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Trade Balances and International Competitiveness in Cyber-physical, Digital Task-intensive, ICT Capital-intensive and Traditional Industries

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Trade Balances and International Competitiveness in Cyber-physical, Digital Task-intensive, ICT Capital-intensive and Traditional Industries

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Abstract

In this report, we analyse the international competitiveness of the EU in four industry groups over the period 1995-2018. The groups are delineated by specific factor intensities, where these intensities are assessed from digital tasks performed by labour services and ICT capital stocks. The EU's positions relating to trade balances, revealed comparative advantages and unit value ratios are assessed relative to its main competitors, such as the US, China, Japan and South Korea. The trade specialisation patterns confirm EU advantages in traditional industries, which still represent the largest part of global trade, and in the group of digital task-intensive industries. In the cyber-physical group of industries, which are characterised by both high digital task and ICT capital intensities, the EU records a trade deficit, although this has been receding in recent years. Competitiveness indicators depict heterogeneity among EU countries. The loss of international competitiveness for some technology front-runners is a worrying sign. On the positive side, however, a reduction in trade deficits or an improvement in product quality and market shares is evident for certain EU countries, especially in the Central European region.

Keywords: international competitiveness, EU, EU-CEE, trade balances, revealed comparative advantages, unit value ratios, digital tasks, ICT capital, digitalisation

JEL classification: F14, L11, L60, O33

CONTENTS

TABLES AND FIGURES

1. Introduction

This report revisits the issue of international competitiveness of EU countries in the industries deemed to be most closely related to digital transformation. To this end, the report analyses trade balances, revealed comparative advantages (RCAs) and unit value ratios (UVRs) calculated from export data for the EU and its main competitors, such as the US and China, as well as some other 'peer' countries. The analysis of international competitiveness of the EU is undertaken for four groups of industries. The categorisation of industries is based on factor intensities in two types of labour and capital respectively. Following the approach in Guarascio and Stöllinger (2022), labour services are divided into digital tasks and non-digital tasks, while capital stock is separated into ICT capital and non-ICT capital. These distinctions give rise to four industry groups: (i) 'cyber-physical' industries, characterised by both a high digital task-intensity and a high ICT-capital intensity; (ii), 'digital' industries, which are intensive in the use of labour services providing digital tasks; (iii) 'ICT' industries, which are intensive in the use of ICT capital; and (iv) 'traditional' industries.

This report addresses the following research questions: does the EU have trade surpluses in 'cyber-physical' industries as well as in 'digital' and 'ICT' industries, and how does the trade balance position compare with those of major competitor countries; are EU countries prepared to deal with the shift to cyber-physical production systems that characterise the 'digital revolution'; and do they have RCAs in industries that can be deemed essential in the digital era. We discuss the potential implications of the identified trade specialisations for overall export growth.

The remainder of this report is organised as follows. Section 2 sets out the methodology and data sources, including the details of the industry classification and the indicators used to measure competitiveness. It also discusses the related literature. Section 3 contains the results of the empirical analyses. We summarise the main conclusions in Section 4.

2. Methodology and data sources

2.1. INTRODUCING A NEW CLASSIFICATION OF INDUSTRIES

The analysis of the trade balance and RCAs is undertaken at the level of groups of industries. The industries are differentiated along two dimensions: the digital task content of the labour used in the production of goods and services; and the ICT capital intensity (Table 1). This results in four industry groups: cyber-physical industries; digital industries; ICT industries; and traditional industries. The industry-level trade flows are aggregated to these four groups.

Table 1 / Schematic representation of an approach to group industries based on digital task and ICT capital intensity

		Digital tasks in labour services	
		Intensive	**Non-intensive**
ICT capital	**Intensive**	Cyber-physical industries	ICT industries
	Non-intensive	Digital industries	Traditional industries

Source: wiiw elaboration.

The classification of industries as intensive or non-intensive in digital tasks provided by labour services and intensive or non-intensive in ICT capital is based on the proportions of digital tasks and ICT capital employed in the respective industries (see Guarascio and Stöllinger, 2022). For each of these production factors, the factor intensity in terms of value added is calculated at the industry level, for the aggregate of the 25 EU member states[1] analysed in Guarascio and Stöllinger (2022). The industry-specific factor intensities are then normalised and compared with the mean across industries. The means, based on normalised values, are 0.1236 for digital tasks and 0.1336 for ICT capital (Figure 1). If the factor intensity of an industry is greater than the mean factor intensity, it is considered to be intensive.

Using this definition of intensity, we label industries that are intensive in digital tasks and in ICT capital as ‘cyber-physical industries’. Industries are considered to be ‘digital industries’ if they are intensive in digital tasks but not in ICT capital. Conversely, those industries which are intensive in ICT capital but not in digital tasks are referred to as ‘ICT industries’. Finally, there are ‘traditional industries’, which are neither digital task- nor ICT capital-intensive. Figure 1 depicts normalised values for digital task and ICT capital intensities and the resulting classification of 41 industries.[2] As many digital task- or ICT capital-intensive industries are concentrated in services, we use gross exports and gross imports from the 2021 edition of the OECD’s Trade in Value Added (TiVA) database[3] (data sources are discussed in detail in Section 2.2), because it holds information on global trade flows for both goods and services.

[1] Malta and Cyprus are exempted from the analysis in Guarascio and Stöllinger (2022) for reasons of data quality and data availability.

[2] For the list of industries and their factor intensities in digital tasks and ICT capital, see Appendix 1.

[3] OECD Inter-Country Input-Output (ICIO) tables, which cover the period 1995 to 2018. The data are available at https://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm#access

Because further analysis relies on this data source, some of the industries used in Guarascio and Stöllinger (2022)[4] had to be aggregated for this report. This is particularly true for financial and insurance services, and professional, scientific and technical services.

Figure 1 / Classification of industries into industry groups based on digital task and ICT capital intensity

Note: Digital task and ICT capital intensities are normalised to range from 0 to 1. Digital tasks and ICT capital as defined in Guarascio and Stöllinger (2022). For normalised values of digital task and ICT capital intensities and industry codes, see Appendix 1.
Source: own calculation, based on Guarascio and Stöllinger (2022).

Table 2 shows an uneven distribution of industries between the groups. The majority of industries are classified as 'traditional' – a total of 25 out of 41– as their digital task and ICT capital intensities are below the respective thresholds. This group is highlighted in grey in Table 2.

The second-largest group is 'cyber-physical' industries, marked as light blue in Table 2, and comprising seven industries. Among these, *IT and other information services (62T63)* has by far the highest digital task intensity, while *telecommunications (61)* scores highest in terms of ICT capital intensity (Figure 1). Among the manufacturing industries, *computer, electronic and optical equipment (26)* qualifies as a cyber-physical industry, along with *other transport equipment (30)*. The latter of these includes, inter alia, the manufacturing of air and spacecraft and related machinery (30.3), which is also a high-technology industry, as is (26), according to the OECD taxonomy of economic activities based on R&D intensity by Galindo-Rueda and Verger (2016).

4 The analysis of the net factor content of trade in digital tasks and ICT capital according to the Heckscher-Ohlin-Vanek approach uses data from the World Input-Output database (WIOD) which features 56 industries, whereas OECD TiVA data contains 45 industries.

Table 2 / Classification of industries to four groups based on digital task and ICT capital intensity

ICT capital		Digital tasks in labour services: Intensive		Digital tasks in labour services: Non-intensive	
Intensive		**CYBER-PHYSICAL**		**ICT**	
		26	Computer, electronic and optical equipment	**35**	Electricity, gas, steam and air conditioning supply
		30	Other transport equipment	**64T66**	Financial and insurance activities
		53	Postal and courier activities	**77T82**	Administrative and support service activities
		58T60	Publishing, audiovisual and broadcasting activities		
		61	Telecommunications		
		62T63	IT and other information services		
		69T75	Professional, scientific and technical activities		
Non-intensive		**DIGITAL**		**TRADITIONAL**	
		17T18	Paper products and printing	**01T03**	Agriculture
		27	Electrical equipment	**05T09**	Mining
		28	Machinery and equipment, nec	**10T12**	Food products, beverages and tobacco
		31T33	Manufacturing nec; repair and installation of machinery and equipment	**13T15**	Textiles, textile products, leather and footwear
		84	Public administration and defence; compulsory social security	**16**	Wood and products of wood and cork
		90T96	Arts, entertainment and recreation; Other service activities	**19**	Coke and refined petroleum products
				20	Chemical and chemical products
				21	Pharmaceuticals, medicinal chemical and botanical products
				22	Rubber and plastics products
				23	Other non-metallic mineral products
				24	Basic metals
				25	Fabricated metal products
				29	Motor vehicles, trailers and semi-trailers
				36T39	Water supply; sewerage, waste management and remediation activities
				41T43	Construction
				45T47	Wholesale and retail trade; repair of motor vehicles
				49	Land transport and transport via pipelines
				50	Water transport
				51	Air transport
				52	Warehousing and support activities for transportation
				55T56	Accommodation and food service activities
				68	Real estate activities
				85	Education
				86T88	Human health and social work activities
				97T98	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use

Source: wiiw elaboration.

Unsurprisingly, the industries in the cyber-physical group overlap to a large extent with those classified as ICT industries in the PREDICT[5] database, which provides detailed information on value added, employment and R&D. Industries in the cyber-physical group also largely overlap with sectors characterised by a high digital intensity in the taxonomy of digital-intensive sectors proposed by Calvino et al. (2018). These authors classify economic sectors by digital intensities, which are calculated taking into account a multitude of dimensions of the digital transformation. An overlap is also discernible with industries classified as 'high' and 'medium-high' in the taxonomy of economic activities based on R&D intensities by Galindo-Rueda and Verger (2016).

'ICT' industries with high ICT capital intensity and low digital task intensity of labour are few in number because most industries that have a high ICT capital intensity also score high on the digital task dimension. In fact, there are only three ICT industries, highlighted in light orange in Table 2, that fall into this group: *electricity, gas, steam and air conditioning supply (35)*, *financial and insurance services (64T66)* and *administrative and support service activities (77T82)*.

'Digital' industries, marked in light green in Table 2, are more numerous, totalling six. They include, for example, the manufacture of *electrical equipment (27)* and the manufacture of *machinery and equipment (28),* but also *public administration and defence; compulsory social security (84)*, which indicates that public-sector services also require a considerable input of digital tasks.

2.2. COMPETITIVENESS INDICATORS AND DATA SOURCES

An analysis of relative positions of European economies in 'digital and ICT trade' focuses on main competitor countries for the EU. The EU is defined as its current composition of 27 member states and hence excludes the UK, as our intention is to draw conclusions for the future relevant to the EU as it currently stands. Main competitor countries – the US, China, Japan and South Korea – are labelled as the 'peer' group, and remaining comparator countries are referred to as 'other'. The list of countries and assigned country groups is presented in Appendix 2.

The analyses make use of established measures of international competitiveness in the trade literature, starting with trade balances and focusing on the results at the level of our industry groups.

