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COVER NOTE

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COMMISSION STAFF WORKING DOCUMENT

European Competitiveness Report 2014
Helping Firms Grow

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Chapter 6.

ENERGY COSTS AND EU INDUSTRIAL COMPETITIVENESS

Energy costs of production are primarily determined by two factors: they grow with energy prices, but can be mitigated by efficiency improvements, as measured by changes in energy intensity. This chapter analyses all these elements in a common framework in order to study the impact of energy costs on the competitiveness of EU manufacturing industries.

The issue of energy costs and their impact on industrial competitiveness have become central for EU policy making in the context of the EU ambitious climate and environmental objectives and against the challenge of growing competitive pressures from emerging economies. This is all the more important given the slow recovery of the EU industrial output and employment after the crisis.

Climate change policies and rising fuel prices have made energy efficiency improvements a fundamental step of the shift toward low-carbon economy. The Europe 2020 strategy[1] explicitly stipulates a 20% improvement of energy efficiency in the EU as one of its objectives, together with a greenhouse gas emission reduction target of 20% with respect to 1990 levels, as well as an increase of renewable energy in final energy consumption to 20%. In 2012, the new industrial policy strategy called for re-industrialization of Europe, setting a target of 20% share of EU manufacturing in GDP. Moreover, in January 2014, the European Commission adopted a proposal for a new energy and climate policy framework for the period to 2030.[2] The 2030 Framework includes EU targets for reducing greenhouse gas emissions by 40% with respect to 1990 levels, increasing renewable energy to 27% in final energy consumption and improving energy efficiency to 30% in 2030. In tandem with the new energy and climate policy framework, in January 2014, the Commission adopted its industrial policy communication, calling for mainstreaming of industrial competitiveness in all other policy areas and reinforcing the course to re-industrialization.[3] The political crisis in Ukraine added a new dimension to the energy policy debate, the security of supply, which led to the adoption in May 2014 of the energy security strategy.[4]

Against this background, the issue of energy prices and costs and their impact on industrial competitiveness has moved high in the policy debate. Concerns about the external competitiveness of European industry have been particularly reinforced by the recent ‘shale gas revolution’ in the United States, which resulted in plunging prices of natural gas and electricity, benefiting in particular energy-intensive industries such as metals and chemicals, and leading to a revival of manufacturing in the United States. According to a 2013 Commission's Green paper, ‘one of the fundamental objectives of EU energy policy is to ensure that the energy system contributes to the competitiveness of the EU economy by ensuring competitive domestic and international energy markets and prices which are internationally competitive and represent affordable energy for final consumers’ (European Commission 2013b). Furthermore, in May 2013 the European Council called on the Commission ‘to present an analysis of the composition and drivers of energy prices and costs in Member States before the end of 2013, with a particular focus on the impact on households, SMEs and energy intensive industries, and looking more widely at the EU's competitiveness vis-à-vis its global economic counterparts’.

This chapter builds on the recent analytical work undertaken by the Commission in response to the Council requests. The 2012 ECR (European Commission, 2012c) showed that the relative weight of energy in manufacturing inputs in the EU experienced an overall decrease over the past decade, mostly due to continuous technical improvements. Two recent Commission studies (European Commission (2014a, 2014b) document the rise of energy prices in the EU and show that growing network costs and energy taxes are among the main drivers of this increase, even though in some countries price development also reflect environment and climate policy objectives. Several sectoral studies, focusing on energy intensive industries (like steel, aluminium, ceramic, glass), show that their competitiveness may be particularly

1 http://ec.europa.eu/europe2020/index_en.htm
2 See http://ec.europa.eu/clima/policies/2030/index_en.htm
3 http://ec.europa.eu/enterprise/policies/industrial-competitiveness/industrial-policy/communication-2014/index_en.htm

4 http://ec.europa.eu/energy/security_of_supply_en.htm

at risk because of high energy costs (CEPS 2013a, 2013b, 2014a, 2014b).

This chapter builds on and complements the findings of the previous studies analysing in more depth whether energy investments in energy saving technology have been sufficient to maintain competitiveness against the backdrop of rising prices. In that, it contributes as well to the growing academic debate about the role of energy costs and prices on industrial competitiveness (Rennings and Rexhäuser, 2011; Christiansen and Haveman, 1981; Gollop and Roberts, 1983; Greenstone, 2002; Jaffe et al.,1995; Riker, 2012; Eichhammer and Walz, 2011).

The chapter is organised as follows. It starts examining trends in energy prices (Section 6.1), energy intensity and the related energy cost developments (Section 6.2) in the last two decades, using data from WIOD and the International Energy Agency (IEA). The analysis confirms that energy prices have been growing and that energy intensity has been decreasing across most industries both in the EU and for our major competitors. This is consistent with previous findings, including the ECR 2012. However, the analysis shows that energy costs have grown. This trend is especially relevant for energy-intensive industries, where the costs shares are significantly higher than for the rest of the economy. This suggests that energy efficiency gains may not have been sufficient to offset growing energy prices. Section 6.3 verifies this hypothesis through an econometric model, estimating the price elasticities of energy intensities by sector. The estimates range between -0.3 and -1.5, with most of them being less than unity. This result confirms that efficiency gains did not fully compensate for the increase in energy prices. Starting from this observation, Section 6.4 goes further by examining measures of export competitiveness - as export volumes and RCA - to assess if and how they are affected by the growing energy costs. The analysis finds that higher energy costs tend to reduce exports: 1 percentage point increase in the cost share of electricity results in about 1.6 % decline in exports. The result holds over a number of robustness checks. Finally, Section 6.5 concludes and draws the relevant policy implications.

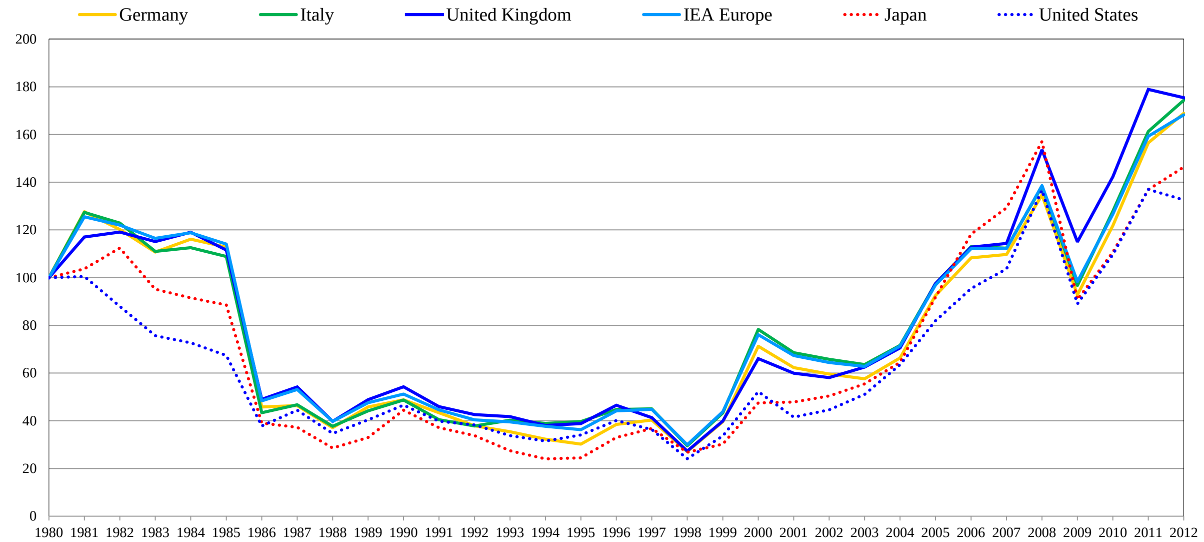
6.1. ENERGY PRICE DEVELOPMENTS

This section provides a short comparative analysis of oil, gas and electricity prices across EU Member States, over time, and in comparison with the EU's major external competitors: the United States, Japan, China and Russia. The analysis is based on end-user prices for industrial consumers, excluding VAT, using data from the IEA and Eurostat. International comparisons are made using PPIs rates. See the background study to this report for more results and for a complete description of the methodology. See also European Commission (2014a, 2014b) for a comprehensive analysis of energy prices, which includes also an investigation of household prices.

6.1.1. Oil prices

The dynamics of gas and electricity end-user prices for industry in the countries and regions covered by the present chapter have been affected to varying degrees by the dynamics of global oil prices. After the two oil 'price shocks' in the 1970s, the world oil price declined substantially in the mid-1980s and remained at generally low levels until the end of the 1990s (see Figure 6.1). However, it surged

Figure 6.1: Real crude oil import price, real index 1980=100



Note: Deflated with PPI. IEA Europe is OECD Europe without Estonia, Iceland and Slovenia.
Source: IEA and national statistics.

dramatically in 2000-08, partly reflecting supply bottlenecks in the face of persistently growing oil demand (especially from emerging economies such as China) and geopolitical conflicts in the oil-rich areas such as Iraq, but also increasing speculation in the global oil markets – particularly in the run-up to the 2008 financial crisis. As a result, by mid-2008 the oil price climbed to some USD 130-140 per barrel. Initially, the global financial and economic crisis resulted in sharply falling oil prices (to levels below USD 30 per barrel by early 2009). However, they soon resumed their upward trend, arguably fuelled not least by the ultra-loose monetary policy of the US Federal Reserve which contributed to abundant global liquidity conditions. Over the past three years, the price of Brent oil – the benchmark oil blend traded in Europe – has hovered around or exceeded USD 100 per barrel. The impact of global oil price dynamics varied across individual countries and regions, depending on exchange rate movements *vis-a-vis* the US dollar. For instance, the trend of appreciation of the euro against the US dollar in the pre-crisis years cushioned the impact of rising oil prices on Europe, while in Japan the surge in oil prices (traded in US dollars) was on the contrary magnified by the depreciation of the yen against the US dollar (Morgan and Emoto, 2007).

However, the **pass-through** from oil to end-user gas and electricity prices has been highly uneven – both across countries/regions and over time. The pass-through to gas prices has been generally greater than that to electricity prices (Figure 6.2). This is explained by the fact that oil and gas can often be used as substitutes, whereas electricity production represents the next stage in the value chain where other inputs also play a role. In addition, electricity can be generated from a number of sources other than oil and gas, such as coal, hydro and nuclear power. Important cross-country differences with respect to the magnitude of this pass-through can be observed (see background report to this study for a detailed analysis). This partly reflects different market structures and the degree of price regulation at various stages of the value chain, but is also due to specific pricing mechanisms which, in some cases, link by contract the prices of oil and gas.

