United Kingdom, which is no longer part of the European Union, and Germany. Both countries have close trade links, with both trade in goods and services earmarked for final demand and trade in intermediate goods being important.¹ According to the Bundesbank's balance of payments statistics, goods and services worth almost 115 billion Euro were exported to the United Kingdom in 2017, accounting for more than seven percent of total German exports. Goods and services worth almost 70 billion Euro were imported, accounting for around five percent of total German imports. While just over half of exports to the United Kingdom are used as intermediate consumption in the production process, the share of imported intermediate consumption in all imports from the United Kingdom is significantly higher at around two thirds. In other words, Germany exports goods and services worth more than 50 billion Euro that are not intended for final demand. Conversely, Germany imports goods and services worth almost 50 billion Euro, which are further processed as inputs in the production process.

While these figures reflect the importance of the two countries as trading partners, they do not provide sufficient information on the importance of the two countries as suppliers of value added to each other. Intermediate inputs from Germany include value added from Germany and value added from upstream stages of the value chain. This (indirect) value added from upstream stages of the value chain is attributed to the intermediate exporter. If a country trades little domestically generated (direct) value added, but serves as a trading platform, its importance for its trading partners is overestimated. If, on the other hand, a country makes (indirect) value-added contributions (at an earlier stage of the value chain) which are included in intermediate exports of another country, the importance of the value-adding country is underestimated. The following is Figure 1 a schematic representation of the wholesale and value-added trade.

¹ Various studies in recent years have addressed the economic impact of Brexit on Germany. Felbermayr et al. (2017) quantified the consequences of Brexit under various assumptions using scenario calculations. Steinhaus et al. (2017) have discussed the possible qualitative consequences of Brexit more strongly. The prospects for the German economy in the case of Brexit were also analysed in the form of surveys (DIHK, 2018; Deloitte, 2016).

Figure 1: Schematic representation of direct and indirect value-added trade between Germany and the United Kingdom



Both countries trade intermediate consumption (Germany = yellow, United Kingdom = blue), which partly includes domestic value added (dark yellow and dark blue) and partly value added from other countries. Some of this domestic value added is delivered directly to the other country, while others are initially delivered to a third country and from there on to the destination country. The first case (direct trade) is direct value added. In the second case, value added is traded indirectly.

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The amount of value added traded directly and indirectly between Germany and the United Kingdom is of considerable importance in real economic terms. In the case of low value-added trade, there are hardly any mutual dependencies. The upstream value-added processes take place elsewhere and wholesale trade can be outsourced to other countries. With a pronounced value-added trade, the mutual dependency is high. Trade barriers between the United Kingdom and Germany and between the United Kingdom and the European Union have a massive impact on the production of both countries in this case. Companies would have to find alternative value-added suppliers in the event of trade restrictions.

The purpose of this short study is to shed light on the value-added trade between Germany and the United Kingdom for the year 2017 at the macroeconomic level as well as at the industry level. Chapter 2 focuses on value-added imports from the United Kingdom to Germany, Chapter 3 looks at value-added exports from Germany to the United Kingdom. The focus here is on trading with value

added, while trading with inputs is essentially used as a benchmark. Trade in value added (and intermediate consumption) between Germany and the United Kingdom is dealt with from four perspectives:

- Value-added imports from German industries from the United Kingdom as a whole (Figure 2)
- Total value-added imports by Germany from United Kingdom industries (Figure 3)
- Total value-added exports from German industries to the United Kingdom (Figure 4)
- Total value-added exports of Germany in United Kingdom industries (Figure 5)

Chapter 4 summarises the value-added links (import and export activity) and shows the industries with the strongest value-added links in Germany and the United Kingdom with the other country. Building on this, chapter 5 of the report examines the extent to which industry sectors in Germany are dependent on the United Kingdom and vice versa. The results on value-added trade are used to visualise the intensity of interdependence and to identify which industries in Germany and the United Kingdom would potentially be most affected by trade restrictions. For the United Kingdom, value-added trade with the European Union is also just a topic of discussion.

i

Methodological approach to the calculation of value-added trade for the year 2017

The production of goods and services is increasingly taking place in different countries, each of which contributes to the value added of final production. Trade in value added has intensified accordingly. Classical bilateral trade statistics, however, only show the value of a "final" traded good or service. The origin of the value added contained therein is completely credited to the last intermediate exporter.

In order to explicitly record and quantify value-added trade, Multiregional Input-Output Tables (MRIO) such as World-Input-Output Tables (WIOT) are required. These include data on intermediate trade between 56 industries in a total of 43 countries as well as the "rest of the world". This rest of the world is a hypothetical country that takes into account the trade flows of all countries not explicitly included in WIOT.

For each industry i in each country j , the intermediate consumption necessary for the production of this industry from all other countries and the final demand for the products of this industry i are listed. Final demand comprises foreign and domestic demand for each industry in each country.

However, trade in intermediate consumption does not allow conclusions to be drawn about the contribution of an industry i in a country j to (foreign and domestic) final demand. The WIOT does include value-added contributions of each industry in each country to production in that country. However, these also include value-added contributions to foreign production: One industry produces inputs that are used in other industries and countries.

In order to calculate the value-added contributions of an industry to the production of an industry or a country intended for final demand, various calculation steps must therefore

be carried out. A detailed description of these steps is documented in Los et al. (2015). The procedure uses the matrix structure of the WIOT. As a result, the value-added contribution of each industry i in each country j to the output of an industry or a country planned for final demand can be given.

Data from the World Input-Output Database (WIOD) comprehensively map the trade structure at industry level, but are only available until 2014. To illustrate the importance of value-added trade between Germany and the United Kingdom with current data, the structure given in WIOD for 2014 is transferred to official data for 2017. While official data on trade in goods are collected by the Federal Statistical Office, data on trade in services are only available within the framework of the balance of payments statistics of the Deutsche Bundesbank.

2 German imports from the United Kingdom

In 2017, industries in Germany imported nearly 35 billion Euro worth of value added from the United Kingdom for their final-demand production. In comparison, intermediate imports were significantly higher at almost 50 billion Euro.² Accordingly, imported intermediate consumption only partly includes value added from the United Kingdom. The most important German recipient industries of value added from the United Kingdom were motor vehicle construction, mechanical engineering, construction and the food products industry (Figure 2).³ It is striking that the construction and food products industries imported significantly more value added from the United Kingdom than the figures for intermediate imports suggest. Value added from the United Kingdom was therefore not only supplied to these industries directly through the import of intermediate goods, but to a large extent indirectly through third countries. The opposite was the case, for example, in the chemicals industry: Value-added imports worth less than 1 billion Euro are offset by intermediate imports worth around 3.5 billion Euro. In addition to the chemicals industry, the metals industry, other vehicle construction and the rubber and plastics industry also imported significantly less value added from the United Kingdom than was suggested by intermediate consumption. Intermediate supplies from the United Kingdom to the chemical industry and the metal production and processing industry in Germany each include more than 2.5 billion Euro of value added from other countries.

At the macroeconomic level, service industries in Germany accounted for almost half of total value-added exports to the United Kingdom. Looking at intermediate consumption exports to the United Kingdom, the contribution of services was around one third. Industry in Germany accounted for slightly more than half of value-added exports in 2017 and for just under two thirds of intermediate exports to the United Kingdom. For the agricultural industry, the share of value-added and intermediate exports was around 1 percent each.⁴

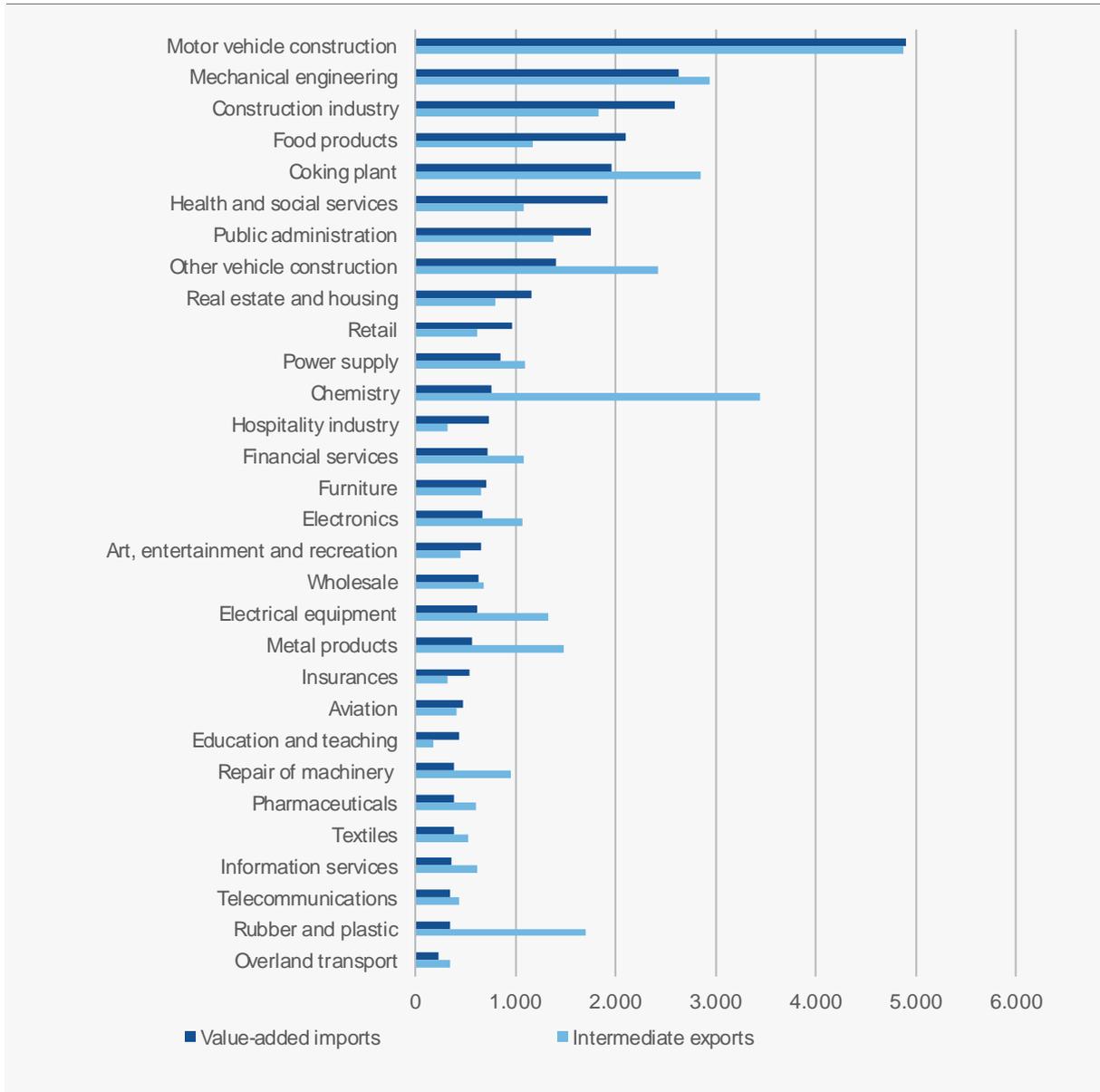
² The short study uses the terms export and import throughout from the perspective of the German economy. Imports are always flows of goods or services from the United Kingdom to Germany, exports are always flows of goods and services from Germany to the United Kingdom. Technically, imports (exports) from the United Kingdom to Germany are identical to exports (imports) from Germany to the United Kingdom.

³ A list of the industry abbreviations used in this brief study can be found in Table 1 the appendix.

⁴ The low importance of the agricultural industry also applies to the following calculations. The agricultural industry is therefore not explicitly mentioned.

Figure 2: Value-added and intermediate imports of German industries from the United Kingdom, in millions of Euro, 2017

30 industries of the German economy with the highest values of value-added imports from the United Kingdom, sorted in descending order by value-added imports



WIOD, own calculations © Prognos 2019

The value-added imports of German industries from the United Kingdom correspond, in reverse, to the value-added exports from UK industries to Germany. Value added imported by Germany from

the United Kingdom in 2017 comes mainly from service industries such as wholesale trade, legal and tax advice, other economic services and financial and information services (Figure 3).⁵