If not otherwise specified, we use gross export and gross import data from the 2021 edition of the OECD's TiVA database.[6] It contains data on trade both in goods and services, which is especially relevant for digital-intensive industries. It allows comparisons on a global level with data for 66 individual countries and the rest of the world category for remaining countries. All trade flows are balanced so that the exports of country *c* to country *p* are identical to the imports of country *p* from country *c*.

5 https://data.jrc.ec.europa.eu/collection/id-0074; methodological explanations to be found in Benages et al. (2018).

6 OECD Inter-Country Input-Output (ICIO) tables, which cover the period 1995 to 2018, oe.cd/tiva, for methodological explanations to be found in OECD (2021).

2.2.1. Trade balance

Trade balances are widely used for an assessment of international competitiveness of countries. A trade surplus is often associated with a strong and prospering economy and higher economic growth. However, the literature survey on empirical studies on the impact of the trade balance on economic growth by Blavasciunaite et al. (2020) shows a variety of results regarding its magnitude, and also that the data source and methodology are relevant factors. The econometric results in Blavasciunaite et al. (2020) for the EU suggest that a deterioration (improvement) in the trade balance goes hand in hand with lower (higher) economic growth. This relationship is independent of the position of the trade balance. Thus, our intention is to consider not only absolute values, but also the evolution over time.

We start by depicting the EU's trade balance performance in global trade, including intra-EU trade, over the period 1995-2018, for which data are available in OECD TiVA. To capture the dynamics in the evolution of trade balances, we split the full time period into three periods and calculate three-year averages (1995-1997, 2005-2007 and 2016-2018) to smooth annual fluctuations. Trade balances in each industry group are calculated as a sum of exports for all industries minus a sum of imports for all industries in this group for each country.

In a second step, in order to reveal the EU's competitive position, we analyse trade balance values and their changes over time for EU and competitor countries in each of four groups.

The trade balance (*B*) of a country *c* is calculated for each group of industries *i* by subtracting all exports from all imports for industries belonging to this industry group (1):

$$B_{c,i} = X_{c,i} - IM_{c,i} \tag{1}$$

where *X* denotes nominal exports in euros, *IM* denotes nominal imports in euros.

Given the under-representation of individual EU countries among the leading surplus countries in absolute terms, and given the small size of many EU economies, we use a relative trade balance indicator to refine our analysis for individual EU countries. Thus, countries' trade balances in each group of industries are expressed as a percentage of total volume of trade of those countries, calculated as a sum of their exports and imports.

Relative trade balance (*RB*) of a country *c* is calculated for each group of industries *i* by dividing the trade balance for this industry group by the overall trade volume of this country (a sum of its exports and imports) (2):

$$RB_{c,i} = \frac{B_{c,i}}{(\sum_{i=1}^{N} X_{c,i} + \sum_{i=1}^{N} IM_{c,i})} * 100 \tag{2}$$

where *B* denotes the trade balance in euros defined by formula (1), *N* a total number of industry groups, (four in our analysis).

2.2.2. Revealed comparative advantage

In addition to trade balances, we calculate revealed comparative advantages (RCAs), another common measure to capture a country's international competitiveness, for four groups of industries.

We use Balassa (1965) RCA index (BRCA), defined as the share of exports *X* of an industry group *i* of a country *c* to total exports of a country *c*, which is divided by the share of global exports of an industry group *i* in total global exports of all goods and services (3):

$$BRCA_{c,i} = \frac{\left(\frac{X_{c,i,}}{\sum_{i=1}^{N} X_{c,i}}\right)}{\left(\frac{\sum_{c=1}^{M} X_{c,i}}{\sum_{i=1}^{N}(\sum_{c=1}^{M} X_{c,i})}\right)} \tag{3}$$

where *M* denotes a total number of countries, *N* a total number of industry groups (four in our analysis).

For a better comparability, we use a modified version of the RCA suggested by Laursen (2015), labelled Revealed Symmetric Comparative Advantage (RSCA). In the RSCA, the BRCA scores are normalised to range from −1 (maximal comparative disadvantage) to +1 (maximal comparative advantage), with 0 as a neutral point (4):

$$RSCA_{c,i} = \frac{(BRCA_{c,i} - 1)}{(BRCA_{c,i} + 1)} \tag{4}$$

where *BRCA* is an index defined according to the formula (3).

In our further analysis, we refer to the RSCA determined by formula (4) simply as RCA.

Some EU countries, such as Germany, Sweden, Finland and Austria, as well as peer countries, such as Japan and South Korea, are identified as successful exporters of particular 'fourth industrial revolution' technologies,[7] which are associated with digital transformation, in the paper by Foster-McGregor et al. (2019). This approach assesses trade in goods associated only with separate technologies. In our report, we take a broader approach to RCA analysis, as we analyse trade in goods and services at the aggregated level of four industry groups. An advantage of this approach is that trade in services data, which is particularly relevant for digital transformation, are included. In the results section below, we examine whether similar positive results are obtained, especially in the cyber-physical group of industries, for the above-mentioned EU countries.

7 Results are presented separately for three individual technologies: robots; 3D printing technologies; and computer aided design and manufacturing (CAD-CAM) technologies. The most recent time period of 2014-2016 is compared with the initial time period of 2000-2002.

2.2.3. Market share

In order to obtain an overall impact of exports in a particular group of industries for specific countries, we complement the results of RCA values with a market share of this country in global exports in each group. Market share *MS* of a country *c* in each group of industries *i* is defined by summarising all exports for industries belonging to this industry group divided by global exports of this group (5):

$$MS_{c,i} = \frac{X_{c,i}}{(\sum_{c=1}^{M} X_{c,i})} * 100 \qquad (5)$$

where *X* denotes nominal exports in euros, *M* denotes a number of countries.

2.2.4. Unit value ratios

In order to evaluate price competitiveness of EU countries in the digital age, we calculate unit value ratios (UVRs). The ability of a country to export a product at a higher unit price than its competitors points to a superior quality of such a product and a specialisation in higher-quality goods. An analysis of unit values or UVRs allows conclusions to be drawn about countries' specialisation in exports of goods of higher quality.

Theoretical models suggest that exporters with higher capital and skill abundance specialise in the export of products with higher unit values, as shown by Schott (2004) for US imports. Moreover, Schott (2008) illustrates China's success in climbing up the quality ladder over time. An empirical analysis of quality upgrading for groups of EU countries and competitors is also provided by Landesmann and Wörz (2006). A comparison of changes in relative prices of goods and market shares on the EU15 market (comprising what are termed 'old' EU countries) has been undertaken for various technology groups for the periods 1995-1998 and 2002-2004. 'New' EU member states managed to upgrade in terms of quality, while also gaining market shares, with the most success in medium-high-tech industries. EU15 countries achieved only slight upgrades in quality or maintained their previous positions in the high-tech group, while market shares diminished in all groups except high-tech industries. China, an important competitor, substantially gained market shares while improving quality in all groups of manufacturing industries except for low-tech industries.

The UVR analysis is limited to exports of goods, as data on quantities are necessary to calculate unit prices. As a consequence, we fall back on data from UN Comtrade,[8] which contain quantities and values of exported goods.

We follow the methodology of Landesmann and Wörz (2006) to explore whether individual EU countries are competitive on global markets in terms of goods quality, measured by UVRs, in the two manufacturing industries (26 – computer, electronic and optical equipment and 30 – other transport equipment) that belong to the cyber-physical group. Calculations are done separately, owing to different patterns detected in each of them. We explore whether any positive tendencies for EU countries in terms of technology upgrade (a positive evolution of UVR) or market shares in global markets are evident between the initial period (1995-1997 three-year averages) and the most recent period (2017-2019

8 According to the Harmonized Commodity Description and Coding System (HS) classification at the 6-digit level. Trade data covers the time period of 1996-2019: https://comtrade.un.org/data/

three-year averages). According to Foster-McGregor et al. (2017), positive changes in manufacturing unit values are also associated with a positive impact on GDP per capita growth in the long run.

The export unit value *u* of a product *i* exported by a country *c* is defined as:

$$u_i^c = v_i^c / x_i^c, \quad (6)$$

where *v* denotes value of nominal exports and *x* denotes exported quantity, *i* denotes an exported product and *c* an exporting country.

We put those values in relation to the global average unit values and calculate UVRs to determine relative positions of countries in terms of price competitiveness. The product-country specific UVRs r_i^c, can then be calculated as:

$$r_i^c = ln \left({u_i^c}/{u_i^{ref}} \right) \quad (7)$$

where *u* denotes unit values defined according to the formula (6), *i* denotes an exported product and *c* an exporting country, and the superscript *ref* indicates the reference group; for our analysis, we use the world as a whole.

Calculations are based on detailed information on products as classified by the Harmonized Commodity Description and Coding System (HS) at the 6-digit level. After calculating UVRs, we exclude outliers according to a procedure proposed by Landesmann and Wörz (2006).[9] UVRs for individual products are aggregated up to the level of industries for each country using a weighted averages approach, with shares of product exports in total industry exports.

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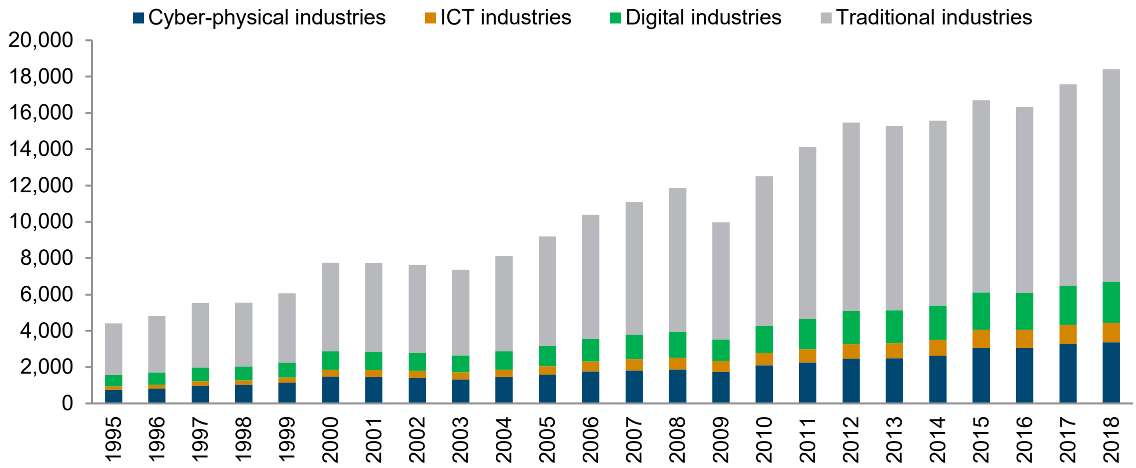
9 All observations with UVR below 25th percentile minus 1.5 times the interquartile range between 25th and 75th percentile, as well as all observations with UVR above 75th percentile plus 1.5 times the interquartile range between 25th and 75th percentile are excluded from further analysis.