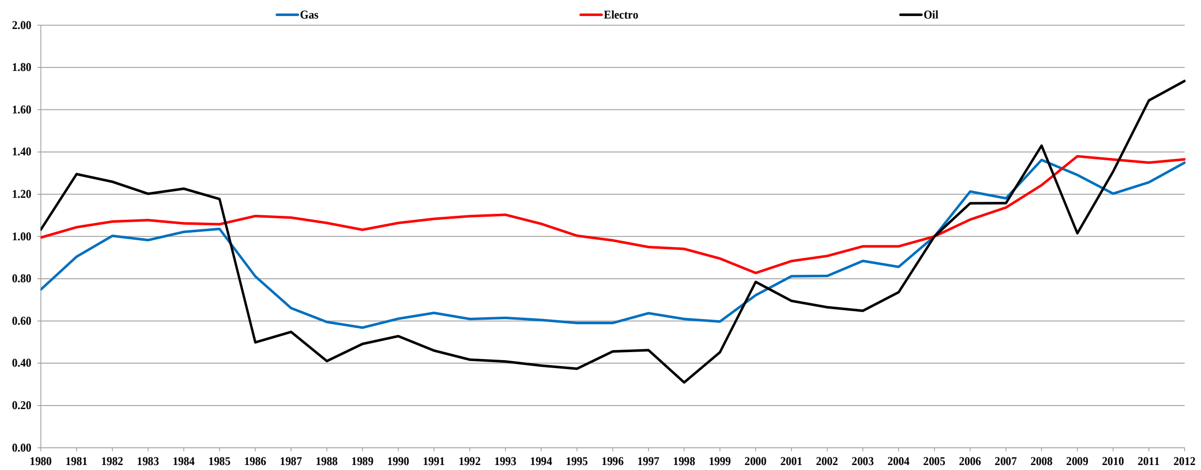
6.1.2. Natural gas prices

In continental Europe, the dynamics of upstream gas prices have until recently broadly followed oil price dynamics. This is not surprising given that the region is heavily dependent on gas imports and import contracts typically link the price of gas to that of oil. Historically, most of natural gas imports have come from three major external suppliers: Russia (in the past, the Soviet Union), Norway, and Algeria, largely via pipelines. Currently, imported gas accounts for around half the EU's gas consumption, with half of those imports coming from Russia.

The bulk of gas imports to continental Europe are made under long-term contracts which typically stipulate supply volumes for years in advance and contain a formula linking the gas price to the price of oil/oil products so that swings in global oil prices translate into changes in gas import prices in Europe after a short delay.

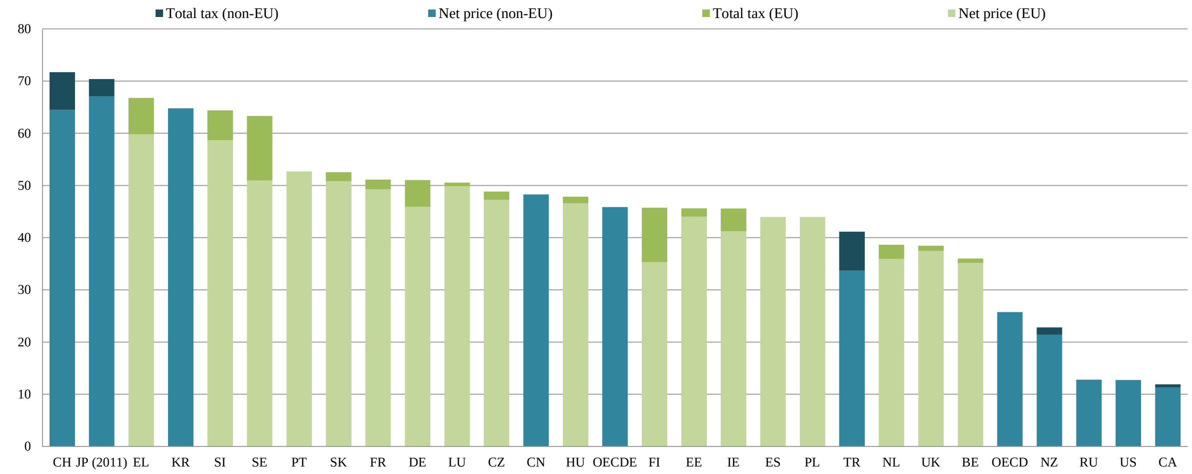
But the pass-through to end-user prices for industry has been generally cushioned by other (less volatile) end-price components such as transport and distribution costs and margins, which are typically regulated. In particular, regulated gas transport costs, which are usually relatively stable, account for a significant share of the final price. As a result, although the price paid for gas by final consumers

Figure 6.2: Oil, gas and electricity prices in OECD Europe, 1980-2012, real index, 2005=100



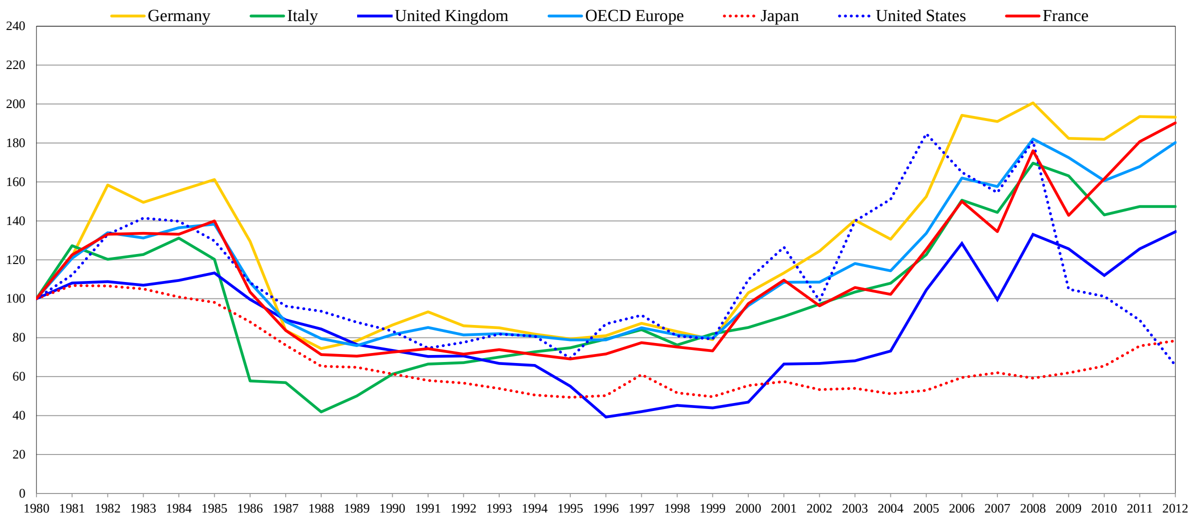
Note: Deflated with PPI. Oil price is crude oil import price for IEA Europe (OECD Europe without Estonia, Iceland and Slovenia); gas and electricity prices are end-user prices for industry.
Source: wiiw calculations based on IEA data.

Figure 6.3: End-user gas price for industry and its components in 2012 by country, in USD/MWh



Source: IEA, national statistics

Figure 6.4: Real gas end-user price for industry, real index 1980 = 100



Note: Deflated with PPI.
Source: own calculations based on IEA data.

often increased as much as upstream prices in absolute terms, the increase in percentage terms has generally been much smaller (Morgan and Emoto, 2007). In addition, the excise taxes on gas which are levied in many Member States have in some cases provided an extra cushion to end-user prices. Since excise taxes are typically specified in volume rather than value terms, an increase in the pre-tax price led to a less-than-proportional increase in the final price – unless the excise tax rate itself was adjusted upwards accordingly (as was the case in Germany). A decomposition of gas prices per country is showed in Figure 6.3.

From 2009 onwards, gas prices in continental Europe de-coupled somewhat from oil prices and initially fell (Figure 6.4). This was caused by the combined effect of weak gas demand in Europe and the shale gas ‘revolution’ in the United States, as a result of which the country has become almost self-sufficient in terms of gas supply. As a consequence, liquefied natural gas (LNG) shipments from third countries (such as Qatar), which previously targeted the US market, have been re-oriented to markets elsewhere, notably Europe and the Asian-Pacific area. Spot prices paid for LNG have generally been lower than for natural gas shipped through pipelines, putting pressure on traditional gas suppliers such as Russia and Norway, and contributing to the overall downward trend in gas prices in Europe. This pressure resulted in numerous re-negotiations of long-term gas supply contracts in favour of buyers. However, more recently the gas price decline has come to a halt and has even reversed in a number of countries, as LNG's share in European markets started to fall again due to it being diverted to more lucrative markets in the Asian-Pacific basin.

Unlike in continental Europe, in the United States and the UK the link between oil and gas prices is generally less pronounced. To the extent that it existed historically, it primarily reflected substitution possibilities between oil and gas rather than contractual price links. Upstream gas prices in both the United States and the UK are largely determined by the interplay of supply and demand in the wholesale gas market, with LNG imports playing a relatively important role. This pricing mechanism makes upstream gas prices in these two countries much more volatile than in continental Europe (see for example Corbeau, 2010; Biermann, 2008).[5] In addition, in the United States there is a strong link between wholesale and end-user gas prices. This is partly due to low taxation: unlike in European countries (including the UK), there is no federal excise tax on gas in the United States.[6]

Between 2000 and 2006, gas prices for industry in the United States rose quite fast, largely due to the supply constraints following the 2005 hurricane and a surge in gas demand, as several new gas-fired power stations came on-stream. However, from 2006 they started to fall relative to oil prices, and since 2009 have been falling rapidly also in absolute terms thanks to the steep growth in shale gas supplies. As can be seen from Figure 6.4, the resulting drop in real gas prices for industry in the United States has been dramatic and un-mirrored in other countries and regions (see for example Kefferpütz, 2010). The increased gas supplies in the United States have also been helped by export restrictions: in order to export natural gas, producers need to obtain an export licence from the regulatory authorities. As a result, gas prices for the US industry currently stand at around a quarter of the OECD-Europe average. Restrictions are likely to be relaxed somewhat in the near term and increased exports are expected to boost US gas prices. However, a sizeable price gap will most likely remain vis-a'-vis Europe and Japan (IEA, 2013).

In Japan, the increase in gas prices during the pre-crisis years was much less pronounced than in other countries and regions covered by the present study, largely because of 'in-built' price caps in the formula linking the price of imported LNG to the oil price. However, the price of imported gas nearly doubled in Japan in the post-crisis years after the coal-fired power generation capacities had been largely destroyed in areas hit by the 2007 earthquake and the suspension of nuclear power generation following the 2011 Fukushima disaster (IEA 2013). In addition, the very high level of end-user gas prices for industry in Japan is also due to the absence of tariff differentiation between industrial and residential users, implying a de facto cross-subsidisation of households by industry (Yuying et al., 2013).

Finally, domestic gas tariffs in China and Russia have historically been set with little regard to international energy price developments. In China, gas prices continue to be heavily regulated, with upstream prices and transport tariffs being set by central government and end-user prices by provincial authorities. However, since 2006 the country has become a net gas importer, with more expensive imported gas putting the traditional 'cost-plus' formula under increasing pressure. As with Japan, the high level of gas prices for industry in China also partly reflects the continuing cross-subsidisation between industrial and residential users – the latter generally pay much less than industry.

In Russia, the low gas prices paid by industry help offset the negative impact of poor energy efficiency on industrial competitiveness, particularly in energy-intensive branches which are prominent. To great extent, this low level of tariffs reflects the cross-subsidisation of domestic customers by Russia's state-owned gas monopolist Gazprom at the expense of export shipments (largely to Europe, which is the main export market and where prices are the highest). Although Russia has, since 2006, pursued a programme of gradual domestic tariff hikes, not least because of its WTO-accession commitments, the initial targets have been repeatedly postponed. As a result, the real gas price for domestic industrial users in Russia has increased only moderately in recent years.

