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Positioning Austria in the Global Economy: Value Added Trade, International Production Sharing and Global Linkages

Robert Stehrer and Roman Stöllinger

Abstract

This study investigates Austria's positions in international production sharing and global value chains exploiting the recently available Global Input-Output Database (WIOD). Researchers and policy-makers become increasingly aware of the fact that production processes are more and more organised internationally, which implies that indicators based e.g. on gross export values become less meaningful as part of this value is made of imported intermediates. As such, statistics and indicators based on a value added rather than gross trade basis and emphasis on the actual (domestic) value added creation due to exports are needed for policy-makers and researchers to draw a more accurate picture of the link between trade and value added creation and the implications thereof. Making use of indicators for measuring different aspects of complex production relations established in the literature such as the degree of vertical specialisation, value added trade and global value chain income, we find that Austria has intensified its participation in international production sharing since 1995 as evidenced, e.g., by the substantial increase in its vertical specialisation index. Tight supplier-customer relationships, above all in medium-high- and high-technology-intensive manufacturing industries, with Germany and increasingly with the neighbouring CEEC economies have contributed strongly to this development. However, international production sharing is also inextricably linked to 'employment sharing', meaning that in the presence of vertical specialisation not all jobs related to Austrian exports are also located in Austria. In fact, if based on the individual countries' labour productivities, Austrian exports embody more foreign than domestic jobs due to significantly lower productivity levels in some of the partner countries. Nevertheless, the development of Austrian exports has been very dynamic over the past decade as manifested for example in a trade surplus since the early 2000s. A counterfactual exercise that compares the actual amount of domestic jobs embodied in Austrian exports with the hypothetical amount of jobs that would be needed to produce Austria's imports domestically suggests that foreign trade has a positive employment impact in Austria amounting to some 90,000 jobs in 2009 – a result that is closely linked to Austria's trade balance surplus. The strong export performance of Austria is also revealed by the rising share in total EU value added exports which exceeded 3% in 2011, though this is sometimes masked by the fact that the share in global value added exports declined slightly between 1995 and 2011 as a result of new important players in the arena of international trade, above all China. Finally, analysing the trade slump of the year 2009 we find that 're-shoring' activities of Austrian firms as well as the so-called 'composition effect' contributed to the crisis-related decline of Austrian exports.

Keywords: production fragmentation, value added trade, internationalisation

JEL-codes: F14, F15, F63, O52

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Positioning Austria in the Global Economy: Value Added Trade, International Production Sharing and Global Linkages

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Abstract

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1. Introduction

The global production and trading system has become increasingly complex over the past decades. International economic exchanges between firms now tend to be multi-faceted: simple trade transactions have in many cases being replaced by an intertwining of trade in goods, international investment in production facilities and technology and the use of infrastructure services to coordinate the geographically dispersed production which Baldwin (2011) has termed the trade-investment-services nexus. Underlying the trade-investment-services nexus that characterises 21st century trade are the information and communication technology (ICT) revolution as well as the continuous efforts to reduce remaining tariffs and other trade barriers. These factors led to changes in the organisation of production which became more internationalised – the 'second unbundling' (Baldwin, 2011) – leading to increasing international fragmentation of production and related phenomena such as offshoring or 'trade in task'. The fragmentation of production, also referred to as vertical integration or international production sharing, means that countries no longer specialise necessarily in the production of certain types of goods but rather in individual 'tasks' along a product's value chain which therefore becomes more global in nature. By this, global value chains arise which become increasingly complex networks of international supplier-customer relationships, long-term contracts on the provision of services and tailor-made parts and components. These networks are typically managed by large multinational companies with international production facilities (Gereffi et al., 2005)[1].

There is some disagreement on whether vertical integration, trade in tasks (Grossman and Rossi-Hansberg, 2008; Baldwin and Robert-Nicoud, 2010) and offshoring (Feenstra and Hanson, 1996; Feenstra, 2010) are really fundamentally new phenomena or whether they are just variants of import and export transactions[2]. Irrespective of that, the fact that trade transactions are taking place on an ever more granular level implies that conventional trade statistics are no longer fully adequate to capture the structure of international trade and individual countries' position in the global economy (Hummels et al., 2001; Cattaneo et al., 2010; WTO, 2010; IMF, 2011; Sydor, 2011; De Backer and Miroudot, 2012; OECD-WTO, 2012; Stehrer et al., 2012; Foster and Stehrer, 2013a; Timmer et al., 2013). Because conventional trade statistics are set up on the basis of gross flows, the presence of trade in intermediates, ubiquitous in international production chains, blurs the statistics so that a recorded export (or import) transaction does not capture the amount of value added that was actually added by the exporting country (Maurer and Degain, 2010). From an economic point of view, the question of where actual production is taking place, i.e. where value added is created and jobs are generated, is more compelling than focusing on gross flows. A famous example of misleading results emerging from gross trade statistics in the presence of global production sharing is China's role as the world's leading exporter of high-tech products although its main role so far is the

[1] Famous examples of such global value chains are the production of Apple's iPod (see Dedrick et al., 2010) and Nokia's mobile phone N95 (see Ali-Yrkkö et al., 2010).

[2] For example, Groshen et al. (2005) argue that the 'offshoring of jobs is best seen as another form of import activity rather than an altogether new phenomenon'. Findlay and O'Rourke (2007) describe the trade relations in the early 16th century between the Ottoman Empire and the Safavid Empire in which the latter supplied raw silk which was then processed in the town of Bursa and was then sent by caravans to Europe as one of 'vertical interdependence'.

assembly of high-tech parts and components developed elsewhere into a final product which is then re-exported[3].

Though there are now numerous studies providing overviews concerning these ongoing trends as well as studies analysing the effects of the economic crisis of 2008/2009, there is still lack of in-depth studies on individual countries concerning their trade patterns and position in the global production structure. In this study we focus on Austria, a small open economy which has developed strong trade and production links with the Eastern European countries – therefore being, together with Germany, a country strongly enhancing the European integration process – but also with other countries in the world. In doing so, we calculate a series of existing indicators on vertical specialisation and trade in value added measures, relying on information from the World Input-Output Database (WIOD). The chosen indicators allow drawing a rather complete picture of Austria's position in the global economy in individual industries and over time (1995-2011) and will yield a 'country trade statistical profile' for Austria. We further compare the results for Austria with those for other countries. In several instances we will focus on a subset of peer countries such as Germany, which is Austria's most important trading partner, and Finland, which is another small open economy with high income and wage level, or use the EU-15 as a reference group.

The structure of the study is as follows. Section 2 briefly reviews the basic methodology used throughout the study. Sections 3 to 7 contain the results on various topics relating to international production sharing and global linkages. The availability of inter-country input-output tables, such as the WIOD tables, strongly facilitates the use of input-output techniques of which the basics are summarised in this section. This includes the degree of vertical specialisation in Austrian exports (Section 3) and an analysis of Austria's export and import performance in terms of value added trade (Section 4). Section 5 takes a closer look at Austria's (bilateral) trade balances, pointing out some differences between these balances in gross terms and in value added terms. Section 6 is dedicated to the analysis of income generated in Austria by the global value chains of different industries. In Section 7 the focus switches from value added and income to employment and presents some results on the job embodiment in Austrian exports. Section 8 investigates in some detail the impact of the Great Recession and the following trade slump for Austria and, using the input-output concepts employed in this study, provides results of the structure of this trade slump in the case of Austria. Section 9 concludes by summarising the main findings of the study and presenting some thoughts on future research.

2. Data and methodological aspects

Recently, a number of initiatives have been ongoing to capture the phenomena of vertical integration and global production sharing on a world-wide scale. The most comprehensive outcome emerging so far from these activities is the recently released World Input-Output Database (WIOD)[4].

The WIOD brings together information from national accounts statistics, supply and use tables, trade in goods and services data and corresponding data on factors of production (capital and labour) for

[3] This is not to deny that China has embarked on an impressive catching-up process that led to a significant structural upgrading. This includes a shift towards more complex and technology-intensive manufacturing industries and the build-up of considerable domestic R&D capacities.

[4] The WIOD is the outcome of a recent effort undertaken in a project within the Framework 7 programme. The data is available on www.wiod.org.

40 countries over the period 1995–2009 (an update of the data until 2011 might become available in autumn 2013); for a detailed documentation see Timmer et al. (2012). The database covers all 27 EU countries, plus Turkey, and includes other major economies such as the NAFTA countries (USA, Canada and Mexico), the BRIIC countries (Brazil, Russia, India, Indonesia and China), Japan, Korea, Taiwan and Australia. Existing supply and use tables and, if not available, estimated tables have then been adjusted to national accounts on gross output, value added and final demand, thus assuring consistency with officially available National Accounts data. The resulting tables contain information on the supply and use of 59 products in 35 industries, together with information on final use and value added. Accompanying this information, corresponding trade data were collected at the detailed product level. Data on goods trade are taken from UN Comtrade at the HS 6-digit product level, which can be aggregated to the CPA products (Statistical Classification of Products by Activity) at the 2-digit level, as reported in the supply and use tables, and have been split into various use categories by applying a correspondence to broad end-use categories (BEC) for which the officially available information from the United Nations Statistics Division (UNSTAT) was adapted.

Bilateral data on services trade have been collected from various sources (IMF, OECD; Eurostat) and reconciled with the product information in the supply and use tables. Relying on these underlying data, the starting point has been the import vector provided in the supply tables. First, import values for each country and product are split up into the three use categories. Second, within each use category a proportionality assumption is applied to split up the imports for each use category across the relevant dimensions. This results in an import-use table for each country. Finally, each cell of the import-use table is again split up by country of origin, resulting in bilateral import-use tables for each country. Merging these tables provides a full set of inter-country supply-and-use tables. Finally, an international input-output table was constructed by applying the transformations of model D, as described in the Eurostat manual (Eurostat, 2008) to which a rest of world was constructed.

Figure 2.1: Outline of world input-output table (WIOT)

	Intermediate use			**Final use**			
	Country A	**Country B**	**Country C**	**Country A**	**Country B**	**Country C**	
Country A	A sources from A	B sources from A	C sources from A	A demands in A	B demands in A	C demands in A	GO in A
Country B	A sources from B	B sources from B	C sources from B	A demands in B	B demands in B	C demands in B	GO in B
Country C	A sources from C	B sources from C	C sources from C	A demands in C	B demands in C	C demands in C	GO in C
Value added	VA in A	VA in B	VA in C				
Gross output	GO in A	GO in B	GO in C				

This results in a world input-output table (WIOT) for 41 countries (including rest of world such that there are *C=41 countries*) and 35 industries (*N=35*), i.e. the intermediates demand block is of dimension 1435x1435 plus additional rows on value added and columns on final demand categories (see schematic outline in Figure 2.1). The world input output tables of the WIOD are supplemented with additional data on employment and skills collected in the WIOD's Socio-Economic Accounts (SEA).

In this project we exploit information provided in WIOD's world input-output table to position Austria in the world economy in terms of these global value chains. Together with additional information on employment and a breakdown of value added into its components (capital and labour income by educational categories) from the SEA, this set of detailed information on global production linkages allows to derive a set of indicators recently established in the literature (e.g. Hummels et al., 2001; Trefler and Zhu, 2010; Johnson and Noguera, 2012; Stehrer, 2013; Foster and Stehrer, 2013a).

Calculating these indicators relies heavily on input-output techniques. The starting point therefore is the well-known relationship that gross output equals demand for intermediates plus final demand:

(1) $$\mathbf{q} = \mathbf{A} \cdot \mathbf{q} + \mathbf{f} = (\mathbf{I} - \mathbf{A})^{-1} \cdot \mathbf{f}$$

where $\mathbf{q}$ denotes a vector of gross output for each country and industry (i.e. of dimension 1435x1), $\mathbf{A}$ is a matrix of intermediate inputs per unit of gross output (of dimension 1435x1435) and $\mathbf{f}$ is a vector of final demand (i.e. household and government consumption and capital formation) by country and sector (and therefore again of dimension 1435x1). A final product, e.g. a car, is made of many other products and services produced in other industries and due to the international linkages also in other countries. To capture direct and indirect linkages across sectors and countries, one can rely on the famous insight of Leontief which uses the fact that final gross output equals the Leontief inverse $(\mathbf{I} - \mathbf{A})^{-1}$ multiplied with the vector of final demand, in this case capturing all direct and indirect linkages across sectors and countries. From this basic relation a series of relevant indicators capturing a country's position in the global production process can be derived. The basic input-output identity in equation (1) is exploited throughout the study. Pre-multiplying this identity with a vector of value added created per unit of output (e.g. value added) or inputs (e.g. employment) needed to produce a unit of gross output allows one to trace the value added and therefore GDP (or employment) creation effects through the global value chain.

3. Vertical specialisation and the foreign value added content of exports

Increasing offshoring and international fragmentation of production implies that an industry uses more inputs from upstream activities from other countries, referred to as vertical specialisation. For the vertical specialisation measures we follow Stehrer et al. (2012) and Foster and Stehrer (2013a) who make use of Trefler and Zhu's (2010) approach to calculate the factor content of trade of all WIOD countries and adjust it slightly to calculate the value added content of each country's gross exports and imports[5]. As suggested by Stehrer et al. (2012) and Foster and Stehrer (2013a) this delivers all elements necessary to calculate the share of domestic and foreign value added in a country's exports and imports[6]. More specifically, it contains information on the domestic and foreign value added content of exports, the latter being available by partner country in the WIOD[7]. The value added content of imports can be split up into the direct (bilateral) value added imports from the partners, the foreign multilateral value added content of imports (which is value added created, for example, in Italy but embodied in Austria's imports, in gross terms, from Germany) and re-imports of value added (i.e. value added originally created in Austria, then exported and coming

[5] The adjustment simply consists of replacing the direct factor requirements with value added created per unit of gross output and showing that this traces all value added created along the value chain and also satisfies national accounts identities.

[6] This measure is conceptually similar to the most widely used measure of vertical specialisation introduced in Hummels et al. (2001) which is based on a gross output concept. In fact, empirically these two measures are also highly correlated.

[7] More information on the definition of the vertical specialisation measure is provided in the Appendix.

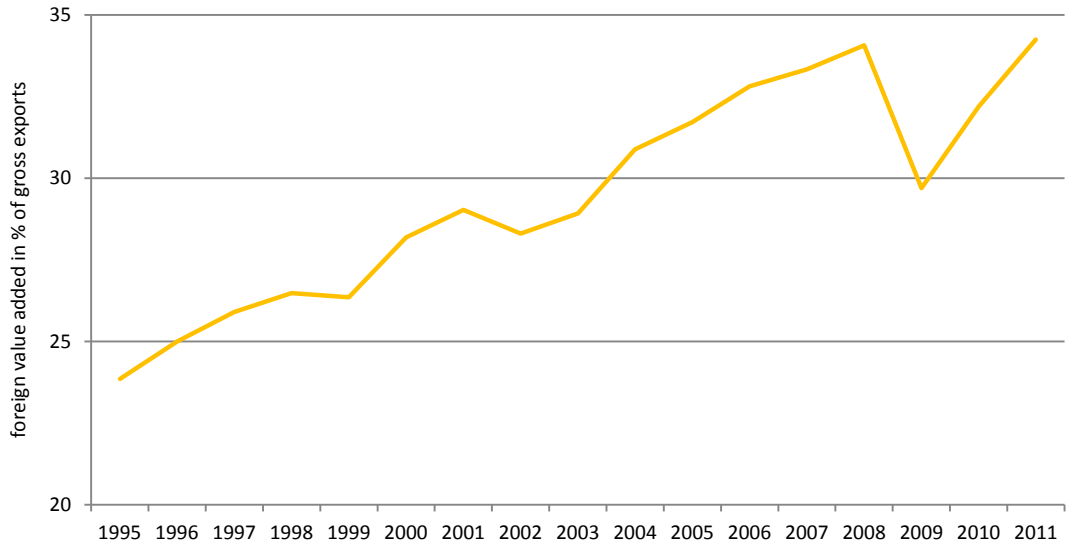
back to Austria) which are a subset of the multilateral value added content of imports. Koopman et al. (2013) refer to this as 'returned domestic value added'.

Box 3.1 – Measuring vertical specialisation

Formally, vertical specialisation of country *r* can be expressed as the value added created in other countries which enters production in country *r* as imported intermediate inputs. Vertical specialisation can be calculated with respect to the foreign inputs in production of (domestically consumed or exported) final goods, final goods plus exported intermediates (the latter also feature as final demand for a particular country in national accounts) or total exports which then include both intermediate and final goods exports (though one might split them up as well). In the latter case, vertical specialisation is calculated as $VS^r = \boldsymbol{v}^{-r}\boldsymbol{L}\boldsymbol{x}^r$ where $\boldsymbol{v}^{-r}$ denotes a 1xNC value added coefficients vector including zeros for country *r* and non-negative values for all other countries, $\boldsymbol{L}$ is the global Leontief inverse, and $\boldsymbol{x}^r$ denotes an NCx1 vector of country *r*'s exports and zeros otherwise. When being interested in the foreign value added content of exports from a particular country, one includes only value added coefficients from this country, i.e. $VS^{rs} = \boldsymbol{v}^s\boldsymbol{L}\boldsymbol{x}^r$. Of course, it holds that $VS^r = \sum_{s\neq r}^{C} \boldsymbol{v}^s\boldsymbol{L}\boldsymbol{x}^r$ (see Foster and Stehrer, 2013a for further details).

Figure 3.1 presents the foreign value added embodied in Austrian exports over the period 1995-2011. This share has increased from slightly less than 25% in 1995 to almost 35% in 2008, thus by 10 percentage points.

Figure 3.1: Foreign value added embodied in Austrian exports in % of gross exports, 1995 to 2011



Source: WIOD database; wiiw calculations.

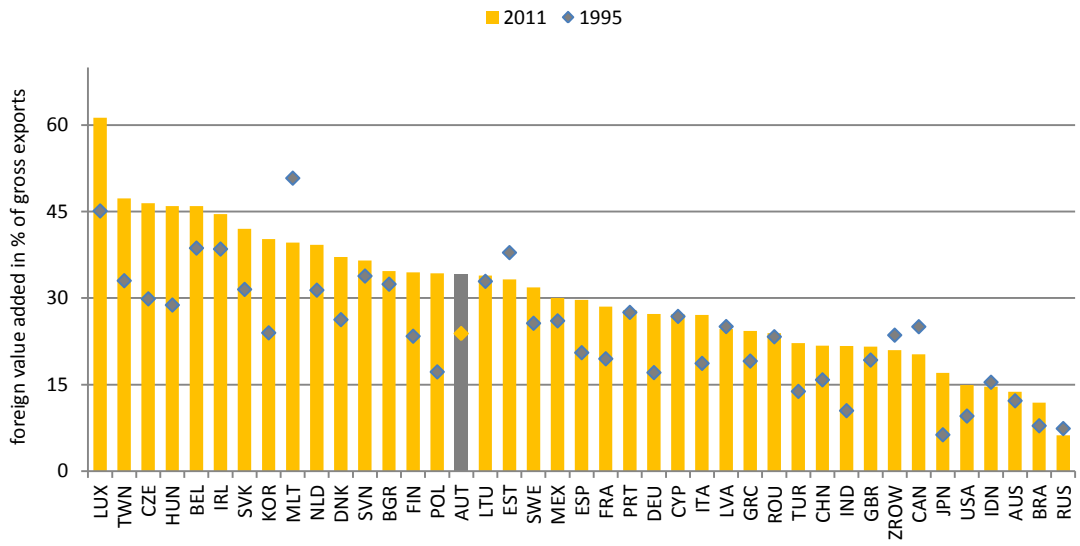
Over the crisis period this share dropped to about 30% but recovered thereafter and in 2011 reached again the pre-crisis level of almost 35%. This drop in the foreign value added content of Austrian exports was mainly due to a change in the composition of exports as will be shown in detail further below.

From a comparative perspective, Austria – with a share of about 35% of foreign value added embodied in its exports – is in the middle range of countries as presented in Figure 3.2. Higher shares are observed for most of the Eastern European countries, particularly the Czech Republic (46%), Hungary (46%), and the Slovak Republic (42%). Other European countries with similar or higher

shares are Finland (34%), Denmark (37%), the Netherlands (39%), and Belgium (46%). Further countries, such as Sweden (32%), Spain (30%), France (29%), Germany (27%) and Italy (27%), show slightly lower shares of foreign value added embodiment in their exports. This is not surprising as generally larger countries face lower foreign value added content of exports (for example, the United States and Japan have shares of 15% and 17%, respectively). Furthermore, a country's industrial structures (e.g. the share of manufacturing) as well as natural resource endowments play an important role.

From a dynamic perspective, Figure 3.2 shows that in almost all countries the share of foreign value added in their exports increased, in some instances quite strongly. There are a few exceptions to this, such as Malta, Estonia and Canada which show markedly lower shares in 2011 as compared to 1995, and countries with rather constant shares such as Lithuania, Portugal, Cyprus, Latvia and Romania, though this is partly caused by crisis effects. Particularly large changes are observed for the Central and Eastern European countries (CEEC) such as the Czech Republic (17 percentage points), Hungary (17 p.p.), Poland (17 p.p.) and the Slovak Republic (10 p.p.). Compared to the EU-15 countries the increase of 10 p.p. in Austria is similar to those found for Denmark (11 p.p.), Finland (11 p.p.) and Germany (10 p.p.).