3. International trade competitiveness of the EU in the digital era

3.1. GLOBAL TRADE DEVELOPMENTS BY INDUSTRY GROUPS

The share of traditional industries in the global exports of goods and services was relatively stable, at around 63-67%, over the period 1995-2018 (Figure 2), The share of cyber-physical industries fluctuated between 16% and 19%. Although the share of the ICT group in global trade increased from 4% to 6%, the share of the digital group declined from 14% to 12% between 1995 and 2018. Although trade data in real terms are not available in the database, the relative stability of shares in global trade over time and an absence of a clear upward trend in the non-traditional industry groups can be partly attributed to declining prices of ICT-related goods, as pointed out by van Ark (2016). However, various methods for calculating real trade flows, especially in the ICT sector, can make conclusions based on real values even less reliable. For this reason, we stick to the analysis in nominal terms.

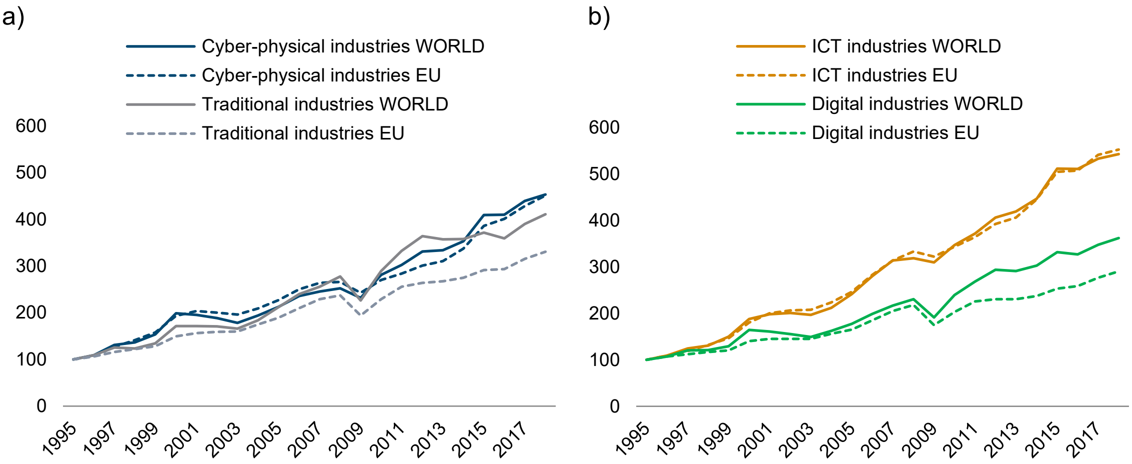
Figure 2 / Evolution of global trade in goods and services by industry group, in EUR bn



Note: Cyber-physical industries are intensive in digital tasks and in ICT capital; ICT industries are intensive in ICT capital, but not in digital tasks; digital industries are intensive in digital tasks, but not in ICT capital; traditional industries are neither digital task- nor ICT capital-intensive.
Sources: OECD TiVA, 2021 ed.; own calculations.

Figure 3 depicts cumulated euro-based nominal export growth over the time period 1995-2018. The highest global trade growth was observed in the ICT group, followed by the cyber-physical and the traditional groups. The development of global trade in the digital group was the least dynamic. Export growth of EU countries, including intra-EU trade (dashed lines), followed the global pattern for cyber-physical and ICT groups. For traditional and digital groups of industries, a gap between EU and global growth rates widened from around 2010, with the former lagging behind the latter.

Figure 3 / Comparison of global and EU export growth by industry groups in 1995-2018 (1995=100)

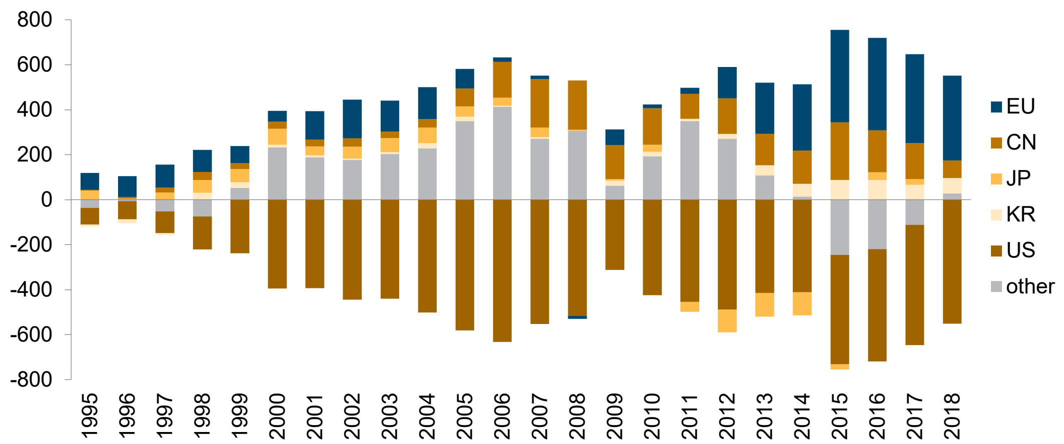


Note: Cyber-physical industries are intensive in digital tasks and in ICT capital; ICT industries are intensive in ICT capital, but not in digital tasks; digital industries are intensive in digital tasks, but not in ICT capital; traditional industries are neither digital task- nor ICT capital-intensive.
Sources: OECD TiVA, 2021 ed.; own calculations.

3.2. TRADE BALANCE DYNAMICS

Global trade data for goods and services reveal that the EU as a whole posted a trade surplus in every year except one in the period 1995-2018. (The exception was 2008, as a result of the global financial crisis, following recession and the associated collapse of trade, which hit European countries very hard.) The magnitude of the EU's trade surplus varied over time, reaching its peak during the period 2015-2018. By contrast, the US posted large trade deficits above USD 100bn in 1997-2018. For remaining peer countries except Japan in 2011-2015, 2018 and 'other' countries in 1995-1998 and 2015-2017, the trade balance was positive (Figure 4). The fact that so many countries repeatedly posted surpluses is explained by the magnitude of the US deficit.

Figure 4 / Evolution of trade balances over 1995-2018 by country groups, EUR bn

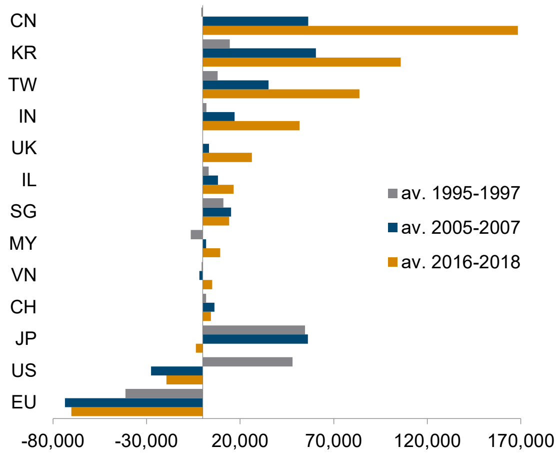


Sources: OECD TiVA, 2021 ed.; own calculations.

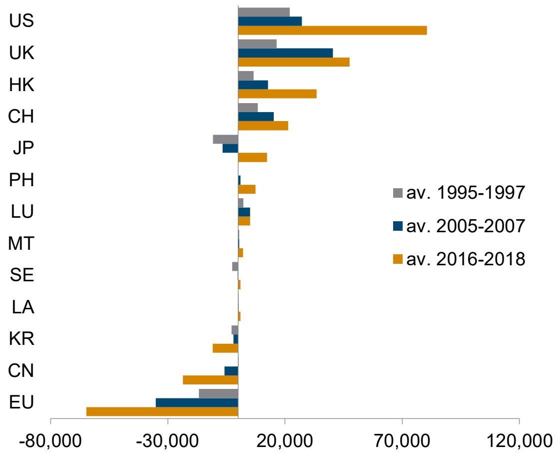
Figure 5 depicts trade balance at the level of industry groups for the EU as a whole, all countries in the 'peer' group – the US, China, Japan and South Korea – and individual countries from the EU and from the 'other' group, comprising the ten countries with the largest trade surpluses in absolute terms. Three-year averages are calculated for the initial period (1995-1997 averages), the middle period (2005-2007 averages) and the most recent period (2016-2018 averages).

Figure 5 / Evolution of trade balances by industry group, in EUR m

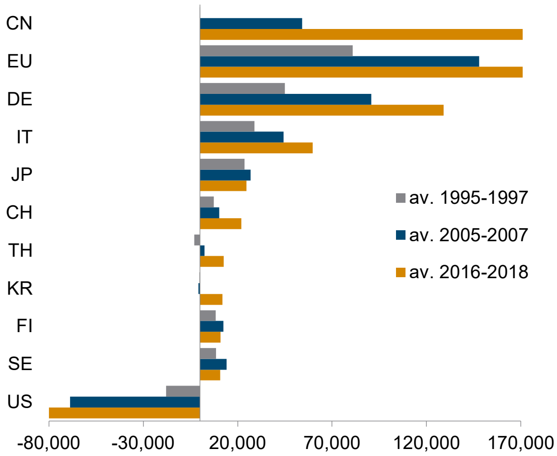
a) Cyber-physical industries



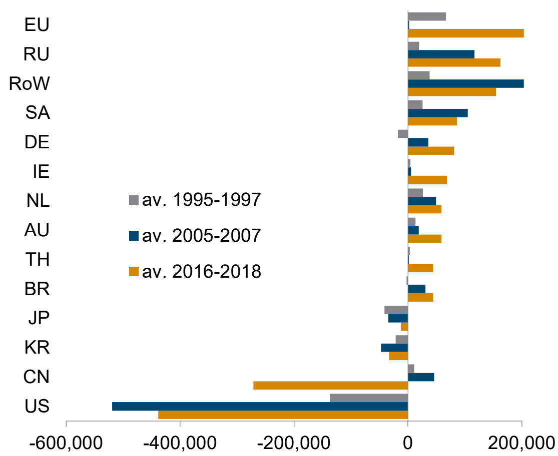
b) ICT industries



c) Digital industries



d) Traditional industries



Note: The top ten countries in terms of average trade balance values for 2016-2018, the EU and all peer countries are depicted. RoW – countries included in the OECD TiVA dataset as the 'rest of the world' category. Cyber-physical industries are intensive in digital tasks and in ICT capital; ICT industries are intensive in ICT capital, but not in digital tasks; digital industries are intensive in digital tasks, but not in ICT capital; traditional industries are neither digital task- nor ICT capital-intensive.
Sources: OECD TiVA, 2021 ed.; own calculations.

The EU as a whole posted large trade deficits for cyber-physical industries (panel a in Figure 5 and ICT industries (panel b in Figure 5) in the most recent period (2016-2018), which showed substantial deterioration relative to the initial period (1995-1997). For the ICT group, the EU's negative trade balance has recently also deteriorated relative to the middle period (2005-2007), but for the cyber-physical group, a slight reduction of the trade deficit is observed.

Only seven EU countries recorded trade surpluses in the cyber-physical industry group in the most recent period, and none of them is among the top ten. Of the peer countries, only China and South Korea posted trade surpluses, which improved over the period of analysis. Taiwan, India and the UK are among the top 'other' countries with the largest and improving trade surpluses.