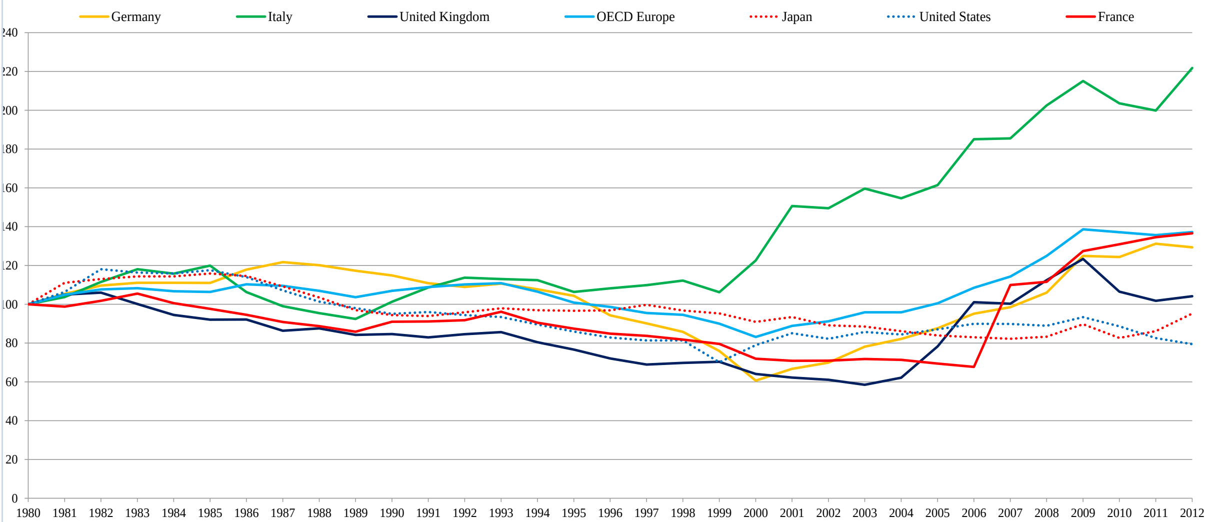
6.1.3. Electricity prices

Between the mid-1980s and the beginning of the 2000s, trends in real industrial end-user prices for electricity in the EU, the United States and Japan were largely similar, showing an overall declining trend (Figure 6.5). From 2000, industrial electricity prices started to rise in the EU, China and the United States, while they continued to fall in Japan. In the EU, the price rise was tremendous, with prices in 2012 some 40% above the 1980 level, and differences between Member States growing considerably. In the United States, instead, electricity prices rose only modestly and started to

5 This price volatility has a high-frequency nature (monthly and even daily) and therefore cannot be seen from Figure 2.4 which is based on annual data.

6 However, some US states impose taxes on oil and gas production (often called 'severance' or 'conservation' taxes), which are sometimes paid by the gas purchaser. As of 2012, 31 US states levied such taxes (National Conference of State Legislatures, 2012).

Figure 6.5: Real electricity end-user price for industry, real index 1980=100



Note: Deflated with PPI.
Source: IEA.

fall in 2010 as a result of the boom in the production of shale gas, which has increasingly been replacing coal in power generation. By 2012, real electricity prices in the United States were some 20% below the 1980 level, whereas in Japan they were nearly as high as in 1980.

As a result of these developments, electricity price differences across the world regions have widened over the past 12 years. While nominal electricity prices are highest in Japan and lowest in Russia, the gap between Europe and China on the one hand and the United States on the other hand, has widened dramatically. In 2012, European electricity prices stood on average at USD 147 per MWh – one quarter below Japan's level but some 30% higher than in China and double the US and Russian level. Interestingly, the wider price gap between Europe and the United States can be attributed only partly to the recent shale gas revolution, which did not take effect until the end of the 2000s: the bulk of the gap dates back to the pre-crisis years and is due to price growth in Europe. The most likely explanation for this gap is the sharp increase of network costs (+21% for industrial consumers in the period 2008-2011) and electricity taxation (+67%) in the EU, as documented in European Commission (2014a, 2014b), with end-user prices increasing more than wholesale prices. Table 6.1 shows price changes for each component at the Member State level.

In its *New Policies Scenario of the World Energy Outlook 2013*, IEA projects that the gap in industrial electricity prices between the United States on the one hand and the EU and China on the other hand will continue to widen modestly (IEA, 2013). By 2035, electricity prices in the EU are projected to increase by 24% and become the highest among the major industrialised countries.

Figure 6.6 shows a wide variation in electricity prices for industry not only between the European Union and other major economies, but also within the EU, with the highest prices observed in Cyprus, Malta and Italy, and the lowest in Sweden, Finland, Estonia, Bulgaria and Romania. For instance, electricity prices in Cyprus are three times higher than those in Sweden. The figure also shows that in most EU Member States, energy and supply prices are the most important component of electricity end-user price for industry. However, network costs make up almost 60% of the price in Lithuania and the Czech Republic, and about 50% in Slovakia, Denmark and Latvia. Finally, national taxes and levies are highest in Germany and Italy, accounting for 32% and 30%, respectively, of the electricity price. By contrast, no taxes and levies for industrial electricity consumers are charged in Lithuania, Malta, Latvia and Romania.

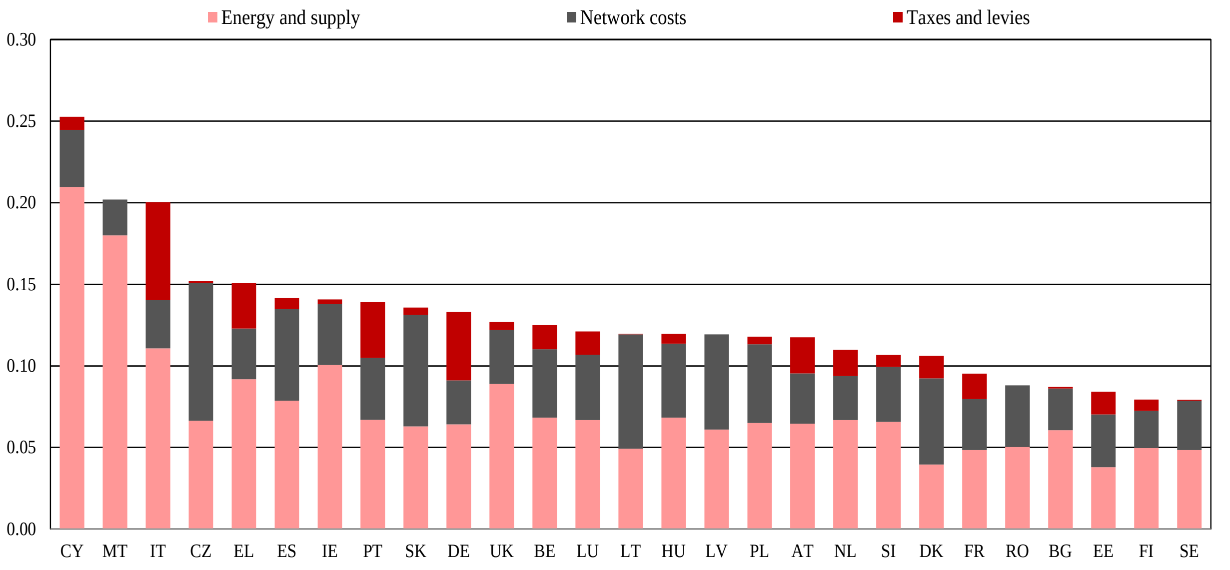
Overall, industrial electricity prices increased between 2008 and 2012 in most EU Member States, with the exception of Romania, Slovenia, Hungary, Denmark and the Netherlands. Price increases were lowest in Slovakia and Sweden with 2% and 4%, respectively, but reached about 17% in Germany, and were even higher in Latvia and Estonia (30%). Table 6.1 demonstrates that these price increases were driven largely by the sharply rising network costs and taxes and levies, while energy and supply costs even went down in a number of countries. For instance, energy and supply costs in Germany fell by

Table 6.1: Electricity price developments in the EU countries, 2008-2012, cumulative % change

	Energy and supply	Network costs	Taxes and levies	Total Price
Austria	-8.4	28.7	48.1	8.4
Belgium	-13.2	33.0	9.4	4.2
Bulgaria	16.2	42.8	100.0	23.8
Cyprus [1]	38.7	0.9	1.3	30.0
Czech Republic	-14.6	39.5	-8.3	8.3
Denmark	-40.7	81.7	3.0	-2.5
Estonia	32.3	5.0	174.5	30.9
Finland	3.9	24.2	169.2	16.1
Germany	-10.4	3.4	204.2	17.2
Greece [2]	20.9	-7.3	157.4	26.2
Hungary	-17.8	-7.9	158.3	-11.1
Ireland [2]	11.5	-5.1	540.0	8.0
Italy	1.7	18.4	143.0	26.6
Latvia	12.7	60.8	0.0	32.0
Lithuania [1]	6.5	15.4	-91.3	7.3
Luxembourg [3]	2.0	2.3	-2.3	1.9
Malta	15.3	0.0	0.0	13.4
Netherlands	-15.3	32.2	18.4	-1.7
Poland	29.9	-1.2	-15.8	12.9
Portugal	17.5	46.7	30.3	27.6
Romania	-15.6	-17.1	0.0	-16.3
Slovakia	-18.9	22.6	528.6	2.0
Slovenia	-19.7	-6.4	102.9	-12.0
Estonia	-2.6	85.8	24.6	23.9
Sweden	-11.7	34.0	20.0	3.8
UK	9.5	42.5	17.8	17.1

Note: Consumption band IB: 20 MWh < Consumption < 500 MWh. 1) 2010-2010.- 2) 2009-2012.- 3) 2007-2011.
Source: Eurostat.

Figure 6.6: Weighted average electricity price for industrial consumers in EU Member States 2012, EUR/kWh



Note: Weighted average electricity price based on the electricity consumption data from WIOD (2007/2008) weighted by the number of enterprises taken from Eurostat.
Source: Eurostat, WIOD and wiiw calculations.

10%, while network costs increased by 3%, and taxes and levies by as much as 204% over this period. However, in the absence of a harmonised reporting methodology for breaking down electricity prices into individual cost components any cross-country comparisons should be treated with caution.

One important factor explaining the absolute levels and dynamics of electricity prices is the **generation mix**. Although this is quite diverse across the EU, with coal (25%), gas (24%), nuclear power (27%) and renewables (21%) each providing about a quarter of total supply, the average figure masks large differences among Member States (Figure 6.7). In some countries, electricity generation is dominated by just one fuel: petroleum products in Cyprus and Malta (100%), coal in Estonia and Poland (about 86%), nuclear power in France (75%), whereas in Germany, Denmark, Spain, Finland, Hungary, Romania and Slovenia, for example, the electricity generation mix is much more diversified.

These differences in the generation mix affect several components of the electricity price. For instance, energy and supply costs are determined by the variable costs of electricity generation, which are nearly negligible for renewables, but higher for nuclear power, followed by coal, natural gas, and petroleum products. The high level of industrial electricity prices in Cyprus and Malta is entirely explained by the use of petroleum products in electricity generation, which drives energy and supply costs upwards. In contrast, countries such as France or Denmark, which derive the bulk of their electricity from nuclear power and renewables, respectively, have correspondingly low energy and supply costs. The renewables boom in Denmark in recent years also explains the impressive drop in its costs of energy and supply (by 40% between 2008 and 2012, see Table 6.1).