Figure 3.2: Foreign value added embodied in exports in % of gross exports, 1995 and 2011

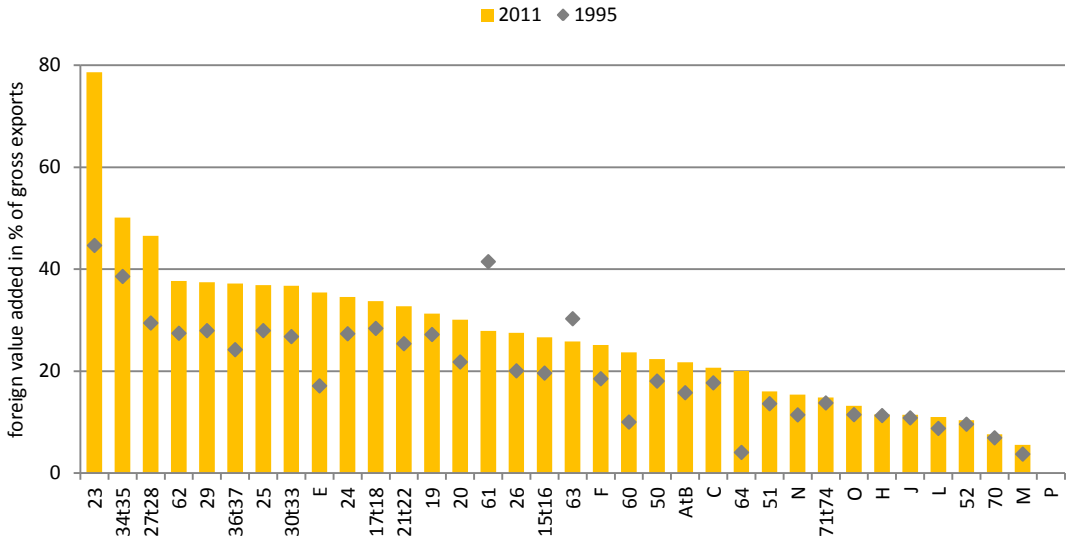


Note: Countries are ranked according to 2011.

Source: WIOD database; wiiw calculations.

Industries differ with respect to their vertical specialisation patterns, as presented in Figure 3.3. Apart from coke, refined petroleum and nuclear fuel (NACE 23), mostly high- and medium-high-tech industries have the largest shares of vertical specialisation. These industries are in particular the transport equipment industry (NACE 34t35) with 50%, the basic metals and fabricated metal industry (NACE 27t28) with 47%, the machinery industry (NACE 29) with 37%, and the electrical and optical equipment industry (NACE 30t33) with 37%.

Figure 3.3: Foreign value added embodied in exports in % of gross exports by industry, 1995 and 2011



Note: Industries are ranked according to 2011. For the industry classification, see Appendix.

Source: WIOD database; wiiw calculations.

Thus, for these industries, the value of Austrian exports is to more than one third (and up to one half as in the case of the transport equipment industry) made up by value added from other countries. This foreign value added is embodied in Austrian exports as the latter are produced by use of imported intermediates.

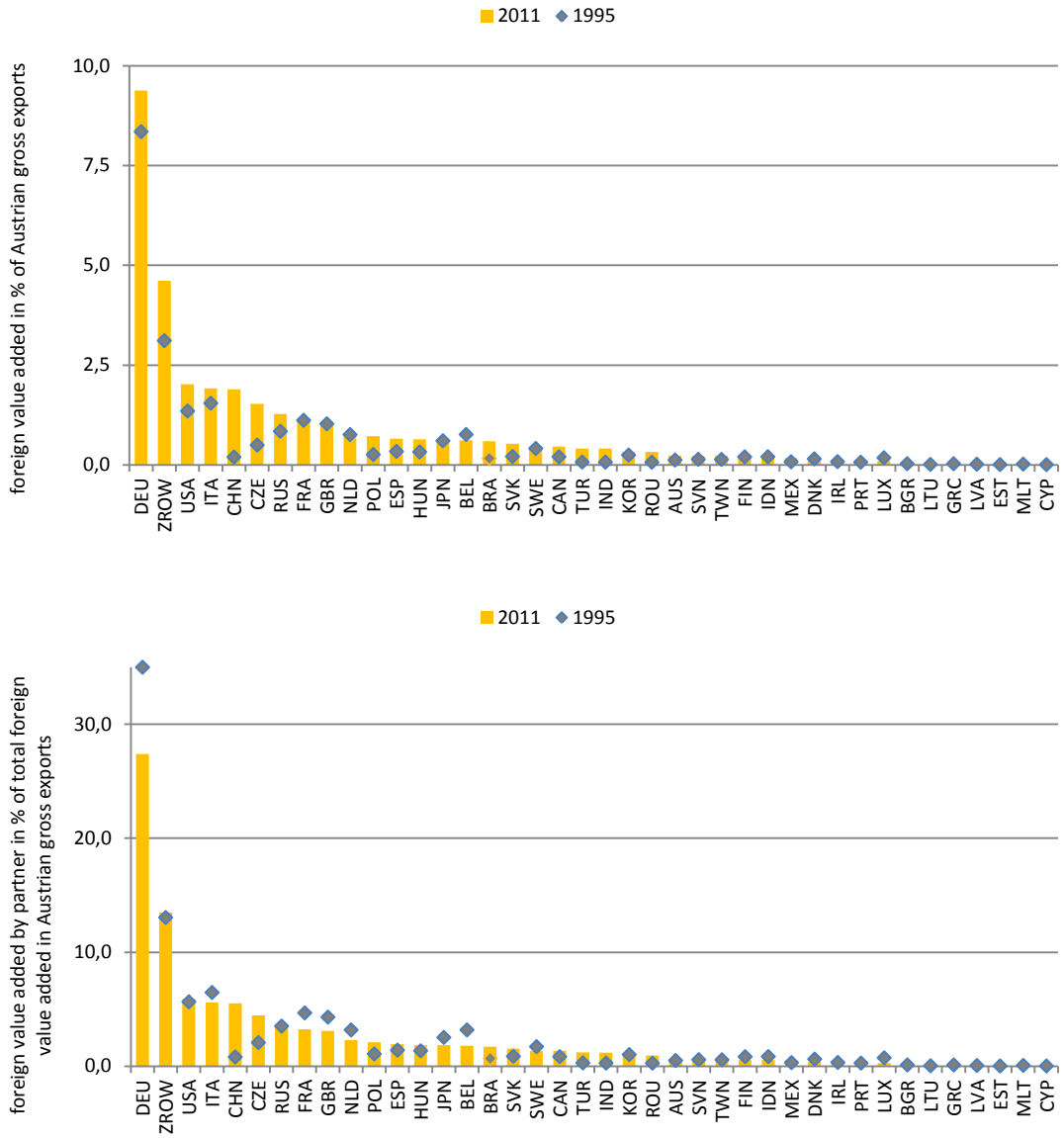
Further industries with relatively larger shares are air transport services (NACE 62), the manufacture of rubber and plastics (NACE 25), and electricity, gas and water supply (NACE E) with shares well above 30%. These industries tend to be more intensive in natural resources, energy and raw materials. It is further interesting to note that there are a couple of other manufacturing and services industries which have a share of foreign value added larger than 20% though for most services industries (e.g. transport services) the degree of vertical specialisation drops to 10%-15% or even lower.

When considering the changes over time one observes that the largest increases occurred in the industries with high technology intensity, particularly in the transport equipment industry (NACE 34t35) with a foreign content increase of 12 p.p. and basic metals and fabricated metal (NACE 27t28) with a respective increase of even 17 p.p., but also for the machinery industry (NACE 29) with 9 p.p., and the electrical and optical equipment industry (NACE 30t33) with 10 p.p. Other significant increases are observed for transport services and the energy sectors together with post and telecommunications (NACE 64) though in the latter case from a very low level. Decreases are only observed in water transport (NACE 61) and other transport activities (NACE 63).

Finally, the question of where these final embodiments are source from has to be addressed. Figure 3.4 (upper panel) presents the foreign value added content of Austrian exports by partner countries. Germany with more than 9%, the rest of world (note that this includes Switzerland, Norway and oil-exporting countries) with 4.5% and the United States, Italy and China with 2% each, provide the bulk of foreign value added embodied in Austrian exports. Other European countries play a lesser role because these are more distant (e.g. France, Great Britain and the Netherlands with about 1%) or

rather small such as some of the Central and Eastern European countries. With respect to the latter, the Czech Republic is the relatively most important with a share of more than 1.5% of its value added embodied in Austrian exports.

Figure 3.4: Foreign value added embodied in exports in % of gross exports by partner (upper panel) and foreign value added embodied in exports in % of foreign value added embodied in gross exports (lower panel), 1995 and 2011



Note: Industries are ranked according to 2011.

Source: WIOD database; wiiw calculations.

Looking again at changes over time, one observes that international integration of Austrian production increased with respect to almost all countries, indicating the general intensification of international fragmentation of production. Exceptions to this in Austria's trade relations are France, the United Kingdom, the Netherlands, Japan, Belgium and Sweden, which show more or less constant or slightly declining shares. Particularly strong increases of their shares of value added in Austrian exports are observed in trade with Germany (1 p.p.), the rest of world (1.5 p.p.), China (1.7 p.p.) and the Czech Republic (1 p.p.). Integration with the other countries and particularly with

the Central and Eastern European countries have been in the range from 0.3 to 0.5 percentage points (e.g. for Poland with 0.5 p.p., and Hungary and Slovakia with 0.3 p.p. each).

The differences in the changes of bilateral vertical integration in Austria's trade affect the relative share of each partner country in total foreign content embodied in Austrian exports. However, at the same time there are general shifts in the relative importance of bilateral trade relations, particularly due to the intra-European catch-up process of the CEEC and the integration of China and other large emerging markets in the global economy. This is why despite the increase in vertical specialisation in trade with Germany, the share of Germany in Austrian foreign value added content decreased from 35% in 1995 to 27% 2011 (lower panel of Figure 3.4). In contrast, China's share in total foreign value added embodied in Austrian exports rose from 1% in 1995 to more than 5% in 2011. The share of the Czech Republic increased by 2.4 p.p.; positive but smaller changes are observed for other Central and Eastern European countries as well. The relative importance of most of the EU-15 partners in the foreign content declined, particularly in the case of France, the United Kingdom, the Netherlands, Italy and Belgium. The same is true for Japan.

Summarising, Austria's integration in international production networks increased between 1995 and 2011 with a dip occurring in the year 2009 due to the economic crisis. Nowadays about 35% of the value of Austrian gross exports are foreign made. Compared to the situation in 1995, this share increased by about 10 percentage points. With this magnitude, Austria ranges in the middle across the countries analysed here, but over time experienced a slightly larger increase in its share of foreign value added mostly due to more intensive production sharing with Eastern European countries and Germany, but also China. With respect to particular industries, it turns out that the medium-high- and high-tech industries are more internationally integrated together with the transport services industries. These industries also experienced the largest increases in their vertical specialisation over time.

4. Trade in value added

4.1. Introduction

Decomposing of Austria's gross exports in domestic and foreign value added content as shown in the previous section is useful for investigating its degree of vertical specialisation and emphasising the sourcing structures of the respective industries' production. Analysing a country's trade as driven by external final demand on a value added basis provides a differentiated but (maybe surprisingly) related concept (see Stehrer, 2012 and 2013), the so-called value added trade, which from this perspective is more appropriate.

In comparison to gross exports, value added exports give a more appropriate picture of a country's position in international markets as it reveals the actual value added that is domestically produced and linked to external demand. Hence, in contrast to gross exports, value added exports take into account trade in intermediates and corrects for the implied double counting of trade flows which occurs in traditional trade statistics. Therefore, indicators of international competitiveness such as export markets shares but also the general export development over time are more accurately captured by value added trade. Moreover, value added exports also reflect more accurately the relative importance of individual industries to a country's export performance which in terms of

gross exports is sometimes blurred by high imports of intermediate goods. This section therefore tracks Austria's export and import performance over the period 1995-2011 in terms of value added trade and, where insightful, compares it to gross trade flows. On occasion, comparisons with other EU Member States are drawn, e.g. in the case of export market shares in value added terms. Results are presented for global trade, trade by partner country and exports by industry.

Box 4.1 – Value added exports and imports

Value added exports and value added imports are calculated using the external demand vectors as starting points. By using the information of the (direct and indirect) global sourcing patterns for intermediates (provided in the Leontief Inverse) these final demand vectors of Austria's trading partners are assigned to Austria to the appropriate extent. Applying the (sector-specific) Austrian value added coefficients to this external demand assigned to Austria yields the value added that is generated in Austria but consumed abroad. Put differently, the value added exports of Austria are simply the part of domestic value added that is produced to satisfy the final demand by partner countries, taking into account trade in intermediates. This is why Johnson and Noguera (2012) also refer to these value added exports as 'output transfers' as production of one country is transferred to other countries according to multilateral production linkages and final demand structures.

Value added exports can be calculated for individual industries and for the economy as a whole as well as bilaterally or for all trading partners. In matrix terminology bilateral value added exports of country *r* shipped to country *s* can be expressed as $VAX^{rs} = \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}^s$ where $\boldsymbol{v}^r$ denotes a 1xNC vector including value added coefficients of country *r* and zeros otherwise, $\boldsymbol{L}$ is the global Leontief inverse and $\boldsymbol{f}^s$ denotes an NCx1 column vector with final demand of country *s* in its own country and other countries including country *r*. The aggregate value added exports of country *r,* denoted VAX^{r*}, are obtained by adding up the bilateral value added exports across trading partners, i.e. $VAX^{r*} = \sum_{s \neq r}^{C} \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}^s$. Likewise, the value added imports of Austria (or any other country *r*) can then be retrieved by adding up the bilateral value added exports of each trading partner to Austria thereby making use of the fact that Austria's bilateral value added imports from partner country *s* are the value added exports of country *s* to Austria.

The difference between value added exports calculated this way and the domestic value added content of gross exports discussed in the previous section are the re-imports, i.e. value added that is created in Austria and in a first step exported, but then re-imported for final domestic use. Such re-imports are corrected for (i.e. excluded) in the calculation of value added exports.

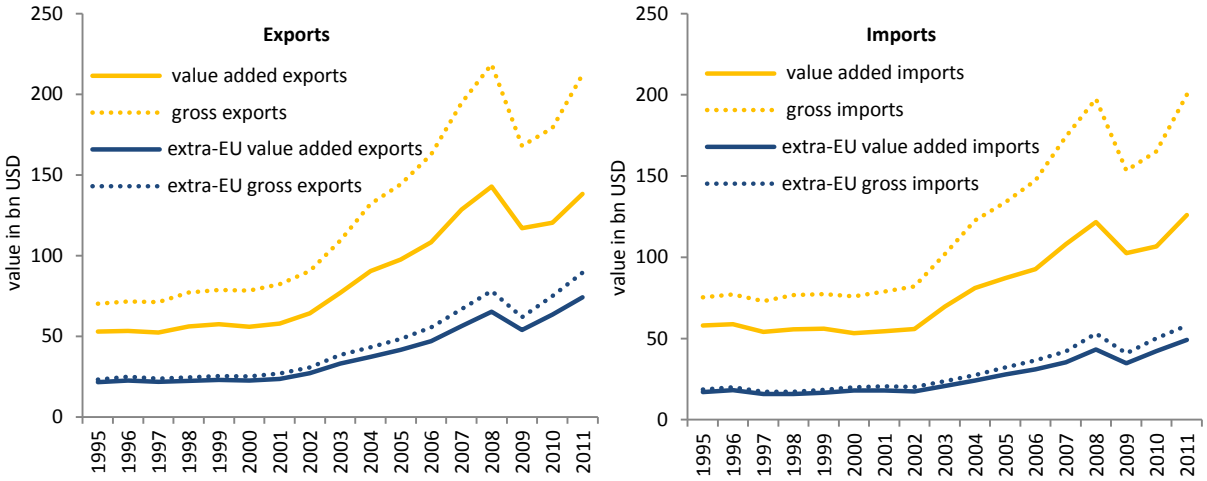
4.2. Overview – Austria's value added exports

The natural starting point for the analysis is to look at Austria's total value added exports and imports over the period of investigation, i.e. from 1995 to 2011. The results, shown in Figure 4.1, are both reassuring and interesting. They are reassuring because both value added exports and value added imports are systematically lower than gross exports and gross imports respectively as must be the case due to the elimination of double counting; and because by and large the developments of both types of trade flows follow the same general trends as should be the case for strongly interrelated variables. They are interesting because they reveal the extent to which gross trade flows are inflated by trade in intermediates and that this has been increasing over time.

Austrian total value added exports almost tripled between 1995 and 2008, reaching USD 143 billion in 2008 (Figure 4.1, left panel) but then declined sharply, by 18%, in 2009 due to the Great Recession and the accompanying trade collapse during the winter 2008/2009. Yet this decline in terms of value added is lower than the 23% decline registered in gross export flows. Since 2010 exports have been recovering, with value added exports growing by almost 15% in the year 2011. As of 2011, however,

Austria's value added exports have not fully recovered and have not reached the pre-crisis peak of 2008. The situation is different for value added imports, which reached USD 126 billion in 2011, surpassing the 2008 value by some USD 4.5 billion. Over the entire period 1995-2011, Austrian value added exports grew on average by 6.2% annually while value added imports grew by 5% annually.

Figure 4.1: Development of Austria's value added trade and gross trade flows in comparison, 1995-2011



Source: WIOD, wiiw calculations.

Comparing value added flows with gross flows shows that in 2011 value added exports of Austria equalled 65% of reported gross exports. The ratio between value added imports and gross imports in 2011 was similar, amounting to 63%. Note that these ratios – which Johnson and Noguera (2012) termed VAX ratios – show a continuously declining trend over time on both the export and import side, with only a short interruption related to the crisis of 2008/09. This signals an increasing role of trade in intermediates and international production sharing in Austrian exports and imports which mirrors the global trend. In Figure 4.1 this can be read off the fact that the distance between the value added exports (imports) curve and the gross exports (imports) curve is widening over time.

Figure 4.1 also shows Austria's extra-EU exports and extra-EU imports, again according to the value added trade concept and the gross flows. The striking feature here is that the gaps between value added exports (imports) and gross exports (imports) are much smaller. This confirms the fact that trade in intermediates and international production sharing is more important in Austria's trade with EU Member States than in trade with third countries. Related to this, it should be mentioned that gross trade statistics overestimate to some extent the importance of intra-EU trade flows. In the case of Austria, the intra-EU exports constituted 46% of total value added exports (leaving 54% for extra-EU exports) while gross exports would suggest an intra-EU share of 58% (leaving 42% for extra-EU exports) where all figures refer to 2011[8].

4.3. Global market shares based on the concept of value added trade

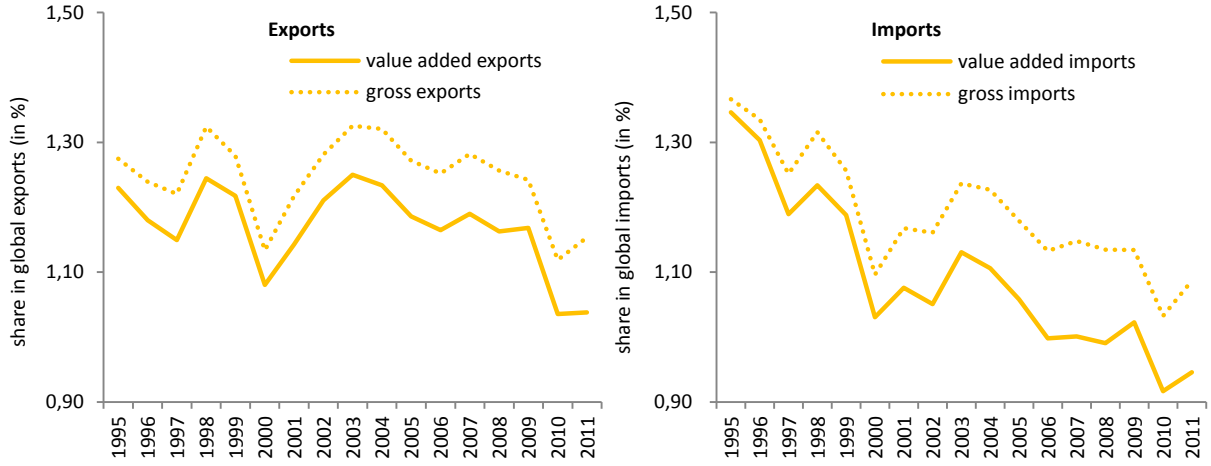
As with gross exports, it is possible to calculate export and import market shares for Austria (or any other country) based on the concept of value added trade. Austria's market shares based on value added exports and imports indicate the share of value added that is (directly and indirectly)

[8] On the import side, Austrian value added imports would account for 61% of intra-EU imports while gross imports would suggest a share of 71% of intra-EU imports (2011).

produced in Austria and linked to foreign demand in total in the global value added that is linked to foreign demand. A country's share in global value added exports is an excellent indicator of that country's external competitiveness. Notably, it is a more adequate measure of international competitiveness than the gross export market share because the double counting of trade flows introduced by trade in intermediate goods is corrected for. With international trade becoming more granular and complex, leading to ever finer specialisation on individual components of a product or steps in the production process, it also becomes more important to single out a country's value added embodied in its exports. At the same time value added exports are also a better indicator of competitiveness than simple value added shares because the 'home market effect' is excluded. For example, a large economy, say India, can have a large domestic automotive industry but produces mainly for the domestic market and only low revenues are generated by export activity due to a lack of international competitiveness. In such a case value added shares would overstate India's international competitiveness in the automotive industry. Therefore, with a view to international competitiveness it makes sense to take into account only the value added exports. Austria's market shares in global value added exports and imports are depicted in Figure 4.2.