Despite very small trade surpluses, Luxembourg, Malta and Sweden are among the top ten of the ICT group, where the largest positive balances are concentrated in the US, the UK and Hong Kong. This may be related to the large exports of financial services in these countries. Of the peer countries, only the US and Japan posted a trade surplus in the most recent period. Moreover, both countries experienced a continued improvement in their trade balance.

In the digital group of industries, however, the EU posted a large positive trade balance (panel c in Figure 5). This trade surplus has expanded over the observation period, which is mostly explained by the large trade surplus of Germany in the machinery industry (NACE code C28). Apart from Germany, the top ten countries with the highest trade surpluses in this industry group also include Italy, Finland and Sweden. By contrast, however, Finland and Sweden recorded a deterioration of their trade balances in the most recent period relative to the middle period. Among peer countries, only the US had a trade deficit, which deepened over time. It is also worth mentioning that China's trade surplus in this group of industries grew continuously over the sample period. China has thus taken over the lead from the EU.

In the traditional group of industries (panel d in Figure 5), the EU recorded a persistent trade surplus, with a significant increase between the initial and the most recent period, even after a marked decline of the surplus to a negligible level in the middle period. Germany, Ireland and the Netherlands as individual EU member states are among the top ten countries. All peer countries posted trade deficits in the most recent period. Improvement in trade balances is evident in Japan, South Korea and the US relative to the middle period, while a sharp deterioration is evident in China.

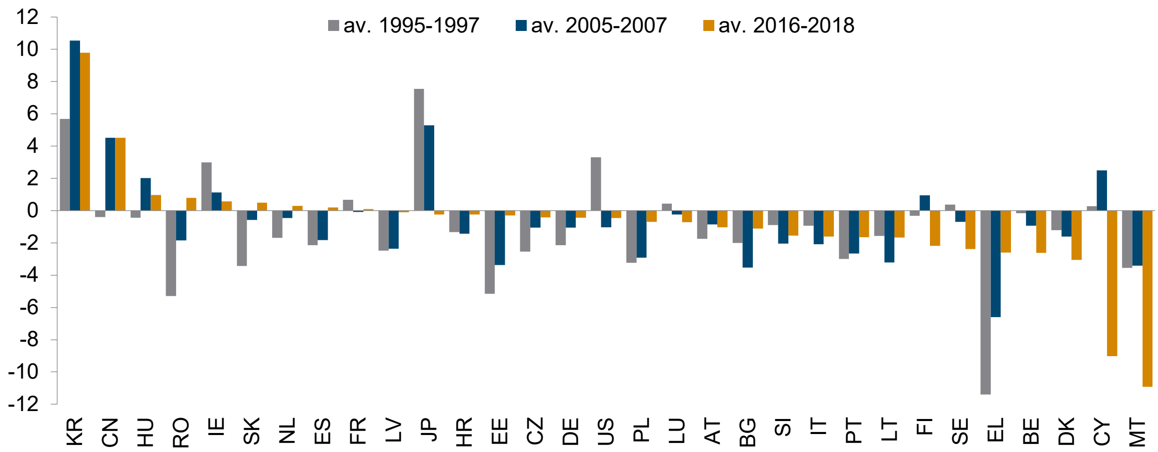
Given the small size of many EU economies, we analyse the performance of individual countries relative to their trade volume, with a relative trade balance indicator. Figure 6, 7, 8 and 9 compare individual EU countries and four peer countries over the same periods as stated above.

South Korea and China are clear outperformers in the cyber-physical group, with relative trade surpluses in 2016-2018 of 9.8% and 4.5% respectively (Figure 6). Both countries had already achieved leading positions in the middle period (2005-2007). China's relative trade surplus of 4.5% has remained unchanged since then. The relative trade surplus of South Korea declined slightly from 10.5% in the middle period (2005-2007) to 9.8% in the most recent period (2016-2018).

Most of the EU countries run trade deficits in the cyber-physical group. Only seven EU economies post relative trade surpluses in the most recent period and those surpluses are rather small: Hungary 1%, Romania 0.8%, Ireland 0.6%, Slovakia 0.5%, the Netherlands 0.3%, Spain 0.2% and France 0.1%.

Three of those seven countries belong to the EU-CEE group of Central and Eastern European EU member states.[10]

Figure 6 / Evolution of trade balances of EU and competitor countries in the cyber-physical group of industries as percentage of total trade of those countries



Note: Trade balance in one group of industries to the total volume of trade calculated as a sum of exports and imports of those countries. Cyber-physical industries are intensive in digital tasks and in ICT capital.
Sources: OECD TiVA, 2021 ed.; own calculations.

Some EU countries, traditionally considered to be digital front-runners, have become net importers. For example, Sweden, with a positive trade balance of 0.4% in cyber-physical industries in the initial period, reported a trade deficit of 2.4% in the most recent period. Finland's relative trade surplus of 0.9% in the middle period turned into a relative deficit of 2.2% in the most recent period.

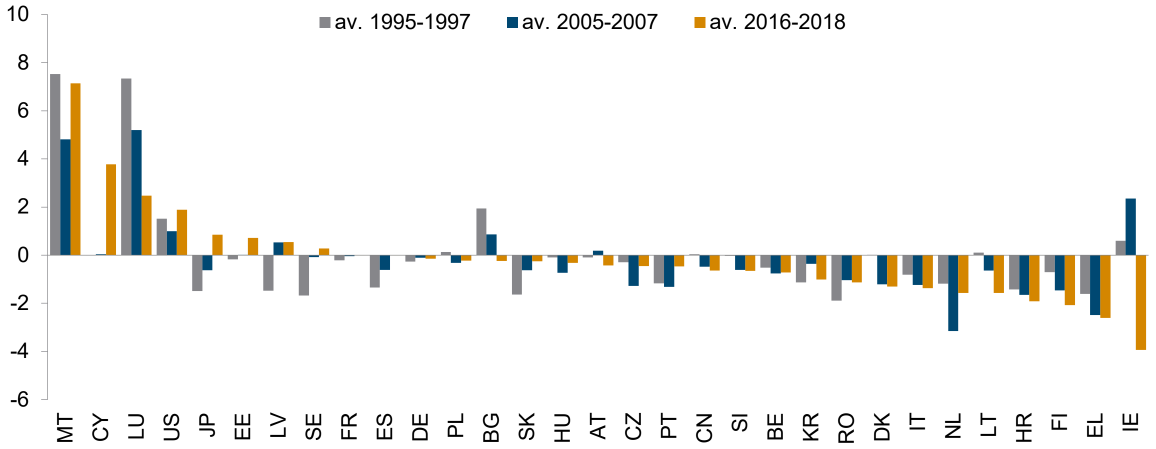
On a positive note, improvements in relative trade balances in percentage points between the middle and the most recent periods can be seen for 17 of the 27 EU economies. Greece and four EU-CEE countries – Estonia, Romania, Bulgaria and Latvia – are the five countries with the highest positive changes in percentage points (pp) between the middle period and the most recent period; Romania is running a trade surplus in the most recent period. In a longer-term perspective, Greece, Romania and Estonia are the EU economies that have seen the largest improvements in their trade balances relative to the initial period.

In the ICT group of industries (Figure 7), Malta, Cyprus and Luxembourg are the largest net exporters relative to their total trade among EU and peer countries. This can be explained by their low trade volumes and stronger specialisation in those industries, as their exports in the ICT group reach 37%, 31% and 59%, respectively, of the total exports of those countries in the most recent period (2016-2018). Only three other EU countries – Estonia, Latvia and Sweden – posted relative trade surpluses (and these were very small, at below 1%) in the ICT group in the most recent period. Among peer countries, the US was a persistent large net exporter over the entire period under consideration. In the most recent period, the US posted a relative trade surplus of 1.9%. Japan has evolved from a net importer to a net exporter, with a relative trade surplus amounting to 0.9% in the most recent period. The

10 Appendix 2 includes a list of countries, which denotes those belonging to EU-CEE.

largest improvements in relative trade balances in pp from the initial to the most recent period are discernible in Cyprus, Japan, Latvia, Sweden and Slovakia.

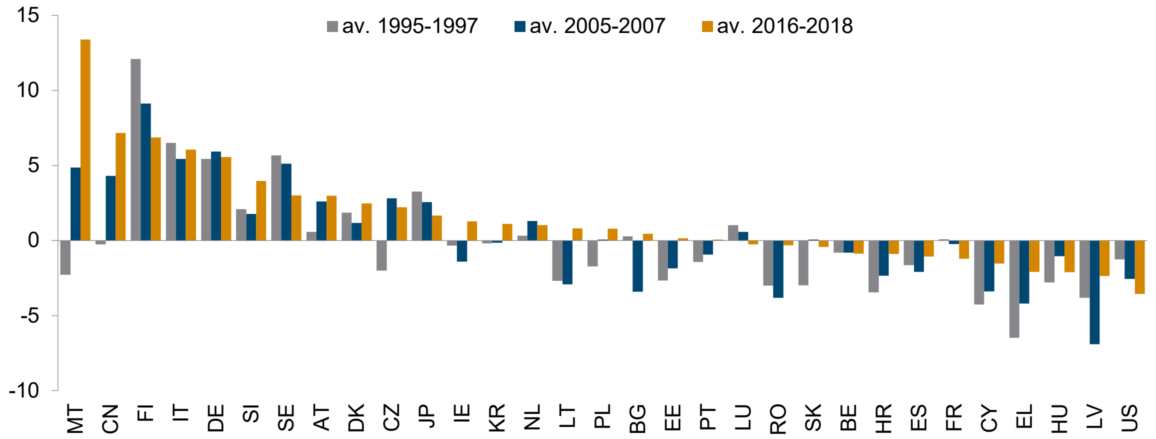
Figure 7 / Evolution of trade balances of EU and competitor countries in the ICT group of industries as percentage of total trade of those countries



Note: Trade balance in one group of industries to the total volume of trade calculated as a sum of exports and imports of those countries. ICT industries are intensive in ICT capital, but not in digital tasks.
Sources: OECD TiVA, 2021 ed.; own calculations.

China is the second-largest net exporter in the digital group of industries (Figure 8), with a trade surplus of 7.2% of total trade in the most recent period, exceeded only by Malta, with 13.4%. More EU countries – a total of 16 – recorded trade surpluses in this group than in the cyber-physical or ICT groups. In Finland, Italy and Germany, the trade surplus was above 5% of their total trade. After Malta and China, Greece, Czechia and Lithuania achieved the largest improvements in their trade balances in pp, and the latter two countries turned their positions from a deficit into a surplus.