The growing role of **renewables** has been to a large extent facilitated by targeted EU support schemes such as 'feed-in tariffs', which guarantee preferential rates for renewable electricity provided to the grid and represent long-term contracts, e.g. 20 years in the case of Germany. The tariffs are usually paid by electricity consumers and linked to their consumption. The costs of support for renewables are added to the electricity price either in the form of network charges (i.e. Denmark) or through taxes and levies (e.g. in the UK or Austria), often compensating the low energy and supply costs associated with renewables used for electricity generation. Thus, the net price effect for the electricity end-user depends on who bears the costs of support for renewables and may differ across EU Member States. For instance, in Germany energy-intensive industries pay sharply reduced renewable surcharge rates, while self-generation is exempted altogether (Folkers-Landau, 2013). For these industries, renewable energy may therefore well be cheaper than energy from fossil fuels (Sensfuß, 2011; Kubat and Kennedy, 2011). Renda (2013) compared support costs for the aluminium industry in selected countries and found that in 2012 aluminium smelters in Italy paid twice as much for electricity as those in Germany, France, Greece or Slovakia (see also Section 6.1.4).

In addition, the EU **Emissions Trading Scheme** (EU ETS) might lead to higher costs – both direct and indirect (through higher energy prices) – for energy-intensive sectors. However, there is no compelling evidence so far of this having resulted to any "carbon leakage", i.e. increase in the carbon emissions of a non-EU country due to relocation of production activities outside the EU. Protective measures that have been put in place, free allocation, and the allowed use of cheaper international credits, have proven to be effective. There is also the possibility for Member States to provide state aid to compensate for the indirect carbon cost for the most electro intensive sectors (European Commission, 2012a).

If not matched by corresponding gaps in energy intensity levels, cross-country differences in energy prices may have significant repercussions on production costs and industrial competitiveness. For instance, cheap energy in the United States, particularly when it comes to natural gas, more than compensates for the relatively high energy intensity of US manufacturing (which is only about 20% higher than in the EU – see Section 6.2.2) and potentially represents an important competitive advantage for US producers, particularly in energy-intensive branches. With respect to EU's other major competitors, energy cost competitiveness is likely to be less of an issue. In Russia, cheap energy is compensated by the very high energy intensity of production, whereas in both China and Japan energy prices are at least as high as in the EU and, in the case of China, are coupled with a much higher energy intensity of manufacturing.[7] At the same time, the potential energy cost disadvantages to Chinese industrial producers are probably counteracted by other cost factors such as cheap labour.

6.1.4. Sub-sectoral analysis

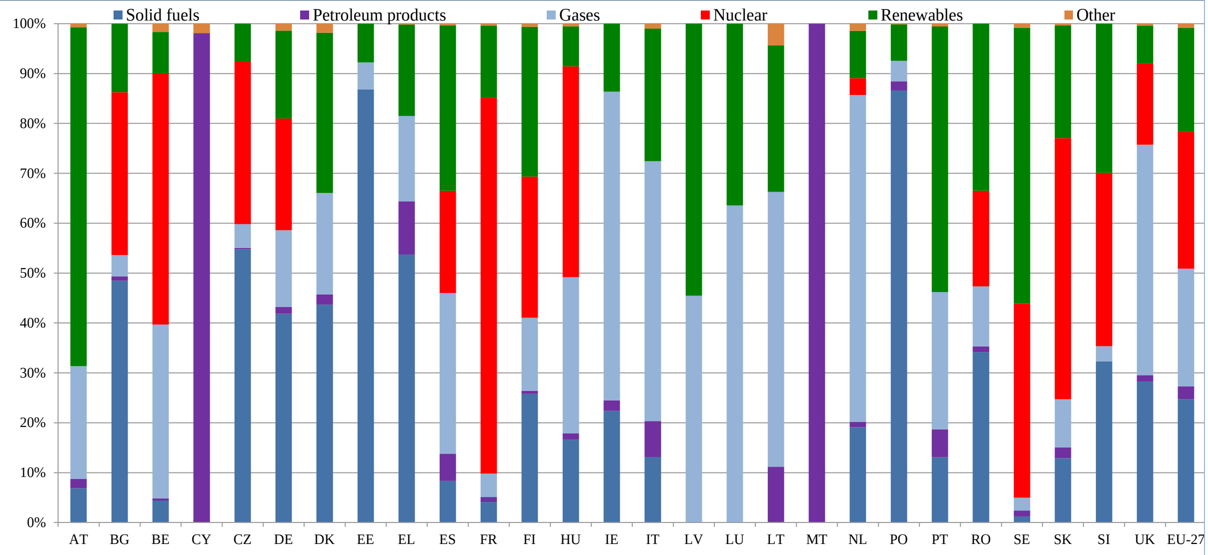
The data sources used for the analysis above do not allow for a granular analysis of specific industries. Even the 2-digits NACE classification used in most of the following sections hide a high level of

[7] Excluding NACE Rev. 1 23 (coke, refined petroleum and nuclear fuel).

heterogeneity within sectors. In particular, the price of energy products is a crucial variable for the competitiveness of energy intensive industries, which deserve a more detailed analysis. Data extracted from CEPS (2013a, 2013b, 2014a, 2014b) show that industrial energy prices are highly influenced by one-to-one bargaining between facilities and energy suppliers. The actual prices paid vary on the basis of many factors, like the duration of the procurement contract and the consumption level of the facility.

Table 6.2 shows the energy prices faced by the surveyed industries for the year 2012 highlighting a large heterogeneity across sectors. Looking at the price growth between 2010 and 2012, though, we can see that almost all sectors experienced a price increase above 30% for their dominant energy source, either natural gas or electricity (dominant source indicated by a star).

Figure 6.7: Electricity generation mix in the EU Member States, 2010



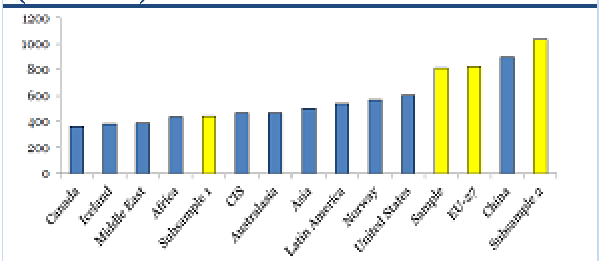
Source: European Commission Energy-Country Factsheets 2012.

Table 6.2: Energy prices for selected Energy Intensive Industries (2012)

Industry	Electricity price (€/MWh)	Growth (2010-2012)	Natural gas price (€/MWh)	Growth (2010-2012)
Basic Metals				
Aluminium	-		-	
Steel	71.4*	32%	32.2	7%
Chemicals				
Ammonia	71.1	11%	31.2*	41%
Chlorine	56.4*	-5%	-	-
Other Non-Metals and Mineral Products				
Bricks and Roof Tiles	102.4	13%	39.5*	30%
Wall and Floor Tiles	97.6	21%	31.7*	27%

*Note: Growth refers to the period 2010-2012. * indicates the main energy source for the industry*
Source: Data extracted from CEPS (2013a, 2013b, 2014a, 2014b).

Figure 6.8: Power costs per tonne of aluminium (USD 2012)



Source: CEPS (2013a).

Interestingly, there is also large heterogeneity within sectors. The case of aluminium producers is an interesting example (See CEPS, 2013a). As shown above, aluminium production relies on electricity as its main energy source (it accounts for 30% of total production costs). In Figure 6.8, facilities are classified according to their sensitiveness to energy market conditions. A first, highly sensitive group

Table 6.3: Energy cost shares in basic prices (in % of gross output)

	Total economy				Manufacturing				Manufacturing*			
	1995	*2000*	*2007*	*2011*	*1995*	*2000*	*2007*	*2011*	*1995*	*2000*	*2007*	*2011*
EU-27	3.0	3.2	4.1	4.6	3.8	4.8	6.3	7.5	2.3	2.2	2.8	3.0
China	5.2	5.9	7.7	7.7	6.2	7.0	7.8	8.1	4.4	4.7	5.7	5.9
Japan	2.8	3.3	4.8	5.1	3.4	4.6	7.3	8.0	2.9	3.3	4.6	5.4
US	2.8	3.6	4.6	4.6	4.8	6.5	10.2	11.3	2.3	2.8	3.1	2.9

*Note: * not including NACE Rev. 1 23 coke, refined petroleum and nuclear fuel.*
Source: WIOD; wiiw calculations.

can be defined that meets its demand entirely via the market but is not on long term arrangements with electricity suppliers. This is labelled as Subsample 2 in the figure. A second, less sensitive group procures electricity through long-term contracts or relies on self-generation (labelled as Subsample 1). The first group suffers particularly high costs compared to the second, paying prices that can be as high as twice those paid by the second group. When compared with international competitors, we can see that such price difference produces very different rankings for the two types of facilities: plants with long-term procurement contracts are comparable to the cheapest power cost countries, whereas plants with short-term contracts show the highest power costs among international competitors.

6.2. ENERGY COST SHARES AND ENERGY INTENSITIES

6.2.1. The relevance of energy cost shares and other input factors

The purpose of this section is to provide a comparative analysis, at country and industry level, of the relevance of energy costs in production and the patterns of energy efficiency across countries and over time. The first step is to compare energy cost shares in gross output relying on the national supply and use tables, which provide information on inputs by energy product: coal (CPA 10); crude oil and natural gas (CPA 11); coke, refined petroleum and nuclear fuels (CPA 23); and electrical energy, gas, steam and hot water (CPA 40). Data are available from the WIOD project (www.wiod.org). Though these comparisons highlight an important aspect of cost competitiveness, it should be stressed that several other dimensions can affect the international performance of firms, including the quality of products, product differentiation, etc. These aspects are strictly related to the quality of the workforce and their skills and training, but also to provisions of high-quality intermediates and geographic factors such as proximity to consumers.

Table 6.3 shows **energy cost shares** for the EU-27 and other major economies over the period 1995-2011. The cost shares are reported for the total economy, the manufacturing industries and the manufacturing industries excluding the sector Coke, refined petroleum, and nuclear fuel (NACE Rev. 1 23). The analysis excluding this sector is interesting because the bulk of energy inputs are used in it as feedstock rather than energy source. The cost shares are calculated in basic prices, thus excluding taxes and margins.[8] These figures reveal some important points. For the EU-27, the energy cost share in 2011 stood at 4.6% for the total economy. This is broadly in line with Japan (5.1%) and the United States (4.6%). Only China shows a higher energy cost share with 7.7%. However, for manufacturing the energy cost share in the EU-27 (7.5%) is more in line with Japan (8.0%) and China (8.1%), while the United States shows a much higher share of 11.3%. Energy cost shares in manufacturing (NACE Rev. 1 15-37) tend to be higher as compared with the total economy due to the generally low energy intensity of the services sectors (although the transport industry, for example, is energy-intensive). In nearly all cases, energy cost shares have been on the rise over the time period considered. It is also worth noting that, in manufacturing, energy cost shares increased in the United States (+6.5 pps) and Japan (+ 4.6 pps) more than in the EU-27 (+ 3.7 pps) and China (+ 1.9 pps).