On both the export and the import side the market share of Austria is lower in terms of value added trade than in terms of gross trade. As expected, this difference is growing over time, with the market share in global value added exports being some 10% lower than the market share in gross exports. On the export side, the difference between the two concepts of market shares amounts to 14%. This difference is explained by the fact that Austria, as a producer of a large number of advanced manufacturing products, is also strongly engaged in international production sharing which means that it exports and imports a large amount of intermediate goods and parts and components. Strong engagements in international supply chains and intermediates trade tend to inflate gross trade statistics.

Figure 4.2: Austria's share in exports and imports, value added trade and gross trade flows in comparison, 1995-2011



Source: WIOD, wiiw calculations.

The other interesting aspect is of course that Austria's shares in global value added exports and imports have been declining between 1995 and 2011[9]. The export market share in value added terms wet down from 1.2% in 1995 to roughly 1% in 2011 with the main drop occurring after the crisis of 2009. However, Austria's export market shares have been relatively stable compared to import

[9] The same is true for gross trade flows.

market shares, which dropped to just below 1% in 2011 over the same period (again in value added terms).

These declines in market share do not necessarily signal a general deterioration in Austria's international competitiveness. They rather reflect the entry of important emerging markets, notably China, into the international trade arena. Given the new global environment, i.e. the rise of China and the growing competitive pressure of emerging markets in global trade more generally, Austrian exports performed quite well. This can be seen when comparing Austria's development of export market shares with that of other EU Member States or groups of Member States, which is done in Table 4.1. Austria, together with Germany, is one of the established industrial countries in the EU that could expand its share in combined exports of the EU-27. This holds true for total EU exports, which include intra-EU exports, as well as for extra-EU exports only. Between 1995 and 2011 Austria's share in total EU exports grew by 0.3 percentage points to 3.1%. For extra-EU exports the share rose to a similar level (3%) gaining half a percentage point since 1995. It is worth noting that this expansion of market shares in total EU exports occurred in a period marked by a remarkable catch-up process of the Central and Eastern European Member States, in particular the CEEC-5 which includes the Czech Republic, Hungary, Poland, Slovakia and Slovenia.

Table 4.1: Share of Member States and groups of Member States in total EU and total extra-EU exports, in %

	Shares in total EU value added exports					Shares in total extra-EU value added exports				
	1995	2000	2007	2009	2011	1995	2000	2007	2009	2011
Austria	2.8	2.8	3.0	3.1	3.1	2.5	2.4	2.7	2.8	3.0
Germany	24.5	23.1	24.9	24.3	24.8	25.9	24.2	26.4	26.1	26.2
Benelux	14.1	12.3	11.6	12.7	12.3	10.2	9.4	9.3	10.1	10.0
Nordic countries	8.2	8.2	7.5	7.1	7.5	8.9	8.9	8.5	8.1	8.3
United Kingdom	12.8	15.1	13.3	12.0	12.0	15.3	18.0	15.1	13.7	13.3
France	14.0	13.1	10.8	11.0	10.8	15.0	13.3	10.6	11.6	11.0
Southern countries	17.5	17.7	17.5	17.5	17.3	17.2	17.3	17.4	17.4	17.1
CEEC-5	3.7	4.3	6.8	7.5	7.8	2.8	3.0	5.1	5.3	6.0
Other	2.4	3.5	4.6	4.9	4.6	2.2	3.5	4.8	5.0	5.1

Note: Benelux are Belgium, Netherlands, Luxembourg; Nordic countries are Denmark, Sweden and Finland; Southern countries are Spain, Portugal, Italy, Greece, Cyprus and Malta; CEEC-5 are Czech Republic, Hungary, Poland, Slovakia and Slovenia; Other include Ireland, Estonia, Latvia and Lithuania, Bulgaria, Romania.

Source: WIOD, wiiw calculations.

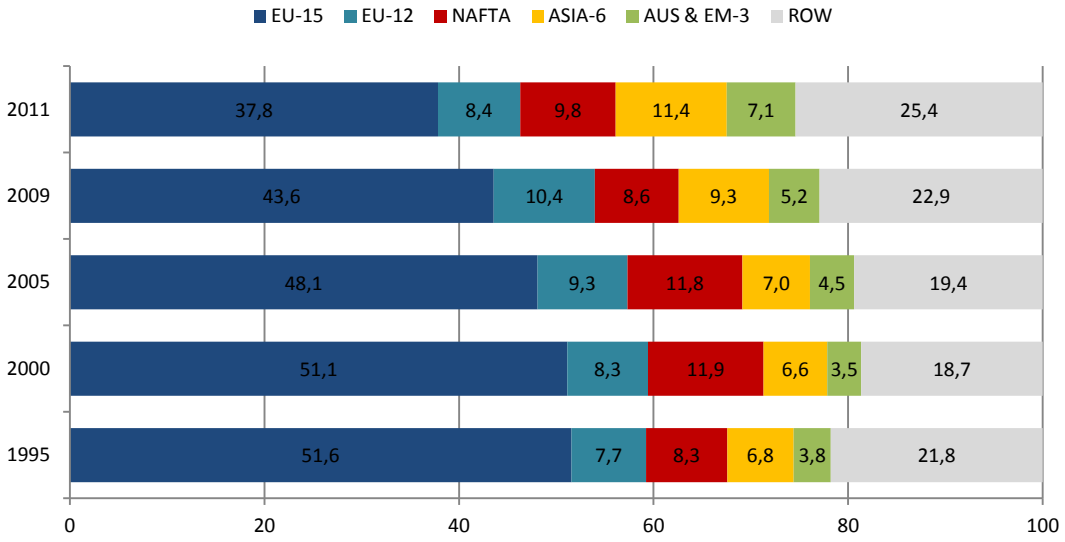
4.4. Destination markets for and sources of Austrian value added exports and imports

We now turn from the comparison of Austria's export market shares to the geographical patterns of Austrian exports. Austria's export orientation reflects the traditional 'gravity factors', which include the geographic proximity and integration in an economic bloc and the size of the trading partners.

Given the importance of the 'gravity factors' (size, distance, trade barriers) the fact that Austria's exports are strongly geared towards other EU Member States remains valid when considering geographic export patterns in terms of value added exports. In 2011 46% of Austrian value added exports were destined for the markets of other EU Member States (Figure 4.3). The overwhelming majority of these intra-EU value added exports satisfied demand in EU-15 countries (38% of total value added exports). Note, however, that the share of Austria's intra-EU exports in terms of value added exports – while still important – is lower than in terms of gross exports where the share amounts to 58%. The difference is once again due to the fact that the degree of trade integration

(and hence the amount of intermediates trade) is higher between Austria and its EU trading partners than between Austria and third countries.

Figure 4.3: Austria's value added exports by region and country groupings, 1995-2011



Note: NAFTA includes USA, Canada and Mexico; ASIA-6 includes Japan, China, India, Indonesia, South Korea and Taiwan; AUS & EM-3 includes Australia, Brazil, Russia and Turkey; ROW is rest of the world (countries that are not individually included in the WIOD database). ROW includes Switzerland.

Source: WIOD, wiiw calculations.

Of the extra-EU country groupings as depicted in Figure 4.3, ASIA-6[10] emerges as Austria's most important market for value added made in Austria with a share of 11.4% in 2011, followed by NAFTA which absorbed about 10% of Austria's value added exports. The share of value added exports shipped to the ASIA-6 countries rose from 6.8% in 1995 to 11.4%, a development that was strongly (though not exclusively) driven by China and to a lesser extent India which are both included in the ASIA-6 grouping. The rise in the relative importance of emerging markets is also reflected in the rising share of value added exports absorbed by Brazil, Russia and Turkey (7.1% in 2011) which together with Australia form the AUS & EM-3 group. Austrian value added exports to the ASIA-6 countries and the AUS & EM-3 group grew by 9.6% and 10.3% respectively per year – more than twice as much as Austrian intra-EU exports. The 'rise of Asia' and high growth in some other large emerging markets also explain the shift away from intra-EU exports and towards extra-EU destinations in Austria's export structure, which is indicated by a shrinking of the blue bars in Figure 4.3. Within the intra-EU exports it is useful, however, to distinguish between the EU-15 and EU-12 members. Due to the intra-European convergence process, represented by the catch-up of the Central and Eastern European Member States, Austria's exports to these countries performed quite well. Value added exports destined to the EU-12 grew by 6.8% annually between 1995 and 2011, with the share in Austria's overall value added exports rising to 8.4% with an interim high of more than 10% in 2009.

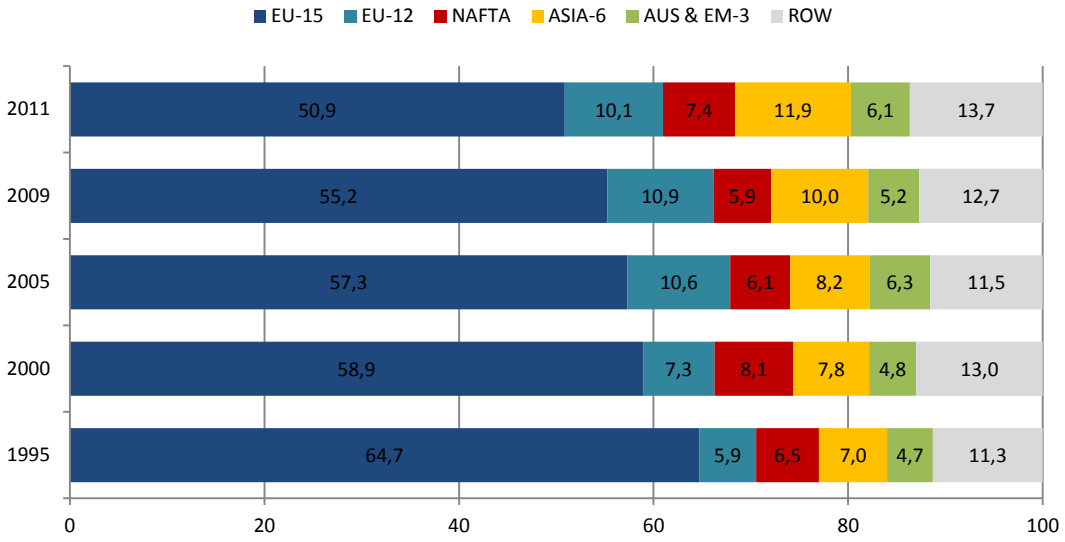
A lot of the discussion of Austria's regional export orientation is also valid for the import patterns. For example, comparing gross imports with value added imports one finds that gross flows overstate the importance of Austria's intra-EU imports, which accounted for 71% of total imports in 2011 while

[10] ASIA-6 comprises Japan, China, India, South Korea, Indonesia and Taiwan.

the share in terms of value added imports was 61% (Figure 4.4). This implies that third countries are more important as trading partners than suggested by traditional trade statistics.

With regards to the changes in the geographical import patterns, the relative decline of EU trading partners is also discernible in value added imports. However, this trend was much weaker on the import side – at least until 2009. Only then did the share of imports from EU-15 countries decline considerably. The main reason for the milder shift towards extra-EU imports is that the Central and Eastern European Member States (the EU-12) have become important sources of value added for Austria, accounting for 10% of Austria's value added imports in 2011.

Figure 4.4: Austria's value added imports by region and country groupings, 1995-2011



Note: NAFTA includes USA, Canada and Mexico; ASIA includes Japan, China, India, Indonesia, South Korea and Taiwan; AUS & EM-3 includes Australia, Brazil, Russia and Turkey; ROW is rest of the world (countries that are not individually included in the WIOD database). ROW includes Switzerland.

Source: WIOD, wiiw calculations.

In contrast, and somewhat surprisingly, the shares of ASIA-6 countries, which include China, i.e. 'the factory of the world, and that of large emerging markets outside Asia (AUS & EM-3) in Austrian value added imports did not expand more than the respective shares in value added exports. In fact, the growth of Austrian value added exports to the ASIA-6 between 1995 and 2011 was higher (9.6% annually) than the growth of Austrian value added imports from these countries, which amounted to 8.5% annually. This suggests that the emergence of new trading partners on the one hand increases the competitive pressures, on the other hand, however, it also constitutes formidable export opportunities for existing and new exporters.

In Table 4.2 and Table 4.3 Austria's most important export and import partners are singled out and ranked both in terms of gross trade flows and value added trade. Unsurprisingly, Germany emerges as Austria's most important trading partner, absorbing 16.8% of Austrian value added exports. Note, however, that the share is considerably lower in value added terms than in terms of gross exports, which stood at 26.1% in 2011. This difference stems again from the fact that production sharing between Austria and Germany is particularly intensive because many Austrian small and medium-sized suppliers and contractors are strongly oriented towards Germany's large engineering and automotive industries. There are also some differences in the rankings. First of all, Italy appears to be

a less important source of demand for value added produced in Austria than suggested by gross exports and it only occupies rank 5 in the list of Austria's main export destinations in value added terms whereas it is the second largest export partner behind Germany. Secondly, large extra-EU markets tend to absorb higher shares of Austrian value added than suggested by gross exports. For example, China is in third position in terms of value added exports (occupying rank 5 in gross exports) and Russia and Brazil are found among the top ten, which is not the case in the list of gross export destinations. A main reason for the increased importance of extra-EU markets in the value added trade statistics are Austria's 'indirect exports' to emerging markets via Germany, which is a strong exporter to China but also other emerging markets.

Table 4.2: Austria's most important export destinations – gross exports vs. value added exports, 2011

	Gross exports					Value added exports			
Rank	to	Share in %	Export value in USD million	Annual growth 1995-2011	Rank	to	Share in %	Export value in USD million	Annual growth 1995-2011
1	Germany	26.1	55,484	6.5%	1	Germany	16.8	23,301	4.2%
2	Italy	6.1	13,020	6.2%	2	USA	7.9	10,932	6.8%
3	USA	5.4	11,492	8.4%	3	China	6.9	9,566	19.4%
4	Switzerland*	5.3	11,333		4	Switzerland*	6.1	8,441	
5	China	5.2	10,942	21.2%	5	Italy	5.7	7,849	5.3%
6	France	3.2	6,778	6.9%	6	France	3.8	5,262	5.4%
7	Hungary	3.2	6,759	8.9%	7	United Kingdom	3.6	5,024	2.4%
8	Czech Republic	2.9	6,246	8.3%	8	Russia	2.4	3,289	7.6%
9	United Kingdom	2.8	5,989	2.3%	9	Brazil	2.3	3,198	15.7%
10	Poland	1.9	4,045	11.8%	10	Spain	2.1	2,845	4.8%
	Total		212,267	7.2%		Total		138,303	6.2%

Note: *Switzerland is not included as a separate country in the WIOD. Switzerland's share in Austrian exports was approximated based on its share in the non-WIOD countries (i.e. the rest of the world) which we obtained for both goods trade and services trade from conventional databases.

Source: WIOD, Eurostat trade in services database, Comext; wiiw calculations.

Table 4.3: Austria's most important import sources – gross imports vs. value added imports, 2011

	Gross imports					Value added imports			
Rank	from	Share in %	Import value in USD million	Annual growth 1995-2011	Rank	from	Share in %	Import value in USD million	Annual growth 1995-2011
1	Germany	36.3	72,682	5.8%	1	Germany	29.1	36,696	3.9%
2	Italy	6.4	12,740	4.8%	2	Switzerland*	7.1	8,906	
3	Switzerland*	5.7	11,448		3	China	6.5	8,194	16.5%
4	Czech Republic	5.0	9,994	12.0%	4	USA	5.8	7,275	5.3%
5	China	4.8	9,599	17.5%	5	Italy	5.7	7,128	2.7%
6	USA	3.9	7,753	7.0%	6	United Kingdom	3.4	4,223	3.1%
7	Hungary	2.9	5,821	9.8%	7	France	3.1	3,957	1.8%
8	France	2.6	5,219	2.9%	8	Czech Republic	3.1	3,862	8.7%
9	United Kingdom	2.4	4,869	3.4%	9	Netherlands	2.7	3,420	3.3%
10	Netherlands	2.4	4,794	3.5%	10	Russia	2.7	3,357	4.4%
	Total		200,017	6.3%		Total		126,052	5.0%

Note: *Switzerland is not included as a separate country in the WIOD. Switzerland's share in Austrian exports was approximated based on its share in the non-WIOD countries (i.e. the rest of the world) which we obtained for both goods trade and services trade from conventional databases.

Source: WIOD, Eurostat trade in services database, Comext; wiiw calculations.

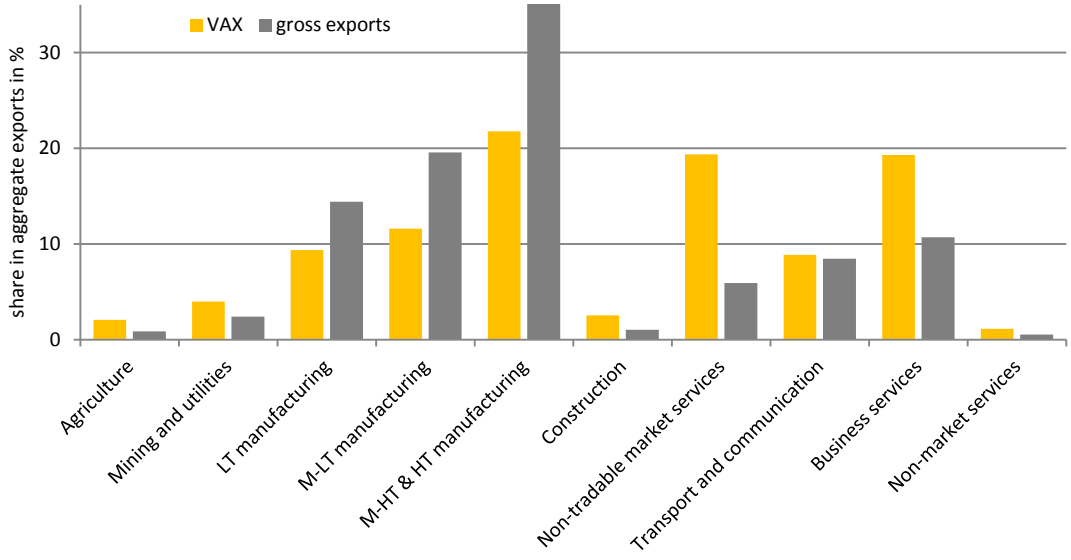
Thirdly, and linked to the previous point, the Central and Eastern European Member States Hungary, the Czech Republic and Poland, which have advanced to major export destinations, are not among the top ten according to the value added exports concept. This means these countries are important as partners for Austrian firms in international production networks, including as locations for foreign direct investment, but their relevance as a source of external demand for Austrian value added is overstated in traditional export statistics. Some of these phenomena are also found on the import side. Germany is of course also the number one source of Austrian imports but its share in value added imports of 29% is almost 7 percentage points lower than in gross terms. As in the case of exports, China in particular but also the United States and again Russia move up the ranking when switching from gross imports to value added imports. In contrast, the Czech Republic, the sole Central and Eastern European trading partner among the top ten import destinations, moves down from rank 4 to rank 8 when value added exports are considered.

To summarise, the value added trade rankings in Table 4.2 and Table 4.3 indicate that the real importance of large countries, in particular some large emerging markets but also the United States, for value added creation in Austria and as an ultimate source of imports is larger than suggested by traditional trade statistics. Central and Eastern European Member States are important partners in production networks but their role as sources of demand for Austrian value added and as sources of Austrian imports is overstated by gross trade flows.

4.5. The industry structure of Austria's value added exports

So far aggregate Austrian trade flows and exports to as well as imports from different destinations have been analysed. It is equally possible to disaggregate value added trade by industries. It is in fact the industry level at which the most significant differences between gross exports and value added exports emerge. Figure 4.5 highlights this point by comparing Austria's export structure by broad industry groups according to the two different concepts in 2011.