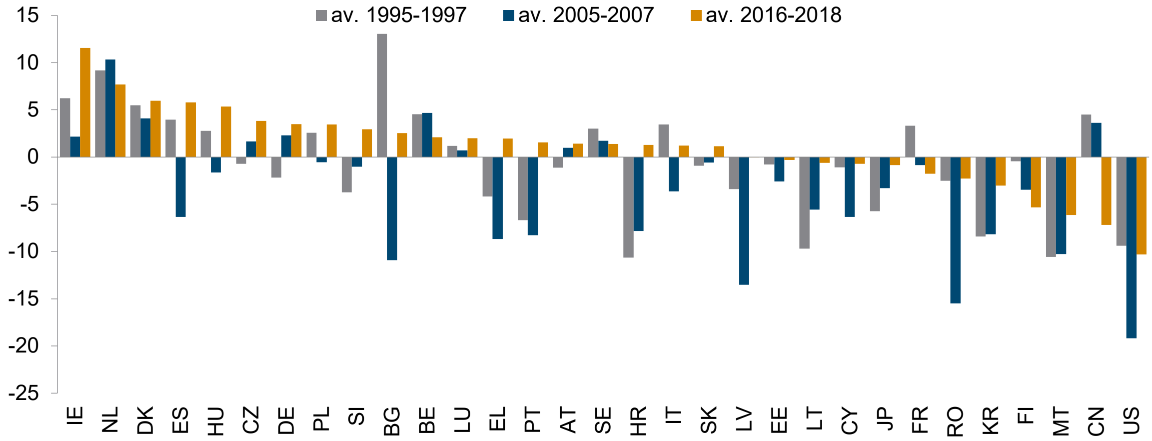
Figure 8 / Evolution of trade balances of EU and competitor countries in the digital group of industries as percentage of total trade of those countries



Note: Trade balance in one group of industries to the total volume of trade calculated as a sum of exports and imports of those countries. Digital industries are intensive in digital tasks, but not in ICT capital.
Sources: OECD TiVA, 2021 ed.; own calculations.

More than two-thirds of EU countries (19 out of 27) are net exporters in the traditional group of industries (Figure 9), with all four competitor countries running trade deficits in this group. Clearly, EU member states outperform their peer countries in traditional industries.

Figure 9 / Evolution of trade balances of EU and competitor countries in the traditional group of industries as percentage of total trade of those countries



Note: Trade balance in one group of industries to the total volume of trade calculated as a sum of exports and imports of those countries. Traditional industries are neither digital task- nor ICT capital-intensive.
Sources: OECD TiVA, 2021 ed.; own calculations.

The main conclusion of this trade balance analysis is that EU countries are well positioned in the traditional group of industries. This is a positive sign, given that the traditional group is still the largest industry group in global trade. By contrast, cyber-physical industries – which are expected to be more relevant for the digital transformation – are not a strong trade surplus positions in most EU member states. However, EU countries have relatively strong positions in the digital group. Only a few EU countries are net exporters in cyber-physical and ICT industries. Nevertheless, positive tendencies of catching up in terms of improving relative trade balances over longer time periods in the cyber-physical and ICT groups are apparent in some EU countries, especially in EU-CEE, which were net importers in those groups in the initial period. In all groups, heterogeneity of the competitive positions of EU countries is clearly evident.

3.3. REVEALED COMPARATIVE ADVANTAGES

Below, we compare symmetric revealed comparative advantages (RCAs) of the EU and peer countries across industry groups, focusing on the most recent period (2016-2018). We put this specialisation measure into a global trade perspective, comparing RCAs with the market shares of those countries (Table 3).

In the cyber-physical group, the group of peer countries (on average) demonstrate a clear advantage in terms of market share of 40.8% and a positive simple average RCA of 0.06. A revealed comparative disadvantage of the EU is underpinned by both a negative simple average RCA value and lower market share. Among EU countries with market shares of above 1%, RCA values are positive only for France, the Netherlands and Belgium. Other EU countries with positive RCAs – Hungary, Romania and Estonia – have only low market shares (below 1%) in terms of global exports in this industry group.

Table 3 / Revealed comparative advantages and export market shares of EU and peer countries by industry groups, average in 2016-2018

Cyber-physical industries			ICT industries			Digital industries			Traditional industries		
Country	RCA	Market share, in %	Country	RCA	Market share, in %	Country	RCA	Market share, in %	Country	RCA	Market share, in %
CN	**0.10**	**16.5**	**US**	**0.15**	**18.2**	**CN**	**0.20**	**20.2**	**US**	**-0.18**	**9.4**
US	**0.02**	**14.0**	LU	0.52	6.1	DE	0.24	11.7	**CN**	**-0.22**	**8.6**
KR	**0.23**	**6.4**	FR	0.10	5.2	**US**	**-0.23**	**8.5**	DE	-0.01	7.0
DE	-0.11	5.7	IE	0.27	4.9	**JP**	**0.14**	**6.4**	**JP**	**-0.11**	**3.9**
FR	0.01	4.4	DE	-0.19	4.9	IT	0.35	5.4	FR	-0.10	3.5
JP	**-0.12**	**3.8**	**JP**	**-0.01**	**4.8**	**KR**	**-0.11**	**3.2**	IT	0.08	3.1
NL	0.04	2.7	NL	0.10	3.1	FR	-0.15	3.1	**KR**	**-0.20**	**2.7**
IE	-0.04	2.6	**CN**	**-0.72**	**2.2**	NL	-0.19	1.7	ES	0.26	2.6
BE	0.04	1.4	BE	0.14	1.8	AT	0.24	1.7	NL	-0.04	2.3
IT	-0.30	1.4	ES	0.04	1.6	ES	0.01	1.6	BE	0.10	1.6
ES	-0.04	1.4	IT	-0.25	1.6	PL	0.25	1.5	IE	-0.31	1.5
SE	-0.08	1.0	SE	-0.03	1.1	SE	0.12	1.5	PL	0.23	1.5
PL	-0.03	0.9	**KR**	**-0.60**	**1.0**	IE	-0.43	1.1	AT	0.00	1.0
AT	-0.15	0.8	AT	-0.14	0.8	CZ	0.24	1.0	SE	-0.09	1.0
HU	0.07	0.6	MT	0.38	0.5	FI	0.27	1.0	DK	0.24	0.9
CZ	-0.05	0.6	DK	-0.06	0.5	DK	0.21	0.8	CZ	0.13	0.8
LU	-0.57	0.5	PL	-0.43	0.4	BE	-0.28	0.7	HU	0.10	0.6
FI	-0.07	0.5	CZ	-0.33	0.3	HU	0.07	0.6	PT	0.32	0.5
DK	-0.16	0.4	CY	0.46	0.3	RO	0.19	0.5	SK	0.23	0.4
RO	0.09	0.4	HU	-0.24	0.3	SK	0.22	0.4	EL	0.60	0.4
SK	-0.02	0.3	PT	-0.02	0.3	PT	0.17	0.4	RO	0.10	0.4
PT	-0.15	0.2	FI	-0.39	0.2	SI	0.31	0.3	FI	-0.24	0.3
EE	0.03	0.1	SK	-0.36	0.1	MT	-0.01	0.2	LU	-0.80	0.2
HR	-0.05	0.1	EL	0.07	0.1	BG	0.19	0.2	BG	0.31	0.2
EL	-0.14	0.1	BG	0.02	0.1	EL	0.10	0.1	SI	0.12	0.2
BG	-0.21	0.1	SI	-0.11	0.1	LT	0.28	0.1	LT	0.42	0.2
SI	-0.31	0.1	HR	0.06	0.1	EE	0.03	0.1	HR	0.13	0.1
CY	-0.34	0.1	LV	0.20	0.1	HR	0.01	0.1	EE	-0.04	0.1
MT	-0.64	0.1	EE	-0.08	0.1	LU	-0.92	0.1	LV	0.19	0.1
LT	-0.16	0.0	RO	-0.66	0.1	LV	-0.17	0.0	CY	-0.42	0.0
LV	-0.07	0.0	LT	-0.24	0.0	CY	-0.80	0.0	MT	-0.80	0.0
EU	**-0.13**	**28.3**	**EU**	**-0.04**	**34.8**	**EU**	**0.02**	**39.3**	**EU**	**0.03**	**30.6**
Peers	**0.06**	**40.8**	**Peers**	**-0.30**	**26.1**	**Peers**	**-0.07**	**35.0**	**Peers**	**-0.18**	**24.6**

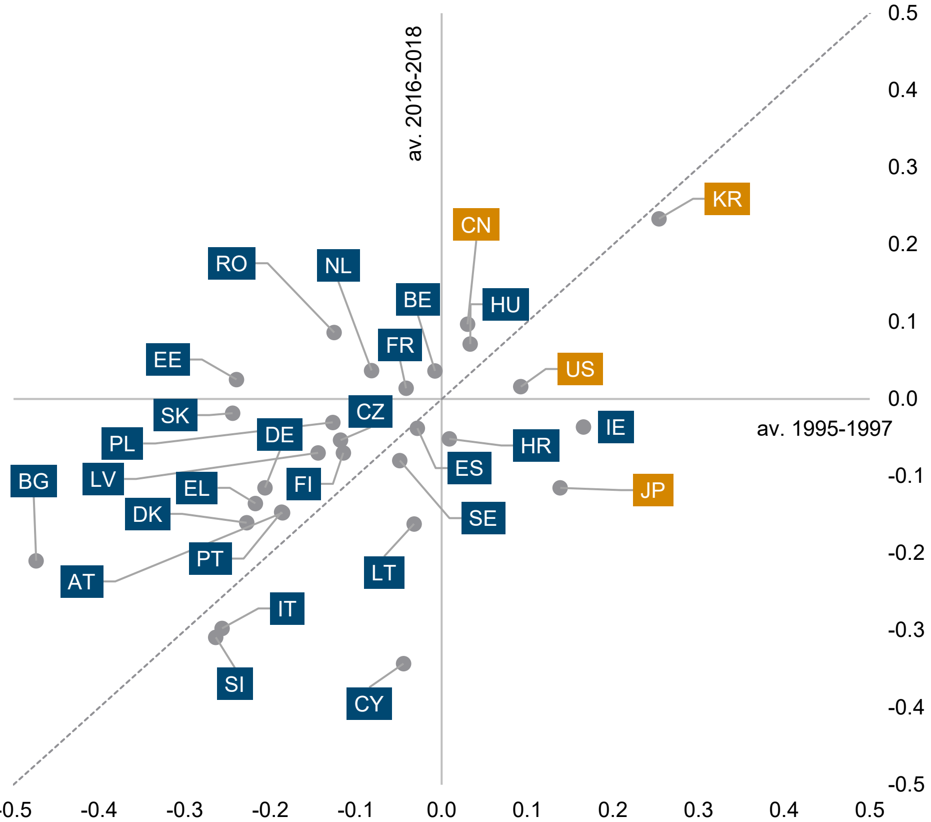
Note: Cyber-physical industries are intensive in digital tasks and in ICT capital; ICT industries are intensive in ICT capital, but not in digital tasks; digital industries are intensive in digital tasks, but not in ICT capital; traditional industries are neither digital task- nor ICT capital-intensive. Countries are sorted by market share in the respective group. Values of RCA range from minimum (grey) to maximum (gold) in each group. Values for EU and peers are calculated as simple averages.
Sources: OECD TiVA, 2021 ed.; own calculations.

In the ICT group, the EU has larger market share than the peer countries. Moreover, despite negative RCAs for both groups, the value in the EU is less negative. Among the five EU countries with market shares of above 3% – Luxembourg, France, Ireland, Germany and the Netherlands – only Germany has a negative RCA value. By contrast, of the peer countries, only the US has a positive RCA in this industry group. The US is also the country with the highest market share in the ICT group, amounting to 18.2%.