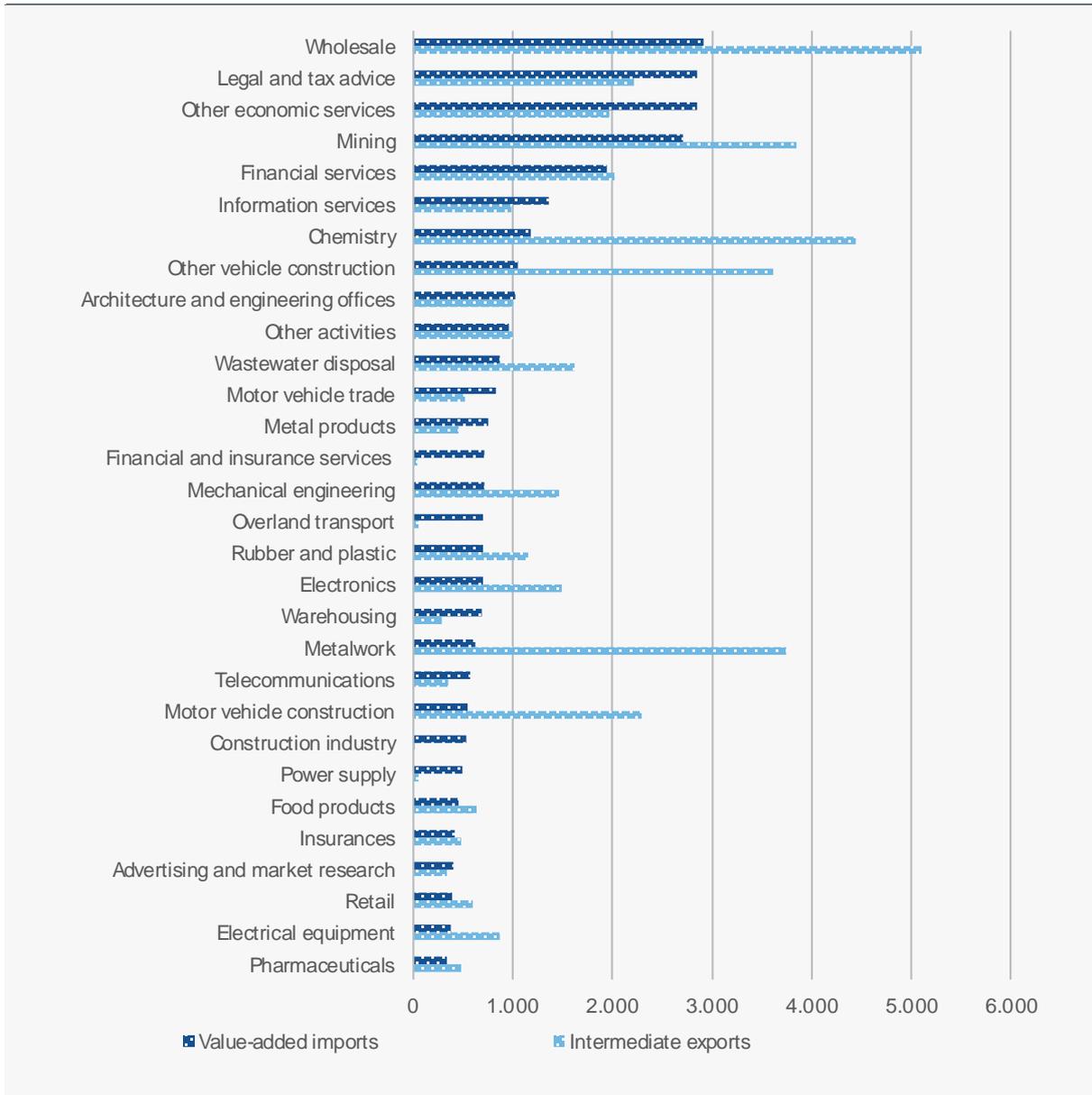
The chemical, motor vehicle construction, other vehicle construction, metalworking and mining industries in the United Kingdom delivered substantial value added to Germany in 2017, albeit significantly less than the advance deliveries to Germany would suggest. Conversely, some service industries, such as other economic services, financial and insurance services, legal and tax advice and overland transport, show a higher value of value-added deliveries compared to intermediate supplies to Germany. Accordingly, a substantial contribution to value added from these industries was delivered to Germany via intermediate inputs from third countries.

At the sectoral level, around two thirds of value-added imports from the United Kingdom come from services and around one third from industry. In contrast, just under 60 percent of intermediate imports come from industry in the United Kingdom and a good third from the service industry. Here, too, the importance of service industries for the bilateral trade analysis with data on wholesale trade is underestimated.

⁵ In order to make it clear whether value-added and intermediate trade is represented for industries of the German economy or the United Kingdom, the figures show industries of the German economy (Figure 2 and Figure 4) as flat and industries of the United Kingdom (Figure 3 and Figure 5) as dotted lines. This distinguishing feature is taken up in Figures 6 and 7.

Figure 3: Value-added imports and intermediate goods by Germany from United Kingdom industries, in million Euro, 2017

30 industries of the United Kingdom with the highest values of value-added imports to Germany, sorted by value of value-added imports in descending order



WIOD, own calculations © Prognos 2019

3 German exports to the United Kingdom

In 2017, the value of value-added exports from Germany to the United Kingdom (for the final-demand production planned there) was a good 50 billion Euro, well below the value of intermediate exports at just under 70 billion Euro. The most important value-added exporters from the German economy to the United Kingdom were companies in the industries of other economic services, wholesale trade, pharmaceuticals, motor vehicle construction and chemicals (Figure 4).

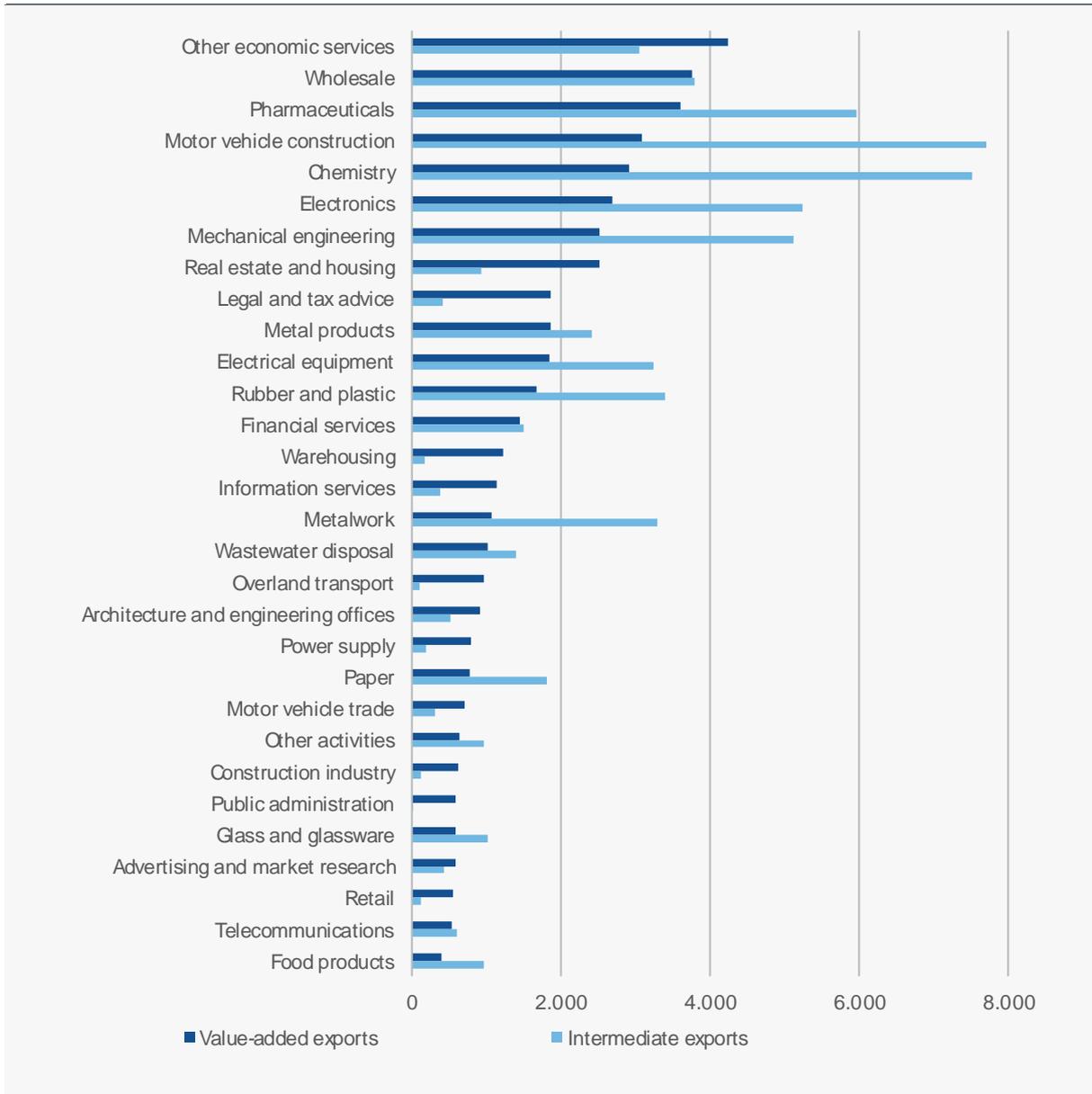
As with value-added imports, there is also a clear discrepancy between value-added exports of the German economy and the value of intermediate exports. Services such as real estate and housing, legal and tax advice and other economic services exported significantly more value added to the United Kingdom than intermediate exports. German industry sectors such as motor vehicle construction, chemicals and mechanical engineering exported large amounts of intermediate consumption to the United Kingdom. However, only a (small) part of this is value added generated and exported in the respective German industry. For example, in motor vehicle construction and in the chemical industry, around 4.5 billion Euro each of the intermediate inputs exported to the United Kingdom do not come from Germany.

In services such as real estate and housing, legal and tax advice, warehousing and information services, the value of value added exported in 2017 was significantly higher than the value of intermediate consumption exported to the United Kingdom. Substantial value added from these industries was therefore supplied to the United Kingdom via intermediate consumption from third countries.

In 2017, industry exported about three quarters of the total intermediate consumption exported to the United Kingdom, and the services industry about a quarter. The picture shifts when looking at value-added exports. Industry exported just under half of the value added exported, while the services industry exported slightly more than half.

Figure 4: Value-added and intermediate exports from German industries to the United Kingdom, in millions of Euro, 2017

30 industries of the German economy with the highest values of value-added exports, sorted by value of value-added exports in descending order



WIOD, own calculations © Prognos 2019

While in 2017 just over half of the value added to the United Kingdom was supplied by industry sectors in Germany, it was mainly services industries in the United Kingdom that used these value-added exports by Germany to the United Kingdom for final-demand production (Figure 5). By far the most important recipient of German value added is the health and social services industry. Value added from Germany to the value of more than 10 billion Euro is demanded from this industry and

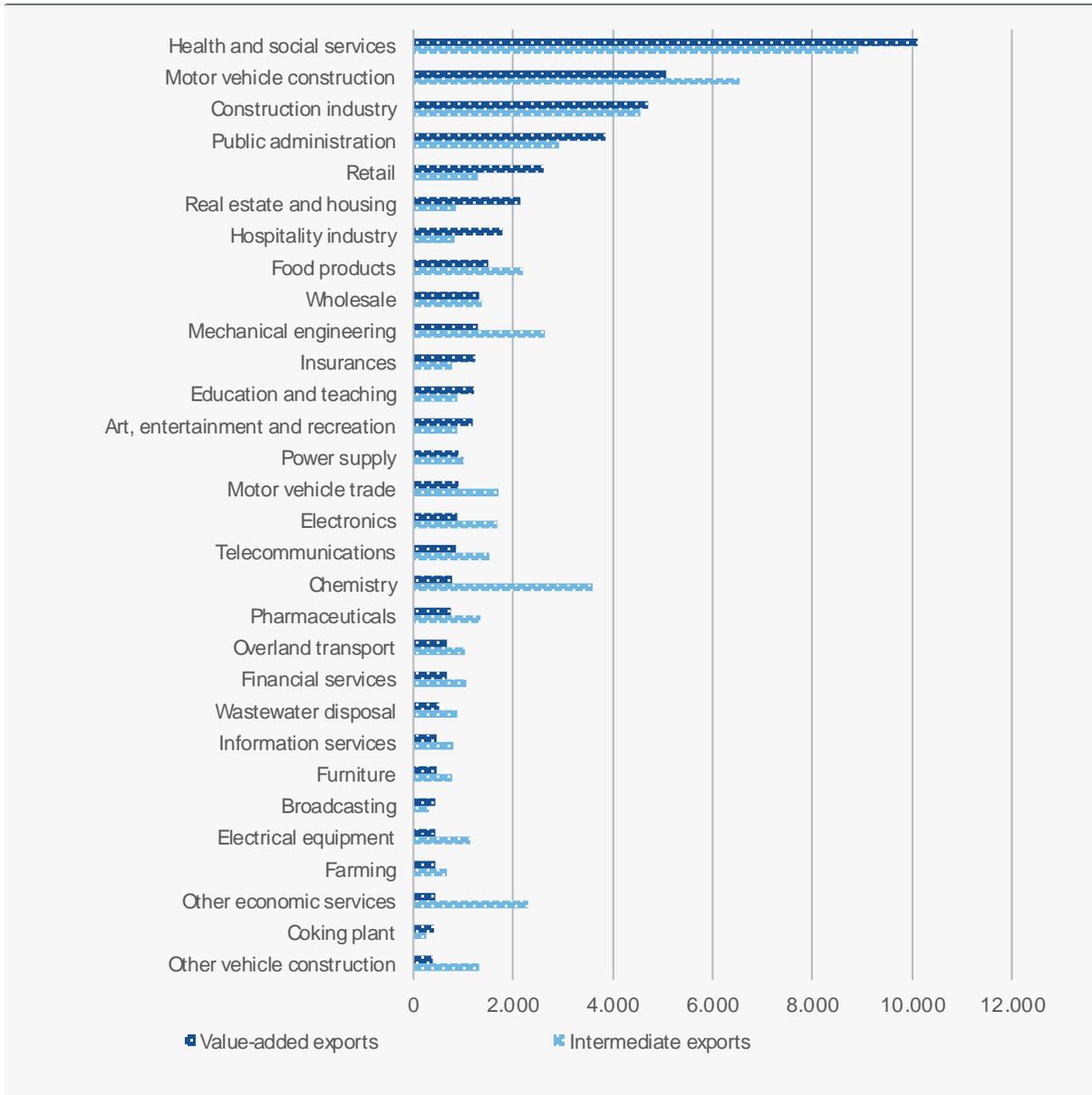
used for the final-demand production. In addition to motor vehicle construction and the construction industry, the service industries of public administration, retail trade, real estate and housing as well as the hospitality industry are other important customers for value added from Germany.

Particularly in the United Kingdom's industry sectors of chemicals, metal production and processing, rubber and plastics and motor vehicle construction, the intermediate inputs supplied from Germany accounted for only part of German value added. In 2017, for example, just under 3.6 billion Euro in advance payments were made from Germany to the chemicals industry in the United Kingdom. These intermediate inputs, however, included value added of just under 800 million Euro generated in Germany. On the other hand, value added from Germany was much more important than suggested by the value of intermediate consumption in service industries in the United Kingdom such as retail trade, real estate and housing, health and social services, hospitality, and public administration. In these industries, value added flows indirectly from Germany to the United Kingdom via third countries.