However, these results are quite sensitive to the inclusion of the sector Coke, refined petroleum and nuclear fuel (NACE Rev. 1 23). When excluding it, the energy cost shares drop to about 3% in the EU-27 and 2.9% in the United States, but are higher in China (5.9%) and Japan (5.4%). Also in this case, energy cost shares have increased over time, although much less than when the production of coke, refined petroleum and nuclear fuel is included.

At the level of aggregation used for this analysis, energy costs are smaller than other industrial inputs but comparable in size to, for instance, agricultural inputs or transport and communication (Table 6.4). Cost shares would be somewhat different when using purchaser prices: shares tend to be higher, with

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[8] This allows for a better international comparison, since not all countries report data in purchaser prices (i.e. including domestic tax and trade and transport margins, see Timmer et al., 2012, for details).

differences of 1-2 percentage points on average: for example, the energy cost shares for the EU-27 were 5.6% in 1995 and 7% in 2011 for the total economy and about 4% in both years in manufacturing (not including NACE Rev. 1 23).[9] Chemicals and chemical products). Japan and China show much higher energy cost shares in Chemicals and chemical products (NACE Rev. 1 24), Other non-metallic mineral (NACE Rev. 1 26), and Basic and fabricated metals (NACE Rev. 1 27-28). Not surprisingly, industry NACE 23 (Coke, refined petroleum and nuclear fuels) has a much larger energy cost share, ranging from 47% in Japan to more than 70% in China. The EU-27 (62%) has a lower share than the United States (68%).

Table 6.4: Structure of production costs for Manufacturing industries (excl. NACE Rev. 1 23), in % of gross output by type of input, 2011

	Energy	Agriculture etc.	Mining and utilities	Low- tech	Medium-low-tech	Medium-high- and high-tech	Construction	Non tradable market services	Transport and communication	Business services	Non-market services	Value added
EU-27	3.0	3.2	0.9	6.7	13.7	14.9	0.4	12.2	3.4	9.2	0.3	32.1
China	5.9	5.7	3.2	12.3	17.4	23.8	0.0	4.3	2.5	3.2	0.3	21.3
Japan	5.4	3.1	0.7	6.2	17.1	19.9	0.5	8.2	2.6	5.6	0.1	30.6
US	2.9	5.3	0.7	7.8	11.2	14.7	0.4	7.6	2.7	10.3	0.1	36.5

Source: WIOD; wiiw calculations.

Table 6.5: Energy cost shares by manufacturing industry in basic prices (in % of gross output)

	EU-27		China		Japan		US	
	1995	*2011*	*1995*	*2011*	*1995*	*2011*	*1995*	*2011*
Food, Beverages and Tobacco	1.7	2.5	1.3	1.5	1.5	2.3	1.8	2.0
Textiles and Textile Products	2.2	3.1	1.2	2.2	2.2	3.3	1.7	2.2
Leather, Leather and Footwear	1.1	1.4	0.5	1.2	1.6	2.0	1.2	0.8
Wood and Products of Wood and Cork	2.0	2.8	3.1	3.1	1.9	2.5	2.1	3.1
Pulp, Paper, Printing and Publishing	2.5	3.2	3.8	3.6	3.4	4.8	2.4	3.2
Coke, Refined Petroleum and Nuclear Fuel	47.8	62.0	56.9	72.2	20.8	47.0	62.2	67.9
Chemicals and Chemical Products	4.4	7.4	9.9	18.9	6.8	13.1	5.9	7.8
Rubber and Plastics	2.5	3.5	2.8	3.3	3.1	3.3	3.0	2.5
Other Non-Metallic Mineral	5.6	7.4	10.5	15.5	9.2	16.8	4.6	5.8
Basic Metals and Fabricated Metal	3.7	4.1	7.7	9.8	4.4	10.2	3.3	4.2
Machinery, n.e.c.	1.2	1.3	2.8	3.5	1.2	1.5	1.1	1.0
Electrical and Optical Equipment	1.0	1.1	1.3	1.4	1.6	2.2	1.3	0.5
Transport Equipment	1.2	1.1	1.8	1.6	1.2	1.6	0.7	0.8
Manufacturing, n.e.c.; Recycling	1.4	2.1	1.9	1.9	2.0	3.0	1.2	0.8

Source: WIOD; wiiw calculations.

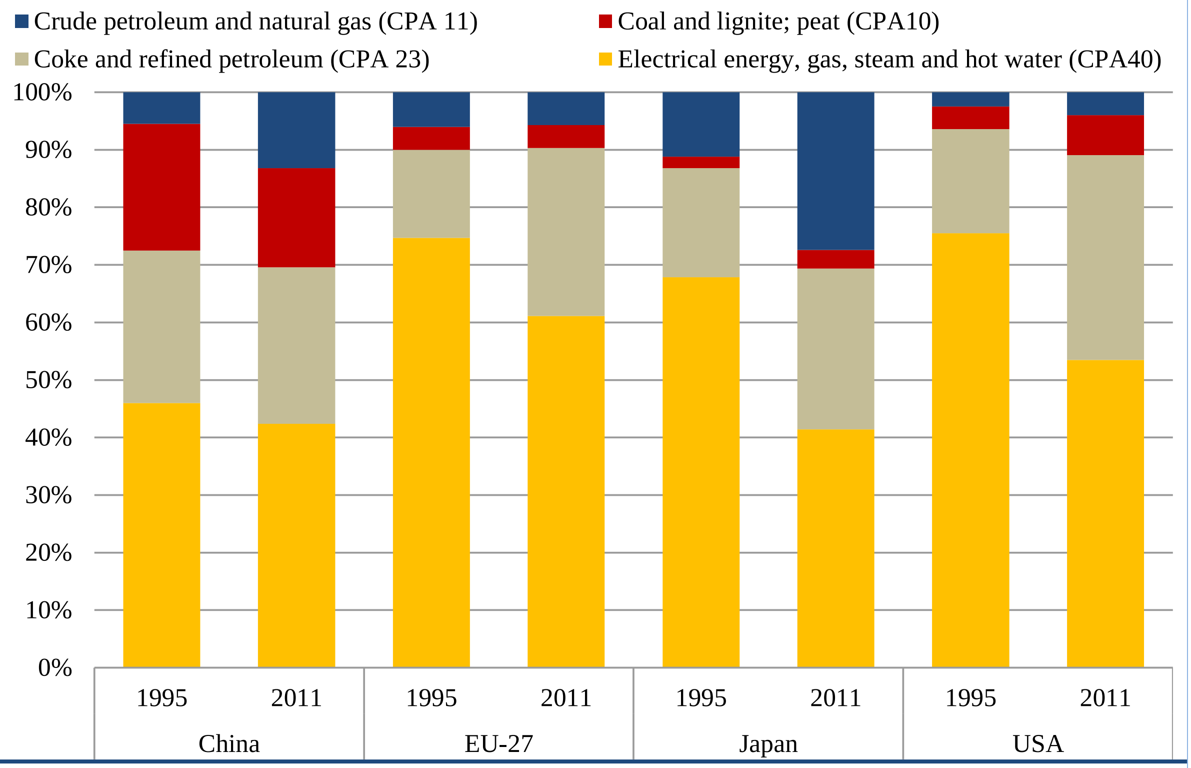
There are large sectoral differences beyond these aggregate numbers. Table 6.5 shows energy **cost shares by industry** at the 2-digit level of sectoral aggregation in NACE Rev 1 for the EU and its major competitors. In the EU-27, cost shares range between about 1% in Transport equipment, Electrical and optical equipment and Machinery and 7% in Chemicals and Other non-metallic mineral products. In the United States, energy cost shares are lower than in the EU-27 in almost all industries (important exceptions are NACE Rev. 1 20, Wood and products of wood; and NACE Rev. 1 24,

An analysis of the evolution of **Real Unit Energy Costs** (RUEC) for these fourteen manufacturing subsectors (European Commission 2014a) confirms the existence of substantial heterogeneity both across subsectors and Member States. The sectors with the highest RUEC are Coke, refined petrol and nuclear fuel, Chemicals, Other non-metallic minerals, Basic metals and Rubber and plastics. The sector Coke, refined petroleum and nuclear fuel is characterized by high RUEC also in comparison to other countries and its growth rate is among the

9 Note that for the US data are only available in basic prices (see Timmer et al., 2012 for details).

highest ones. For Chemicals, Other non-metallic minerals, Basic metals and Rubber and plastics, RUEC levels in the EU are generally comparable with those of Japan, but are higher than the US. In other sectors, the EU RUEC fares better on an international level. For example in the wood and wood product sector, the RUEC is the second lowest in 2009 (after Japan).

Figure 6.9: Structure of energy costs by CPA categories in manufacturing (excl. NACE Rev. 1 23) in the major economies. Costs in % of total energy costs, 1995-2011



Note: Figures do not include NACE Rev. 1 23 Coke, Refined Petroleum and Nuclear Fuel.
Source: WIOD; wiiw calculations.

Countries also differ with respect to the structure of energy cost shares according to the four CPA categories used here (Figure 6.9). In the EU-27, the largest, but decreasing cost share is due to Electrical energy, gas, steam and hot water (CPA 40) followed by Coke and refined petroleum (CPA 23), whose share is, instead, increasing. The other two categories account for only 4% (Coal) and 5.7% (Crude oil and gas). This pattern is rather similar in other advanced countries, as the United States and Canada, which have a higher share of coke. Japan is different, with the share of Electrical energy, gas, steam and hot water (CPA 40) standing at about 40%, and those of Crude oil and gas (CPA 11) and Coke and refined petroleum (CPA 23) at about 27%.

Summing up, at the level of large sectoral aggregates, energy cost shares are smaller than other industrial inputs, standing at slightly less than 5% of gross output in the advanced countries considered here (EU-27, Japan and United States), though they generally increased over time. Looking at manufacturing (NACE Rev. 1 15-37) only, the energy cost shares are higher, though this depends heavily on the inclusion of coke, petroleum and nuclear fuel (NACE Rev. 1 23). Excluding this industry from manufacturing reduces overall energy cost shares to about 3%, which is even less than the energy cost share for the total economy. However, a more disaggregated analysis would reveal that some industries and firms face much larger energy costs (see, for example, Renda, 2013; Riker, 2012).

6.2.2. Energy intensities

This section focuses on changes in energy intensity, i.e. energy use divided by value added, over time and across countries. As well as supply-use and input-output tables, the WIOD provides energy accounts, i.e. energy flows (gross energy use) in terajoules (TJ), with the same country and industrial coverage from 1995 to 2009. This enables us not only to describe general patterns, but also to study the changes in energy efficiency by means of decomposition analysis. The aim is to disentangle changes in energy usage per unit of output into an energy intensity effect, i.e. changes in energy intensity at constant industrial structures, and a structural change effect, i.e. changes in overall intensity due to structural shifts.