In the digital group, again the EU has larger market share than the peer group, and a clear comparative advantage (positive RCA values). The EU countries with the highest market shares are Germany, with 11.7%, and Italy, with 5.4%. Both countries also have positive RCAs, of 0.24 and 0.35 respectively. More EU countries posted positive RCAs in this group than in the cyber-physical and in the ICT groups. This is particularly true for EU-CEE countries. This demonstrates that the EU is more competitive on the global market in industries in the digital group.

In the traditional industry group, the EU's dominance in terms of market share and positive average RCA is clearly apparent. As in the digital group, numerous EU countries posted positive RCAs. By contrast, all individual peer countries in the traditional industry group have negative RCAs, although their role in global exports in this group, measured as market shares, is rather high.

Figure 10 / Comparison of RCA in the cyber-physical group, 1995-1997 to 2016-2018



Note: Malta, with values of (-0.4, -0.6), and Luxembourg (-0.7, -0.6), are not depicted.
Sources: OECD TiVA, 2021 ed.; own calculations.

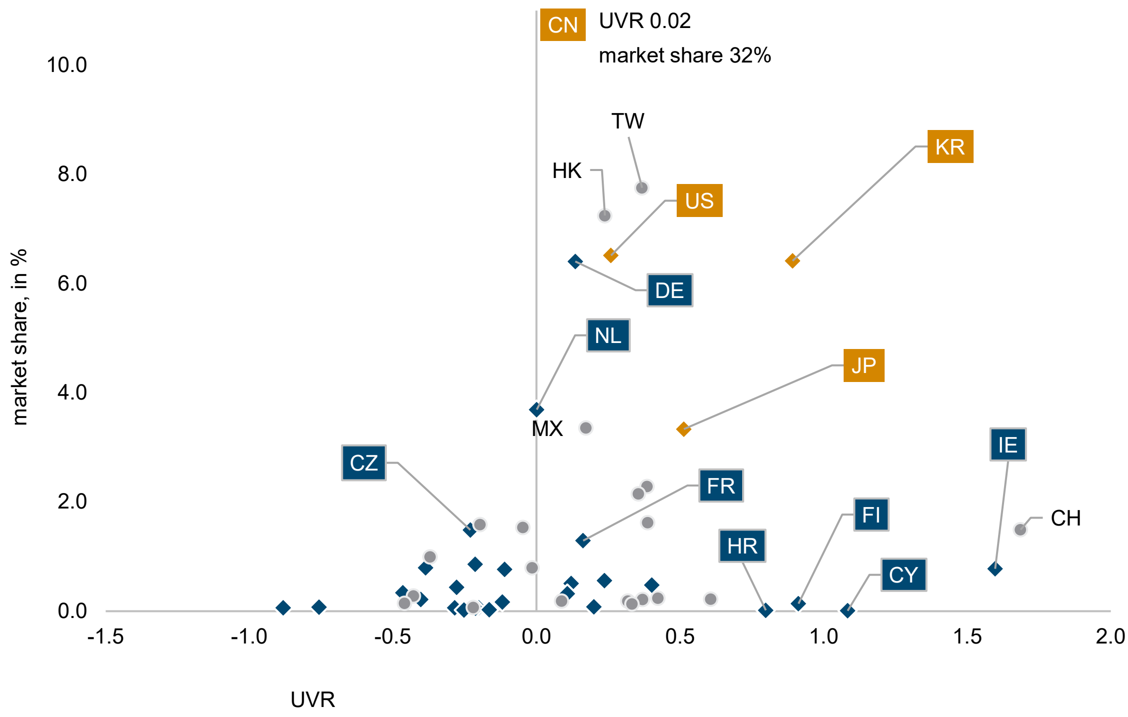
Despite the unfavourable positions of the EU countries in the cyber-physical group, positive changes over the sample period are discernible in many member states. Figure 10 illustrates how RCA values in the cyber-physical group have evolved over time, comparing three-year averages for the initial period (1995-1997) and the most recent period (2016-2018). Countries above the grey 45-degree line improved their RCAs over time; those below the line experienced a deterioration of their RCAs. Among peer countries, only China saw its RCA improve. Among EU countries, 18 out of 27 improved their RCA values. However, for most of the EU countries, the RCA remained negative in the most recent period. In Romania, the Netherlands, Belgium, France and Estonia, RCA values turned positive. Hungary, which already had positive RCA initially, further expanded its advantage over time.

3.4. UNIT VALUE RATIOS FOR MOST DIGITAL-INTENSIVE INDUSTRIES

The analysis of trade balances and RCAs revealed that the EU as a whole and most EU countries are not very competitive in the cyber-physical group. In order to investigate whether EU economies are 'quality leaders' – i.e. whether they tend to export goods of superior quality – we analyse UVRs for the two manufacturing industries within the cyber-physical group.

Figure 11 compares the price competitiveness as measured by the combined evolution of UVRs and market shares over the period 2017-2019 for the computer, electronic and optical equipment industry (NACE Rev.2 industry 26) and Figure 12 shows the corresponding analysis for the other transport equipment industry (NACE Rev.2 industry 30).

Figure 11 / Unit value ratios and market shares for manufacturing of computer, electronic and optical products (26) from the cyber-physical group in 2017-2019



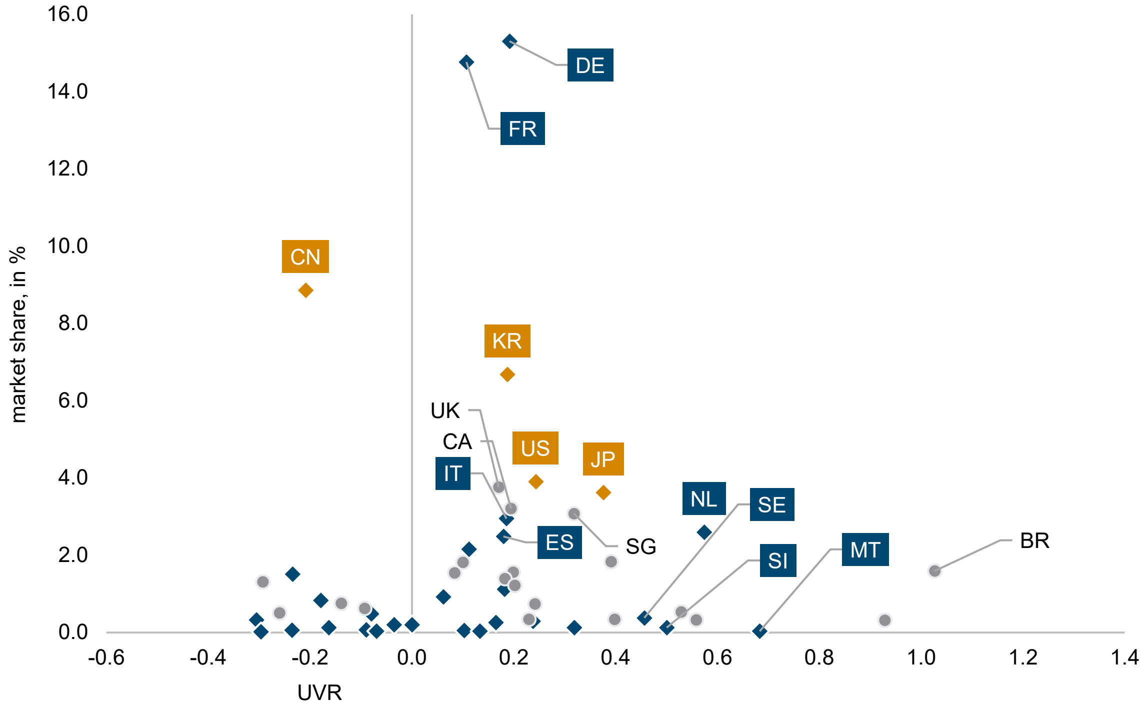
Note: Only top 20 ‘other’ countries by market shares depicted; only selected EU and peer countries are labelled.
Sources: UN Comtrade; own calculations.

Only a minority of EU countries – 12 out of 27 – have positive UVRs in the case of the computer, electronic and optical equipment industry in the period 2017-2019. Most of those countries are non-EU-CEE economies, with Croatia being the sole exception. Overall, the positions of individual

EU countries are quite heterogenous. A trade-off between larger market share (Germany, the Netherlands) and rather low positive UVRs and higher UVRs (Ireland, Finland) with relatively low shares can be observed. Among competitor countries, Switzerland, with a market share of 1.5%, emerges as the leader in terms of product quality, with a UVR of 1.7. All peer countries posted positive UVRs, although in the case of China, which held the largest market share of around 32%, the positive UVR amounted to only 0.02 (Figure 11).

In other transport equipment manufacturing (30), Germany and France have the largest export shares, with positive UVRs of 0.2 and 0.1 respectively. Sixteen out of 27 EU countries record UVRs above zero, with the highest for Malta, the Netherlands, Slovenia and Sweden. As for peer countries, only China has a negative UVR; given its large market share of around 9%, this appears to signal a competitive position owing to low prices. Brazil is at the top of the UVR ranking, while the UK, Canada and Singapore post the largest market shares among 'other' countries (Figure 12).

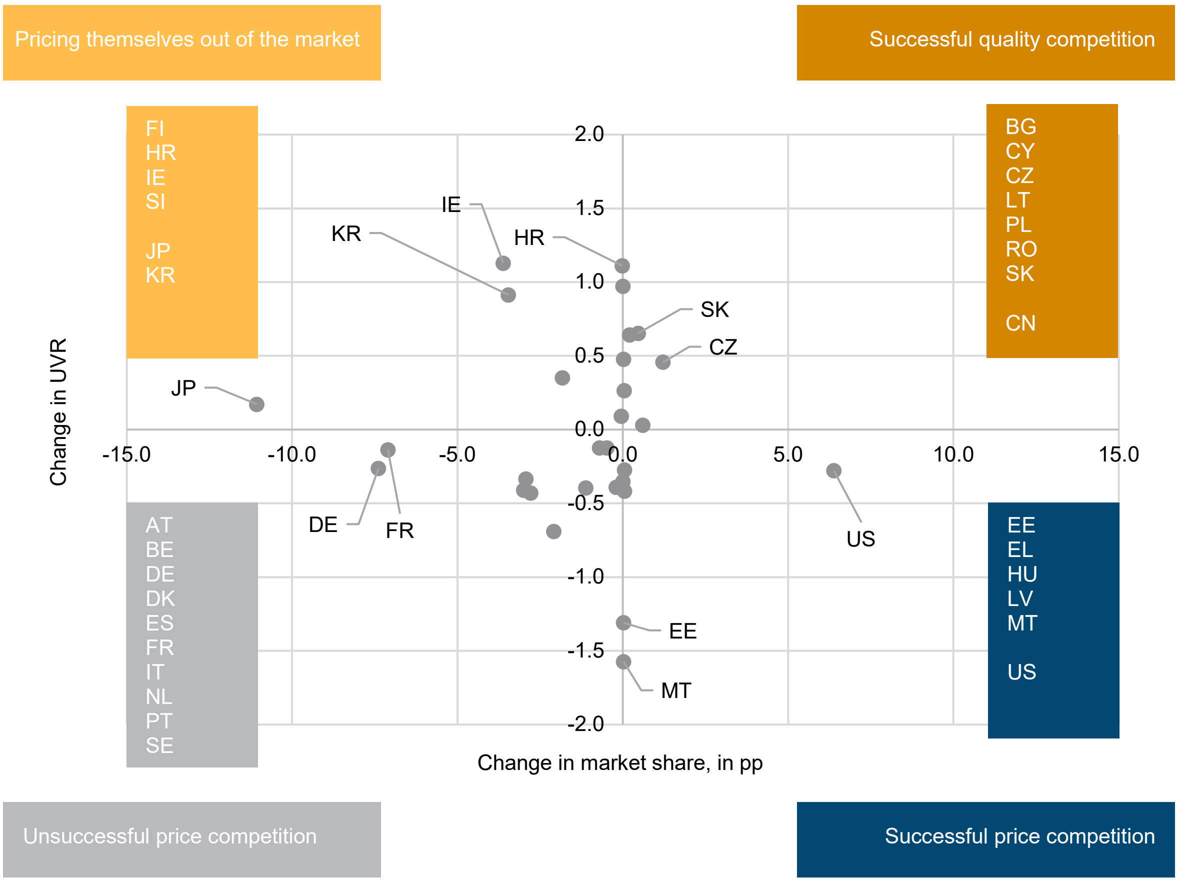
Figure 12 / Unit value ratios and market shares for manufacturing of other transport equipment (30) from the cyber-physical group in 2017-2019