There is also a clear discrepancy between the value of intermediate consumption and value added in industry and services for the recipient industries of exports from Germany in the United Kingdom. While in 2017 slightly more than half of the recipient industries of intermediate exports from Germany belonged to the services industry, it is only slightly more than a quarter when looking at value-added exports. In the service industries, the share of intermediate consumption received was slightly more than half; it rises to around three quarters when value-added exports from Germany are considered.

Figure 5: Value-added and intermediate exports by Germany to United Kingdom industries, in million Euro, 2017

30 industries of the United Kingdom with the highest values of value-added imports from Germany, sorted by value of value-added imports in descending order



WIOD, own calculations © Prognos AG, 2019

4 Industries with the strongest value interdependence

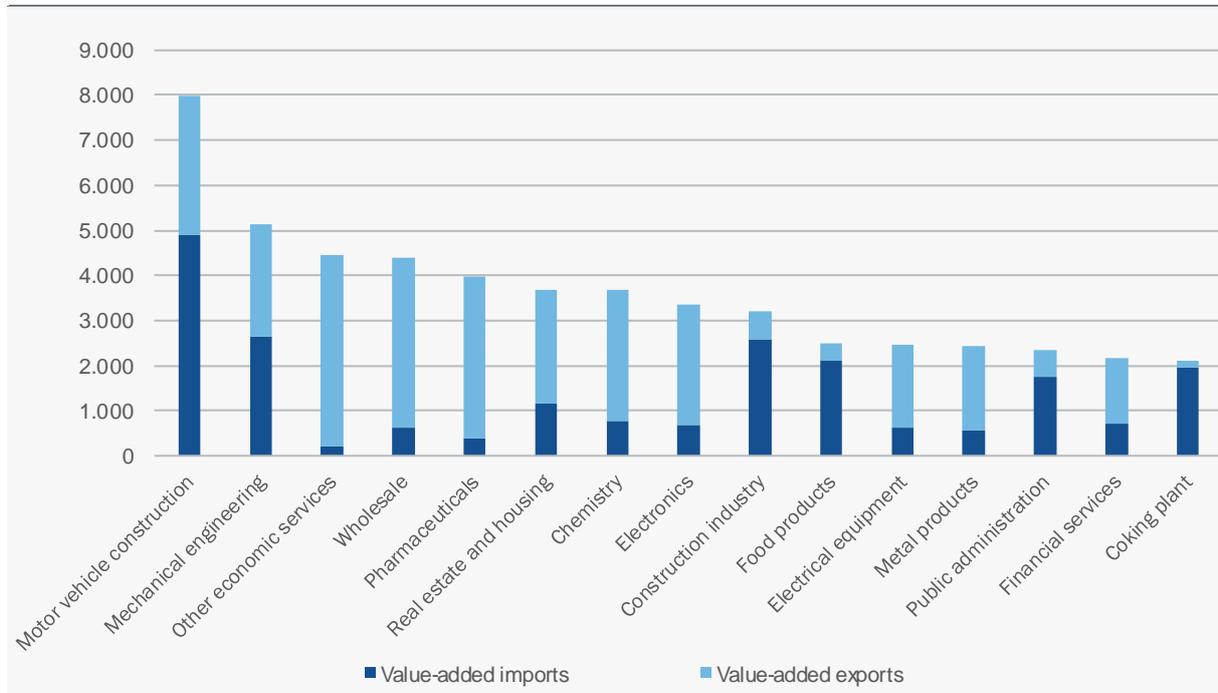
The value of the value-added trade between Germany and the United Kingdom allows conclusions to be drawn for all industries in both countries about the real economic links between the two countries. This shows that, from the point of view of the German economy, motor vehicle construction and mechanical engineering have the strongest value-added links with the United Kingdom. In 2017, motor vehicle construction in Germany imported nearly 5 billion Euro in value added from the United Kingdom and exported over 3 billion Euro in value added (Figure 6). Similar to mechanical engineering, which imported value added worth just under EUR 3 billion and exported value added worth around EUR 2.5 billion in return. Compared with the absolute values of the interdependencies of inputs, these and some other industries are losing considerable importance, including the chemical and electrical industries. Other industries such as construction, food products, real estate and housing are gaining in importance.

Some industries of the German economy, such as wholesale trade, the pharmaceutical industry, real estate and housing or the chemical industry, are essentially linked to the United Kingdom via value-added exports. Others such as the food products industry, public administration or the coking plant are heavily dependent on value-added imports from the UK.

At the sectoral level, a look at value-added trade shows that imports and exports of intermediate goods clearly overestimate the importance of industry. Only a good 50 percent of the value-added trade is generated by industry of the German industry. By contrast, the contribution to wholesale trade amounts to a good 70 percent. This loss of importance of industry from the value added perspective is offset by an increase in the importance of services. Almost half of the value added traded is imported or exported by service industries in Germany.

Figure 6: Value-added trade with the United Kingdom from the point of view of German industry, in millions of Euro, 2017

15 industries of the German economy with the highest values of value-added trade (aggregated value-added imports and exports) with the United Kingdom, sorted in descending order by value of total value-added trade



Imports and value-added exports from the point of view of the industries of the German economy. The values are identical to those in the Figure 2 and Figure 4.

WIOD, own calculations © Prognos 2019

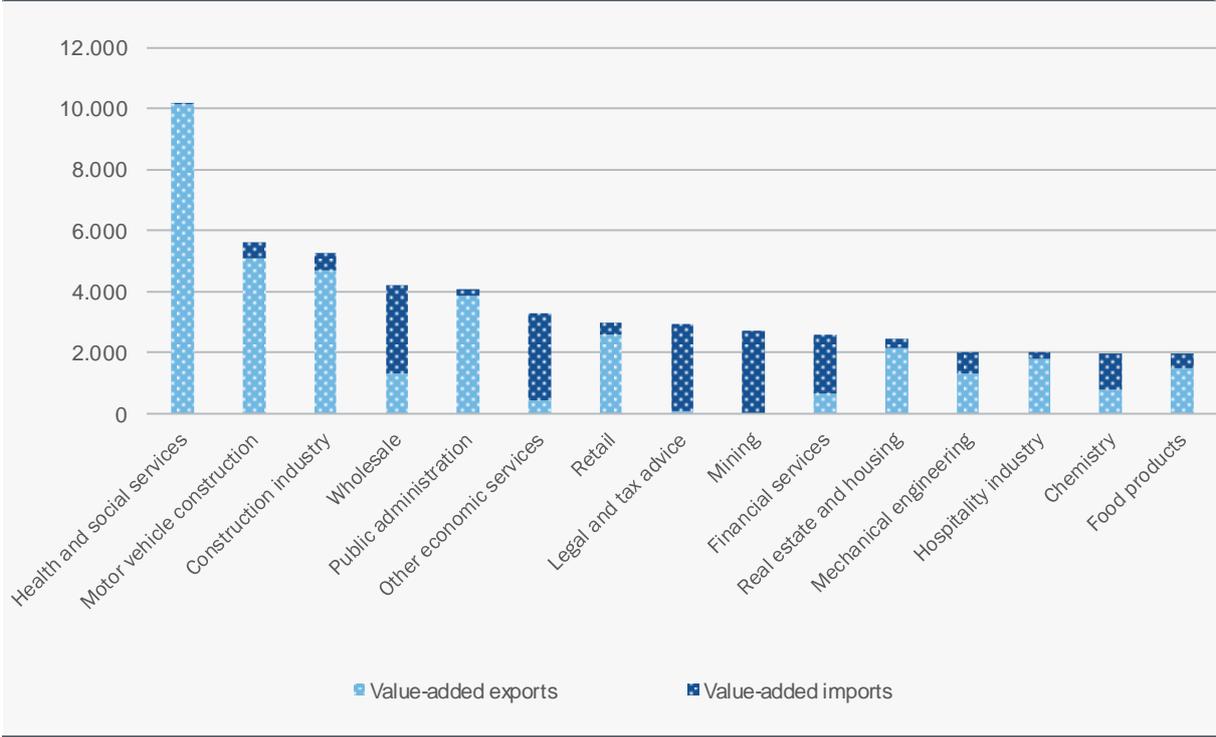
From the point of view of the United Kingdom, the health and social services system is heavily dependent on value-added exports from Germany. In 2017, more than 10 billion Euro of value added was delivered to this industry in the United Kingdom. Motor vehicle construction, the construction industry and the retail trade are also highly dependent on value-added exports from Germany (Figure 7). Imports of value-added from the wholesale trade, other economic services, legal and tax advice and financial services industries of the United Kingdom are particularly important for the final-demand production of the German economy. Compared to the wholesale values traded, the chemical industry is far less significant if the focus is on value-added trade. The motor vehicle construction, mining and wholesale industries are also losing weight as a result of this perspective. Conversely, health and social services, construction and real estate and housing are more central from a value-added perspective compared with the value of intermediate trade.

The industry sectors of the United Kingdom also show a loss of importance if value-added trade is considered instead of intermediate trade with Germany. Just under 50 percent of the intermediate consumption traded between Germany and the United Kingdom is imported or exported by industry sectors in the United Kingdom. On the other hand, the contribution of industry in the United Kingdom to value-added trade with Germany is only just under 30 percent. In the United Kingdom, the services industry is gaining significantly in importance through the value-added perspective. Around

70 percent of the total value added traded between the two countries goes into or comes from UK service industries.

Figure 7: Value-added trade between Germany and the United Kingdom from the point of view of United Kingdom industries, in million Euro, 2017

15 United Kingdom industries with the highest values of value-added exports from Germany to the United Kingdom and value-added imports from Germany to the United Kingdom, sorted by value of total value-added trade in descending order



Imports and value-added exports from the perspective of the German economy. Value-added exports are exports from Germany to industries in the United Kingdom, value-added imports are imports from Germany to industries in the United Kingdom. The values are identical to those in the Figure 3 and Figure 5.

WIOD, own calculations © Prognos 2019

5 Potential impact of Brexit on industries

The analysis to date has revealed the extent of value links between the United Kingdom and Germany at sectoral level. The focus was on the absolute value of the value added traded. In order to determine how strongly an industry would potentially be influenced by Brexit, it is necessary to consider not only the absolute value-added trade but also the value-added trade relative to the total value added generated, the importance of value-added trade for the final-demand production in both countries as well as the final demand trade between both countries, in each case at industry level. The following section analyses, first for Germany (section 5.1) and then for the United Kingdom (section 5.2), which industries would potentially be strongly affected by Brexit. The basis for this is the consideration of three variables.

1. The value-added share from imports in domestic final-demand production at industry level(*share of value-added imports*)
2. The share of exported value added in domestic value added(*share of value-added exports*)
3. The share of final demand exports in total final demand exports(*share of final demand exports*)

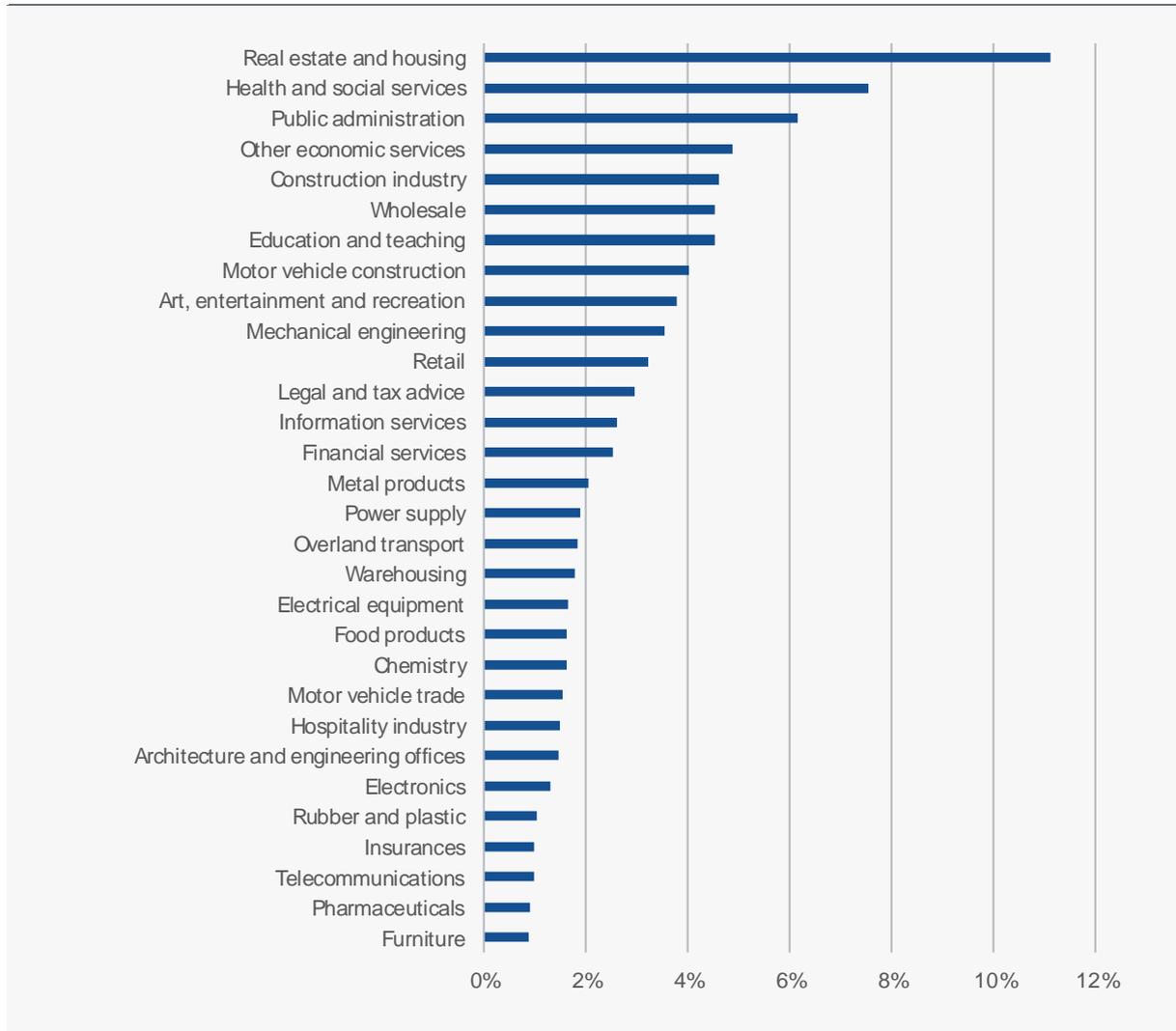
All three measures show the importance of the United Kingdom (Germany) for the value added and production performance of each industry of the German economy (the United Kingdom) from different perspectives. The basis for this consideration is the economic structure of 2014 given in WIOD, which is assumed to be kept constant until 2017.