Energy intensity is measured as terajoules divided by value added in constant 2005 prices, and converted with PPP rates for 2005. The figures are, to a certain extent, sensitive to measurement issues, particularly for countries like China. First, calculating energy intensity as a ratio to gross output tends to indicate lower energy intensities in China due to the relatively lower share of value added in gross output, (see Table 6.4). Secondly, in this chapter, PPPs rather than exchange rates have been used to convert value added to a common currency, since the Chinese exchange rate is strongly undervalued.[10] It should be noted, however, that the choice between exchange rates and PPPs does not affect the results of the decomposition analysis reported below.

in the EU-27 and up to 34.6 in the United States. This is not surprising as manufacturing industries tend to be more intensive in energy use than services (with the exception of transport services). As for the total economy, these levels have decreased substantially since 1995. Considering manufacturing without Coke, refined petroleum and nuclear fuel industry, the energy intensity levels are only slightly higher than for the total economy, with the same patterns and dynamics observable.

Surprisingly, in manufacturing (including NACE Rev. 1 23) China's energy intensity is even lower than that of more advanced countries due to a much lower energy intensity in NACE Rev. 1 23. However, when considering manufacturing without this sector, the energy intensity in China is higher than in the more advanced countries. Similarly, the energy intensity of manufacturing in the EU-12 is lower than in the EU-15. The higher energy intensity in US manufacturing as compared with the EU-27 is explained by the larger share of industry NACE Rev. 1 23 in the United States (about 10% versus 3% in the EU-27). However, even without this industry, the energy intensity of manufacturing in the EU-27 is still lower than in the US, which also holds for almost all individual sectors.

Table 6.6: Energy intensities (TJ per million USD of value added in PPPs 2005), 1995 and 2009

	Total economy		Manufacturing		Manufacturing*	
	1995	**2009**	**1995**	**2009**	**1995**	**2009**
EU-27	10.4	7.8	31.1	24.6	12.2	9.1
EU-15	9.8	7.6	30.1	25.9	11.0	9.4
EU-12	15.8	9.7	39.1	18.7	23.4	7.8
China	20.4	13.6	38.3	20.4	26.4	13.3
Japan	9.5	8.3	25.0	22.9	11.2	9.9
US	13.1	9.0	46.7	34.6	16.4	11.1

*Note: * not including NACE Rev. 1 23 coke, refined petroleum and nuclear fuel.*
Source: WIOD; wiiw calculations.

As with cost shares, there are substantial differences when considering the manufacturing sector only and depending on whether NACE Rev. 1 23 (Coke, refined petroleum and nuclear fuel) is included. Table 6.6 shows energy intensities for the total economy, manufacturing and manufacturing excluding NACE Rev. 1 23, now also differentiating between EU-15 and EU-12 countries. At the total economy level, energy intensities in 2009 were the lowest in the EU-15 and the EU-12, while in Japan and the United States they were above the EU-27 level by 6% and 15%, respectively. China shows a level almost double that of the EU-27. Notably, energy intensity decreased in all regions and countries considered, particularly so in the EU-12 (from 15.8 to 9.7 TJ per million USD) and China (from 20.4 to 13.6 TJ per USD million). Considering manufacturing only, in 2009 energy intensity levels are much higher, ranging from around 20 TJ per USD million in the EU-12, China and Japan, to 25.9

As seen above, energy intensities have tended to converge across countries and within the EU-27 in particular. Such convergence can be driven simultaneously by two factors: first, energy intensities in each industry might decline; second, the structure of the economy may shift towards less energy-intensive activities or industries. To analyse this in more depth, the **log mean Divisia index** is applied (see Ang, 2004; Mulder and deGroot, 2012) whereby changes in energy use per unit of output

[10] The ratio of exchange rate to PPP (defined as USD per national currency unit) in China in 2005 stood at 0.42. A sensitivity analysis is provided in the background study to this chapter. European Commission (2014a) provides results using market exchange rates. A more appropriate choice would be to use sectoral PPPs, which are however not available. Lacking better data, neither of these choices is perfect, so the results have to be interpreted with caution given these statistical shortcomings.

Table 6.7: Results from decomposition analysis of changes in energy intensity

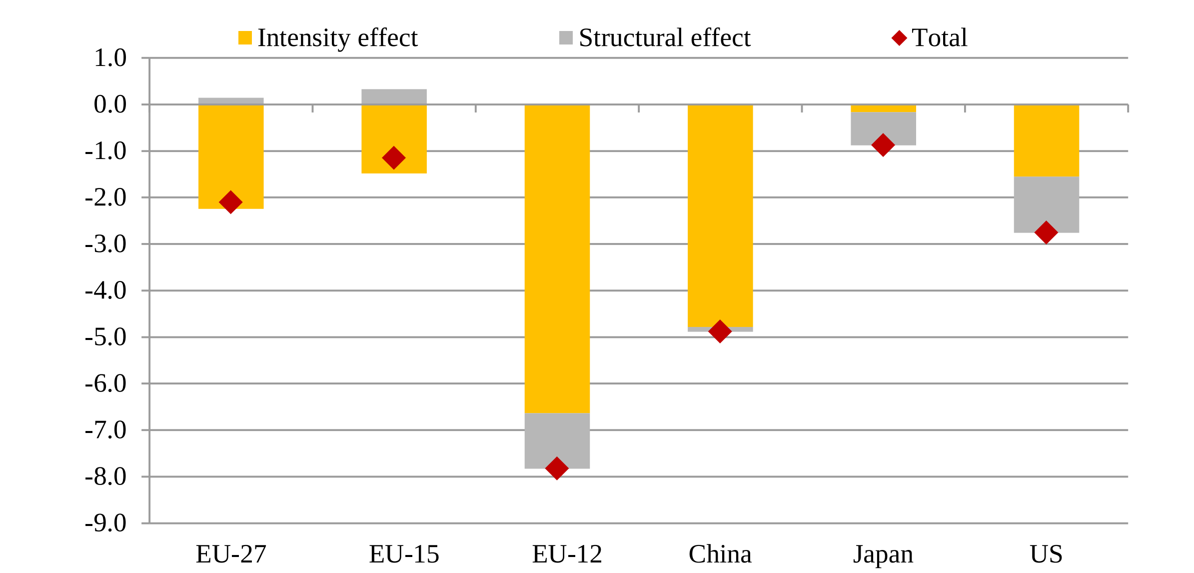
	Annualised growth rates in %, 1995-2009								
	Total economy			Manufacturing			Manufacturing*		
	Total	Intensity effect	Structural effect	Total	Intensity effect	Structural effect	Total	Intensity effect	Structural effect
EU-27	-2.1	-0.5	-1.5	-1.7	-0.5	-1.2	-2.1	-2.2	0.1
EU-15	-1.9	-0.7	-1.1	-1.1	-0.8	-0.3	-1.2	-1.5	0.3
EU-12	-3.5	-0.8	-2.7	-5.3	-1.5	-3.8	-7.8	-6.6	-1.2
China	-2.9	-4.0	1.1	-4.5	-4.3	-0.2	-4.9	-4.8	-0.1
Japan	-1.0	0.2	-1.1	-0.6	1.1	-1.7	-0.9	-0.2	-0.7
US	-2.6	-3.0	0.4	-2.1	-5.3	3.2	-2.8	-1.5	-1.2

*Note: * not including NACE Rev. 1 23 Coke, Refined Petroleum and Nuclear Fuel.*
Source: WIOD; wiiw calculations.

can be split into **intensity** and **structural** effect. The numbers in Table 6.7 indicate the average annual changes in percentage terms.[11] The analysis shows that for China and the US, the intensity effect is stronger relative to the structural effect across all sample specifications. For all other countries, the structural effect dominates for the total economy. Looking at manufacturing only, in the EU the decline was mainly driven by the EU-12 Member States, with the structural effect being relatively more important.

However, the relative importance of the structural versus the intensity effect is sensitive to the inclusion of the most energy-intensive sector NACE Rev. 1 23 (Coke, refined petroleum and nuclear fuel), which is characterised by declining shares in value added, thus giving more weight to the structural effect. This is highlighted in Figure 6.10 (based on results reported in Table 6.7). For all countries and regions, an increase in overall energy efficiency has been observed. In this case, the intensity effect dominates in all countries except Japan. The structural effect in the EU-15 and EU-27 points towards a shift towards more energy intensive activities, in particular the chemical industry. In the EU-12, Japan and the United States the negative contribution of the structural effect is mostly explained by a strong shift towards higher-tech industries such as Electrical and optical equipment and Transport equipment. Surprisingly, structural shifts relative to intensity reductions are negligible

Figure 6.10: Results from decomposition analysis for manufacturing industries excl. NACE Rev. 1 23
Annualised growth rates in %, 1995-2009

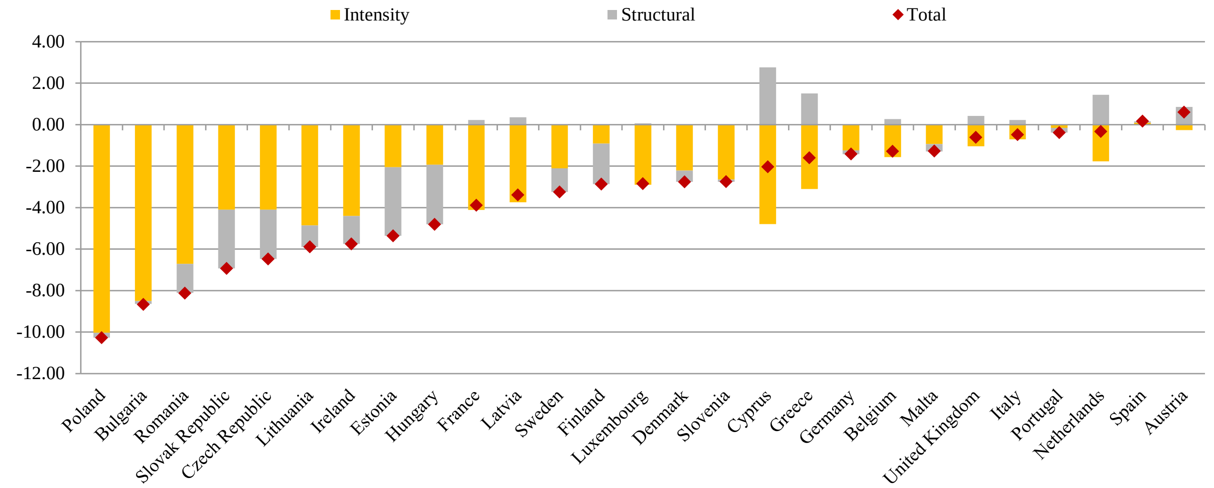


Note: Figures do not include NACE Rev. 1 23 Coke, Refined Petroleum and Nuclear Fuel.
Source: WIOD; wiiw calculations.

in China. The reason for this is that the initial energy intensity of this industry was rather high, despite a significant shift towards the Electrical and optical equipment sector over this period. For this reason,

[11] European Commission (2014a, 2014b) performed a similar analysis based on real unit energy costs, using the shift-share methodology.

Figure 6.11: Results from decomposition analysis for manufacturing industries excl. NACE 23 in EU Member States. Annualised growth rates in %, 1995-2009



Source: WIOD; wiiw calculations.

efficiency gains in China were easier to achieve, and this explains the declining energy intensity that we see in the data.