Note: Only top 20 'other' countries by market shares depicted; only selected EU and peer countries are labelled.
Sources: UN Comtrade; own calculations.

Equally interesting is the analysis of changes in UVRs and export market shares, which together are a good indicator of price and quality competitiveness (Figure 13 and Figure 14). For this exercise, the changes between the period 1995-1998 and the period 2017-2019 are considered for EU and peer countries. Using the classification proposed by Landesmann and Wörz (2006), we identify four groups of countries, depicted in four coloured boxes on each figure. Starting with the computer, electronic and optical products industry (26), we find that seven EU countries, including six EU-CEE economies, EU-CEE countries and China in the gold box are examples of countries competing successfully on quality, in the sense that they managed to increase their UVRs and still gained market share. Five EU countries, including two EU-CEE economies, as well as the US (blue box) represent examples of successful price competition as they gained in market share but experienced a reduction in their UVRs. Two old EU countries and two EU-CEE countries, along with Japan and South Korea (light gold box), are 'pricing themselves out of the market', as they upgraded in quality (increase in UVRs) but lost market share. Ten non-EU-CEE countries (grey box) seem to be examples of unsuccessful price competition as they lost market share and saw their UVRs decline. To sum up, while the 'old' EU countries reduced their UVRs in this industry, eight out of 11 EU-CEE countries managed to upgrade in terms of product quality.

Figure 13 / Changes in UVRs and export market shares in manufacturing of computer, electronic and optical products (26) between 1995-1998 and 2017-2019

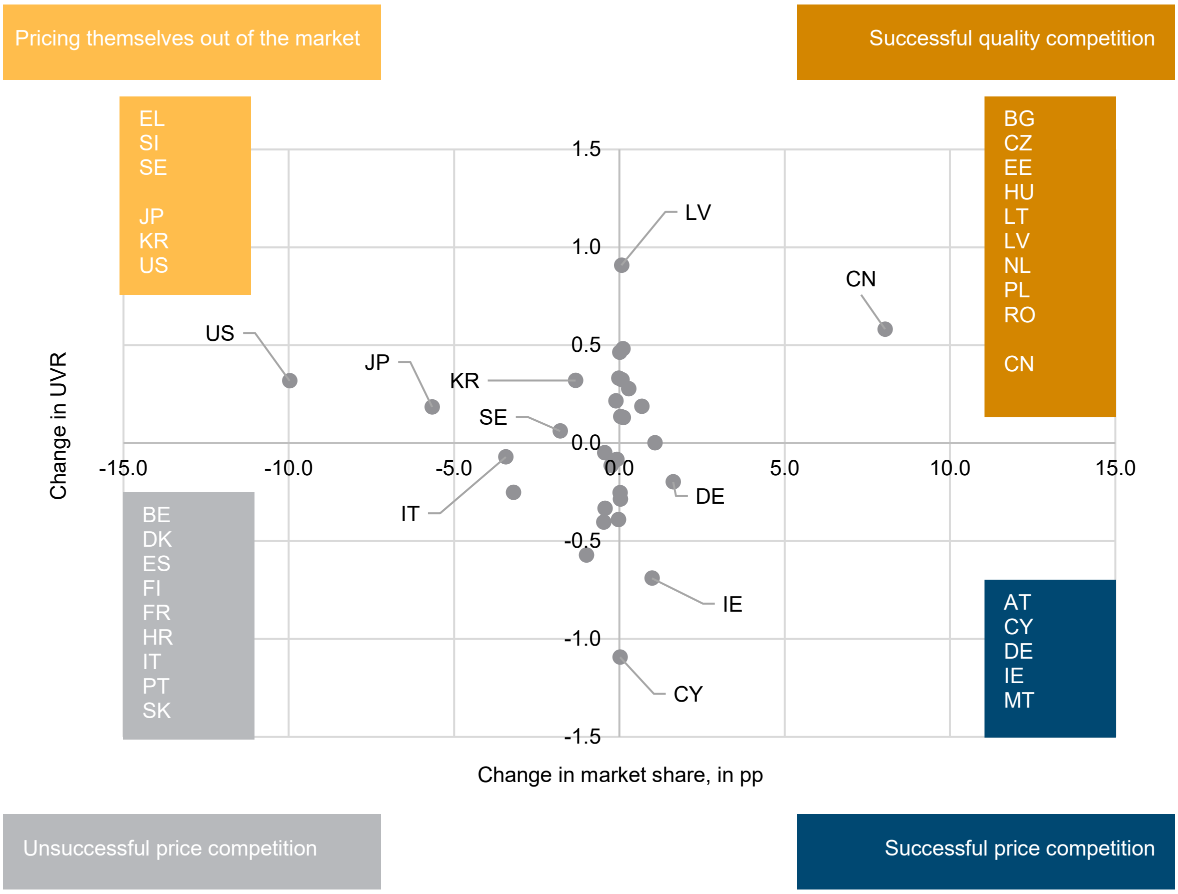


Note: Data for Luxembourg are not available.
Sources: UN Comtrade; own calculations.

An analogous analysis for other transport equipment industry (30) reveals that eight EU-CEE economies and the Netherlands, along with China (gold box) have been successful in quality competition (Figure 14). Three EU countries (with only one, Slovenia, from EU-CEE), as well as all remaining peer countries (light gold box) managed to upgrade their product quality (increase in UVR) but lost market share. Five EU countries proved to be successful price competitors (blue box) as they compensated for a decline in their UVRs by gaining market share. Nine EU countries (two of them from EU-CEE) represent examples of unsuccessful price and quality competition, with declines in both UVR and market share, thereby indicating a general loss of competitiveness.

To sum up, although many EU countries had positive UVRs in the most recent period, a worrying sign is that in both manufacturing industries in the cyber-physical group, many 'old' EU countries had lost competitiveness relative to the initial period. On the upside, some progress in terms of quality upgrading and gaining in market shares is evident for many EU-CEE economies.

Figure 14 / Changes in UVRs and export market shares in manufacturing of other transport equipment (30) between 1995-1998 and 2017-2019



Note: Data for Luxembourg are not available.
Sources: UN Comtrade; own calculations.

4. Conclusions

This report assessed the EU's relative position in global trade based on a series of competitiveness indicators. It focused on a new classification of industries, which are delineated by their factor intensities in digital tasks in labour services and ICT capital. The four defined groups are the cyber-physical group (digital task- and ICT capital-intensive), the ICT group (non-intensive in digital tasks, but ICT capital-intensive), the digital group (digital task-intensive, but non-intensive in ICT capital) and the traditional group (non-intensive in digital tasks and non-intensive in ICT capital).

The nominal export growth of the ICT group (the most dynamic one) and of the cyber-physical group in the EU on average was at par with the global growth of these groups. However, for the traditional group and the digital group, a gap to the detriment of the EU emerged after 2010. In absolute terms, the EU as a whole posted large trade deficits for the cyber-physical group and the ICT group in the most recent period (2016-2018), which expanded substantially relative to the initial period (1995-1997). By contrast, in the digital group and the traditional group, the EU recorded a trade surplus in the most recent period (2016-2018).

As the traditional group still accounted for the largest share of global trade, around 64% in 2018, a trade surplus in this group thus had an impact on the EU's overall good performance in international trade. By contrast, in those groups of industries associated with the digital transformation, relatively successful performance in international trade was evident only in the digital task-intensive digital group, which represented only 12% of global trade in 2018.

In the cyber-physical group, which accounted for 18% of global trade in 2018, the EU as a whole had a rather weak position, as revealed by trade deficits as well as negative average RCAs in the most recent period (2016-2018).

For individual countries, we performed an analysis of the relative trade balance indicator, measured as the trade balance in each group relative to the overall trade (exports plus imports) of a particular country. Only seven EU countries – Hungary, Romania, Ireland, Slovakia, the Netherlands, Spain and France – recorded a relative trade surplus in the cyber-physical group, which in all cases did not exceed 1%, a rather low value compared with 9.8% for South Korea or 4.5% for China. Some EU countries traditionally considered to be digital front-runners, for example, Sweden, with a trade surplus in the initial period (1995-1997), and Finland, with a trade surplus in the middle period (2005-2007), turned into net importers in the cyber-physical industries in the most recent period (2016-2018).

Despite the fact that most EU countries had negative RCAs in the cyber-physical group in the most recent period (2016-2018), the majority of individual EU countries were catching up in terms of RCAs, relative to the initial period (1995-1997). Romania, the Netherlands, Belgium, France and Estonia managed to turn a revealed comparative disadvantage into an advantage (a positive RCA) and Hungary expanded its positive RCA.

About half of the EU countries recorded positive UVRs in the manufacturing of computer, electronic and optical products and 60% of EU countries recorded positive UVRs in the manufacturing of other transport equipment for the most recent period (2017-2019). This reflects a specialisation in the export of relatively high-quality/high-price goods in both cyber-physical manufacturing industries. On the downside, only a small number of EU countries succeeded in improving the quality of their exports and market shares over the long term. EU-CEE countries were relatively successful in this respect, signalling a certain degree of product quality upgrading.

The EU's current trade specialisation shows advantages in the groups of industries that represent the largest part of global trade but are presumably less decisive for the digital transformation. In contrast, in the cyber-physical group, the trade balance and the RCA of the EU as a whole are negative. The trade balance positions and RCAs of individual EU countries are rather weak too, but in many cases improving. For UVRs, a rather different picture emerges: many EU countries are specialising in high-quality exports (as indicated by positive UVRs) but are seeing their UVRs and/or their market shares decline over time, with only a few EU-CEE countries being exceptions to this trend by improving both their UVRs and their market shares.