5.1 Industries of the German economy

Almost one-third of the value added in Germany in 2017 was generated in industry sectors and the construction industry as well as in the energy and water supply and waste water disposal industries. Nearly 70 percent of the value added was generated in service industries, less than 1 percent in agriculture, forestry and fishing. The most important industry in terms of value-added share was real estate and housing, which accounted for a good 11 percent of total value added (Figure 8). This is followed by the health and social services, public administration, other economic services and construction industries. Motor vehicle construction and mechanical engineering also made substantial contributions to value added with 4 percent and 3.5 percent, respectively.

Figure 8: Industry share in the value-added generated in Germany, in percent, 2017

30 industries of the German economy with the highest value-added share



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Importance of value added imported from the United Kingdom for final-demand production in Germany(*share of value-added imports*)

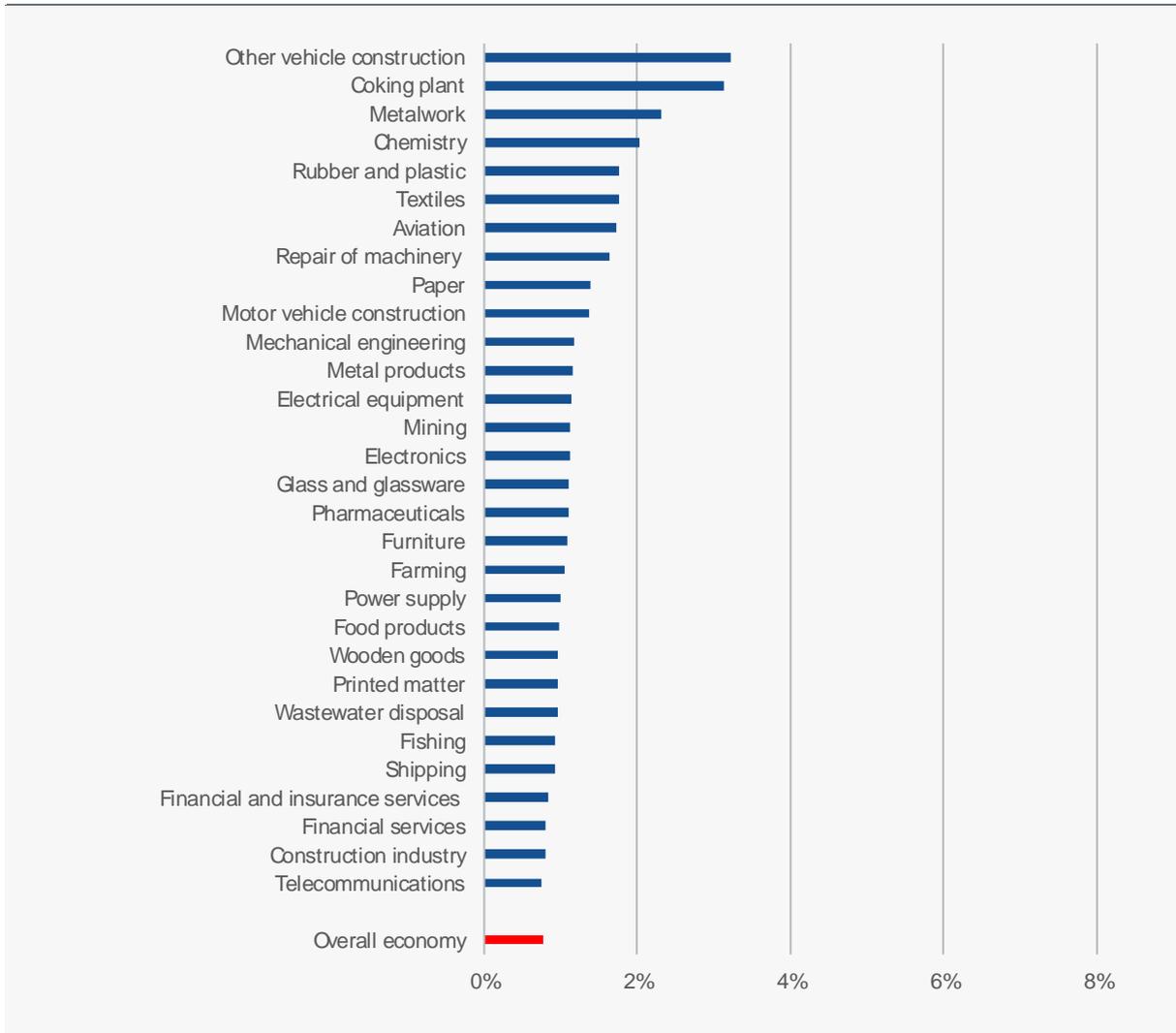
The dependency of domestic production on the United Kingdom is measured by the value added from the United Kingdom contained in final-demand products manufactured domestically. The more an industry depends on value-added imports from the United Kingdom, the greater its dependency.⁶ In total, value-added imports from the United Kingdom account for around 0.8 percent of final-demand produced in Germany. While the motor vehicle construction and mechanical engineering industries import the most value-added from the United Kingdom in absolute terms, the relative importance of imported value-added from the United Kingdom is greatest in the production of other vehicle construction, coking plants and metalworking. The UK's value-added share in these industries is between 2.3 and 3.2 percent (Figure 9).⁷ In the construction industry, which imports the third most value added from the United Kingdom after mechanical engineering and motor vehicle construction, the United Kingdom's contribution to final-demand production in Germany is only 0.8 percent.

⁶ Value-added imports cannot be easily substituted. According to the concept of vertical specialization (see for example Johnson, 2012 or Yi, 2003) companies specialize in certain production steps. With the actual value-added imports, the "special knowledge" for the execution of a certain production step imported in this way also disappears.

⁷ The scaling of the identical figures in this chapter, once from a German perspective and once from the perspective of the United Kingdom, is identical so that the figures can be directly compared.

Figure 9: Value-added contribution of the United Kingdom to the final-demand production of the industries in Germany, in percent, 2017

30 industries of the German economy with the highest value-added share from the United Kingdom in final-demand production and value for the overall economy



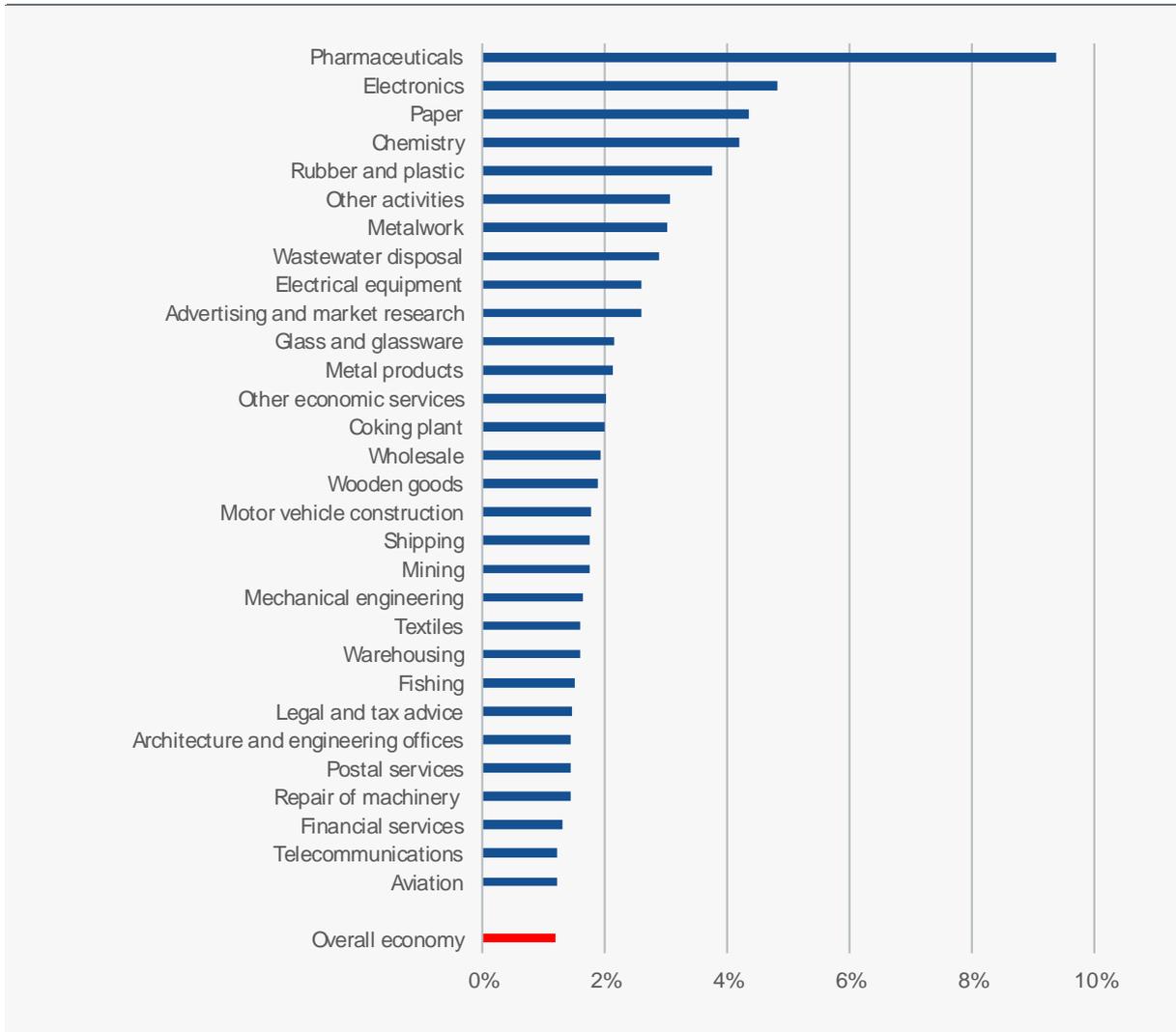
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Share of value added exported to the United Kingdom in domestic value added (*share of value-added exports*)

The value-added share generated in Germany which is exported to the United Kingdom and fed into final-demand production there shows the importance of the United Kingdom as a destination for domestic value added. For Germany as a whole, the value-added share exported to the United Kingdom as a proportion of domestic value added is 1.2 percent. The United Kingdom is of the greatest importance as a sales market for value added generated in Germany for the pharmaceutical industry. Almost 10 percent of the value added generated in Germany in this industry flows into the final-demand production in the United Kingdom (Figure 10). Electronics, paper, chemicals, rubber and plastics also export a substantial part of the domestic value added to the United Kingdom.

Figure 10: Share of value added exported to the United Kingdom in the value added generated in the industries in Germany, in percent, 2017

30 industries of the German economy with the highest share of value-added exports to the United Kingdom and value for the overall economy



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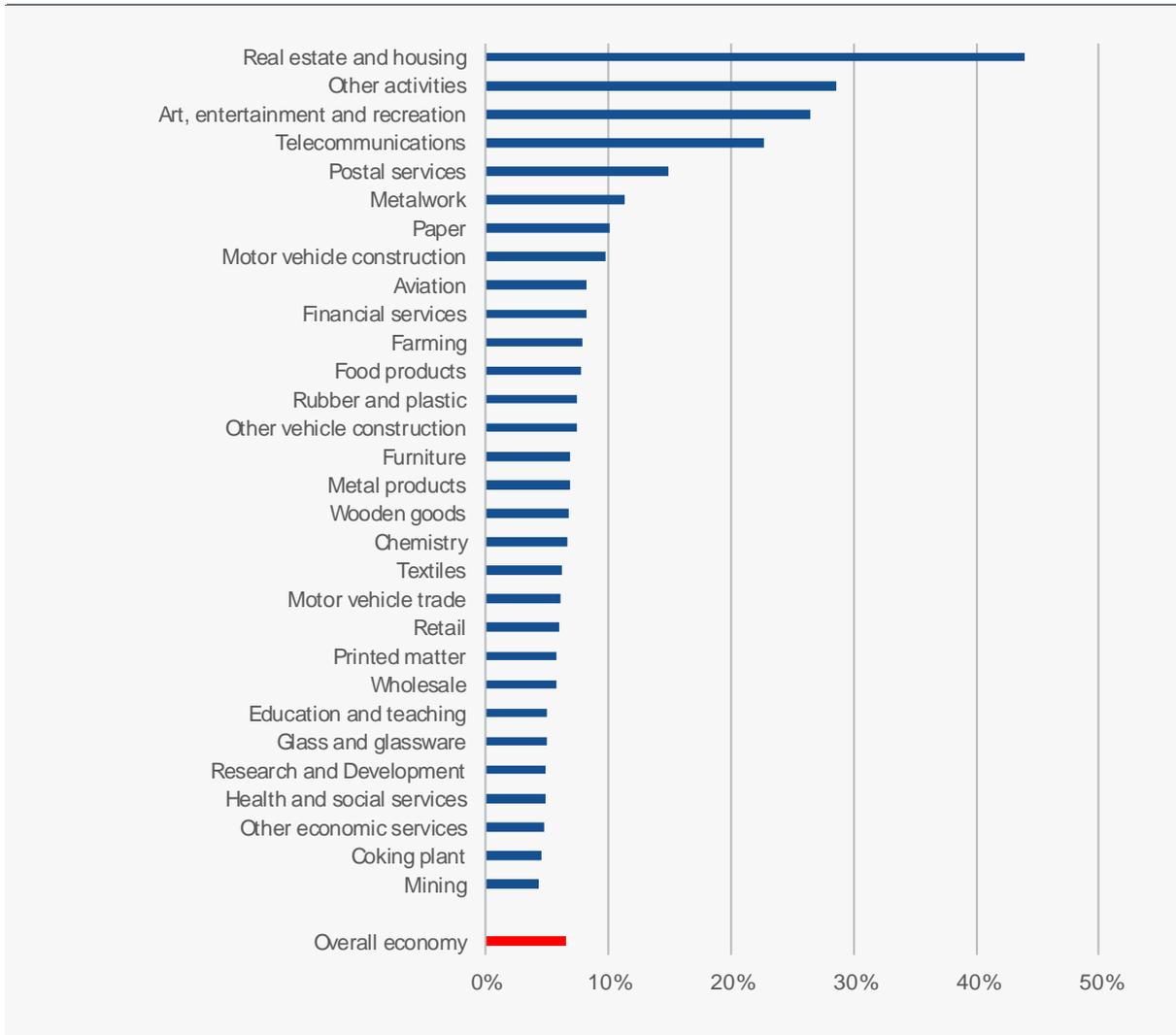
Share of the United Kingdom as destination country for exports of final-demand products from Germany(*share of final demand exports*)