Energy intensity changes over time have also been down for individual Member States – see Figure 6.11 for the results for manufacturing (excluding NACE Rev.1 23). As hinted at also by Table 6.7, energy intensity in manufacturing dropped further in eastern European countries, most notably Poland (-10%) and Slovakia (-8.6%), with the declines in most other countries ranging between -7.2% (Estonia) and -5.2% (Latvia). Only Slovenia showed a lower decline of energy intensity of -2.8% per annum. In most east European countries, the intensity effect dominated, though the structural effect also played an important role due to the shift to the higher-tech industries. Exceptions are Poland, Bulgaria and Latvia, where only the intensity effect mattered. In Poland this is because, despite a structural shift away from Textiles and towards Transport equipment, initial energy intensity levels were rather similar, so that the structural shift did not show up in a change in overall energy intensity. Similarly, in Bulgaria the structural shifts were strong but generally between sectors with initially similar levels of energy intensity. In **western European** countries, the changes in the overall energy intensity of manufacturing (excluding NACE Rev. 1 23) were generally less pronounced, up to about -3% with the exception of France and Ireland, with some MS slightly increasing their energy intensity. The intensity effect broadly dominated Western Europe, with the exceptions of Finland and Sweden. In Cyprus, Greece and the Netherlands, the structural effect was even positive. In Cyprus and Greece, there was a strong structural shift towards non-metallic mineral products (and basic and fabricated metals in the case of Greece) which have a relatively high energy intensity. In the Netherlands, a shift towards chemicals and chemical products drove the positive structural effect.

Summarizing, the analysis shows that a strong convergence process has taken place across the major economies and particularly within Europe, where the EU-12 countries have been successful in decreasing their energy intensities (or increasing energy efficiency). For the manufacturing industries excluding NACE Rev. 1 23 (coke, refined petroleum and nuclear fuel), this process has been driven mostly by a technological reduction of energy intensities, although a structural shift towards higher-tech industries has also played a role, particularly in the EU-12 countries. By contrast, in the EU-15 a structural shift towards chemicals and chemical products (NACE Rev. 1 24) has constrained the scope of energy intensity reduction, which has been driven exclusively by technological improvements.

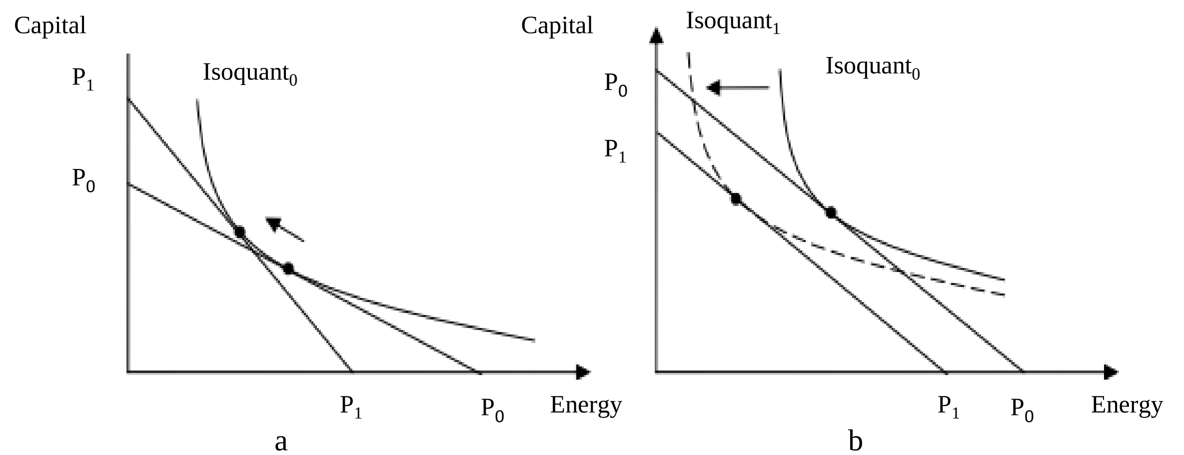
6.3. MEASURING THE IMPACT OF ENERGY PRICES ON ENERGY INTENSITY

The aim of this section is to estimate how individual industries' energy intensity has responded to energy price increases. Using a panel of 30 countries over the period between 1995 and 2009, the price elasticity of energy intensity are estimated, providing an assessment of whether energy efficiency improvements have been sufficient to offset the impact of increased energy prices. The exercise also provide some guidance as to the extent to which energy prices (which can be affected by policymakers e.g. via changes in taxation) can be used as a tool to induce the desired improvements in energy efficiency.

The responsiveness of energy intensity to changes of energy price depends essentially on the expected returns on investment in new energy-efficient equipment. Such a decision trades off higher initial capital costs and lower future energy operating costs. In theory, (See Figure 6.12a), an increase in the price of energy relative to capital induces a partial substitution of energy by capital in producing the same quantity of output (a shift from P_0 to P_1), thus resulting in a new equilibrium. In this case, energy and capital are substitutes. But capital may substitute labour rather than energy and have limited or no impact on energy intensity. Technological developments may also play a role. For instance, technological change (see Figure 6.12b) allows for the use of less capital and less energy at the same time to produce the same volume of output (Isoquant$_0$ shifts to Isoquant$_1$).

future gains from reduced energy consumption outweighs the initial costs of capital investment; in other words, the higher the cost of energy-efficient capital or the lower the energy savings, the less likely a firm is to invest in energy efficiency. For this reason, energy-saving investments in response to energy price increases are likely to be greater in energy-intensive sectors (as, for instance, pulp and paper, chemicals, glass, cement or basic metals). In fact, the massive use of energy magnifies even small price increases, resulting in much bigger gains from reduced energy consumption than in industries consuming little energy. But other factors can also constrain energy-efficient investments. For instance, access to external funds (e.g. bank credit), which may be required to finance investments, may play an important role. Moreover, information asymmetries in terms of the energy-efficient properties of

Figure 6.12: Energy efficiency-improving substitution (a) versus energy-saving technological change (b)



Source: Gillingham, Newell and Palmer (2009).

However, in real life a decision on whether to invest in new energy-saving equipment depends on many factors (a good overview is provided by Gillingham, Newell and Palmer, 2009). For instance, the role of expectations is crucial. If the energy price is expected to stay at a new (higher) level for a protracted period, the willingness to invest in new capital will clearly be greater than if the energy price shock is deemed temporary. Conversely, expectations of persistently lower energy prices may not lead to capital disinvestment. This means that expected lower energy prices may not symmetrically translate into energy efficiency losses. Also relevant are expectations with respect to other factors, such as changes in operating costs relating to energy use (e.g. pollution charges) or the lifetime of the equipment. Clearly, the time horizon for decisions plays a role as well.

Investment in energy-efficient technologies are undertaken only if the discounted present value of

investments, may result in suboptimal levels of energy-efficiency, determining the so called 'energy efficiency gap'.

To quantify the response of industrial energy intensity to energy price shocks, panel-data estimations with country fixed effects were undertaken. The estimation technique was chosen to capture the substitution effects between energy and energy-saving capital investment (seeing e.g. Dahl, 1993). The estimations are based on annual data for 30 countries between 1995 and 2009, sourced from IEA (energy prices) and WIOD (all other variables).[12] As electricity and natural gas are the two most important energy types for most industries,

[12] The panel covers 21 EU Member States (i.e. the EU-28 without Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Malta and Romania) and 9 non-EU countries: the United States, Turkey, Russia, Mexico, South Korea, Japan, Canada, China and Australia.

separate regressions were run for gas and electricity for each of the fourteen manufacturing industries.[13] The baseline estimating equation is the following:

$$\ln\left(\frac{\text{Energy Use(e)}_{it}}{\text{VA}_{it}}\right) = \alpha_1 \ln(\text{RP}^e_{it-1}) + \alpha_2 \ln(\text{K}_{it-1}) + \gamma_c + \text{time\_trend} \quad + \varepsilon_{iet}$$

Where *i* is industry (according to NACE Rev. 1 classification at the 2-digit level), *e* is energy product (electricity or gas); *t* is year; *VA* is industrial value added in national currency at constant 1995 prices; *RP* is the relative energy price (nominal price in national currency/MJoule taken from IEA, deflated with the industry output deflator from WIOD); *K* is the capital stock per employee (at constant 1995 prices); γ is the country fixed effect; and ε is the error term.

Table 6.8 reports the results of the estimations for electricity intensity in the baseline specification, with capital stock per employee and the time trend serving as control variables. The regressions were run for the restricted sample of EU member states and for the full sample. To capture the long-run elasticities, regression were run using a moving average of energy prices over the past five years. The obtained price elasticities of electricity intensity are generally in line with expectations. In the EU-21, the price elasticity coefficient is negative and significant for eight industries, ranging between about -0.3 in Textile and Textile Products and -1.5 in Leather, leather products & footwear (see column 2). Thus, depending on the industry, a 1% increase in the price of electricity (relative to the output price) brings about a 0.3% to 1.5% reduction in the electricity intensity of production.

The regressions were also run using one year lagged prices to capture short-run changes. These can be induced by innovations that do not require large investments or deep restructuring of the production process. Examples could be the optimization of the existing processes, the use of more performing materials as well as behavioural changes. In this case (column 1), the absolute value of the price elasticity of electricity intensity tends to get somewhat smaller, albeit with some exceptions such as Transport Equipment, that is significant only in the short run. This result confirms that energy-efficiency improvements in response to energy price shocks mostly tend to take place with a time delay.[14]

When considering the full sample, the results are overall comparable but elasticities tend to be smaller in absolute terms, suggesting that EU member states performed better in terms of energy efficiency improvements. In particular, this is the case for Leather, Pulp and paper, and Basic metals industries (column 4). In the short-run, elasticities lose significance for some industries, including Textiles, Coke and refined petroleum and Transport

Table 6.8 : Own-price elasticities of electricity by industry

Manufacturing industries, according to NACE Rev. 1	EU-21		Total Sample	
	short-run	long-run	short-run	long-run
	(1)	(2)	(3)	(4)
Food, beverages & tobacco	-0.443***	-0.529***	-0.445***	-0.622***
Textiles & textile products	-0.289***	-0.292**	-0.011	0.211
Leather, leather products & footwear	-0.901***	-1.580***	-0.498***	-0.737**
Wood, products of wood & cork	-0.415***	-0.354	-0.452***	0.057
Pulp, paper, paper products, printing & publishing	-0.284***	-0.614***	-0.215***	-0.442***
Coke, refined retroleum & nuclear fuel	-0.344**	-0.183	-0.072	-0.177
Chemicals & chemical products	0.144	0.208	0.051	0.076
Rubber & plastics	-0.077	-0.177	0.233*	0.402
Other non-metallic mineral	-0.252***	-0.257	-0.216***	-0.345***
Basic metals & fabricated metal	-0.393***	-0.628***	-0.322***	-0.395***
Machinery, n.e.c	-0.446***	-0.427**	-0.240*	-0.360**
Electrical & optical equipment	-0.771***	-0.705**	-0.702***	-0.620**
Transport Equipment	-0.167**	0.017	0.029	0.468**
Manufacturing, n.e.c; Recycling	-0.425***	-0.605***	-0.128	-0.201

Source: own calculations.

[13] The details of the baseline econometric model and of alternative specifications are available in the Background study to this report.

[14] In many cases, the reason for the statistically insignificant own-price coefficients is the large Newey-West standard errors, which were computed to take into account autocorrelation when using the five-year moving averages. Using conventional standard errors instead would result in a total of seven industries exhibiting a negative and significant long-run relationship between gas prices and gas intensity.

industries.