Figure 4.5: Austrian gross exports and value added exports by broad industries, 2011

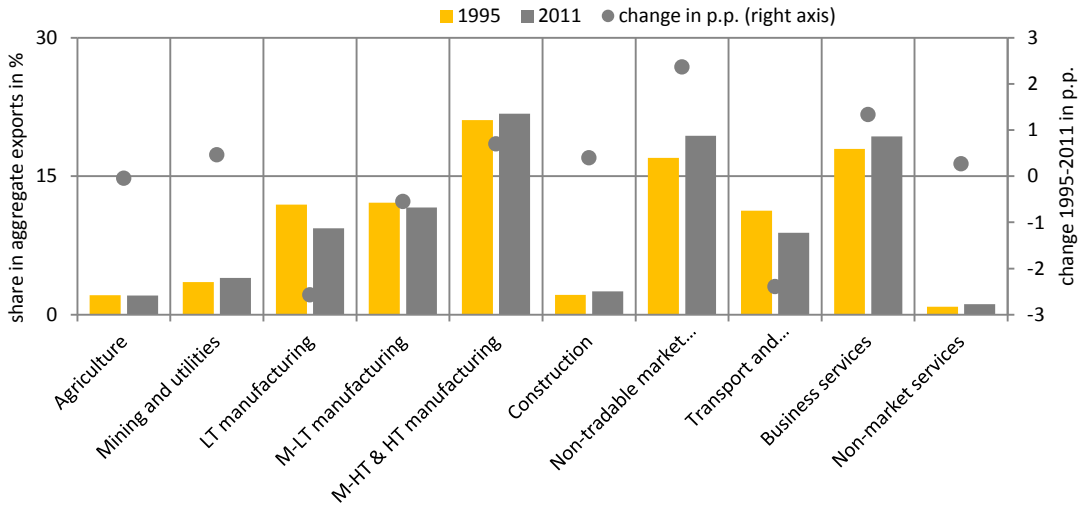


Note: Industry groups based on NACE Rev. 1. LT manufacturing = low-tech manufacturing industries; M-LT = low-to-medium-tech industries; M-HT & HT = medium-to-high- and high-tech industries. For the definition of industry groups see Appendix.

Source: WIOD, wiiw calculations.

The most striking feature in Figure 4.5 is that the relative importance of services, including in particular non-tradable services and business services, in value added exports is much higher than in gross exports; the opposite is true for manufacturing industries. These differences have two major explanations. Firstly, trade in intermediates is more developed in manufacturing than in services, which shifts the relative shares towards the latter when switching from gross exports to value added exports. The most extreme example are the medium- and medium-high-technology-intensive industries (which comprise among others machinery, the electric and the transport equipment industries) whose 22% share in value added exports is some 15 percentage points lower than in gross terms. Secondly, and more importantly in quantitative terms, services constitute more than two thirds of Austrian GDP. Hence, it is not surprising that in value added terms services represent almost half of Austrian exports rather than a quarter as it is the case in gross terms. This reveals an interesting aspect concerning the inter-linkages between manufactures and services. While services are more important in trade than suggested in gross trade statistics, manufactures are essential for the Austrian economy because they provide a 'carrier function' for services which tend to be, on average, less tradable. This point can be illustrated by looking at the group of services labelled 'non-tradable services', which include for example retail and wholesale trade or real estate activities. Since they are largely non-tradable, the share of these services in gross exports is less than 6%, but it is about 20% in terms of value added exports. This is facilitated by manufactures, which make it possible to 'indirectly export' activities which by themselves are not tradable. While the relative share of manufactures is much lower in value added exports, they are required to develop competitive advantages in many services, including also business services (see Stöllinger et al., forthcoming, and Nordås and Kim, 2013)[11].

Figure 4.6: Change in Austria's export structure by industry, value added exports, 1995-2011



Note: Industry groups based on NACE Rev. 1. LT manufacturing = low-tech manufacturing industries; M-LT = low-to-medium-tech industries; M-HT & HT = medium-to-high- and high-tech industries. For the definition of industry groups see Appendix.

Source: WIOD, wiiw calculations.

Tracking the Austrian industry structure in value added terms over time reveals a favourable if modest structural shift as indicated in Figure 4.6. By this, we mean that the share of medium-high-

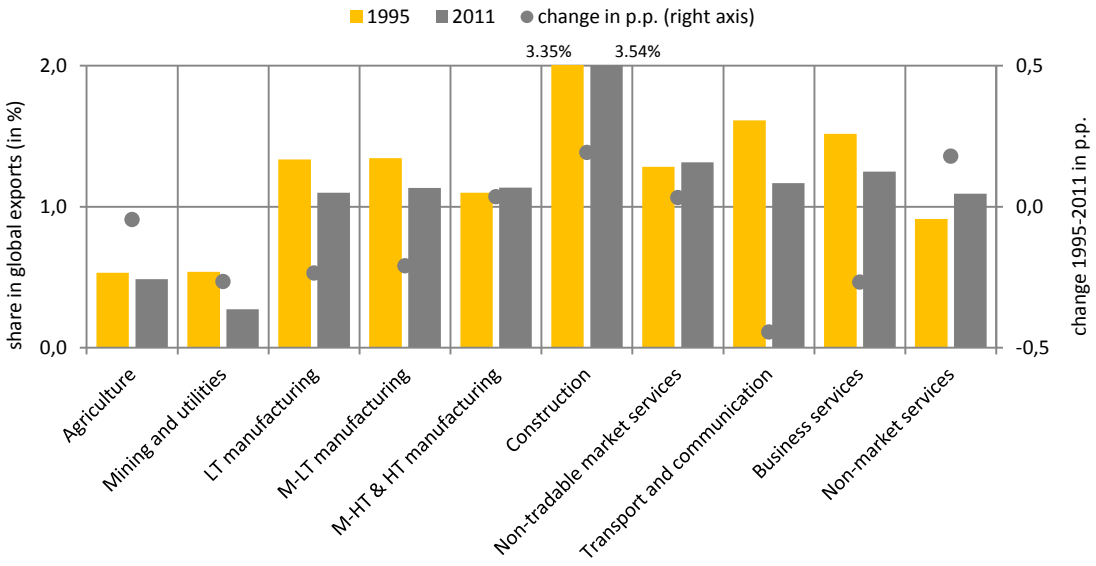
[11] An alternative for exporting services indirectly is of course the foreign direct investment channel (Mode 3 of services trade in WTO terminology). However, indirect exports have the advantage that they lead to a direct improvement in the current account.

and high-tech industries, which are generally supposed to have higher potential for positive externalities and learning effects, increased by 0.7 percentage points between 1995 and 2011 (to 21.8%). Moreover, business services, which are important for knowledge generation and include a number of high value added activities (e.g. marketing and consulting activities, R&D), increased by 1.3 percentage points to 19.3% in 2011[12].

There is also a direct connection between the Austrian industry structure and the export market shares. The latter are depicted in Figure 4.7. In line with the observed structural change, Austria's share in global value added exports increased slightly to 1.14% in 2011. However, the expansion and structural shift towards business services in Austria was not strong enough to bring about an expansion of the global market share. So the growth of business services in Austria was underperforming between 1995 and 2011 compared to the growth in global demand. At the same time the market share in value added exports of business services was still significantly above Austria's market share in aggregate exports (which was about 1% in 2011).

A noticeable feature in Austria's value added exports is the high market share in the construction sector, which amounted to 3.5% in 2011. This could signal a more international orientation of the construction sector (and hence implicitly also high international competitiveness) than in other countries. Alternatively, it could mean that the Austrian construction sector is oversized and strongly in need of consolidation, as has recently been suggested in the context of the insolvency of Austria's second largest construction company.

Figure 4.7: Austrian export market shares by industry groups, value added exports, 1995-2011



Note: Industry groups based on NACE Rev. 1. LT manufacturing = low-tech manufacturing industries; M-LT = low-to-medium-tech industries; M-HT & HT = medium-to-high- and high-tech industries. For the definition of industry groups see Appendix.

Source: WIOD, wiiw calculations.

Note also that in 2011, Austria's market share in value added exports was roughly 1.1% in low-tech, medium-tech and medium- to low-tech manufacturing industries respectively – slightly above the aggregate export market share. Depending on the perspective, the equal performance of the three

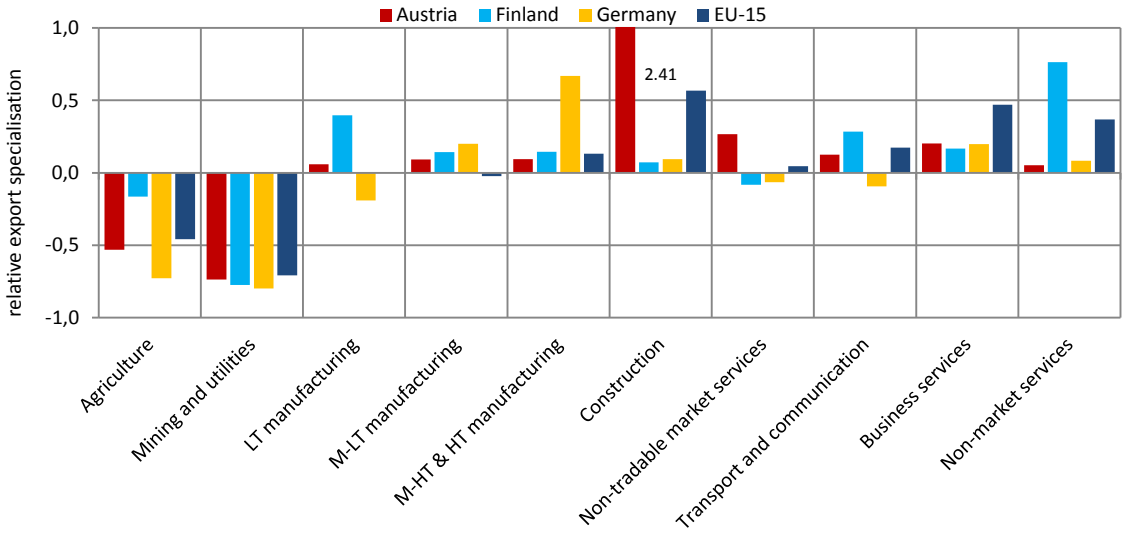
[12] The structural shift towards medium- and medium-high-tech manufacturing industries is also discernible in gross export data whereas the share of business services in gross exports declined between 1995 and 2011.

broad groups of manufacturing industries could indicate a lack of international specialisation or reflect a well-diversified manufacturing sector in which firms manage to occupy niches and develop comparative advantages in industries of varying technology intensity.

In Figure 4.8 Austria's relative specialisation pattern – which we calculate as the difference between the industry-level export market share and the aggregate export market share relative to the aggregate export market share – is compared to that of two peer countries, Finland and Germany, as well as to that of the EU-15. A commonality of all four economies is that market shares in value added exports of primary industries (agriculture and mining) are below their aggregate share whereas all of them have a relative specialisation in medium-high- to high-tech manufacturing industries and in business services. The same is also true for construction and non-market services.

Within the manufacturing industries, the large difference in the extent of specialisation in medium-high- to high-tech manufacturing industries between Austria and Germany is surprising. This comparison suggests that Austria's manufacturing sector is less geared towards 'advanced' manufacturing than that of Germany. However, a comparison with Finland, which is also a small open economy with high income, would lead to a different conclusion. Finland is relatively more specialised in low-tech manufacturing industries despite the stronghold in the electronic industry. The reasons for this specialisation pattern are Finland's relatively large wood and pulp and paper industries.

Figure 4.8: Relative export specialisation patterns of selected countries by industry groups, value added exports, 2011



Note: Industry groups based on NACE Rev. 1. LT manufacturing = low-tech manufacturing industries; M-LT = low-to-medium-tech industries; M-HT & HT = medium-to-high- and high-tech industries. For the definition of industry groups see Appendix. The relative specialisation is the difference between the industry-level export market share and the aggregate export market share to the aggregate export market share. Positive values indicate relative specialisation in that industry, negative values indicate a lack of specialisation in that industry.

Source: WIOD, wiiw calculations.

A commonality of Austria, Germany and Finland is that overall they seem to be more specialised in manufacturing than in services compared to the EU-15. In particular, these three countries have a relatively smaller focus on business services in their value added-based export structure than the EU-15. There are, however, also deviations from this general pattern such as Austria's specialisation in non-tradable market services, Finland's non-market services or Germany's low-tech manufacturing industries.

5. Trade balances in value added and factor income terms

5.1. Bilateral trade balances

Considering imports and exports in value added terms raises the question to which extent this might change a country's trade balance. Case studies on international production fragmentation for individual products such as the iPod would suggest that, though the United States reports imports from China of USD 150, the actual value added embodied in the iPod created in China is only USD 5, which would mean much lower imports of the United States from China. However, the logic applied in such studies for single products cannot be generalised and does not translate to the country level. At the aggregate level, the trade balance in value added terms is equal to the gross trade balance as the trade balance in national accounts basically reflects a country's overall saving position (see Stehrer, 2012 and 2013, for details). At the bilateral level, however, this need not be the case. Thus a country might have a lower trade deficit (surplus) in value added terms as compared to gross trade statistics with some countries and a larger trade deficit (surplus) in value added terms as compared to gross trade with some other countries (for bilateral accounts, see Stehrer, 2013). Likewise, shifts of positions from deficit to surplus or vice versa are possible in bilateral trade balances.

Box 5.1 - Illustrating the differences between net trade in gross and value added terms

The differences between the trade balance in gross and value added terms result from the possibility that a country might trade with another country only indirectly via a third partner. In the example below, country A exports an intermediate worth 10 to B, which then – after adding some value of its own – ships the final product worth 15 to C, where it is consumed. In this case no physical shipment of goods between A and C would be observed, though there is value added created in country A which is finally absorbed in country C. Thus B runs a trade deficit with A of 10 whereas trade between A and C would be zero. Country C would however run a trade deficit with B of 15. However, though there is no physical flow of goods between A and C, there is still value added created in A and absorbed in C. In this example, though the trade balance between A and C in gross terms would be zero, in value added terms country C would have a trade deficit with A of 10 and a trade deficit with B of 5. Country A would however report a trade surplus with B in gross terms, whereas – in this simplistic example – the trade balance in value added terms between A and B would be zero. Note that in both concepts country A has an overall (i.e. multilateral) trade surplus of 10, B of 5 and C a trade deficit of 15.

	Gross terms		
	A	B	C
A	.	-10	0
B	10	.	-15
C	0	15	.

	Value added terms		
	A	B	C
A	.	0	-10
B	0	.	-5
C	10	5	.

Applying the concept of value added exports at the bilateral level and the mirror image, i.e. value added imports in a bilateral way (see Box 5.2) allows calculating trade balances in value added terms and comparing them to trade balances in gross terms (see Box 5.1). In Table 5.1 these bilateral imbalances both in gross and value added terms, expressed in per cent of GDP, are reported for Austria with its trade partners as included in the WIOD database for selected years.

Table 5.1: Bilateral trade balances in gross and value added terms in % of GDP, selected years

	Gross terms				Value added terms			
Partner	1995	2000	2007	2011	1995	2000	2007	2011
AUS	0.07	0.18	0.25	0.16	0.05	0.13	0.19	0.13
AUT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BEL	-0.16	0.30	0.03	-0.18	-0.20	0.05	-0.01	-0.11
BGR	0.05	0.07	0.28	0.11	0.03	0.04	0.16	0.06
BRA	-0.05	0.02	0.02	0.43	-0.04	0.01	0.01	0.32
CAN	0.07	0.00	0.19	0.03	0.02	0.00	0.13	0.08
CHN	-0.10	-0.10	-0.50	0.34	-0.07	-0.05	-0.31	0.34
CYP	0.01	0.02	0.04	0.02	0.01	0.02	0.04	0.01
CZE	0.06	-0.02	-0.49	-0.94	0.02	-0.04	-0.29	-0.35
DEU	-4.01	-4.25	-4.62	-4.29	-3.52	-3.01	-3.05	-3.34
DNK	0.03	0.08	0.11	0.02	0.01	0.03	0.06	-0.01
ESP	0.27	0.82	0.46	0.02	0.17	0.58	0.51	0.07
EST	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
FIN	0.02	-0.14	-0.03	0.03	-0.02	-0.09	-0.01	0.02
FRA	-0.43	-0.08	0.33	0.39	-0.32	0.02	0.39	0.33
GBR	0.59	1.16	0.50	0.28	0.37	0.80	0.46	0.20
GRC	0.07	0.20	0.29	0.18	0.09	0.18	0.26	0.15
HUN	0.19	0.23	0.58	0.23	0.12	0.11	0.17	0.02
IDN	0.02	-0.11	-0.01	-0.04	0.02	-0.09	-0.02	-0.04
IND	0.05	-0.01	0.10	-0.32	0.05	0.01	0.11	-0.12
IRL	-0.06	-0.07	0.13	-0.07	-0.06	-0.06	0.05	-0.05
ITA	-0.47	0.57	1.11	0.07	-0.53	0.27	0.83	0.18
JPN	-0.13	-0.12	0.07	-0.02	-0.17	-0.12	0.01	-0.01
KOR	-0.04	-0.03	0.20	0.22	-0.04	-0.03	0.09	0.06
LTU	0.00	0.01	0.00	-0.01	0.00	0.01	0.01	0.00
LUX	-0.13	-0.07	-0.03	0.04	-0.07	-0.02	-0.02	-0.01
LVA	0.00	0.01	0.07	0.00	0.00	0.01	0.06	0.01
MEX	0.00	0.02	0.14	0.09	-0.01	0.04	0.10	0.08
MLT	0.00	0.00	0.02	0.01	0.00	0.00	0.02	0.01
NLD	-0.51	-0.47	-0.45	-0.58	-0.37	-0.29	-0.31	-0.41
POL	-0.03	0.29	-0.07	-0.02	-0.06	0.20	-0.01	-0.08
PRT	-0.06	-0.01	0.12	-0.02	-0.02	0.04	0.09	0.03
ROU	0.11	0.07	0.57	0.28	0.08	0.05	0.41	0.21
RUS	-0.26	-0.43	0.08	0.28	-0.29	-0.53	-0.24	-0.02
SVK	0.04	-0.19	-0.72	-0.50	0.02	-0.06	-0.28	-0.17
SVN	0.16	0.12	0.56	0.07	0.08	0.05	0.24	0.02
SWE	-0.07	-0.08	0.01	0.04	-0.10	-0.07	0.02	0.01
TUR	-0.05	0.05	0.14	0.00	-0.03	0.05	0.17	0.10
TWN	0.00	0.01	0.12	-0.07	0.01	0.01	0.03	-0.05
USA	0.23	0.94	2.27	0.93	0.29	1.24	1.93	0.91
ZROW	2.28	2.45	3.82	5.83	2.23	1.92	3.65	4.47
Total	-2.25	1.42	5.69	3.06	-2.25	1.42	5.69	3.06

Source: WIOD database; wiiw calculations.

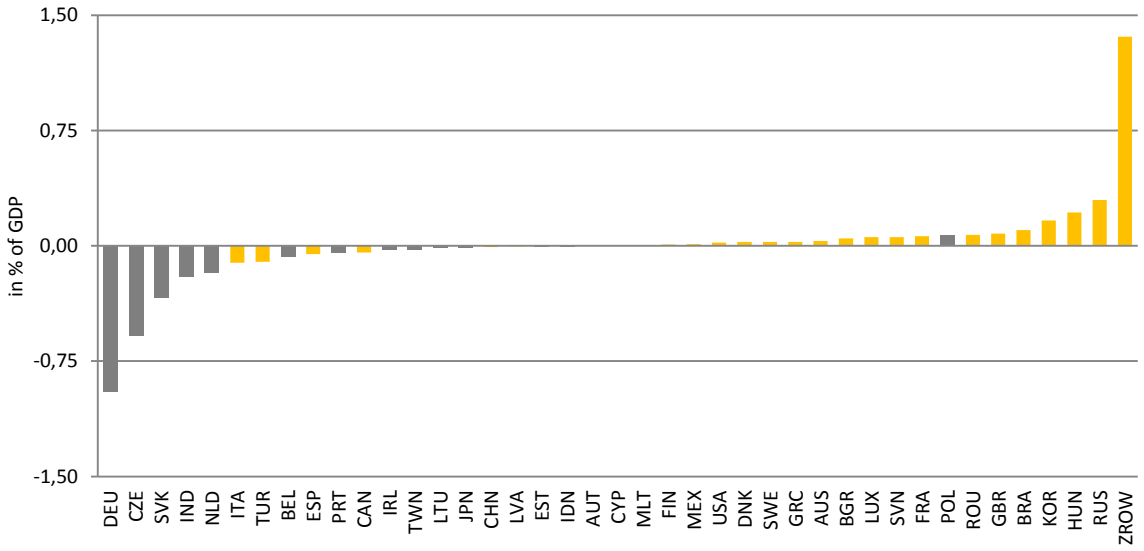
Box 5.2 – Calculating net trade in value added

Formally, value added exports of country r can be expressed as the value added created to satisfy final demand in all other countries, or formally as $VAX^{r*} = \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}^{-r}$ where $\boldsymbol{v}^r$ denotes a 1xNC vector including value added coefficients of country *r* and zeros otherwise, $\boldsymbol{L}$ is the global Leontief inverse, and $\boldsymbol{f}^{-r}$ denotes an NCx1 column vector including final demand of all other countries. Bilateral value added exports are analogously defined as $VAX^{rs} = \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}^s$; in this case $\boldsymbol{f}^s$ denotes an NCx1 column vector with final demand of country *s* in its own country and other countries including country *r*. Therefore, $VAX^{r*} = \sum_{s \neq r}^{C} \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}^s$. The bilateral trade balance in value added terms is then given by $NVAX^{rs} = NVAX^{rs} - NVAX^{sr}$ (see Stehrer, 2012 and Stehrer, 2013 for details).