Not only goods and services used in the production process are traded. The export of finished goods and services is also an indicator of the importance of the United Kingdom as a destination for exports from German industries. In absolute terms, goods from the motor vehicle construction, mechanical engineering and food products industries are the most important export items of the German economy, both globally and to the United Kingdom.⁸ Relative to total final demand exports, the German economy recently supplied just under 7 percent of final demand exports to the United Kingdom (Figure 11). Services such as real estate and housing, other activities, arts, entertainment and recreation and telecommunications export more than 20 percent of their total final demand to the UK. Also more than 10 percent of final demand exports to the United Kingdom come from the postal service, metalworking, paper and motor vehicle construction industries.

⁸ The final demand exported from Germany also includes value added from the United Kingdom and other countries.

Figure 11: Share of final-demand production exported to the United Kingdom in total final-demand production exported, in percent, 2017

30 industries of the German economy with the highest share of the United Kingdom as target country for final demand exports and value for the overall economy



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Intensity of dependency of German industries on the United Kingdom

The three industry rankings to illustrate the dependency of German industries on the United Kingdom and thus the potential impact of Brexit do not show a uniform picture. For example, while a significant part of final demand exports from the real estate and housing industry goes to the United Kingdom, the other two figures indicate that the United Kingdom is not highly relevant to this industry. In order to illustrate the potential impact of Brexit on industries of the German economy, the three individual aspects are combined to form an index. This index of the intensity of the dependency decreases can take values between 0 and 10, whereby higher values indicate a higher intensity of the dependency. The index consists equally weighted of the three individual components shown

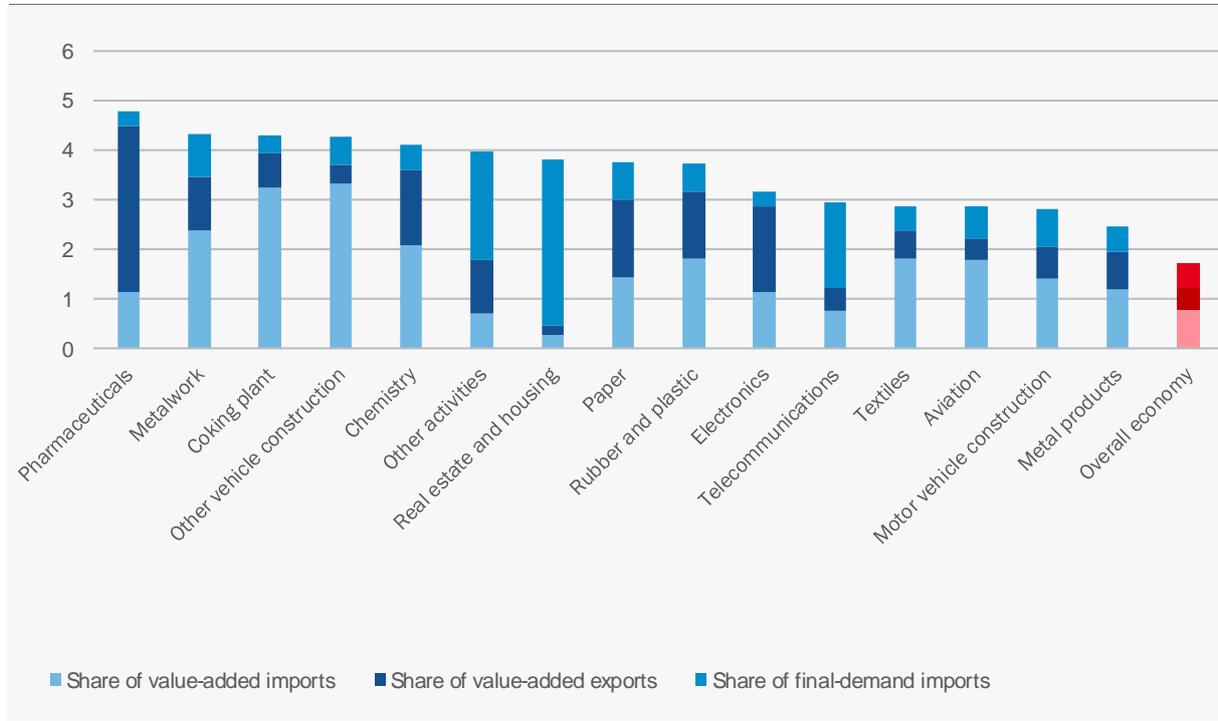
in Figures 8-10.⁹ The index shows the intensity of UK dependency relative to sectoral value added and production.

According to this index, the German pharmaceutical, metalworking, coking plant and other vehicle construction industries would potentially be most affected by Brexit (Figure 12). While the value-added share exported to the United Kingdom is particularly important in the pharmaceutical industry, metalworking, coking plants and other vehicle construction are heavily dependent on value-added imports from the United Kingdom. The other activities and real estate and housing industries, on the other hand, are increasingly dependent on the United Kingdom as a destination for final demand exports. For the most important industries of the German economy in absolute value-added trade with the United Kingdom, namely motor vehicle construction and mechanical engineering (see Figure 6), on the other hand, Brexit would have only a moderate to minor impact in relative terms.

⁹ Formally, the three index components were calculated according to the formula $x_{ind} = (x - x_{min}) / (x_{max} - x_{min}) * 10/3$ and then added together. The minimum and maximum values are country-specific, i.e. the industry with the highest value for an indicator within a country receives the value 10/3. If cross-country minima and maxima were calculated, slight shifts would result. For example, other vehicle construction in Germany would only be ranked 11th instead of 4th, as this industry would receive only just under half of the total indicator figure of 10/3 for value-added imports. Overall, however, the shifts are manageable. The index values only serve the purpose of comparability between industries within a country. They are not suitable for deriving absolute statements on the potential impact on industries.

Figure 12: Intensity of dependency of German economic industries on trade with the United Kingdom, Index, 2017

15 industries of the German economy with the highest index values, sorted in descending order, as well as value for the overall economy



Value-added imports is an indicator based on the value-added share imported from the United Kingdom in the final-demand production per industry in Germany (see Figure 9). *Value-added exports* is an indicator based on the value-added share exported to the United Kingdom in total domestic value added per industry (Figure 10). *Final demand exports* is an indicator based on the share of final-demand products exported to the United Kingdom in the final-demand exports exported in total (Figure 11).

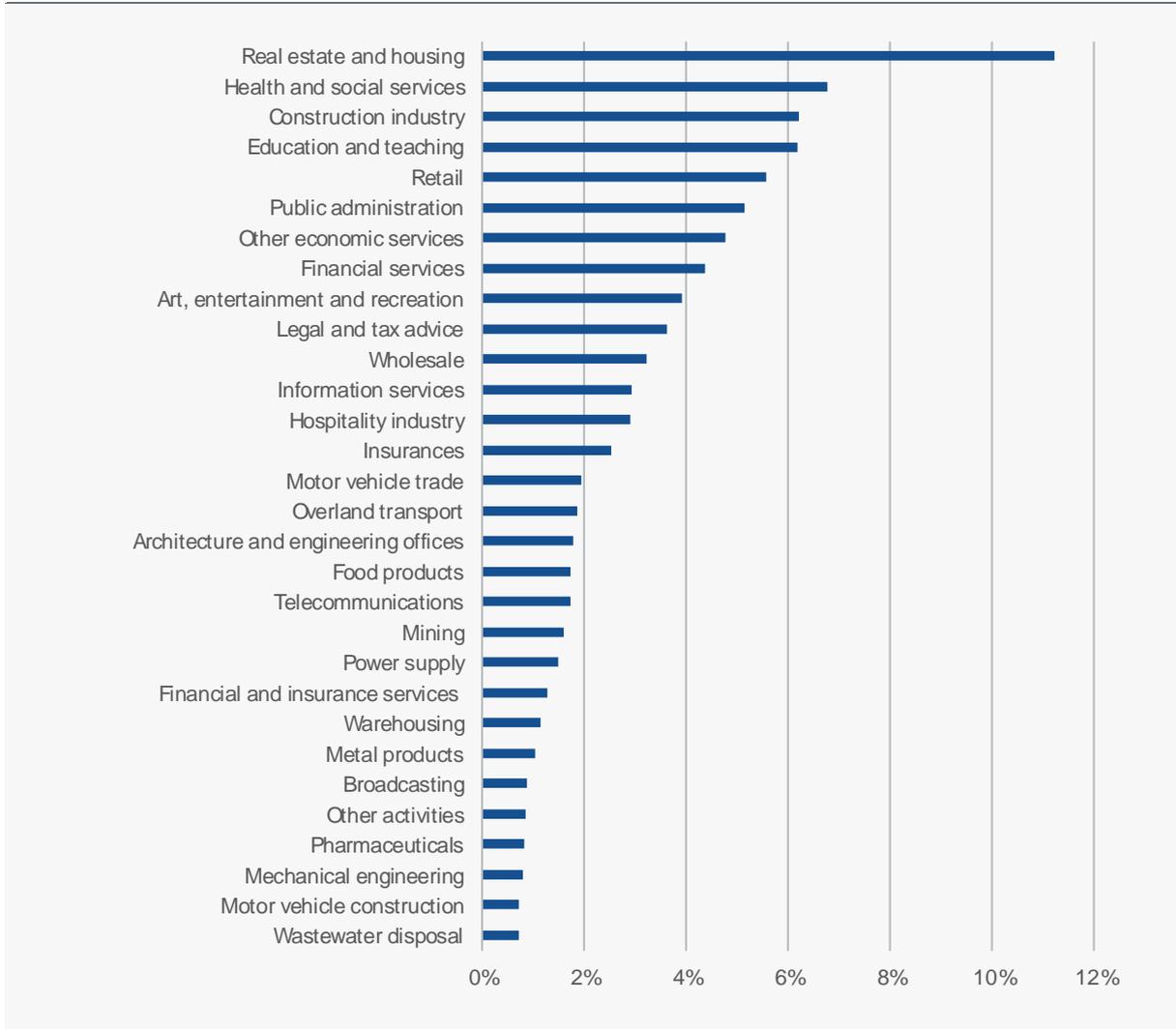
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5.2 Industries in the United Kingdom

In the United Kingdom, industry, construction, energy, water supply and sanitation accounted for almost 20 percent of total value added. Around 2 percent came from agriculture, forestry and fishing. The remaining almost 80 percent was accounted for by service industries. As in Germany, the most important industry from a value-added perspective in the United Kingdom was real estate and housing, closely followed by health and social services. The construction, education and teaching, retail trade and public administration industries each accounted for more than 5 percent of total economic value added. The most important industry sector was the food products industry, which accounted for 1.7 percent of total economic value added.