To sum up the results for the EU and main competitors, Table 4 provides an overview of the current positions for the main indicators of competitiveness for the EU, the US and China.

Table 4 / An overview of competitive positions, averages for 2016-2018

	EU			USA			China		
Groups	TB	RCA	UVR*	TB	RCA	UVR*	TB	RCA	UVR*
Cyber-physical	-	-	++	-	+	++	+	+	+-
ICT	-	-	n/a	+	+	n/a	-	-	n/a
Digital	+	+	n/a	-	-	n/a	+	+	n/a
Traditional	+	+	n/a	-	-	n/a	-	-	n/a

Note: TB – trade balance, RCA – symmetric revealed comparative advantage, UVR – unit value ratio; + (-) indicates a positive (negative) value; *based on goods exports only, as of 2017-2019; a separate sign indicates the UVR for, first, the manufacturing of computer, electronic and optical products and, second, the manufacturing of other transport equipment.
Sources: OECD TiVA, 2021 ed.; UN Comtrade; own calculations.

Trade data and competitiveness indicators show that EU countries need to ramp up efforts to increase their competitive positions in trade for industries with high ICT capital and digital tasks intensity. Although catching up is apparent in terms of RCAs, and although the quality of exported goods is improving for some countries, for most EU economies there is still room for improvement in the realm of trade in the digital era.

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Appendices

APPENDIX 1. ASSIGNMENT OF INDUSTRIES TO FOUR GROUPS ACCORDING TO THEIR DIGITAL AND ICT INTENSITIES

Appendix Table 1 / Assignment of industries to four groups according to their digital and ICT intensities

Industry code	Industry name	Industry group	digital task intensity (normalised)	ICT capital intensity (normalised)
01T03	Agriculture	traditional	0.0245	0.0209
05T09	Mining	traditional	0.0361	0.0315
10T12	Food products, beverages and tobacco	traditional	0.0547	0.0671
13T15	Textiles, textile products, leather and footwear	traditional	0.0845	0.0725
16	Wood and products of wood and cork	traditional	0.0952	0.0873
17T18	Paper products and printing	digital	0.1576	0.1292
19	Coke and refined petroleum products	traditional	0.0248	0.0559
20	Chemical and chemical products	traditional	0.084	0.086
21	Pharmaceuticals, medicinal chemical and botanical products	traditional	0.0728	0.0786
22	Rubber and plastics products	traditional	0.0957	0.0634
23	Other non-metallic mineral products	traditional	0.0831	0.0657
24	Basic metals	traditional	0.0866	0.084
25	Fabricated metal products	traditional	0.1172	0.0678
26	Computer, electronic and optical equipment	cyber-physical	0.2127	0.32
27	Electrical equipment	digital	0.134	0.0806
28	Machinery and equipment, nec	digital	0.1281	0.0808
29	Motor vehicles, trailers and semi-trailers	traditional	0.1002	0.0946
30	Other transport equipment	cyber-physical	0.1294	0.181
31T33	Manufacturing nec; repair and installation of machinery and equipment	digital	0.1383	0.0962
35	Electricity, gas, steam and air conditioning supply	ICT	0.0658	0.148
36T39	Water supply; sewerage, waste management and remediation activities	traditional	0.0827	0.0988
41T43	Construction	traditional	0.0776	0.0656
45T47	Wholesale and retail trade; repair of motor vehicles	traditional	0.0924	0.0946
49	Land transport and transport via pipelines	traditional	0.0484	0.082
50	Water transport	traditional	0.0223	0.0991
51	Air transport	traditional	0.0532	0.0889
52	Warehousing and support activities for transportation	traditional	0.0617	0.0956
53	Postal and courier activities	cyber-physical	0.3552	0.1612
55T56	Accommodation and food service activities	traditional	0.0237	0.0468
58T60	Publishing, audio-visual and broadcasting activities	cyber-physical	0.2894	0.3986
61	Telecommunications	cyber-physical	0.1902	1.00000
62T63	IT and other information services	cyber-physical	1.0000	0.40920
64T66	Financial and insurance activities	ICT	0.1105	0.15720
68	Real estate activities	traditional	0.0025	0.02140
69T75	Professional, scientific and technical activities	cyber-physical	0.2168	0.17040
77T82	Administrative and support service activities	ICT	0.1184	0.27260
84	Public administration and defence; compulsory social security	digital	0.1352	0.07860
85	Education	traditional	0.0771	0.06360
86T88	Human health and social work activities	traditional	0.0425	0.05400
90T96	Arts, entertainment and recreation; Other service activities	digital	0.1424	0.10840
97T98	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	traditional	0.0000	0.00000
	Mean (threshold for classification as digital / ICT)		0.1236	0.1336

Note: Digital task and ICT capital intensities are normalised to range from 0 to 1. Digital tasks and ICT capital as defined in Guarascio and Stöllinger (2022). Industry classification is slightly more aggregated than that in the OECD TiVA database.
Source: own calculations, based on Guarascio and Stöllinger (2022).

APPENDIX 2. COUNTRY LIST

Appendix Table 2 / Country list

Country group	Country code iso2	Country name
EU	AT	Austria
EU	BE	Belgium
EU (EU-CEE)	BG	Bulgaria
EU	CY	Cyprus
EU (EU-CEE)	CZ	Czechia
EU	DE	Germany
EU	DK	Denmark
EU (EU-CEE)	EE	Estonia
EU	EL	Greece
EU	ES	Spain
EU	FI	Finland
EU	FR	France
EU (EU-CEE)	HR	Croatia
EU (EU-CEE)	HU	Hungary
EU	IE	Ireland
EU	IT	Italy
EU (EU-CEE)	LT	Lithuania
EU	LU	Luxembourg
EU (EU-CEE)	LV	Latvia
EU	MT	Malta
EU	NL	Netherlands
EU (EU-CEE)	PL	Poland
EU	PT	Portugal
EU (EU-CEE)	RO	Romania
EU	SE	Sweden
EU (EU-CEE)	SI	Slovenia
EU (EU-CEE)	SK	Slovakia
peer	CN	China
peer	JP	Japan
peer	KR	South Korea
peer	US	USA
other	AD	Andorra
other	AE	United Arab Emirates
other	AG	Antigua and Barbuda
other	AL	Albania
other	AM	Armenia
other	AN	Neth. Antilles
other	AO	Angola
other	AR	Argentina
other	AU	Australia
other	AW	Aruba
other	AZ	Azerbaijan
other	BA	Bosnia and Herzegovina
other	BB	Barbados
other	BD	Bangladesh
other	BF	Burkina Faso

contd.

Appendix Table 2 / (contd.) Country list

Country group	Country code iso2	Country name
other	BH	Bahrain
other	BI	Burundi
other	BJ	Benin
other	BM	Bermuda
other	BN	Brunei Darussalam
other	BO	Bolivia
other	BR	Brazil
other	BS	Bahamas
other	BT	Bhutan
other	BW	Botswana
other	BY	Belarus
other	BZ	Belize
other	CA	Canada
Other	CD	Dem. Rep. of the Congo
other	CF	Central African Rep.
other	CG	Congo
other	CH	Switzerland
Other	CI	Côte d'Ivoire
other	CL	Chile
Other	CM	Cameroon
other	CO	Colombia
other	CR	Costa Rica
other	CU	Cuba
other	CV	Cabo Verde
other	DJ	Djibouti
other	DM	Dominica
other	DO	Dominican Rep.
other	DZ	Algeria
other	EC	Ecuador
other	EG	Egypt
other	ER	Eritrea
other	ET	Ethiopia
other	FJ	Fiji
other	FO	Faroe Islands
other	GA	Gabon
other	GD	Grenada
other	GE	Georgia
other	GH	Ghana
other	GL	Greenland
other	GM	Gambia
other	GN	Guinea
other	GT	Guatemala
other	GY	Guyana
other	HK	China, Hong Kong SAR
other	HN	Honduras
other	HT	Haiti
other	ID	Indonesia
other	IL	Israel

contd.

Appendix Table 2 / (contd.) Country list

Country group	Country code iso2	Country name
other	IN	India
other	IR	Iran
other	IS	Iceland
other	JM	Jamaica
other	JO	Jordan
other	KE	Kenya
other	KG	Kyrgyzstan
other	KH	Cambodia
other	KI	Kiribati
other	KM	Comoros
other	KN	Saint Kitts and Nevis
other	KW	Kuwait
other	KZ	Kazakhstan
other	LA	Lao People's Dem. Rep.
other	LB	Lebanon
other	LC	Saint Lucia
other	LK	Sri Lanka
other	LS	Lesotho
other	LY	Libya
other	MA	Morocco
other	MD	Moldova
other	ME	Montenegro
other	MG	Madagascar
other	MK	North Macedonia
other	ML	Mali
other	MM	Myanmar
other	MN	Mongolia
other	MO	China, Macao SAR
other	MS	Montserrat
other	MU	Mauritius
other	MV	Maldives
other	MW	Malawi
other	MX	Mexico
other	MY	Malaysia
other	MZ	Mozambique
other	NA	Namibia
other	NC	New Caledonia
other	NE	Niger
other	NG	Nigeria
other	NI	Nicaragua
other	NO	Norway
other	NP	Nepal
other	NZ	New Zealand
other	OM	Oman
other	PA	Panama
other	PE	Peru
other	PF	French Polynesia
other	PG	Papua New Guinea

contd.

Appendix Table 2 / (contd.) Country list

Country group	Country code iso2	Country name
other	PH	Philippines
other	PK	Pakistan
other	PS	State of Palestine
other	PW	Palau
other	PY	Paraguay
other	QA	Qatar
other	RS	Serbia
other	RU	Russian Federation
other	RW	Rwanda
other	SA	Saudi Arabia
other	SB	Solomon Islands
other	SC	Seychelles
other	SD	Former Sudan
other	SG	Singapore
other	SL	Sierra Leone
other	SN	Senegal
other	SR	Suriname
other	ST	São Tomé and Príncipe
other	SV	El Salvador
other	SY	Syria
other	SZ	Eswatini
other	TC	Turks and Caicos Islands
other	TG	Togo
other	TH	Thailand
other	TJ	Tajikistan
other	TL	Timor-Leste
other	TM	Turkmenistan
other	TN	Tunisia
other	TO	Tonga
other	TR	Turkey
other	TT	Trinidad and Tobago
other	TW	Taiwan
other	TZ	Tanzania
other	UA	Ukraine
other	UG	Uganda
other	UK	United Kingdom
other	UY	Uruguay
other	UZ	Uzbekistan
other	VC	Saint Vincent and the Grenadines
other	VE	Venezuela
other	VN	Vietnam
other	VU	Vanuatu
other	WS	Samoa
other	YE	Yemen
other	YT	Mayotte
other	ZA	South Africa
other	ZM	Zambia
other	ZW	Zimbabwe
other	RoW	Rest of the world

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