The last line in Table 5.1 shows Austria's overall net trade position. In 1995 Austria's trade deficit amounted to about 2.25% of GDP which turned into a surplus thereafter. For example, in 2011 the surplus was about 3% of GDP. It should be noted that these figures are the same irrespective of whether they are calculated in gross or in value added terms. However, as pointed out above, this is different when considering bilateral trade relations. For example, with respect to Germany – as the main trading partner – Austria's trade deficit in terms of GDP in gross terms is between 4%-5% of GDP over the period considered when measured in gross terms. However, when measured in value added terms, the deficit is reduced to slightly above 3%. A second example is Italy, with which Austria recorded a trade surplus of 0.07% of GDP in 2011 when measured in gross terms whereas in value added terms it was slightly larger, amounting to 0.18% of GDP.

Figure 5.1 shows this difference between net trade in per cent of GDP when measured in gross and value added terms for all countries included in the WIOD database. One has to distinguish four different cases depending on whether there is a trade deficit or surplus in gross terms and whether the difference to the surplus or deficit in value added terms is larger or smaller, which is indicated by the different colouring in Figure 5.1. As indicated, for most partner countries with which Austria is running a trade deficit in gross terms, the deficit is lower when measured in value added terms. This concerns particularly Germany, the Czech Republic, Slovakia, India and the Netherlands. With some countries, e.g. Italy, Turkey and Spain, Austria has a trade surplus which is even higher when measured in value added terms as compared to gross trade statistics, though differences in these cases are typically quite small. Thus, when considering trade imbalances in value added terms rather than gross trade with these countries, Austria's overall trade deficit tends to become smaller. However, there is also a bulk of countries for which trade surpluses in value added terms are lower. This group of countries includes Russia, Hungary, South Korea, Brazil and the United Kingdom.

Figure 5.1: Differences of bilateral trade balances in gross and value added terms relative to GDP for 2011, in percentage points



Note: Bars are colour coded: dark negative bar indicates lower trade deficit in value added terms; light negative bar indicates higher trade surplus in value added terms; dark positive bar indicates higher trade deficit in value added terms; light positive bar indicates lower trade surplus in value added terms.

Source: WIOD database; wiiw calculations.

More generally, with a few exceptions, trade deficits and trade surpluses when measured in value added terms tend to become smaller as compared to gross trade figures. The key to understanding

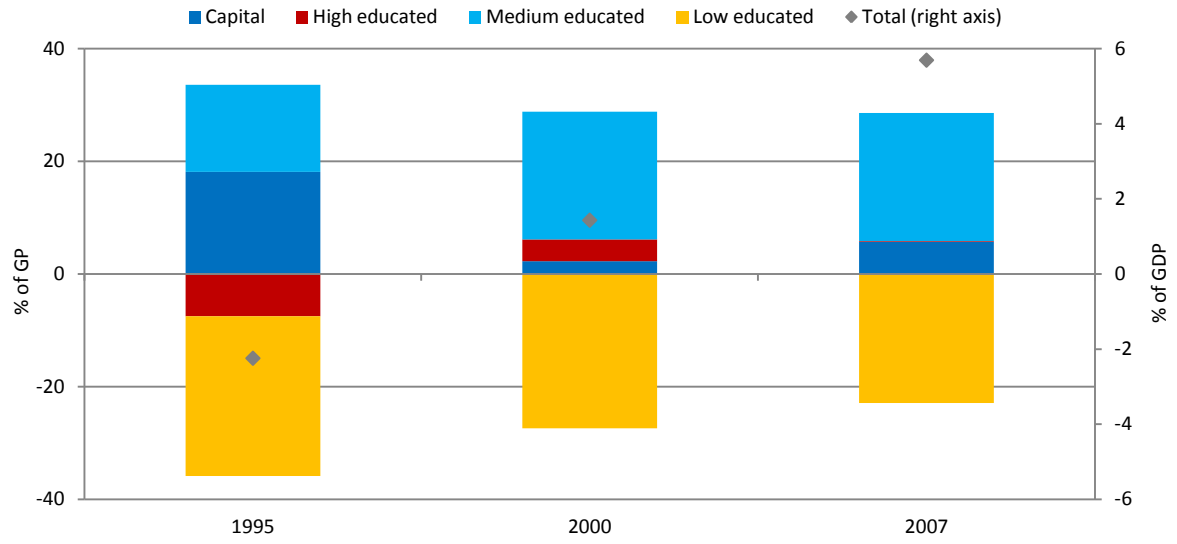
these patterns is of course trade in intermediates: for the former group of countries Austria's imports from these countries tend to embody less value added created in the trading partners (e.g. a car imported from Germany or the Czech Republic embodies also value added from other countries providing intermediates). Though Austrian exports to these countries also embody foreign value added, the former effect dominates. For instance, if Austria delivers technology-intensive components via a third country, the car imported from the final producer would imply a trade deficit which equals the amount of the total car, though in value added terms this is smaller as the intermediates delivered beforehand are no longer included (as in the example shown in Box 5.1). Analogously, Austria's exports to other countries with which Austria runs a trade surplus when measured in value added terms are somewhat reduced as these also include foreign value added. Imports from these countries might embody larger amounts of these partners' domestic value added, however, as this group comprises resource-rich countries (e.g. Russia) or countries with higher service shares (e.g. the United Kingdom).[13]

5.2. Trade balances in factors

A second interesting application from the value added perspective is to consider trade by individual factors of production. Value added exports, i.e. value added created in a country which is absorbed by other countries' final demand, is – by national accounting identities – equal to factor incomes. The socio-economic accounts of the WIOD data allows one to split value added exports and imports into income of labour and capital (defined broadly as e.g. also including depreciation). Labour income can further be split into income of high-, medium- and low-educated workers according to ISCED categories. From a theoretical Heckscher-Ohlin perspective, one would expect that a country relatively better endowed with specific factors exports more products which are intensive in those factors and imports other products for which this country has a comparative disadvantage. However, such an argument needs strong assumptions such as, particularly, factor price equalisation and identical technologies and consumption patterns across countries (see Foster and Stehrer, 2013b, for details). Violations of these assumptions make it more difficult to provide a clear prediction with respect to trade balances by factors of production. Using the WIOD data allows one however to address this issue empirically. This is shown in Figure 5.2 which splits Austria's trade balance in per cent of GDP into the four factors mentioned above. The results suggest that Austria is a net importer of low-educated workers in income terms which e.g. in 2007 accounts for about 20% in terms of Austrian GDP. However, Austria is a strong net exporter in terms of medium-skilled incomes driven by the specialisation structure of Austrian exports (e.g. in higher-tech industries) which are intensive in this factor together with Austria's strong endowments with this type of labour. The contribution of capital income was relatively high in 1995 but has declined over the years. Finally, with respect to high-educated workers' income, a deficit of about 8% is observed in 1995 which turned into a slightly positive amount in 2000 and a negligible surplus in 2007. This relatively low contribution of high-educated workers can be explained by the relatively low share of high-educated workers in Austria due to the Austrian educational system with its emphasis on apprenticeship and vocational training.

[13] At the aggregate level of course trade structures matter as well which would have to be considered individually for each bilateral pair.

Figure 5.2: Structure of Austrian trade balance by factor, in % of GDP



Source: WIOD database; wiiw calculations.

6. Global value chain income at the sectoral level

The inter-industry and inter-country linkages as emphasised when using global input-output tables allow for another slightly different perspective more geared towards an industry-centred point of view. One first key insight in analysing global value chains is that a country does not need to produce the final product itself, but can participate in the production of it via delivery of parts and components or intermediates more generally. As an example, Austria – though not making and exporting cars itself – contributes to the worldwide, and in particular the European, car production by delivering specialised and often custom-made inputs. As the iPod and the Volvo examples as well as a number of other case studies show, providing high-tech intermediate inputs may create more value added than the assembling stage and hence the fabrication of the final product. An extreme example of this is the bicycle industry where component manufacturers tend to set standards and also account for the most of the technological progress. Secondly, these inputs to the final output are not necessarily inputs from the same industry. Production of software which is finally used when using an electronic product (think of a computer or a mobile phone) is not classified as output or value added created in the electronics industry. This is also referred to as the 'smile curve' which was originally suggested by Stan Shih, the founder of Acer. The smile curve emphasises (and in fact visualises) that pre- and post-production stages are becoming more important at least for developed countries and often account for the bulk of a product's value added (see for example De Backer, 2013). The former would include e.g. R&D efforts, design, etc. whereas the latter are transport, marketing, etc. Conceptually related to this international fragmentation of value added creation along the value chain is the calculation of a country's contribution to satisfy global demand in a specific industry. This way of analysing trade relations has become known as the global value chain approach and provides an alternative measure of competitiveness (see Timmer et al., 2013).

Box 6.1 - Sectoral global value chain income

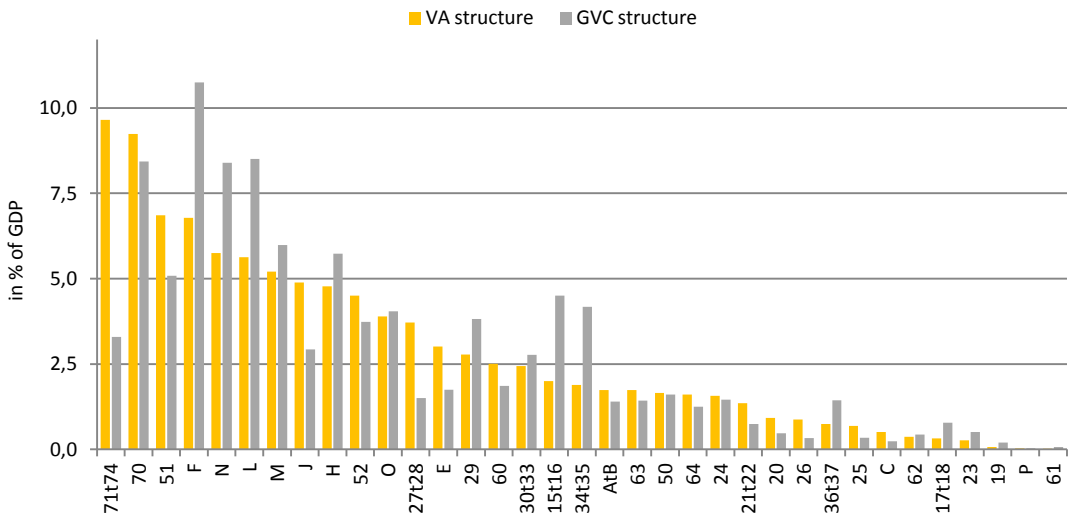
As an example assume that the software industry in country A provides inputs to electronic components in country B. These components are shipped to country C where the final product, e.g. a car, is assembled. From a gross trade perspective, one would argue that country A has a comparative advantage in software, B in electronics and C in cars. From a value added trade perspective, this could be different in case the car assembling country imports a large amount of foreign value added (and assuming that assembly is not value added-intensive) when compared with another country D which might be able to produce most of the components domestically (e.g. Germany compared to the Czech Republic). From a global value chains (GVC) perspective, it could even be the case that country B, which provides high-tech electronic components, pops up as having comparative advantages in car manufacturing.

In this section individual industries or groups of industries such as low-, medium- and high-tech manufacturing or business services are singled out in the final demand vector. Using the methodology akin to that for calculating market shares in value added exports, this allows answering the question how much production and value added creation Austria (or any other country) can attract for satisfying the global demand of a given industry and how this has developed over time.

Box 6.2 - Calculating sectoral GVC income

Formally, the GVC income of country *r* to satisfy world demand for final products made in industry *k* can be expressed as $GVC_k^r = \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}_k$ where $\boldsymbol{v}^r$ denotes a 1xNC vector including value added coefficients of country *r* and zeros otherwise, $\boldsymbol{L}$ is the global Leontief inverse, and $\boldsymbol{f}_k$ denotes an NCx1 column vector including final demand for product made in industry *k* in all countries and zeros for other products (see Timmer et al., 2013 for details). When summing up over all industries one gets the country's GDP, i.e. $GDP^r = \sum_k \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}_k$. If one is interested in only the part of GVC income which is absorbed abroad, one might include only foreign final demand for the respective products. In that case, when summing over all products one would arrive at the country's value added exports, i.e. $VAX^r = \sum_k \boldsymbol{v}^r \boldsymbol{L} \boldsymbol{f}_k^{-r}$.

Figure 6.1: Structure of Austrian sectoral GVC income in % of GDP compared to VA structure, 2011



Source: WIOD database; wiiw calculations. For the industry classification see Appendix.

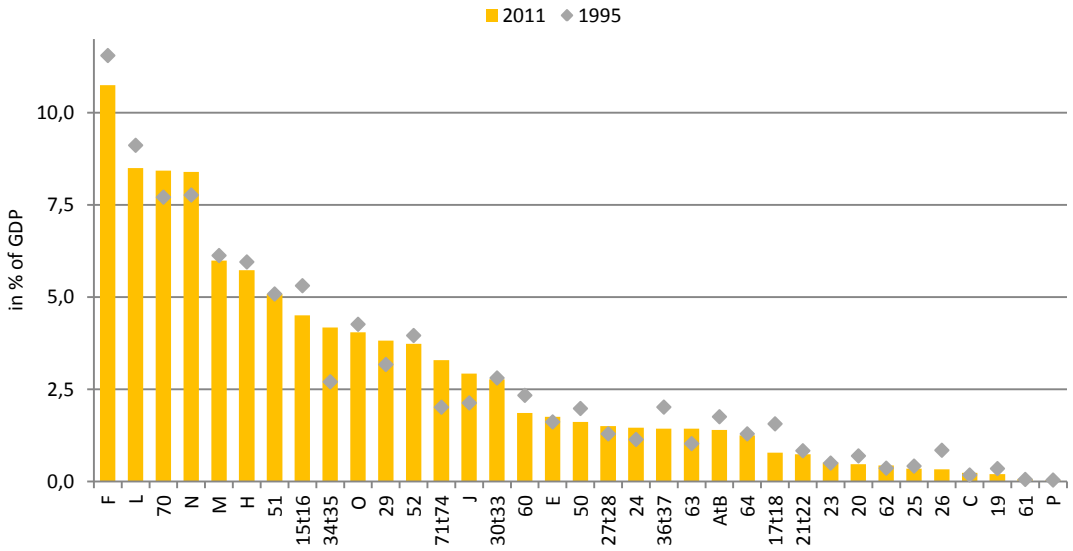
Figure 6.1 presents the structure of Austrian GDP measured in both concepts (see Appendix Table A.2.2 for details). For some sectors the GVC shares are considerably larger as compared to the share of value added of these sectors in Austrian GDP. This set of sectors are comprised of construction (F)

and the services sectors health and social work (N) and public administration (L) and, to a lesser extent, education (M) and hotels and restaurant (H) together with the manufacturing industries machinery (29), food and beverages (15t16) and transport equipment (34t35). To understand this pattern, one should note that in the GVC perspective also other sectors' value added is allocated to the production of the final goods demand, e.g. provision of architectural services in the construction sector, pharmaceuticals in health, parts and components and design in transport equipment production, etc.

This pattern is reversed for some sectors, particularly business services (71t74), wholesale trade (51), financial intermediation (J), and basic metals (27t28). These sectors provide a lot of services and inputs to other sectors' production which are therefore accounted for in the GVC income of the other sectors dependent on these inputs.

Considering the changes over time allows one to see in which of these 'vertically integrated sectors' Austria has strengthened its position in the global value chain. This is reported in Figure 6.2 indicating the changes in the structure of Austrian GDP in GVC terms between 1995 and 2011. Austria has a considerably higher GVC share in transport equipment (34t35), business services (71t74), financial intermediation (J) and machinery (29) whereas it has lost in construction (F) and textiles (17t18) for example. In other sectors Austria's GVC share in total GDP remained constant such as in electrical and optical equipment (30t33) and basic and fabricated metals (27t28).

Figure 6.2: Structure of Austrian GVC income in % of GDP, 1995 and 2011



Source: WIOD database; wiiw calculations. For the industry classification see Appendix.

7. Exports and employment: Production sharing also means employment sharing

7.1. Employment embodied in Austrian exports

Vertical integration and international production sharing is generally seen as an opportunity for firms to organise their operations in a more efficient manner. Austrian firms can profit from international production sharing in at least two ways: Firstly, domestic multinationals have become more productive, increasing their global competitiveness. Secondly, when foreign firms use Austria as a

location for their offshoring activities, subcontracting firms may benefit. Obviously, these offshoring activities have direct employment consequences[14]. In this section we use the concept of vertical specialisation to obtain estimates for the employment associated with Austrian exports. Since foreign jobs creation through trade can be quite important (e.g. Escaith and Timmer, 2012) we will split the employment which is embodied in Austria's trade flows into jobs that are located in Austria and jobs that are located abroad.

Box 7.1 – How to derive the job embodiment in international trade

The conceptual framework for calculating a country's job embodiment in international trade is that for calculating the vertical specialisation of exports and imports. The employment associated with Austrian exports is obtained by substituting the value added coefficient vector in the calculation of vertical specialisation by the respective employment coefficient vector. In matrix terminology, this means that the vector containing the value added coefficients (the vector $\boldsymbol{v}^r$) is replaced with a vector $\boldsymbol{e}^r$ that contains the employment per unit of gross output (i.e. the inverse of labour productivity) of country *r* and all its trading partners (see Trefler and Zhu, 2010). Similar to the vertical specialisation measure, the Leontief inverse in combination with a country's net trade vector allows the identification of the amount of labour (number of jobs) that are linked to that country's exports where the jobs can be located in the exporting country ('direct exports') or in any of the trading partners ('indirect exports'). Formally, country *r*'s job embodiment in international trade, JT^r, is $JT^r = \boldsymbol{e}^r \boldsymbol{L} \boldsymbol{t}^r$ where $\boldsymbol{t}^r$ is an NCx1 vector containing country *r*'s exports in the first 35 rows (one export value per industry) and country *r*'s imports from its trading partners individually in the remaining rows. The employment data required for the employment coefficient vectors are obtained from the socio-economic accounts (SEA) in the WIOD.

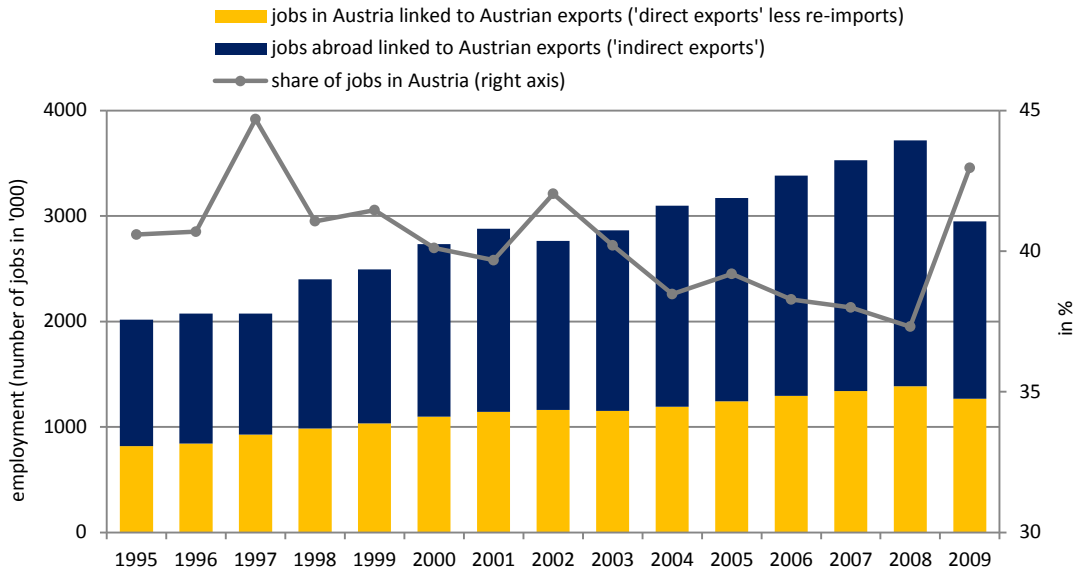
The application of the input-output methodology to employment requires two central assumptions. Firstly, there are fixed labour input requirements. Secondly, for each country it is assumed that the labour productivity to produce the export vector is the same as the labour productivity to produce the output for domestic demand.

We start the analysis by looking at the employment embodied in Austrian exports which is easier to estimate than the employment related to import flows as will become clear soon. Employment linked to Austrian exports (number of jobs) grew at an annualised rate of 4.5% between 1995 and 2008 to reach more than 3.7 million jobs in 2008 (Figure 7.1). Differentiating between jobs linked to Austrian exports that are located in Austria and jobs linked to Austrian exports located abroad one finds that until 2008 the latter grew significantly stronger than the number of jobs in Austria. This implied a decline in the share of the jobs in Austria in the total number of jobs that are linked to Austrian exports between 1995 and 2008. This development is related to the discussion on offshoring and the implications for employment. While vertical specialisation and the integration into international production networks are used by firms as a strategy to make production more efficient, the employment effects are a priori unclear (see e.g. Acemoglu and Autor, 2011; Goos et al., 2010). While more efficient firms (including those that become more efficient due to offshoring) tend to grow and typically also expand employment, the direct effect of offshoring to foreign countries on employment is of course negative. The latter argument makes clear that international production sharing is inextricably connected to a more internationally dispersed location of the jobs that are linked to a country's exports. Note, however, that the jobs abroad linked to Austrian exports would not be created one to one in Austria in the absence of vertical integration and trade in intermediate goods. We will come back to this issue below.