Figure 13: Industry shares of value added generated in the United Kingdom, in percent, 2017

30 United Kingdom industries with the highest value-added share



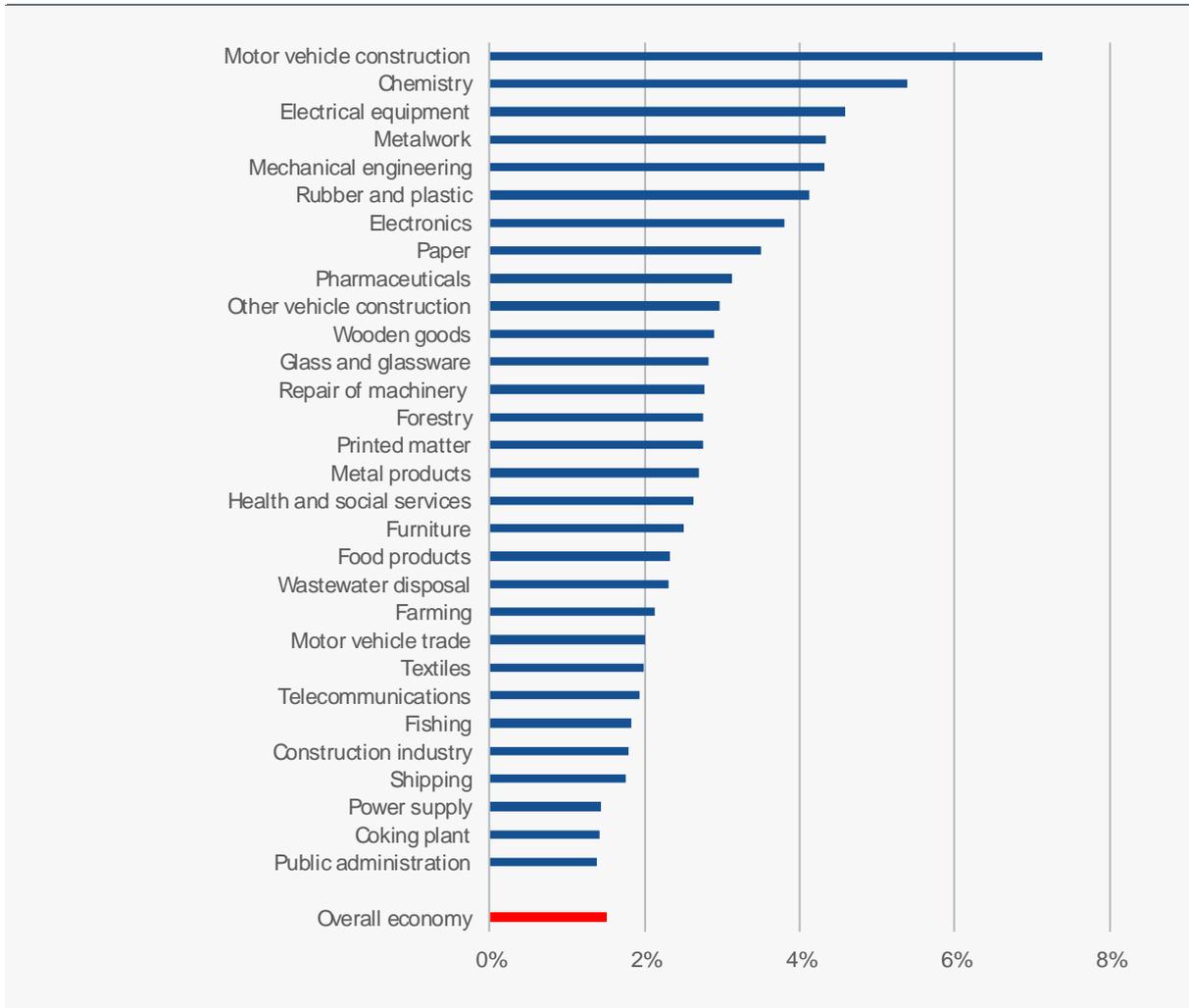
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Importance of value added imported from Germany for final-demand production in the United Kingdom (*share of value-added imports*)

Above all, industry sectors such as motor vehicle construction, chemicals, electrical equipment, metalworking or mechanical engineering are relatively heavily dependent on value-added imports from Germany. In 2017, for example, the value-added share generated in Germany in the final-demand production in motor vehicle construction amounted to more than 7 percent (Figure 14). Overall, value-added imports from Germany are somewhat more important for the United Kingdom than vice versa, with a share of 1.5 percent of final-demand production produced domestically.

Figure 14: Germany's value-added contribution to final-demand production by industry in the United Kingdom, in percent, 2017

30 industries of the United Kingdom with the highest shares of value added from Germany in final-demand production and value for the overall economy



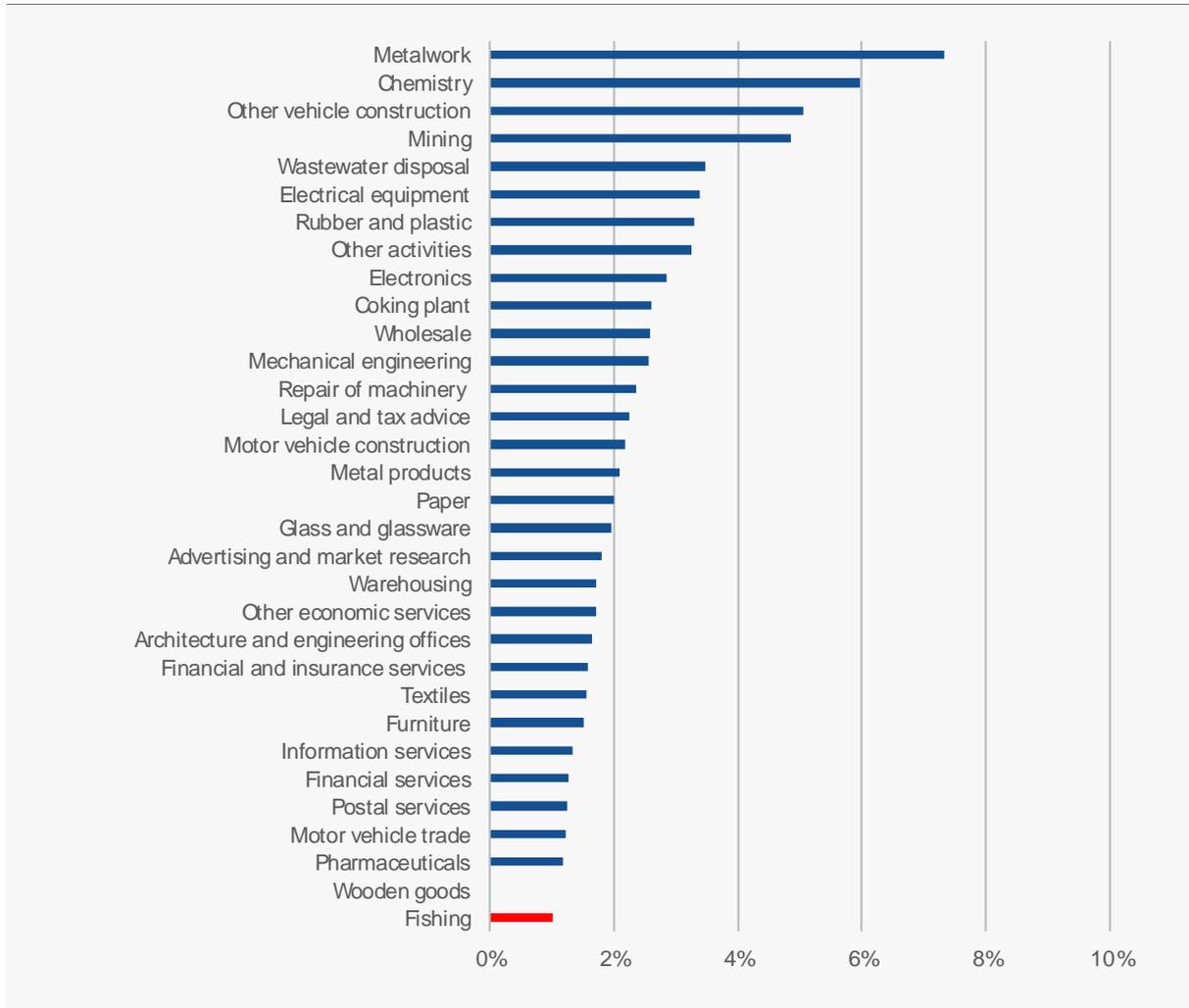
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Share of value added exported to Germany in domestic value added (*share of value-added exports*)

Germany is an important destination for value-added exports from the United Kingdom, particularly for the metalworking, chemicals, other vehicle construction and mining industries. 5 percent or more of the value added generated in these industries is exported to Germany (Figure 15). Around 1 percent of the total value added generated in the United Kingdom is exported to Germany.

Figure 15: Share of value added exported to Germany in the value added generated in the industries in the United Kingdom, in percent, 2017

30 industries of the United Kingdom with the highest share of value-added exports to Germany and value for the overall economy



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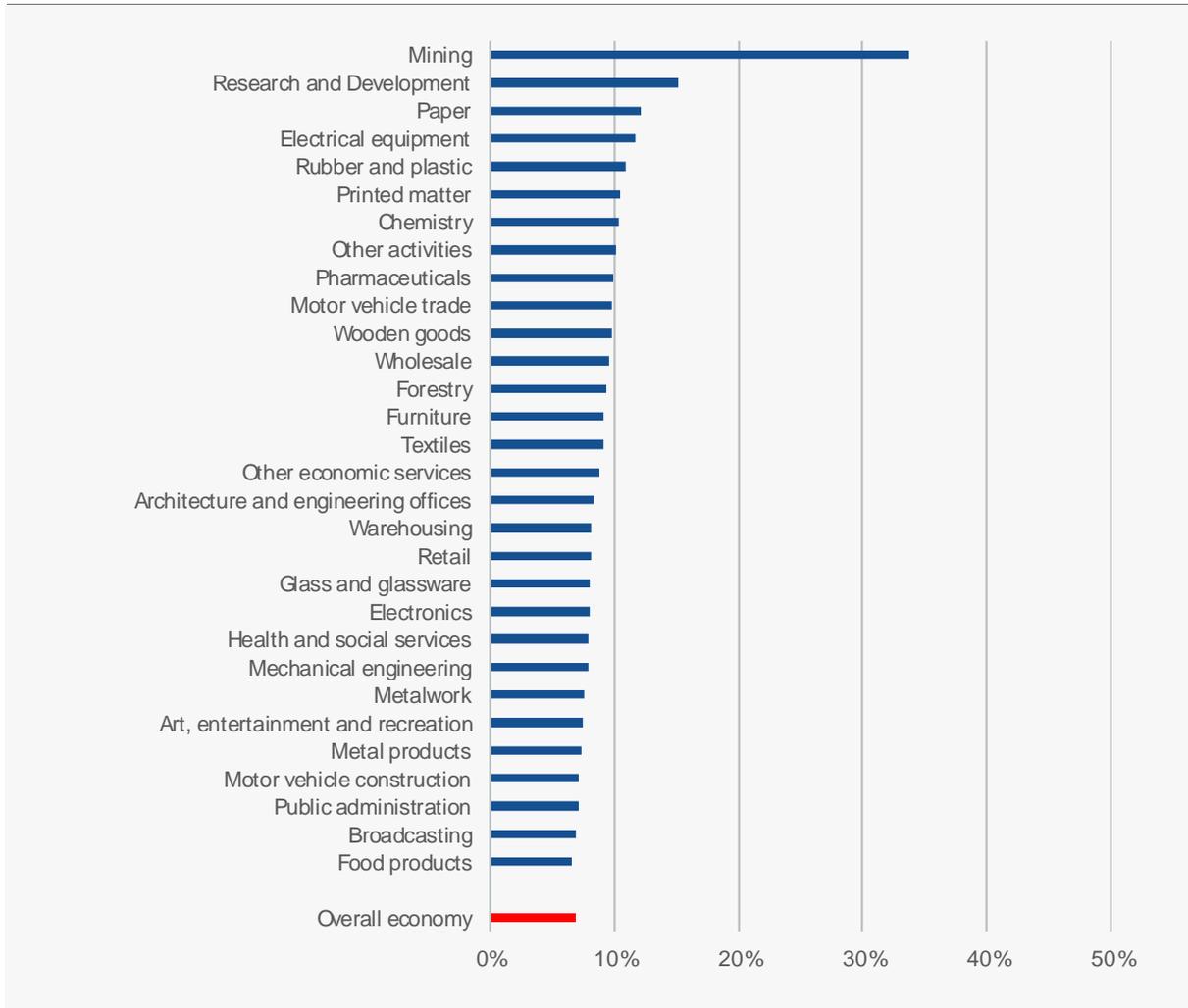
Share of Germany as destination country for exports of final-demand products from the United Kingdom (*share of final demand exports*)

Of the finished goods and services that are exported and supplied to final demand, a large proportion is exported to Germany from the mining and research and development industries as well as from paper (Figure 16).¹⁰ Around one third of the final demand exports of the mining industry from the United Kingdom come from Germany. The figure is still 15 percent from research and development and a good 10 percent from the paper industry. Overall, the United Kingdom exports 7 percent of its final demand exports to Germany.

¹⁰ The final demand exported from the United Kingdom also includes value added from Germany and other countries.

Figure 16: Share of final-demand production exported to Germany in total final-demand production exported, in percent, 2017

30 industries in the United Kingdom with the highest share of Germany as destination country for final demand exports and value for the overall economy



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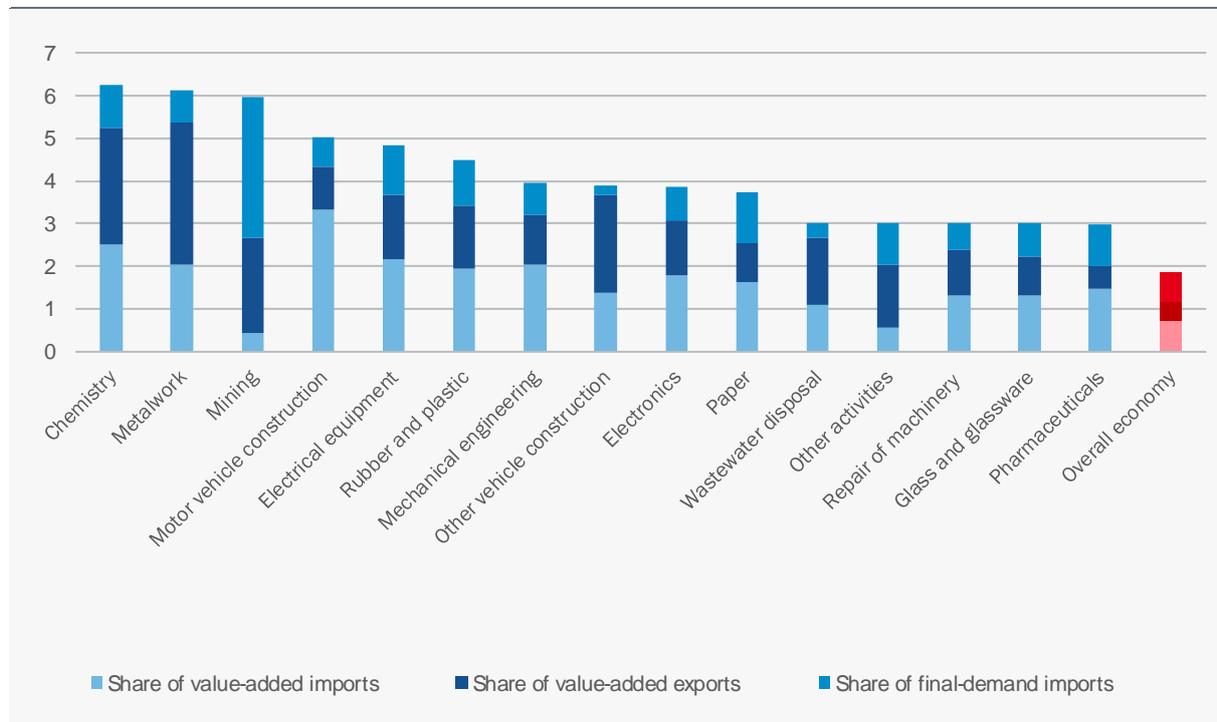
Intensity of dependency of United Kingdom industries on Germany

The rankings for the United Kingdom's industries also show a heterogeneous picture of dependency on Germany. As for Germany (see page - 22 -), the three individual aspects are combined to form an index in order to make visible the potential impact on industries in the United Kingdom. The index shows the intensity of UK dependency relative to sectoral value added and production.

The index assigns a pronounced intensity of dependency on Germany to the chemical, metalworking, mining and motor vehicle construction industries. While the mining industry is heavily dependent on Germany as a destination country for final demand exports, the other three industries are dependent both on value-added imports from Germany and on Germany as an important destination country for value-added exports.

Figure 17: Intensity of dependency of UK industries on trade with Germany, Index, 2017

15 industries in the United Kingdom with the highest index values, sorted in descending order, as well as value for the overall economy



Value-added imports is an indicator based on the value-added share imported from Germany in the final-demand production per industry in the United Kingdom (Figure 14). *Value-added exports* is an indicator based on the value-added share exported to Germany in the total domestic value added per industry (Figure 15). *Final demand exports* is an indicator based on the share of final-demand products exported to Germany in the total final demand exports exported (Figure 16).

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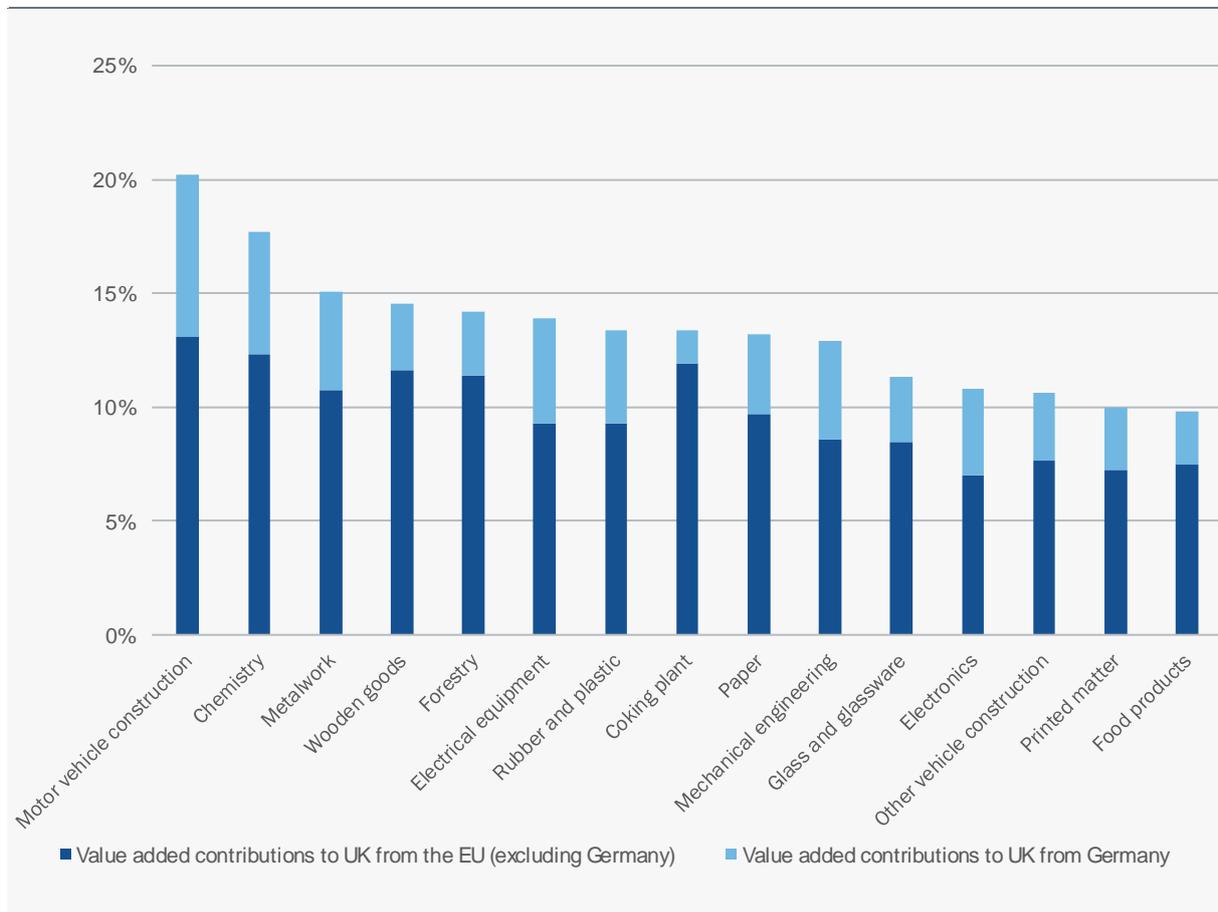
United Kingdom value-added trade with the European Union

From the United Kingdom's perspective, Brexit is likely to affect not only value-added trade with Germany, but with the whole of the European Union. The potential impact of Brexit on industries in the United Kingdom cannot therefore be assessed independently of the extent of value-added trade with the European Union.

Nearly 6 percent of the value added required for final-demand production in the United Kingdom comes from the European Union. Around a quarter of the European Union's value-added contribution to final-demand production in the United Kingdom comes from Germany. The most important are value-added imports from the European Union for the motor vehicle construction, chemical and metalworking industries. With the exception of the food products and power supply industries, the UK industries, which are heavily dependent on value-added imports from the European Union, do not play a major role in the overall economy. The share Figure 18 of the 15 industries in the total value added in the United Kingdom is just under 9 percent - without the food products and power supply industries it is not even 6 percent.

Figure 18: Value-added contributions of the European Union and Germany to final-demand production in the United Kingdom industries, in percent, 2017

15 industries in the United Kingdom with the highest contributions from the European Union, sorted in descending order

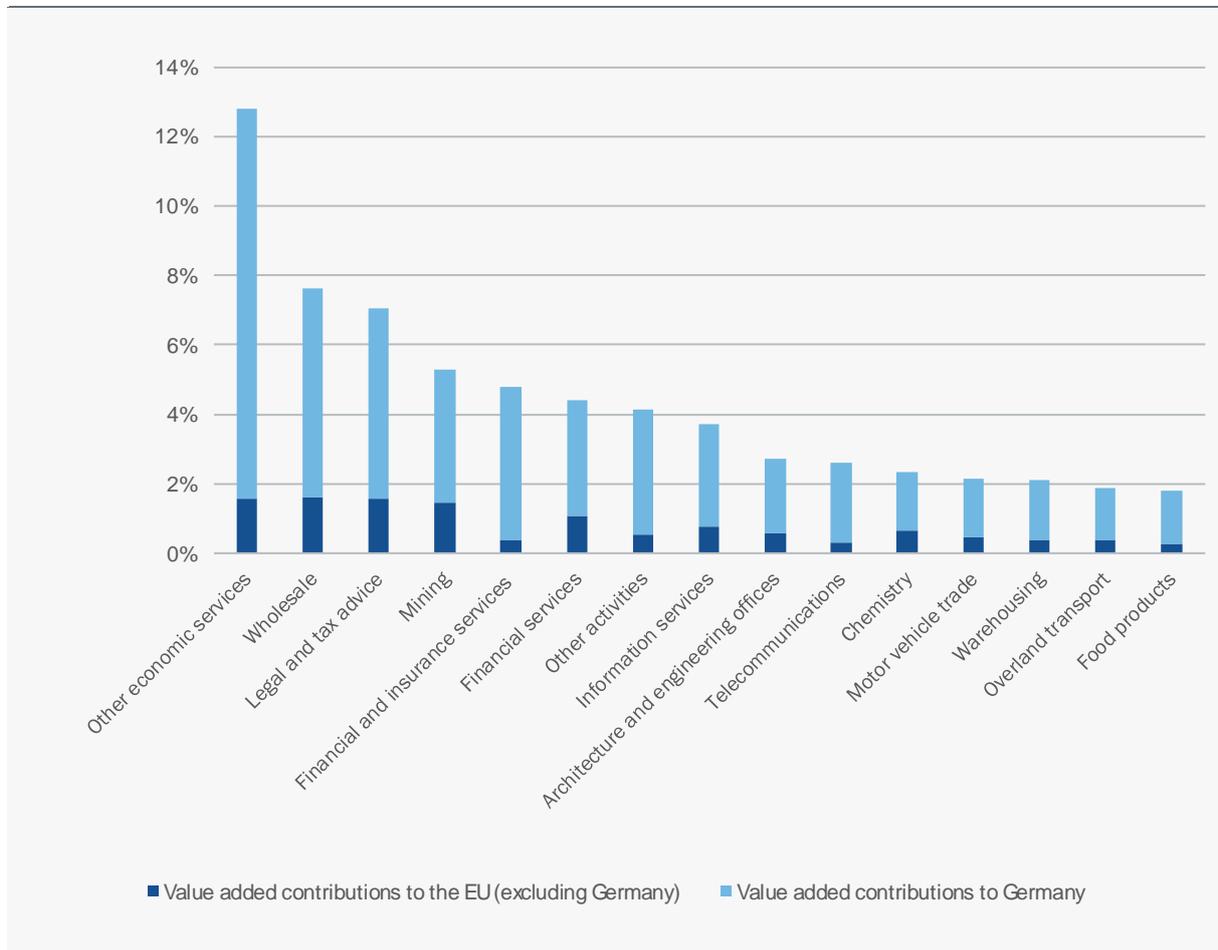


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Conversely, the United Kingdom exports 5 percent of its domestic value added to the European Union. Approximately one fifth of this amount flows into final-demand production in Germany. The European Union and Germany are an important destination for value-added exports (Figure 19), especially for the industries of other economic services, wholesale trade, legal and tax advice. The main industries of macroeconomic relevance for the United Kingdom are mining, other economic services and wholesale trade. These three industries alone account for just under 10 percent of the total value added generated in Germany.

Figure 19: Percentage share of value-added contributions per industry in the United Kingdom to final-demand production in the European Union and in Germany in total value-added contributions for the European Union, 2017

15 industries in the United Kingdom with the highest contributions, sorted in descending order



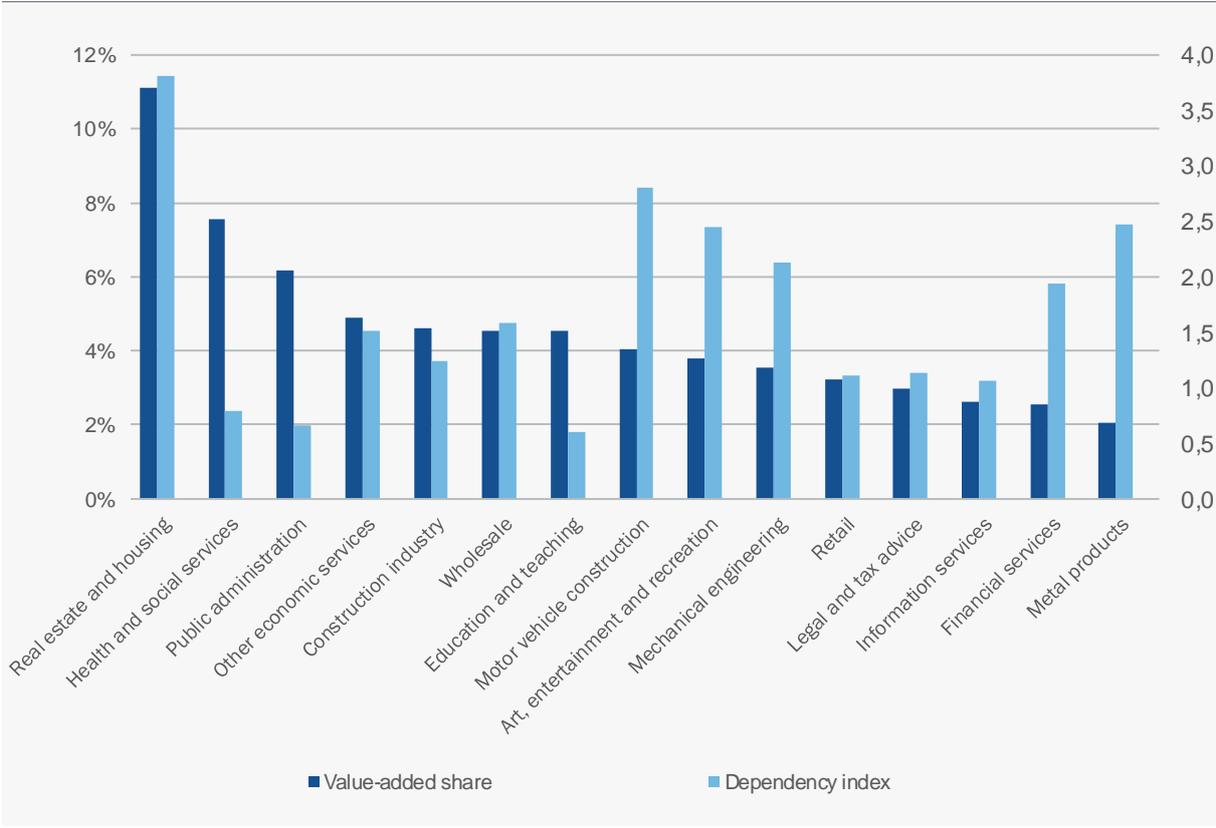
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5.3 Results on the potential impact on industries

In **Germany**, the chemical and pharmaceutical industries, metalworking, the coking plant and other vehicle construction show an above-average degree of dependency on the United Kingdom in relation to the value added generated and traded and the final-demand production. While the pharmaceutical and chemical industries and the coking plant also trade closely with the United Kingdom in absolute terms, the absolute value-added trade with the United Kingdom is significant for other industries, but the relative dependency of these industries on the United Kingdom is less significant. These include mechanical engineering, wholesale trade, construction but also service industries such as other economic services or financial services. In motor vehicle construction, the relative importance of the United Kingdom is much lower than the absolute value-added trade figures suggest (Figure 20).