[14] An empirical analysis of the employment effects of offshoring is provided for example by Foster et al. (2012).

The situation regarding job development changed dramatically in 2009 when the consequences of the Great Recession were felt in international trade. While jobs in Austria and abroad suffered, the decline in the number of jobs abroad was much more pronounced than the domestic reduction in jobs linked to Austrian exports. Taken together, a decline of about 770,000 jobs embodied in Austrian exports was registered in 2009; of which 120,000 concerned jobs located in Austria.

Figure 7.1: Employment linked to Austrian exports, 1995-2009

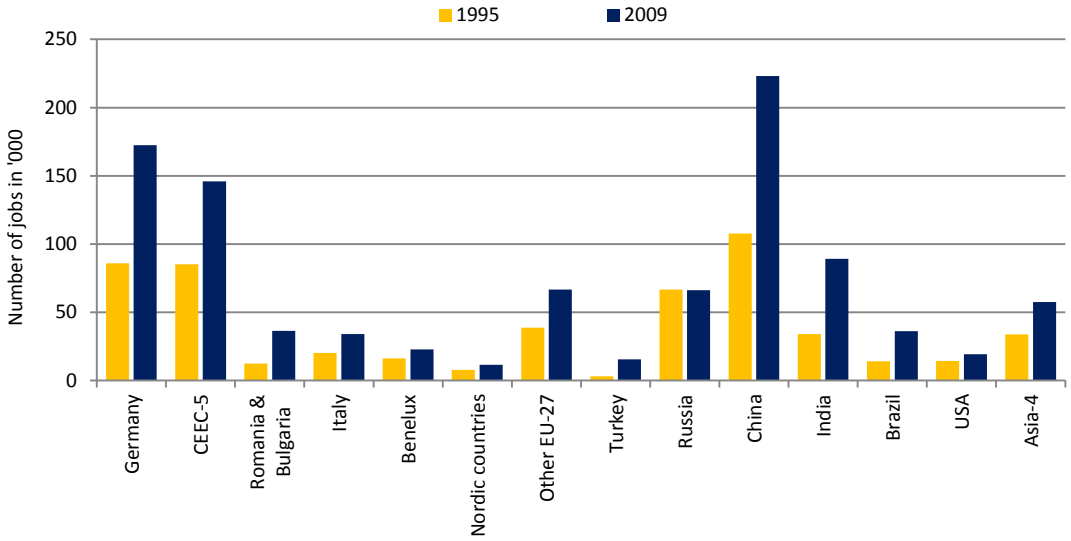


Source: WIOD database; wiiw calculations.

Some caution is warranted when directly comparing the job embodiment in Austrian exports in the domestic economy and abroad. This becomes evident when decomposing the jobs located abroad that are linked to Austrian exports by partner countries (Figure 7.2). The striking result here is that most foreign jobs linked to Austrian exports are located in China (more than 220,000) which accounts for 'only' about 7% of Austrian value added exports. While the strong export growth to China is also contributing to this result, the decisive factor is the difference in labour productivity. Since labour productivity is much lower in China, more employment is required in order to produce a certain amount of value added of inputs than would be required for the same amount of value added in Austria. Differences in labour productivity also explain the prominent role of India and Russia when it comes to jobs linked to indirect exports, i.e. jobs that are located in a country different from the exporting country.

The 170,000 jobs located in Germany and linked to Austrian exports in contrast are explained by the tight trade relations between the two countries and not by huge differences in labour productivity. The CEEC-5 countries, which also account for a considerable amount of jobs abroad linked to Austrian exports, take an intermediate position.

Figure 7.2: Employment linked to Austrian exports by job location, 1995 and 2009

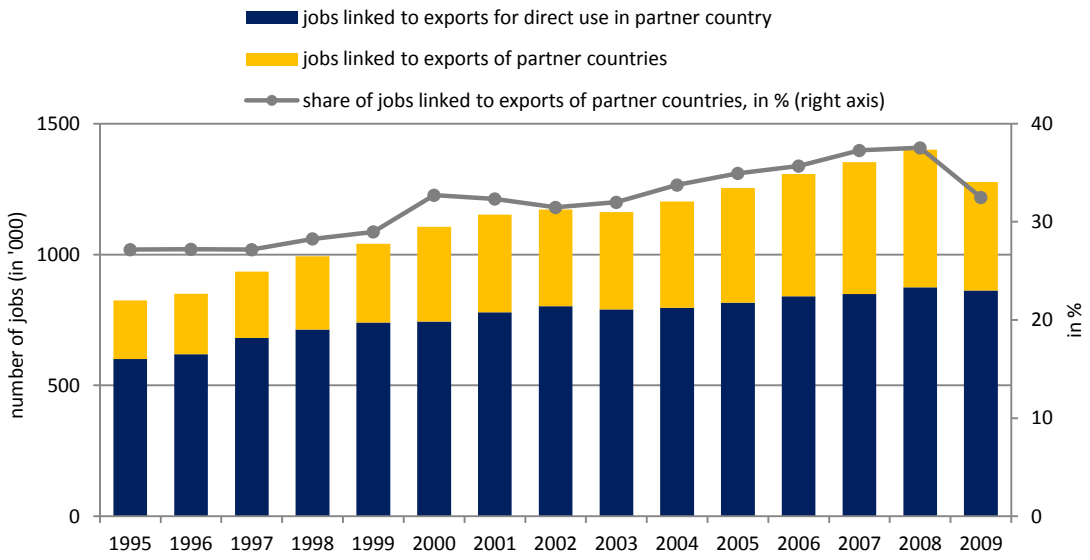


Note: CEEC-5 comprises the Czech Republic, Hungary, Poland, Slovakia and Slovenia; Benelux comprises Belgium, Luxembourg and the Netherlands; Nordic countries comprise Denmark, Finland and Sweden; Asia-4 comprises Japan, South Korea, Indonesia and Taiwan. Australia, Canada, Mexico and ROW not shown.

Source: WIOD database; wiiw calculations.

We can use the information on job embodiment in yet another way. Remember that the number of jobs located in Austria and linked to Austrian exports was 1.28 million in 2009. In addition we use the information of jobs embodied in the exports of other countries but located in Austria, which we can also obtain from the WIOD. In 2009 these amounted to 415,000 jobs. However, these 415,000 jobs are not only embodied in foreign exports (which are equivalent to Austrian imports) but they are also included in the 1.28 million jobs calculated for the domestic job embodiment in Austrian exports. Hence, the 415,000 jobs are part of the 1.28 million jobs because any Austrian value added exported indirectly via Germany must have also been exported from Austria at some stage. In this context we will refer to these jobs as jobs in 'indirect' exports or jobs in 'complex' exports.

Figure 7.3: Employment in Austria linked to direct and 'complex' Austrian exports, 1995-2009

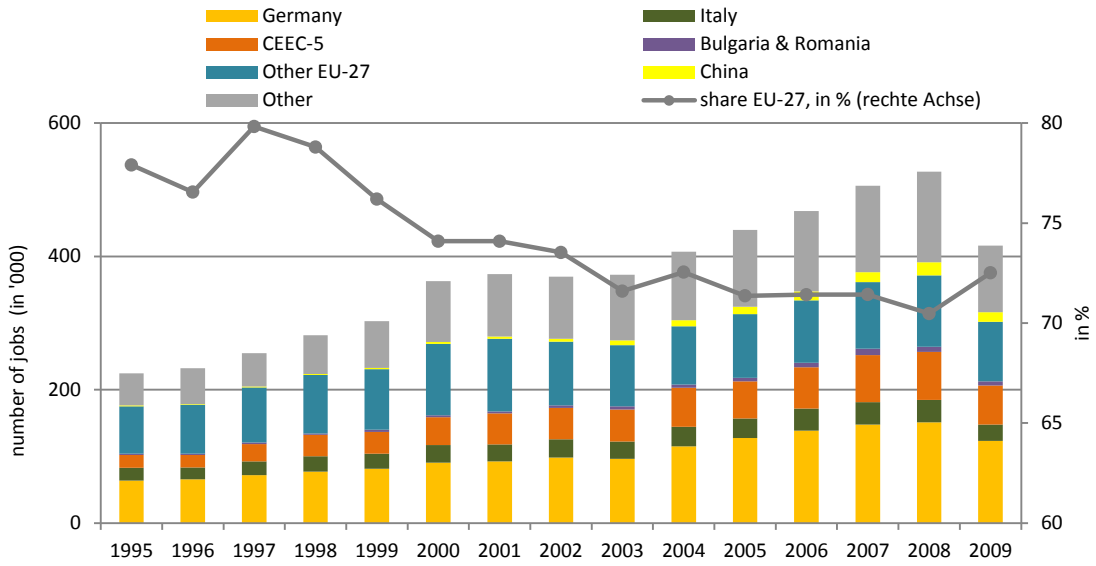


Source: WIOD database; wiiw calculations.

Austrian jobs in complex exports are those that are located in Austria and linked to both Austrian and foreign export flows. This implies that the Austrian value added shipped abroad is not consumed in that country but is further exported. Hence, this is a more complex transaction than a 'simple' Austrian export. Figure 7.3 shows that the number of jobs in Austria linked to complex export transactions more than doubled between 1995 and 2008, reaching 526,000 in that year. This constituted a more dynamic job development than in the case of the 'simple' Austrian exports. In 2009, and despite the impact of the economic crisis, Austrian jobs linked to complex export transactions represented a third of total Austrian jobs linked to Austrian exports – an increase of some 5 percentage points. This confirms the fact that Austrian trade relations have become more complex over the past two-and-a-half decades.

As expected and confirmed in Figure 7.4, the overwhelming majority (73% in 2009) of Austrian jobs linked to complex export transactions involve exports of other EU-27 countries, above all Germany, followed by Italy. With a share of 14% the CEEC-5 considered as a group also accounted for a significant share of Austrian jobs linked to complex exports. The fact that the share of jobs located in Austria and linked to complex export transactions involving an EU partner, i.e. the 73% in 2009, is much higher than the share of intra-EU value added exports in Austria's trade (around 54% in 2009) shows that production sharing is much more developed in Austria's trade with its EU partners than in trade with third countries.

Figure 7.4: Employment in Austria linked to 'complex' Austrian exports by partner country, 1995-2009



Note: CEEC-5 comprises the Czech Republic, Hungary, Poland, Slovakia and Slovenia.

Source: WIOD database; wiiw calculations.

7.2. Austria's job embodiment in net exports: a counterfactual

In the previous section the problem of comparing the number of jobs embodied in Austrian exports that are located in Austria and those that are located in other countries due to differences in labour productivities has been mentioned. The same problem arises when one is interested in the job embodiment of a country's imports. One way to deal with this is to counterfactually assume that a country's imports are produced with the importing country's labour input coefficients. This 'counterfactual' has been applied for calculating a country's job embodiment in net exports (see Groshen et al., 2005; De Backer and Yamano, 2008; Stehrer and Stöllinger, 2013)[15].

Such a counterfactual approach allows for a rough assessment of the net impact of trade on employment in a country. The net effect is simply obtained by comparing a country's job embodiment in exports with the hypothetical number of jobs that the same country would need to produce its imports domestically (i.e. using domestic labour productivity). While such a counterfactual experiment gives a more balanced picture of the employment associated with trade than simply looking at the employment linked to exports, it is also rather simplistic because it implicitly relies on a number of stringent assumptions. First of all, it is assumed that imports and national production are perfectly substitutable with no costs and all products can actually be produced at home. Therefore, the existence of non-competing imports and the (very likely) possibility that some countries may not have the technological capabilities or endowments to produce their entire imports domestically are ignored. Furthermore, the counterfactual experiment neglects potential gains from trade which arise through gains from variety and increasing returns to scale but also the basic fact that the autarky price of the imported goods tend to be higher than with free trade.

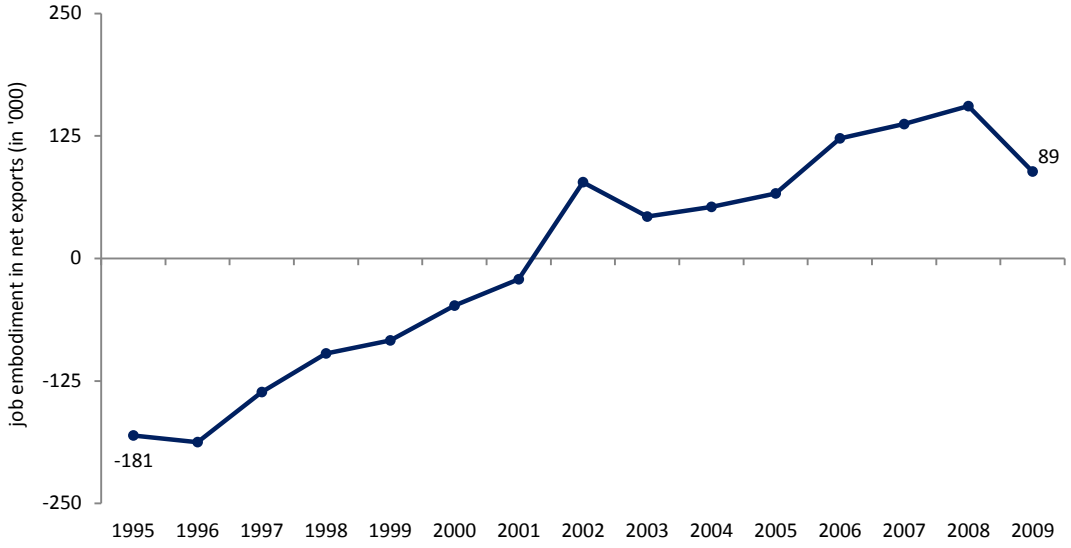
Box 7.2 – From actual job embodiment to the counterfactual

Methodologically, the calculation of the counterfactual job embodiment of net exports is rather straightforward once all information for the actual jobs embodied in exports and imports is available. All that is needed is a manipulation of the labour input coefficient vector $\boldsymbol{e}^r$. Instead of containing the labour input coefficients of country *r* and all its trading partners, a 'counterfactual' labour input coefficient vector $\tilde{\boldsymbol{e}}^r$ is applied. In this 'counterfactual' vector, the labour input coefficients of all trading partners are replaced with that of country *r*. The effect of this adjustment is that country *r's* labour input coefficients are not only applied to exports but to both exports and imports which is exactly what the counterfactual exercise attempts to achieve. The resulting components remain the same so that the counterfactual job embodiment in net exports of country *r*, $\widetilde{JT}^r$, is defined as $\widetilde{JT}^r = \tilde{\boldsymbol{e}}^r \boldsymbol{L}\boldsymbol{t}^r$.

Keeping all the limitations of the counterfactual approach in mind, we can investigate the result for Austria's job embodiment in net exports, which is provided in Figure 7.5. Accepting all the assumptions mentioned above, the counterfactual exercise would suggest that Austria is gaining from trade in terms of employment since the year 2002. For example, in 2009 the amount of Austrian jobs embodied in exports exceeded the amount of hypothetical jobs that would be needed if Austria were to produce its entire imports domestically by 89,000. Hence, in a way the counterfactual exercise that is undertaken in Figure 7.5 is a simulation of the 'employment balance' of international trade for Austria comparing the actual (more or less) free trade situation with a (hypothetical) autarky situation.

[15] Some of this literature (e.g. Groshen et al., 2005) discusses this considering 'net imports'. To be consistent across the report we stick to the definitions of net exports, which are positive if exports exceed imports.

Figure 7.5: Counterfactual job embodiment in Austrian net exports, 1995-2009



Note: Number of jobs embodied in imports calculated using Austrian labour input coefficients.

Source: WIOD database; wiiw calculations.

The positive job embodiment in net exports of 89,000 jobs in 2009 can also be interpreted that Austria's move from its current open trade regime to autarky would reduce the employment in the Austrian economy by 89,000 jobs. It should be emphasised that this employment surplus from foreign trade can be considered as the lower boundary of the 'employment gains from trade' when comparing the open trade regime with a (hypothetical) autarky situation. It is a lower boundary because of the strong assumptions about the productivity levels (i.e. that Austria can produce its imports as efficiently as its current output, which is unlikely given the actual specialisation pattern).

Finally, we should also mention that the way the counterfactual job embodiment of net imports is set up, the positive result for Austrian employment is a direct consequence of its trade surplus since 2002.

Table 7.1 provides a breakdown of the result for Austria's job embodiment in net exports. In this table trade flows are arranged in two groups: a group of trade flows that entail domestic jobs (i.e. jobs in Austria) on the one hand and a group of trade flows with jobs located abroad attached to them, on the other hand.

Domestic jobs are linked to direct exports (column 1 in Table 3) and re-imports (column 2) because these two elements are those with jobs being located in the reporting economy. Adding the jobs embodied in direct exports and in re-imports yields the jobs which are located 'at home' and which are linked to international trade (column 3). Note, however, that the jobs in re-imports enter with a negative sign because they are actually not jobs that can be attributed to trade as the previously exported value added is re-imported and hence used domestically.

Table 7.1: Counterfactual job embodiment in Austrian net exports (in 000) – breakdown by type of trade flows, 1995-2009

	Jobs located at home linked to trade			Jobs located abroad linked to trade						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			(1) + (2)				(4) + (5) + (6)	(3) + (7)	(1) + (6)	(2) + (4) + (5)	(9) + (10)
year	Direct exports	Re-imports	'Jobs at home'	Direct imports	Indirect imports	Indirect exports	'Jobs abroad'	Net job embodiment in international trade	Jobs linked to exports (home + abroad)	Jobs linked to imports (home + abroad)	Net job embodiment in international trade
1995	825	-6	819	-1,035	-231	266	-999	-181	1,091	-1,272	-181
1996	850	-6	844	-1,080	-242	291	-1,032	-187	1,141	-1,329	-187
1997	935	-7	928	-1,136	-265	336	-1,064	-136	1,271	-1,408	-136
1998	994	-8	986	-1,166	-285	368	-1,083	-97	1,362	-1,459	-97
1999	1,042	-8	1,034	-1,197	-304	384	-1,117	-84	1,426	-1,509	-84
2000	1,106	-9	1,097	-1,235	-355	446	-1,145	-48	1,552	-1,600	-48
2001	1,152	-9	1,142	-1,276	-364	476	-1,164	-21	1,628	-1,649	-21
2002	1,172	-9	1,163	-1,214	-334	463	-1,085	78	1,635	-1,557	78
2003	1,162	-10	1,152	-1,230	-350	470	-1,110	43	1,632	-1,589	43
2004	1,203	-11	1,192	-1,287	-384	532	-1,139	53	1,734	-1,682	53
2005	1,254	-11	1,243	-1,331	-411	565	-1,177	66	1,819	-1,753	66
2006	1,307	-12	1,296	-1,346	-438	611	-1,173	123	1,919	-1,796	123
2007	1,353	-13	1,341	-1,383	-476	655	-1,204	137	2,008	-1,871	137
2008	1,400	-13	1,388	-1,407	-501	676	-1,232	155	2,077	-1,921	155
2009	1,277	-11	1,267	-1,300	-394	517	-1,178	89	1,794	-1,705	89

Note: Number of jobs embodied in imports calculated using Austrian labour input coefficients.

Source: WIOD, wiiw calculations.

In the second bloc we group together direct imports (column 4), indirect imports (column 5) and indirect exports (column 6). Summing up these three elements yields the (counterfactual) jobs located abroad and linked to international trade (column 7)[16]. Also here, positive entries (jobs linked to indirect exports) and negative entries (jobs linked to imports) are added up[17]. As a result the number of jobs located abroad is significantly lower than the number of jobs linked to imports (direct and indirect)[18].

Alternatively, one can also group the jobs according to whether they are embodied in exports or imports. This is done in column (9) showing all jobs linked to Austrian export flows and column (10) showing all jobs linked to Austrian import flows.

Obviously, adding up the jobs located at home and linked to trade (column 3) and the jobs located abroad and linked to trade (column 7) yields the job embodiment of international trade (column 8). Of course, it is equally possible to group together jobs linked to exports (column 10) and jobs linked to imports (column 11).

8. Austrian value added trade in the crisis

The crisis-related collapse of world trade triggered by the financial meltdown in 2009 was 'sudden, severe and synchronised' (Baldwin, 2009) with global merchandise exports dropping by more than 12% in real terms, much more than global GDP. One factor that is suspected to have contributed to the more than proportional decline in trade flows is the increasing vertical specialisation which may have resulted in a heightened income elasticity of trade (Freund, 2009; Escaith et al., 2010). If vertical specialisation is part of the explanation for the severe drop in world trade in 2009, value added trade flows should have declined significantly less than gross trade flows. Applying the concept of value added exports allows one to test this hypothesis. Moreover, it allows one to investigate the role of other potential explanatory factors such as the composition effect[19], stressed for example by Bems et al. (2011) by comparing the decline in gross exports versus value added exports at the industry level.

8.1. Changes in gross exports and value added exports during the crisis period

We start the analysis by showing the development of the usual openness measure, i.e. exports in per cent of GDP, together with the value added-based openness measure, i.e. value added exports in per cent of GDP, for Austria over the period 1995-2011 (Figure 8.1)[20]. In both cases the long-term trend is clearly positive, increasing from 31% in 1995 to more than 50% in 2011 for the conventional (gross)

[16] In the case of direct and indirect imports as well as indirect exports the jobs are counterfactual jobs.

[17] The number of (counterfactual) jobs located abroad is negative because jobs linked to imports enter the analysis with a negative sign. The indirect exports, which are positive, are 'deducted' from this negative number.

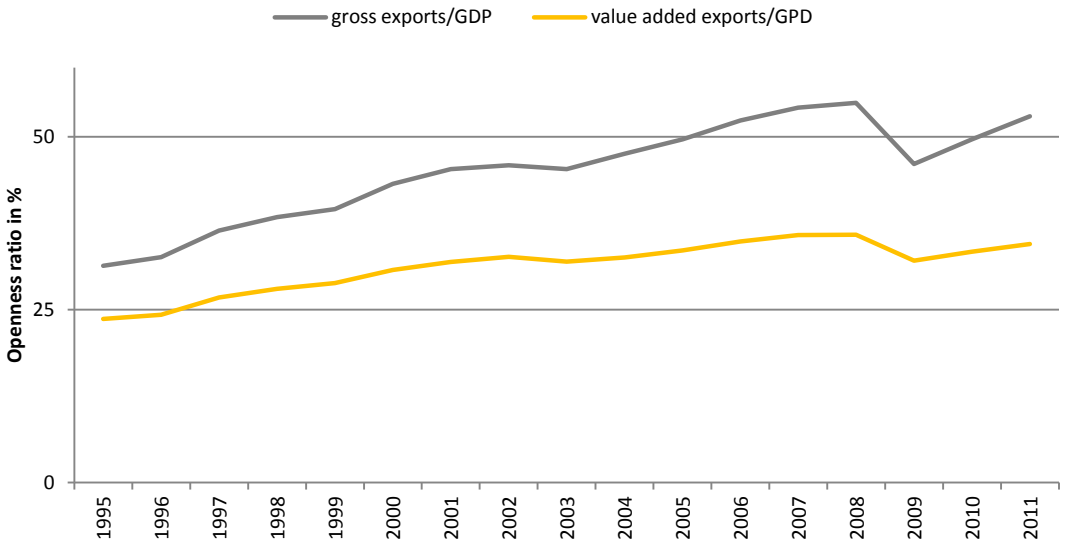
[18] The groups and the allocation of positive and negative signs to trade flows are logically consistent. Consider, for example, that a domestic firm offshores parts of its production, implying that 100 jobs are moved abroad. The net effect of this is that the job embodiment declines by 100. The effect within the individual elements would be that the jobs linked to direct exports decline by 100 and the jobs linked to indirect exports increase by 100. However, since an indirect export by definition must be accompanied by an import flow, there is also an increase of 100 jobs in the country's direct imports from the country where the domestic firm has moved its production to. Hence, in this example the jobs located at home would decline by 100 while the jobs located abroad would remain unchanged (+100 in indirect exports and -100 in direct imports) which in sum leads to a decline of 100 of the job embodiment of international trade in the reporting economy.

[19] The composition effect arises from the fact that the share of investment and transport goods, which have been hit much harder by the crisis, is significantly higher in exports (and imports) than in GDP.

[20] Note that the analysis of the trade collapse in this section is undertaken with nominal values.

openness measure and from 24% to 35% for the value added-based openness concept. The openness measure is a prime example where the use of the value added export concept is more appropriate because it sets into relation a value added-based measure – GDP – with another value added-based measure – the value added exports.

Figure 8.1: Trade openness of the Austrian economy – gross and value added exports in % of GDP, 1995-2011

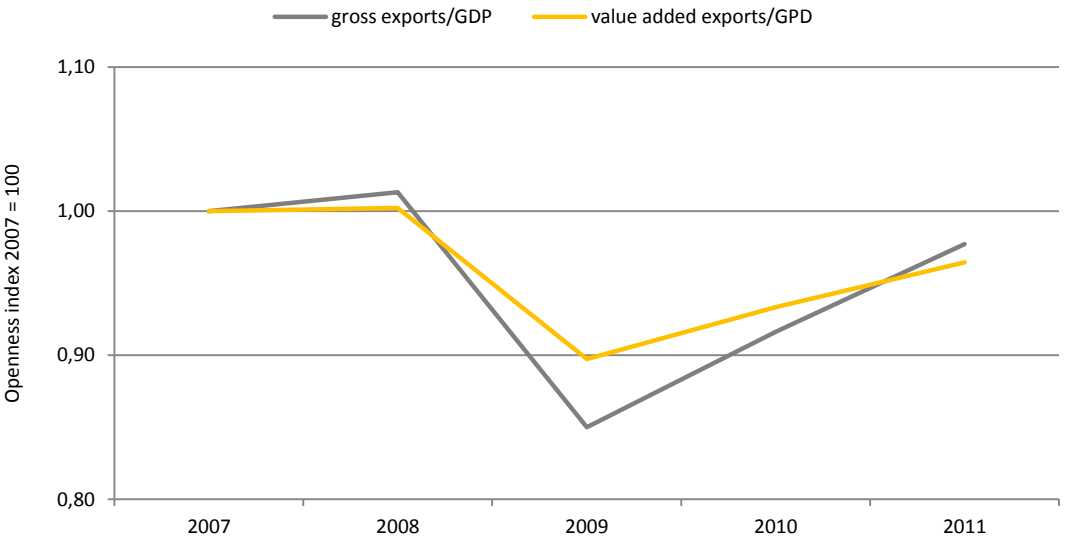


Source: WIOD database; wiiw calculations.

In Figure 8.1 the more than proportionate decline of exports as compared to overall GDP related to the crisis is recognisable by the drop in the openness measures in 2009.

Figure 8.2 presents both these indicators focusing over the crisis period with both indexed to 1 in 2007.

Figure 8.2: The crisis effect on Austria's trade openness – gross and value added exports in % of GDP, index 2007=100

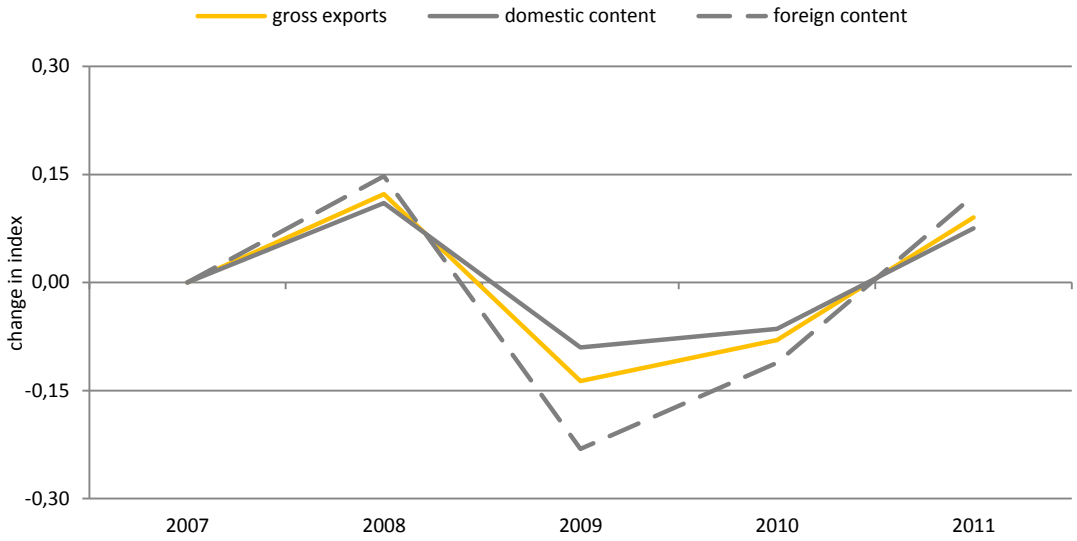


Source: WIOD database; wiiw calculations.

As expected, the drop in Austria's trade openness index in value added terms was less pronounced than the drop of the conventional (gross exports) openness measure. Whereas exports over GDP declined by about 15 percentage points the decline in value added exports-based openness amounted to 'only' 10 percentage points. However, the recovery from the 2009 export slump was also more rapid in the case of gross exports.

We now turn to the reasons for these differentiated developments. Figure 8.3 provides a first indication by splitting gross exports into their domestic and foreign value added content. Whereas gross exports dropped by 15% (compatible with Figure 8.2 above) the foreign content dropped by almost 25%, whereas the domestic content by less than 10%.

Figure 8.3: Index of gross exports, domestic and foreign value added content of exports, index 2007=0



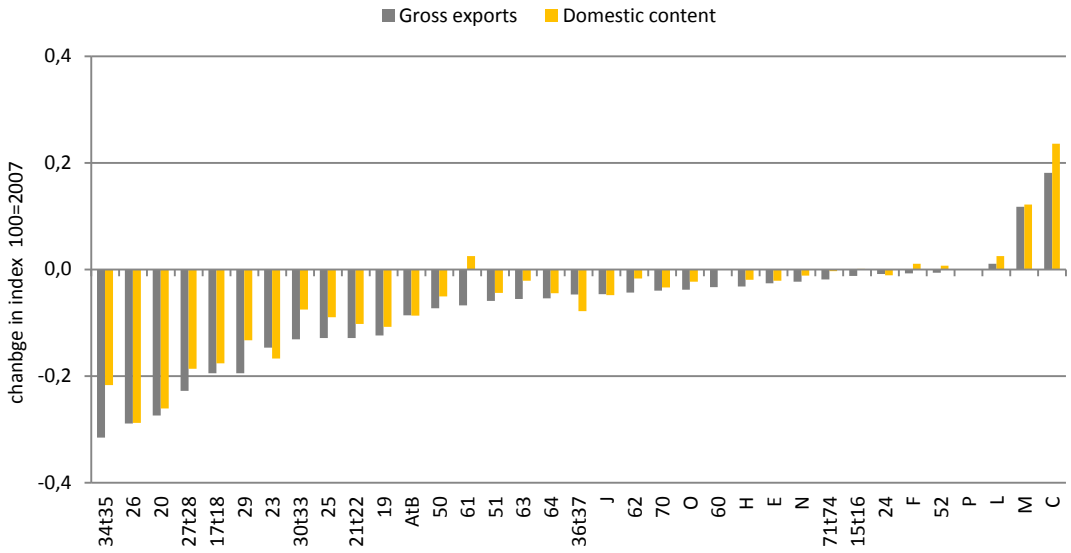
Source: WIOD database; wiiw calculations.

From an accounting perspective, there are three reasons why that could happen: First, in the crisis firms may have started to re-shore formerly offshored activities, leading to a higher domestic content of exports. This effect is further strengthened if re-shoring activities are particularly strong in sectors with relatively high foreign content, which is the second reason. Third, sectors with higher foreign value added content of their exports have been more affected by the crisis. As exports in these sectors declined relatively stronger, the domestic content over the crisis could even increase leading to the patterns shown in Figure 8.3.

These potential explanations are further explored by looking at the decline of Austrian exports between 2007 and 2009 at the level of individual industries. Figure 8.4 presents these developments for gross exports and the domestic value added contained in these exports. First, in almost all sectors the declines in gross terms have been stronger as compared to the decline in domestic value added terms (i.e. in the domestic content). This is particularly true for the transport equipment industry (34t35), but also for the basic and fabricated metals industry (27t28), machinery (29) and the electrical and optical equipment industry (30t33). Second, the above-mentioned industries coincide with the industries that have a high degree of vertical specialisation (see Section 3). Furthermore, the same industries were also those which were most affected by the trade slump in gross terms, which is why they are found on the left-hand side of the graph in Figure 8.4. With respect to the third

argument, one can see that the industries just mentioned are also those which are characterised by a relatively low domestic content (as indicated above). This suggests that both of the potential factors contributed to explaining the fact that the domestic value added part of exports dropped less than the foreign part at the aggregate level. This leads to the question of the relative strength of these two factors.

Figure 8.4: Index of gross exports and domestic content of exports in 2009, index 2007=0



Source: WIOD database; wiiw calculations. For the industry classification see Appendix.

This can be tackled by applying a shift-share analysis which decomposes the changes in the domestic content of exports into the following components: *(i)* the effect of changes in the domestic content of exports in each industry due to changes in offshoring behaviour in the crisis (see first point above); *(ii)* the effects of the differentiated impacts of the crisis by industry (the second point above) and *(iii)* the overall decline of total gross exports. In the simple shift-share analysis there remains an error term comprising all interaction terms between the three components of the shift-share analysis. As these interaction terms are small, they are summarised in a general error term (see Box 8.1) which turns out to be small as well. The results of this shift-share analysis are presented in Figure 8.5.

Box 8.1 – Shift-share analysis of the Austrian export slump in value added terms

The economy's total domestic value added exported, $DVAiX_t$, can be expressed as

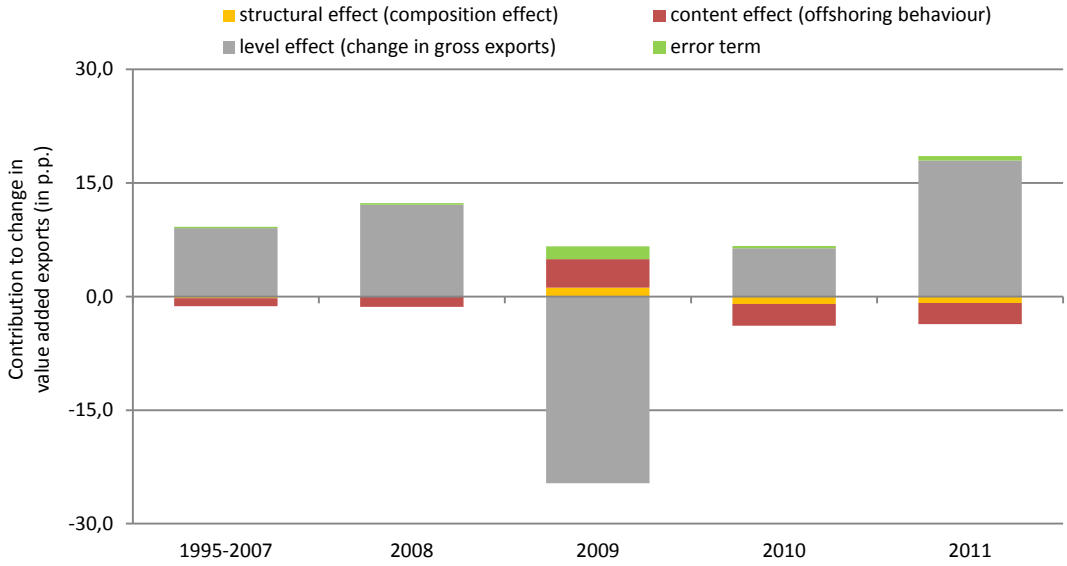
$$DVAiX_t = \sum_i d_{it} s_{it} X_t$$

where X denotes economy-wide gross exports, s_i is the share of industry *i* in these exports, and d_i denotes the domestic share in these exports of industry *i* at time *t*. The change in the domestic value added exports can be expressed as the sum of three terms together with the interaction effects (error term):

$$\Delta DVAiX_t = \sum_i \Delta d_{it} s_{i0} X_0 + \sum_i d_{i0} \Delta s_{it} X_0 + \sum_i d_{i0} s_{i0} \Delta X_t + error$$

where $\Delta X_t = X_t - X_0$ and likewise for Δd_{it} and Δs_{it}. The first term indicates the effects of changes in offshoring behaviour, the second term is a composition effect and the third term is the effect of the overall change in total gross exports. The error term summarises all other interaction effects.

Figure 8.5: Results from shift-share analysis of the changes in Austrian value added exports, 1995-2011



Source: WIOD database; wiiw calculations.

Over the period 1995-2007 gross exports (in current USD) contributed on average 8 percentage points (p.p.) to the growth of Austrian value added exports. The changes in export structures across sectors contributed slightly negatively to Austria's exports in domestic value added terms (-0.2 p.p.). This is explained by the shifts of Austrian exports towards higher-tech industries which are characterised by a higher degree of vertical specialisation and hence a relatively lower domestic value added content (see Section 3). Further, the offshoring activities of Austrian firms also contributed negatively (-1 p.p.) to Austria's exports in value added terms. This pattern was similar between 2007 and 2008 with economy-wide gross export growth amounting to almost 11%.

The pattern has been quite different during the crisis period, i.e. in the year 2009[21]. Whereas the decline of gross exports contributed about 25 p.p. in 2009, there have been 're-shoring' activities taking place which had a positive effect on Austrian value added exports. This positive effect of re-shoring amounted to about 4 p.p. Further, the fact that the sectors with high foreign content in exports (or low domestic content) have been hit harder by the crisis contributed positively to Austrian value added exports during the crisis, though quantitatively this effect was rather small (+1 p.p.).

In summary, this shift-share analysis suggests that the composition effect (i.e. the fact that some industries have been hit harder by the crisis) was quantitatively less important in explaining the Austrian performance in value added exports than the effect of re-shoring, which was by far more important in relative terms.

After the crisis in 2009, the level effect turned positive again as exports have been recovering. Gross exports contributed 6 p.p. and 17 p.p. to the growth of value added exports in 2010 and 2011, respectively. These years have further been characterised by stronger offshoring activities, which contributed negatively to Austrian value added exports (by about -3 p.p.). It is interesting to note that this is even stronger than in the period before the crisis, which may signal that firms find themselves under increased competitive pressure which forces them to exploit all possibilities to

[21] While the trade slump set in already in the fourth quarter of 2008, in annual data it is only discernible in the year 2009.

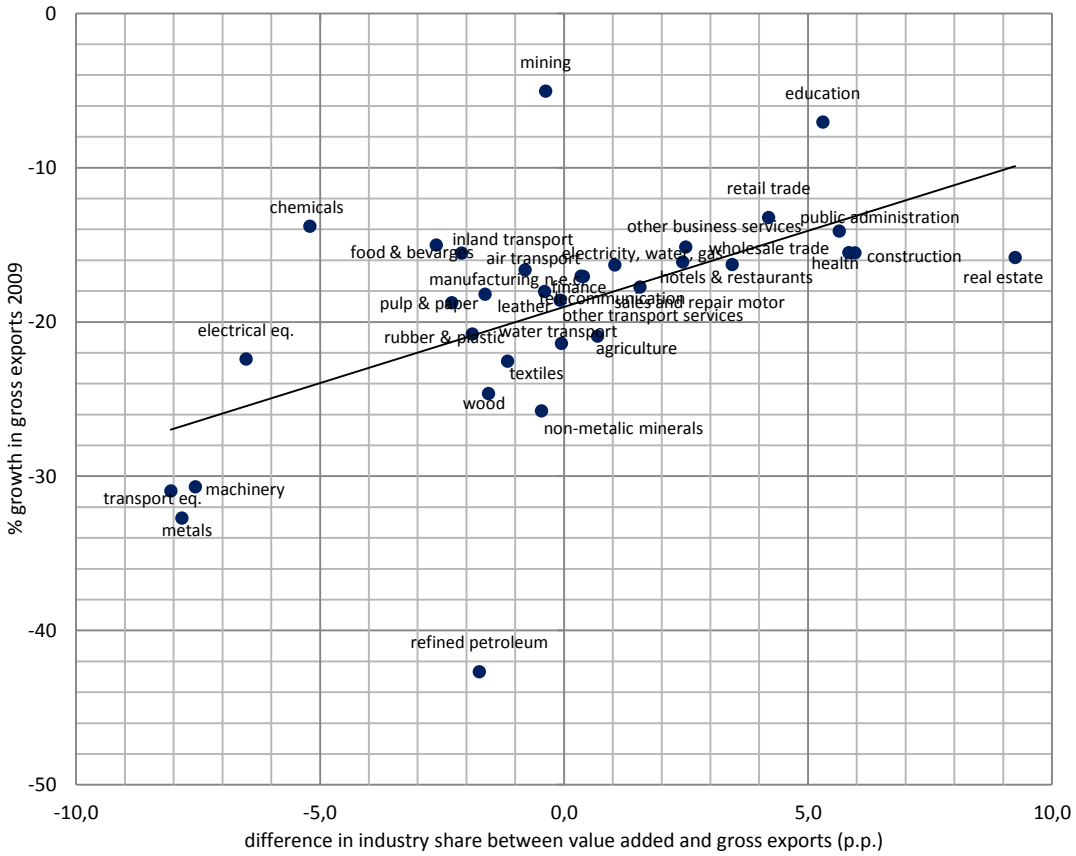
increases their productivity which in some cases may include offshoring of production (or parts thereof). The structural shift effect was working in the negative direction, basically due to the fact that those sectors having been most affected by the crisis also recovered quite quickly.

8.2. The decline of Austrian exports in comparison to GDP

The above analysis has already revealed the major factors that contributed to the strong decline of Austrian exports in the year 2009. In this section we complement the above analysis by comparing the decline in export values with that of the drop in GDP, focusing on the changes between 2008 and 2009. The ratio between the two is referred to as the income elasticity of trade. When we calculate this elasticity (in nominal terms) we obtain a factor of 2.84. That means, for each USD 100 decline in GDP in the crisis year 2009, gross exports declined by USD 284.