Figure 20: Share of value added by industries of the German economy, in percent (left axis) and index of intensity of dependency on the United Kingdom (right axis), 2017

15 industries of the German economy with the highest shares of domestically generated value added and index of the intensity of dependency on the United Kingdom, sorted by value added share in descending order



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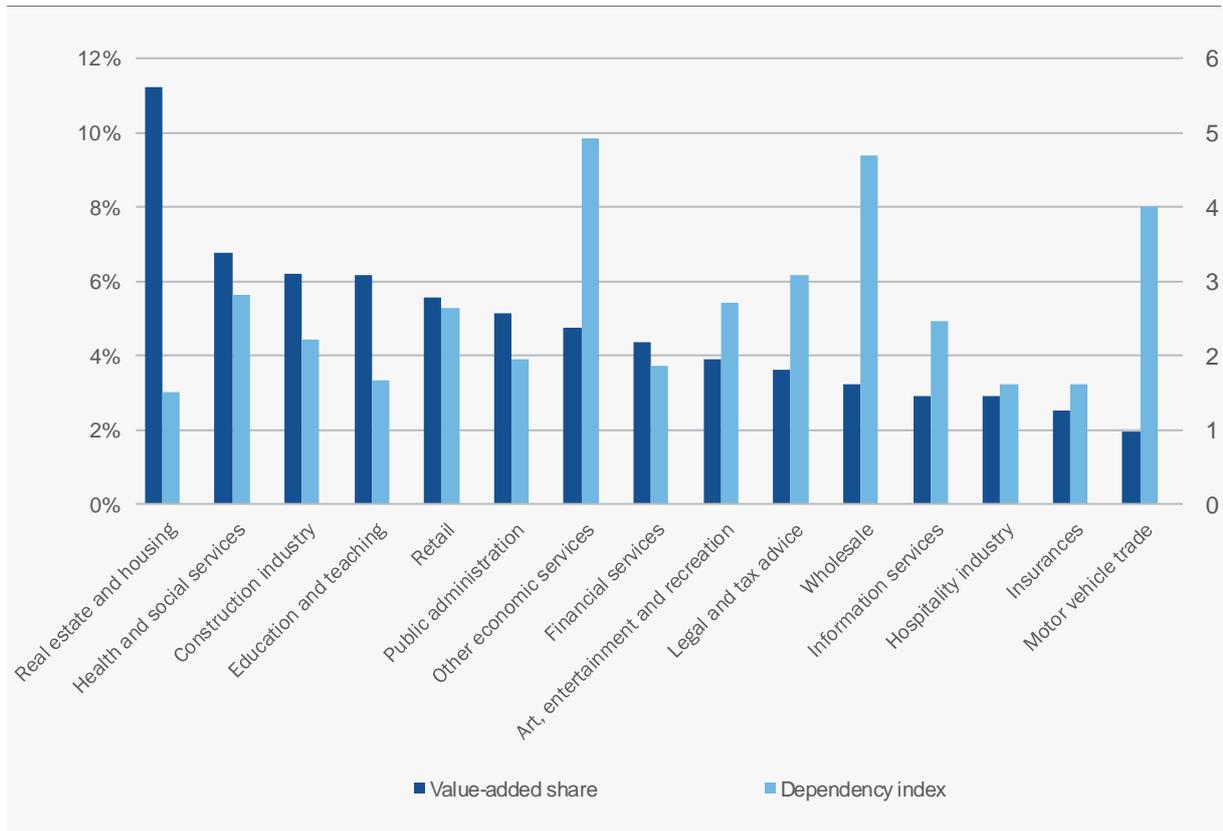
Conversely, the UK's dependency on industries such as metalworking, other vehicle construction, paper, rubber and plastics or other activities is stronger than the absolute figures suggest, relative to

the industry's performance. The industries of real estate and housing and, to a lesser extent, motor vehicle construction, the arts, entertainment and recreation industry and mechanical engineering are of particular relevance to the overall economy in terms of the value-added share generated in Germany as a whole. In these industries, which are relatively heavily dependent on the United Kingdom, more than a fifth of total value added has recently been generated in Germany. The chemical, rubber and plastics, electronics and metal production industries recently accounted for at least 1 percent of the total value added generated. By contrast, the overall economic significance of the remaining industries such as pharmaceuticals, metalwork, coking plants and other vehicle construction was moderate. Brexit may have significant industry-specific effects, but the overall economic effect would probably be small.

In the **United Kingdom**, only the motor vehicle construction, mining, mechanical engineering and chemical industries are among the top 15 in terms of both value-added trade and the intensity of dependency on Germany. However, health and social services, which imports value added worth around 10 billion Euro from Germany, is not as dependent on Germany as this figure suggests. The construction industry, wholesale trade, public administration and other economic services are also not among the 15 industries with the highest intensity of dependency on Germany. Conversely, metalworking and other industry sectors such as paper, rubber and plastics, electronics and pharmaceuticals are more dependent on trade with Germany than the absolute figures for value-added trade suggest. However, the overall economic importance of those industries that are heavily dependent on Germany is low (Figure 21). The 15 industries with the highest index value for measuring the intensity of dependency on Germany recently accounted for around 9 percent of the total value added generated in the United Kingdom. It can therefore be assumed that, although Brexit would have significant industry-specific consequences for these 15 industries, the macroeconomic effects (based on these 15 industries) would be moderate.

Figure 21: Share of value added by industry in the United Kingdom, in percent (left axis) and index of intensity of dependency on the European Union (right axis), 2017

15 industries of the British economy with the highest shares of domestically generated value added and index of the intensity of dependency on the European Union, sorted by value added share in descending order



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How many employees work in particularly affected industries?

Around 13 percent of the total workforce in Germany is employed in the 15 industries of the German economy that are most closely intertwined with the United Kingdom in terms of value added and production output. Around 85 percent of this is accounted for by industry sectors, the remaining 15 percent by service industries. Almost half of this is accounted for by the food products, metal products and motor vehicle construction industries.

In the UK, on the other hand, around 6 percent of the total workforce is employed in the 15 UK industries that are most dependent on Germany. In the United Kingdom, these 6 percent are employed exclusively in industry sectors, particularly food products and mechanical engineering.

6 Bottom line

The analysis of value-added trade between Germany and the United Kingdom shows that industry sectors contribute significantly less to bilateral trade than data on wholesale trade suggest. The main value added included in intermediate trade in industry comes from third countries. The opposite is the case for services in both countries. The value added of service industries in both countries is significantly higher than suggested by intermediate trade. The reason for this is that value added from service industries in Germany and the United Kingdom is often traded via third countries and therefore indirectly delivered to both countries.

In 2017, Germany imported a total of almost 35 billion Euro worth of value added from the United Kingdom. The key recipient industries of the German economy for value added from the United Kingdom are the motor vehicle construction, mechanical engineering and food products industries as well as the construction industry. Imported value added comes mainly from the United Kingdom's wholesale trade, legal and tax advice, other economic services and financial services industries. Substantial value added is also imported into Germany from the mining industry.

Value-added exports from Germany to the United Kingdom amounted to a good 50 billion Euro in 2017. The largest exporters of value added were companies from the service industries other economic services and wholesale trade and from the industry sectors motor vehicle construction, mechanical engineering, electronics, chemicals and pharmaceuticals. In the United Kingdom, exported value added was used for final-demand production, particularly in the health and social services industry. The motor vehicle construction, construction and public administration industries also relied heavily on value added from Germany.

Despite the lesser importance of industry in Germany in trade with the United Kingdom from the value added perspective, in 2017 the motor vehicle construction industry was the most dependent on the United Kingdom. Just under 5 billion Euro in value-added imports are offset by a good 3 billion Euro in value-added exports. The mechanical engineering, pharmaceutical, chemical and electronics industries have also traded substantially with the United Kingdom. Other economic services and real estate and housing also had close links with the United Kingdom, mainly through value-added exports.

In the United Kingdom in 2017, the health and social services in particular received value added from Germany. Motor vehicle construction, the construction industry and the wholesale trade also had close links with the German economy in terms of value added. Most industries in the United Kingdom import considerably more value added from Germany than they export there. Exceptions are the wholesale and other economic services industries, as well as mining, legal and tax advice. Almost all value added that is traded in these two industries flowed to Germany in 2017 as value-added imports.

If the dependency of the German economy's industries on the United Kingdom relative to the industry-specific value added and production performance is considered, the pharmaceutical, metalworking, coking plant, other vehicle construction and chemicals industries are most dependent on the United Kingdom. The motor vehicle construction or mechanical engineering industries, which have a high level of trade with the United Kingdom in absolute terms, are less dependent on the United Kingdom in relation to their output. Interdependence with other countries is strong in these industries, so trade with the UK is relatively insignificant. Measured in terms of the share of the total value added generated in Germany, Brexit would have substantial macroeconomic consequences in addition to a considerable industry-specific influence on the real estate and housing, motor vehicle construction, metal production, chemicals and electronics industries, which are heavily dependent on the United Kingdom.

This also applies to the United Kingdom. In relative terms, the chemical, metalworking, mining and motor vehicle construction industries are most dependent on Germany. By contrast, health and social services, which in absolute figures relies very heavily on value-added supplies from Germany, is only moderately dependent on Germany relative to its own performance. This also applies to a lesser extent to wholesale trade or public administration. Conversely, the intensity of dependency on Germany for industries such as pharmaceuticals, electronics, rubber and plastics or paper is greater than the absolute figures for value-added trade suggest. While Brexit would significantly affect industries heavily dependent on Germany, the macroeconomic consequences would probably be minor. The value-added share in the overall economy indicates that these industries are of little significance in the overall economy. In terms of value-added trade with the European Union, similar industry results can be seen. The other economic services, wholesale trade, legal and tax advice and mining industries make substantial value-added contributions to the European Union. On the other hand, industry sectors such as motor vehicle construction, chemicals or metalworking are essentially dependent on value-added contributions from the European Union.

Appendix

Table 1: Industry abbreviations used

Trade name	Abbreviated form	Trade name	Abbreviated form
Crop and animal production, hunting and related service activities	Farming	Wholesale trade, except of motor vehicles and motorcycles	Wholesale
Forestry and logging	Forestry	Retail trade, except of motor vehicles and motorcycles	Retail
Fishing and aquaculture	Fishing	Land transport and transport via pipelines	Overland transport
Mining and quarrying	Mining	Water transport	Shipping
Manufacture of food products, beverages and tobacco products	Food products	Air transport	Aviation
Manufacture of textiles, wearing apparel and leather products	Textiles	Warehousing and support activities for transportation	Warehousing
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Wooden goods	Postal and courier activities	Postal services
Manufacture of paper and paper products	Paper	Accommodation and food service activities	Hospitality industry
Printing and reproduction of recorded media	Printed matter	Publishing activities	Publishing
Manufacture of coke and refined petroleum products	Coking plant	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	Broadcasting
Manufacture of chemicals and chemical products	Chemistry	Telecommunications	Telecommunications
Manufacture of basic pharmaceutical products and pharmaceutical preparations	Pharmaceuticals	Computer programming, consultancy and related activities; information service activities	Information services
Manufacture of rubber and plastic products	Rubber and plastic	Financial service activities, except insurance and pension funding	Financial services
Manufacture of other non-metallic mineral products	Glass and glassware	Insurance, reinsurance and pension funding, except compulsory social security	Insurances
Manufacture of basic metals	Metalwork	Activities auxiliary to financial services and insurance activities	Financial and insurance services

Manufacture of fabricated metal products, except machinery and equipment	Metal products	Real estate activities	Real estate and housing
Manufacture of computer, electronic and optical products	Electronics	Legal and accounting activities; activities of head offices; management consultancy activities	Legal and tax advice
Manufacture of electrical equipment	Electrical equipment	Architectural and engineering activities; technical testing and analysis	Architecture and engineering offices
Manufacture of machinery and equipment n.e.c.	Mechanical engineering	Scientific research and development	Research and Development
Manufacture of motor vehicles, trailers and semi-trailers	Motor vehicles	Advertising and market research	Advertising and market research
Manufacture of other transport equipment	Other vehicle construction	Other professional, scientific and technical activities; veterinary activities	Other activities
Manufacture of furniture; other manufacturing	Furniture	Administrative and support service activities	Other economic services
Repair and installation of machinery and equipment	Repair of machinery	Public administration and defence; compulsory social security	Public administration
Electricity, gas, steam and air conditioning supply	Power supply	Education	Education and teaching
Water collection, treatment and supply	Water supply	Human health and social work activities	Health and social services
Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	Wastewater disposal	Other service activities	Art, entertainment and recreation
Construction	Construction industry	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	Private households with domestic staff
Wholesale and retail trade and repair of motor vehicles and motorcycles	Motor vehicle trade	Activities of extraterritorial organizations and bodies	Activities of extraterritorial organizations and bodies

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