In the scatter plot presented in Figure 8.6, industries with higher shares in exports than in GDP are found on the left-hand side whereas industries that are important in Austrian GDP but less so in exports are found on the right-hand side. Unsurprisingly, the 'usual suspects' – the transport equipment industry, the basic metals and metal products industry, the machinery industry and the electrical and optical equipment industry – are found in the bottom-left corner. This means that the relatively more export-oriented industries coincide with those that registered the most severe drops in gross exports.

Figure 8.6: Decline of Austrian gross exports and differences in industry shares in GDP and gross exports, 2009



Note: Other Community, Social and Personal Services (O) and Private Households with Employed Persons (P) not shown.

Source: WIOD, wiiw calculations.

Similar to what was done in the shift-share analysis, we can also single out the strength of the composition and of other factors. A useful visualisation of the fact that the industry composition is quite relevant for the income elasticity of trade also in the case of Austria is a scatter plot showing the industry-level decline in gross exports against the difference between the respective industry's share in GDP and gross exports. This scatter plot is shown in Figure 8.6.

We now undertake another exercise to quantify this composition effect and single it out from other factors. The starting point in this analysis is the decline in GDP – amounting to 7.9 percentage points – which we refer to as the 'base effect' (Table 8.1). Then we calculate a 'counterfactual economy-wide drop in value added exports'. This is obtained by applying to the decline of the value added at the industry level the industry shares of the gross exports. The difference between this counterfactual drop in value added exports and the drop in gross exports is the impact of double counting in the gross trade statistics, which contributed 2.9 p.p. to the gross export slump. The composition effect in this exercise is obtained by the difference between the industry-level declines in value added exports once aggregated to the economy level using the industry weights in gross export and once aggregated using the industry weights in GDP. This composition effect adds another 3.9 p.p. to the decline in gross exports between 2008 and 2009. Summing up the base effect, the double counting and the composition effects together account for roughly 15 p.p. of the drop in gross exports, leaving some 7.7 p.p. as a residual effect. This residual effect is a catch-up term for all other factors such as changes in the offshoring behaviour, re-focusing on the core-market, which is often the home market, but potentially also protectionism.

Table 8.1. Factors explaining the difference in the crisis-related drop in GDP and gross exports, 2008-2009

component	contribution to gross export decline in p.p.	contribution to gross export decline in %
base effect (GDP decline)	-7.9	35.2
effect of double counting	-2.9	13.0
composition effect	-3.9	17.5
residual trade shock	-7.7	34.3
gross export decline	-22.3	100.0

Note: Base effect is the decline in GDP; double counting is the difference between the decline of gross exports and the decline of value added exports weighted with the gross export industry shares; the composition effect is the decline of value added exports weighted with the industry shares of gross exports and the decline of value added exports weighted with the industry shares of GDP; the residual trade shock is the catch-all term for all other factors.

Source: WIOD database; wiiw calculations.

Hence, there were two main contributors to the drop in Austrian exports during the crisis: First of all, the drop in GDP itself, which was responsible for 35%[22]. The second largest effect was the residual trade shock with 34%. The composition effect still accounts for 17.5% of the total decline in gross exports according to this methodology.

9. Summary and conclusions

The availability of new of inter-country input-output tables such as the one provided by the World Input-Output Database (WIOD) facilitates the use of input-output methodologies to reveal and analyse the more and more complex production patterns of 21st century trade. Due to the increasing international fragmentation of production, conventional trade statistics are becoming less

[22] This share of 35% is consistent with the income elasticity of exports of 2.84.

informative with respect to the countries where value added is actually created. The advantage of the input-output-based analysis of trade flows is that it allows singling out the value added embodied in gross exports and imports that stems from and is therefore created in different countries and industries. Obviously, with the increasing international specialisation and ever more fragmented international production chains, the importance of attributing each country's or industry's contribution to global value chains has grown tremendously. For this purpose a number of indicators have been developed in the literature. These include measures of vertical specialisation, which indicate the amount of foreign value added embodied in a country's exports; a country's value added exports and imports; the global value chain income, which puts the focus on value added and income generation linked to a particular industry, as well as the job embodiment in international trade which indicates the amount of jobs that are linked to trade flows.

In this study we apply these concepts to Austria's trade patterns and find that Austria's integration in international production networks has remarkably deepened over the longer term despite a setback in 2009 due to the economic crisis. In 2011 about 35% of the value of Austrian gross exports constituted value added created by partner countries. This degree of vertical integration is similar to that of peer countries such as Finland and somewhat higher than that of Germany, which is explained by the fact that Germany is a much larger market and larger economies tend to have a lower degree of vertical specialisation. The intensification of Austria's vertical specialisation and hence its tighter integration into global and regional production networks is evidenced by the increase in its foreign value added content in its exports, which amounted to 10 percentage points between 1995 and 2011. More intensive production sharing with Central and Eastern European countries (CEEC) and Germany have particularly contributed to this development.

Conceptually similar to the vertical specialisation measure are value added exports. Value added exports deliver a more accurate picture of Austria's market shares in international trade. Switching from gross trade flows to the concept of value added trade provides a more accurate and more nuanced view though it does not mean that the history of Austrian trade has to be rewritten. Nevertheless, there are a number of new insights: Firstly, Austria's shares in global exports and imports are smaller in terms of value added trade than in gross trade, amounting to roughly 1% each. This is the mirror image of the fact that Austria is heavily involved in international production sharing. Gross exports therefore include a high amount of foreign value added which is corrected for when moving from gross exports to value added exports. Similarly, deep trade integration within the European Single Markets is the reason why extra-EU markets and in particular large emerging markets absorb a higher share of Austrian value added exports than suggested by traditional trade statistics. This shows up in the list of Austria's most important trading partners, which is quite different from the conventional ranking and where China, Russia and Brazil all figure among the top ten export destination partners. In contrast, none of the CEEC economies are found on this list, indicating that these countries are important for Austria as partners in global value chains but less so as sources of demand for Austrian value added.

Over the period 1995-2011 Austria's global export and import market shares declined slightly, which primarily reflects the emergence of new trading powers such as China and the integration of the CEEC economies into the European economy. This relative decline in Austria's market shares in international trade masks an overall strong trade performance. Austria's relatively successful trade performance is evidenced for example by growing shares in the EU's total value added exports, which rose from 2.8% in 1995 to 3.1%.

The most important difference between Austrian value added trade and gross trade flows emerges at the industry level. Generally speaking, services account for a much larger share of Austrian exports in value added terms because they are less easy to export directly. However, given the important share of services in Austrian GDP and the fact that manufactures embody a growing number of services, the latter accounted for almost half of aggregate Austrian value added exports which record the value added in the industry where it is created. This implies that manufactures, despite their relatively lower share in exports in value added terms, fulfil a crucial 'carrier function' for services which enables the export of services and the creation of comparative advantages in services. The industry-level data also reveal a favourable structural shift towards medium-high- and high-tech industries and business services in Austrian value added exports between 1995 and 2011. However, Austria's market share in global value added exports of business services declined slightly between 1995 and 2011 because their growth did not keep pace with the growth of global demand for this category of services. Overall, Austria – together with Germany and Finland – belongs to the countries with a relatively stronger focus on manufacturing than on services, including business services, when compared to other EU-15 countries. Austria's manufacturing sector, however, appears to be less geared towards 'advanced manufacturing' than that of Germany.

When using value added export and imports to calculate bilateral trade balances, it turns out that some shifts in the bilateral balances across trading partners have occurred. For example, Austria's trade deficit with its main trading partner, Germany, was smaller in value added terms, amounting to about 3% of GDP in 2011, while Austria's surplus with Italy was larger that year. By definition, the overall trade balance position is the same irrespective of whether value added trade or gross trade flows are considered. In the case of Austria, the multilateral trade balance recorded a surplus of 3% of GDP in 2011.

With respect to employment, the number of Austrian jobs linked to export activity grew from 820,000 in 1995 to almost 1.27 million in 2009, with an interim high of 1.39 million in 2008. The formation of international production networks allows countries to specialise vertically, however, it also means that some of the jobs that are linked to Austrian exports will no longer be located in Austria but in Germany, Slovakia, China or any other country (analogously to the fact that the value of Austrian exports in gross terms is larger than its domestic value added content). Undertaking this kind of analysis for Austrian exports, we find that those actually embody even more foreign jobs than jobs in Austria. Note, however, that this comparison of domestic and foreign jobs embodied in Austrian exports is biased towards the latter due to the fact that labour productivity is significantly lower in trading partners such as China or India. The most important locations of these foreign jobs are China, Germany, the CEEC-5 (the Czech Republic, Hungary, Poland, Slovakia and Slovenia) and India, in that order.

The study also contains a counterfactual experiment and asked the question, 'How many jobs would be created in Austria if Austria produced its entire imports domestically?' Comparing this hypothetical number of jobs embodied in Austrian imports with the actual number of Austrian jobs embodied in Austrian exports yields a counterfactual job embodiment in international trade (or net imports). For Austria we find a positive employment outcome in this type of comparison, amounting to 89,000 jobs in 2009. We interpret these 89,000 jobs as the lower boundary of the 'employment balance' of international trade in Austria because we neglect in this analysis potential gains from specialisation and gains from variety. Moreover, in this calculation we also abstract from non-competing imports, i.e. from the fact that some imports cannot be produced domestically.

Given the severity of the trade slump following the Great Recession of 2008 which is discernible in annual trade data of the year 2009, we also used the value added concepts to analyse the structure of the decline in Austrian exports during the crisis. As expected, the decline of gross exports was stronger than the decline in value added exports in 2009. According to the shift-and-share analysis employed in this context, two factors explain these differences: firstly, it seems that there has been some 're-shoring' activity taking place, which had a positive effect on Austrian value added exports. Secondly, the fact that the sectors with high foreign content in exports (or low domestic content) have been hit harder by the crisis contributed positively to Austrian value added exports during the crisis. Quantitatively this second effect, which is a structural effect, is rather small, also compared to the re-shoring effect.

The structural effect – or composition effect as it has been coined in the literature, meaning that the most export-oriented industries were also those most affected by the crisis – plays a more important role if we want to explain why exports declined much stronger than GDP – in the case of Austria by a factor of 2.9 (in nominal terms). Put differently, the crisis-related drop in GDP accounts for just above one third of the export decline. The remaining two thirds are the result of 'double counting', i.e. the fact that trade flows may enter several times in gross export flows, and of the composition effect plus a 'residual trade shock', which is a catch-up term comprising a diverse array of factors such as re-shoring activities of Austrian firms, firms focusing their sales activities on 'core markets' which typically include the domestic market, but also the potential negative impact of protectionist measures imposed by trading partners. Quantitatively, this residual trade shock is large, accounting for more than a third of the total decline in Austrian gross exports in 2009, and twice as large as the composition effect, which is also considerable.

All these results furnish proof of the importance of taking account of the more and more fragmented nature of production, for which the input-output-based analysis of trade developments, in particular deep forms of trade integration and patterns of international production arrangements, proves to be useful. This calls for continued or even intensified efforts to constantly update international input-output databases and to widen the number of countries covered by such databases. The increased data requirement that input-output-based trade analyses entail is more than offset by the new possibilities opened up by such data for the analysis of global production patterns, in particular with regard to value added transfer and employment embodied in international trade flows.

An interesting route for further research, which to begin with could be undertaken for an individual country within a global set-up, is to combine world input-output data with firm-level data. While this would further increase the exigencies with regard to data, it would again institute a new array of research questions to be investigated.

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Appendix

A.1. Country and industry lists

Table A.1.1: List of countries in the WIOD (country abbreviations)

Country code	Country
AUT	Austria
BEL	Belgium
BGR	Bulgaria
CYP	Cyprus
CZE	Czech Republic
DEU	Germany
DNK	Denmark
ESP	Spain
EST	Estonia
FIN	Finland
FRA	France
GBR	United Kingdom
GRC	Greece
HUN	Hungary
IRL	Ireland
ITA	Italy
LTU	Lithuania
LUX	Luxembourg
LVA	Latvia
MLT	Malta
NLD	Netherlands
POL	Poland
PRT	Portugal
ROU	Romania
SVK	Slovakia
SVN	Slovenia
SWE	Schweden
AUS	Australia
BRA	Brazil
CAN	Canada
CHN	China
KOR	South Korea
IDN	Indonesia
IND	India
JPN	Japan
MEX	Mexico
RUS	Russia
USA	USA
TUR	Turkey
TWN	Taiwan
ZROW	Rest of the World

Table A.1.2: Industry classification (based on NACE Rev. 1)

WIOD Nr.	Industry code	Industry Description
1	AtB	Agriculture, Hunting, Forestry and Fishing
2	C	Mining and Quarrying
3	15t16	Food, Beverages and Tobacco
4	17t18	Textiles and Textile Products
5	19	Leather, Leather and Footwear
6	20	Wood and Products of Wood and Cork
7	21t22	Pulp, Paper, Paper , Printing and Publishing
8	23	Coke, Refined Petroleum and Nuclear Fuel
9	24	Chemicals and Chemical Products
10	25	Rubber and Plastics
11	26	Other Non-Metallic Mineral
12	27t28	Basic Metals and Fabricated Metal
13	29	Machinery, Nec
14	30t33	Electrical and Optical Equipment
15	34t35	Transport Equipment
16	36t37	Manufacturing, Nec; Recycling
17	E	Electricity, Gas and Water Supply
18	F	Construction
19	50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
20	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
21	52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
22	H	Hotels and Restaurants
23	60	Inland Transport
24	61	Water Transport
25	62	Air Transport
26	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
27	64	Post and Telecommunications
28	J	Financial Intermediation
29	70	Real Estate Activities
30	71t74	Renting of M&Eq and Other Business Activities
31	L	Public Admin and Defence; Compulsory Social Security
32	M	Education
33	N	Health and Social Work
34	O	Other Community, Social and Personal Services
35	P	Private Households with Employed Persons

Table A.1.3: Definition of industry groups

Industry group	Industry code	Industry description (NACE Rev 1.)
Agriculture etc.	AtB	Agriculture, Hunting, Forestry and Fishing
Mining and utilities	C	Mining and Quarrying
	E	Electricity, Gas and Water Supply
Low-Tech (LT) manufacturing	15t16	Food, Beverages and Tobacco
	17t18	Textiles and Textile Products
	19	Leather, Leather and Footwear
	20	Wood and Products of Wood and Cork
	21t22	Pulp, Paper, Paper, Printing and Publishing
	36t37	Manufacturing, Nec; Recycling
Medium-low-tech (M-LT) manufacturing	23	Coke, Refined Petroleum and Nuclear Fuel
	25	Rubber and Plastics
	26	Other Non-Metallic Mineral
	27t28	Basic Metals and Fabricated Metal
Medium-high- and high-tech (M-HT & HT) manufacturing	24	Chemicals and Chemical Products
	29	Machinery, Nec
	30t33	Electrical and Optical Equipment
	34t35	Transport Equipment
Construction	F	Construction
Non-tradable market services	50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
	52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
	H	Hotels and Restaurants
	70	Real Estate Activities
	O	Other Community, Social and Personal Services
	P	Private Households with Employed Persons
Transport and communication	60	Inland Transport
	61	Water Transport
	62	Air Transport
	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
	64	Post and Telecommunications
Business services	J	Financial Intermediation
	71t74	Renting of M&Eq and Other Business Activities
Non-market services	L	Public Admin and Defence; Compulsory Social Security
	M	Education
	N	Health and Social Work

A.2. Additional results

Table A.2.1: Bilateral trade balances in gross and value added terms

	Gross terms				Value added terms			
Partner	1995	2000	2007	2011	1995	2000	2007	2011
AUS	149	328	903	631	123	237	691	502
AUT	0	0	0	0	0	0	0	0
BEL	-365	551	117	-722	-457	99	-26	-446
BGR	107	119	1014	448	58	69	581	251
BRA	-109	34	79	1712	-94	18	21	1298
CAN	154	-3	673	135	46	2	474	308
CHN	-221	-183	-1793	1343	-147	-89	-1097	1372
CYP	20	36	151	61	21	32	137	58
CZE	127	-31	-1776	-3748	44	-65	-1024	-1418
DEU	-8979	-7709	-16601	-17198	-7878	-5457	-10957	-13395
DNK	75	154	394	73	29	48	225	-28
ESP	599	1480	1658	72	391	1047	1845	288
EST	6	-5	11	-5	6	-1	28	-3
FIN	44	-245	-98	128	-47	-159	-22	91
FRA	-959	-146	1194	1558	-714	38	1388	1305
GBR	1325	2110	1784	1120	835	1461	1665	801
GRC	167	357	1036	704	199	335	930	602
HUN	422	416	2070	938	271	204	606	65
IDN	43	-203	-48	-146	37	-161	-66	-145
IND	121	-20	348	-1266	119	9	391	-473
IRL	-138	-120	453	-296	-127	-115	186	-209
ITA	-1058	1027	3999	280	-1185	489	2993	721
JPN	-283	-216	245	-71	-389	-217	30	-35
KOR	-94	-51	732	885	-90	-53	322	226
LTU	7	11	-4	-50	11	14	50	-6
LUX	-287	-128	-96	175	-167	-34	-57	-53
LVA	3	11	243	8	0	12	209	25
MEX	1	36	504	370	-20	75	368	327
MLT	-6	1	82	56	3	7	61	38
NLD	-1146	-860	-1632	-2327	-835	-526	-1108	-1628
POL	-77	527	-258	-77	-127	359	-46	-337
PRT	-144	-15	419	-72	-52	75	338	109
ROU	255	118	2046	1139	176	94	1456	855
RUS	-576	-778	291	1129	-657	-965	-867	-69
SVK	92	-350	-2579	-2019	40	-114	-1006	-675
SVN	361	218	2017	301	169	95	857	72
SWE	-167	-138	33	152	-220	-119	70	51
TUR	-109	86	514	2	-73	91	613	417
TWN	-11	24	448	-288	18	12	121	-202
USA	515	1704	8141	3739	645	2244	6941	3657
ZROW	5099	4442	13711	23380	5002	3494	13101	17931
Total	-5040	2587	20424	12250	-5039	2587	20424	12250

Table A.2.2: Austrian industry structure and global shares in terms of value added and GVC, 1995 and 2011

	Value added structure		GVC structure		World VA shares		World GVC shares	
	1995	2011	1995	2011	1995	2011	1995	2011
AtB	2.71	1.74	1.76	1.40	0.50	0.23	0.48	0.27
C	0.36	0.51	0.18	0.24	0.13	0.06	0.37	0.21
15t16	2.18	2.00	5.31	4.51	0.63	0.46	0.68	0.47
17t18	0.95	0.33	1.56	0.79	0.66	0.23	0.70	0.33
19	0.16	0.07	0.35	0.20	0.72	0.27	0.77	0.37
20	0.95	0.93	0.69	0.47	1.50	1.54	2.65	3.13
21t22	1.82	1.36	0.83	0.74	0.83	0.68	0.71	0.69
23	0.49	0.27	0.50	0.51	0.51	0.14	0.50	0.24
24	1.29	1.57	1.14	1.46	0.50	0.49	0.64	0.61
25	0.80	0.69	0.42	0.34	0.72	0.56	0.82	0.63
26	1.35	0.88	0.85	0.33	1.18	0.70	2.93	1.50
27t28	3.01	3.72	1.29	1.50	0.86	0.87	1.11	1.21
29	2.23	2.77	3.17	3.82	1.00	1.05	0.91	0.92
30t33	2.57	2.44	2.81	2.77	0.79	0.61	0.70	0.56
34t35	1.21	1.89	2.70	4.18	0.46	0.65	0.55	0.68
36t37	1.12	0.74	2.02	1.43	1.34	0.80	1.40	0.93
E	2.95	3.01	1.62	1.75	0.96	0.80	0.82	0.69
F	8.04	6.78	11.55	10.75	1.04	0.70	0.77	0.49
50	1.96	1.65	1.98	1.61	1.18	0.92	1.26	0.97
51	6.37	6.86	5.09	5.08	0.77	0.64	0.90	0.64
52	4.71	4.50	3.96	3.73	0.65	0.55	0.55	0.47
H	3.94	4.77	5.95	5.73	1.19	1.09	1.17	0.91
60	3.66	2.51	2.34	1.86	1.01	0.54	0.90	0.54
61	0.02	0.02	0.06	0.07	0.06	0.03	0.26	0.18
62	0.36	0.37	0.36	0.43	0.64	0.61	0.57	0.55
63	0.98	1.74	1.03	1.43	0.66	0.88	1.39	1.48
64	2.50	1.61	1.29	1.25	0.90	0.41	0.86	0.44
J	5.67	4.88	2.13	2.93	0.71	0.45	0.46	0.45
70	7.48	9.24	7.71	8.43	0.61	0.60	0.67	0.58
71t74	6.00	9.65	2.02	3.29	0.61	0.62	0.63	0.59
L	6.83	5.63	9.12	8.50	0.68	0.45	0.65	0.45
M	5.43	5.20	6.13	5.99	1.25	0.89	1.17	0.82
N	5.75	5.75	7.77	8.39	0.92	0.66	0.82	0.62
O	4.10	3.89	4.26	4.04	0.87	0.65	0.85	0.65
P	0.04	0.03	0.04	0.03	0.17	0.12	0.19	0.13
Total	100.00	100.00	100.00	100.00	0.77	0.58	0.77	0.58