The results for similar regression using natural gas intensity are more mixed, but generally in line with the analysis above. One reason for the different results may be that the WIOD data on gas consumption do not allow for differentiation between gas used for energy purposes and that used as a feedstock. See the background study to this report for a full analysis of the results.

All in all, these results confirm the responsiveness of industrial energy intensity to energy price shocks, with elasticities generally being higher in absolute value in the long run than in the short run. These elasticities are generally in line with, or somewhat higher than, those obtained in earlier econometric studies (Dahl, 1993; Bohi and Zimmerman, 1984). Another interesting finding is that capital investments tend to reduce the electricity intensity even when they are undertaken for reasons other than electricity price shocks.

Alternative specifications of the regression were tried. First, an additional control variable for the prices of alternative energy types (i.e. gas in the regression for electricity intensity, and *vice versa*) was included. Second, an 'outsourcing component' was included to capture the possibility of relocating the energy-intensive parts of the value chain to locations where the energy prices are lower. These specifications yield a number of interesting insights.[15] In particular, while electricity tends to substitute natural gas if the latter becomes more expensive, the reverse is not confirmed empirically. On the contrary, the cross-price elasticities of gas intensity with respect to electricity prices were found to be negative. Also, while virtually no evidence was found of outsourcing to cheaper locations in response to electricity price changes – the achieved improvements in electricity intensity are primarily due to technological rather than structural factors – in the case of natural gas, such 'outsourcing' effects appear to be present in at least some industries, particularly in the short run. Also in this case, the obtained results are highly industry-specific.

The results show that although the obtained own-price elasticities of energy intensity are generally negative and not negligible, even in the long run (at least when taking five years as a measure of the 'long run') their absolute value is in several cases smaller than one. One notable exception, for the EU-21 is Leather, leather products & footwear. This hints at the fact that energy efficiency improvements in response to price changes have generally not been strong enough to offset the adverse impact of rising energy prices, at least at the high level of aggregation underlying the present study, so that energy-related expenditures increased. Indeed, this is largely what has happened over the past two decades: notwithstanding the energy efficiency gains, the energy-related expenditures – and energy cost shares – have risen (see Section 6.2).

Of course, the findings need a cautious interpretation. Because of data availability, our estimations mainly cover the 'pre-crisis' period. In the 'post-crisis' period (i.e. starting from 2009), the more difficult access to finance, which is typically required to finance energy-saving investments, may result in price elasticities of energy intensity being lower than those obtained in the present study. Moreover, a thorough assessment of the impact of energy prices on competitiveness would require the estimation of elasticities at the country level for all EU's competitors and a careful comparison. Due to data limitation, this is unfortunately not possible.

6.4. ENERGY INTENSITY, ENERGY COST SHARES, AND INDUSTRIAL COMPETITIVENESS

As demonstrated in Section 6.3, higher energy prices have not been fully offset by energy efficiency improvements, resulting in higher energy costs. This chapter aims to understand how these developments have affected the competitiveness of manufacturing industries. Did export competitiveness suffer as a result of insufficient improvements in energy efficiency and/or higher energy costs?

As demonstrated in Section 6.2.1, energy cost shares in manufacturing industries have been rising over the past two decades. Although they are typically low on the aggregate, energy cost shares may account for up to 40-80% of production costs for some particularly energy-intensive sectors as aluminium and chemicals (see e.g. European Commission, 2014b). For these industries, changes in energy intensity or energy costs can be expected to have a considerable impact on their export competitiveness. But even for less energy-intensive industries, any increase of energy cost shares may still affect export competitiveness on the margin. For instance, in highly competitive sectors, if profits are not high enough to offset even an incremental increase in energy costs, export competitiveness may suffer as a result.

In line with the so-called 'Porter hypothesis', environmental and energy regulations can induce energy efficiency and encourage innovations that help improve commercial competitiveness in the

[15] For details see the background study to this report.

medium and long run (Porter and van der Linde, 1995). However, in order to lower their energy intensity, companies often need to undertake investments into new technologies, which can have medium-run payback periods, thus making firms less competitive in the short run. Loss of competitiveness is particularly likely when domestic emission mitigation policies are unilateral: according to the ‘pollution haven hypothesis’, domestic manufacturers may lose market share to foreign competitors and/or relocate production activity to unregulated economies (Joseph and Pizer, 2011). In principle, government support policies can be used to mitigate the deterioration in industrial competitiveness. However, such measures risk subverting the incentives for companies to restructure, resulting in expenditures that show little long-term promise for stimulating the economy or protecting the environment (Frondel et al., 2010). A similar effect could be expected at the industry level, where it can be further reinforced by within-industry reallocations, with most energy-intensive firms potentially driven out of the market.

The findings of previous studies analysing the nexus between energy intensity and competitiveness have been mixed. Some early studies, which focused mostly on the impact of government regulations in the US, found a negative impact of regulations aimed at fostering eco-innovations on industrial competitiveness (see, for instance Christiansen and Haveman, 1981; Gollop and Roberts, 1983; Greenstone, 2002). Part of these studies was later disputed by Jaffe et al. (1995), and similarly inconsistent results were found for individual industries. For instance, while the competitiveness of the US pulp and paper industry suffered from environmental regulations (Gray and Shadbegian, 2003), the opposite was found for the oil refining industry (Berman and Bui, 2001). Riker (2012) found that energy price increases had a clear detrimental effect on the export competitiveness of US manufacturing industries, with the magnitude depending on the energy cost share and the price elasticity of industry’s products in export markets. Using a very different approach, Eichhammer and Walz (2011) analysed the competitiveness gap between developed countries on the one hand, and developing and emerging economies on the other hand. Their conclusion was that at least part of the gap was explained by the much lower energy efficiency in the latter group of countries, which is itself a manifestation of their lower absorptive capacity for energy-efficient technologies.

Focusing on the EU, Rennings and Rexhäuser (2011) analysed the competitiveness effects of implementing energy-saving technologies on European industry, using data from the Community Innovation Survey (CIS). Their results suggest that energy-saving process innovation had only minor effects on the growth rate of firms’ turnover. The European Competitiveness Report 2012 (European Commission, 2012c) found that, by and large, European manufacturing industries have been able to improve their competitiveness by offering new, more energy-efficient products such as consumer durables and capital goods. The report concluded that ‘overall, there seems to be evidence that product innovators introducing energy-saving products on the market enjoy higher sales generated by product innovation compared to conventional product innovators. This, of course, may also reflect an important competitive advantage’.

The contribution of the present study is to attempt to quantify the link between energy intensity/energy cost shares and competitiveness for a wide range of countries and industries based on the time series available from a single dataset (WIOD), which ensures internal consistency and comparability of data.

6.4.1. Empirical Results and Interpretation

To measure the impact of changes in energy intensity and energy cost shares on industrial competitiveness, a panel-data model for the period 1995-2007 was set up, using total (intra- and extra-EU) exports as main dependent variable.[16] The model is estimated as a panel with country-industry fixed effects, in order to account for the unobserved country/industry heterogeneity, thus explaining the export dynamics of each industry in each country over time. The following equation is estimated for our main specification:

$$\begin{aligned}\dot{Comp}_{ijt} &= \alpha_0 + \alpha_1 \dot{lnEnergyint}_{ijt} + \alpha_2 \dot{lnLPVAppp95}_{ijt} + \alpha_3 \dot{HSKL}_{ijt} + \alpha_4 \dot{MSKL}_{ijt} \\ &\quad + \alpha_5 \dot{lnK}_{ijt} + \alpha_6 \dot{lnWagePe}_{ijt} + \alpha_7 \dot{lnGDPppp}_{jt} + \gamma_{ij} + \varepsilon_{ijt}\end{aligned}$$

where $Comp_{ijt}$ is a measure of export competitiveness of industry i in country j in year t. The main independent variable of interest is *lnEnergyint*, measuring the log of energy intensity. We replace or integrate this variable with energy cost shares in alternative specifications. The model also includes a range of control variables customarily used to explain the export performance of a country or industry, such as labour productivity

16 This corresponds to the baseline specification. Alternative specifications using revealed comparative advantages (RCAs) as dependent variables were tried as well.

(*lnLPVAppp95*), the shares of high- and medium-skilled labour (*HSKL* and *MSKL*), capital intensity (*lnK*), wages (*lnWagePe*), and the size of the economy (*lnGDPppp*). The model is estimated in first differences, as indicated by the ˙ signs above the variables in the equation. The years 2008 and 2009 were excluded from the sample since the global economic and financial crisis may have impacted very differently across sectors, thus making results difficult to interpret.[17] The model was run on a sample of 21 EU countries[18] and thirteen NACE 2-digit manufacturing sectors, available from the WIOD database.[19]

Table 6.9 shows the results of our estimations for the total sample of industries (columns 1-3). Energy intensity is negatively related to exports (column 1). Similar results are obtained when energy intensity is replaced by the total energy cost share (column 2). In column 3, we split the energy cost share into its main components. In this specification, only the cost share of electricity, gas, steam and hot water (CPA 40) has the expected significant negative relationship with exports, but energy intensity becomes insignificant.[20] These results suggest that a rise in the cost share component CPA 40 by 1 percentage point (pp) is statistically associated with a 1.6% decline of exports. The fact that only the cost component CPA 40 is significant is not surprising given that, as shown in Figure 6.9, it accounted for more than 60 percent in the EU 27 total energy costs in 2011.

Overall, these findings suggest that, despite energy cost shares being relatively small compared to other cost components, their growth had a significant negative impact on export competitiveness. A comparison of the results across specifications of the model suggests that, in terms of international competitiveness, energy cost shares matter more than energy efficiency. In fact, the coefficient of energy intensity loses significance when cost shares are added in the regression. This can be explained by the fact that energy cost shares are determined by both energy prices and energy intensity. Manufacturing firms across the globe may have access to the same energy saving technologies, so that investments in energy efficiency did not sufficiently alter the relative position of different countries. On the other hand, the substantial differences in energy prices documented in Section 6.1 seem to have impacted the competitiveness of European manufacturing industries.[21] This should be read in light of the results presented in Section 6.3, where it was shown that the price elasticity of EU manufacturing industries were in several cases larger than the full sample of OECD countries. This means that despite the significant achievements of European industry, the improvements in energy intensity were not large enough to compensate for the competitiveness gap generated by the energy price increase.

The results for most of the other control variables have an intuitive interpretation. The coefficient of labour productivity is positive and significant across all the model specifications, suggesting a positive productivity-competitiveness nexus. Wages are found to be positively though not significantly associated with exports. Intuitively, this makes sense: labour productivity gains need to be larger than wage increases in order to result in lower unit labour costs and improved competitiveness. Human capital matters for export competitiveness, too: an increase in the high-skilled labour share is associated with higher exports.

Relatively more counterintuitive is the coefficient of capital intensity, which is found to be negatively associated with exports. This can be explained by the simultaneous presence of two other variables connected to capital intensity: Labour productivity, which is measured as output per employed person; and the share of high-skilled labour, which is a proxy for human capital and relates to capital intensity via a capital-skill complementarity. This could point towards a certain degree of (multi-) collinearity amongst those variables. For this reason, two robustness checks were tried. First, the regressions were run excluding labour productivity. In this case the coefficient on energy intensity becomes larger in absolute terms and more significant, while the results for cost shares stay the same. The coefficient of capital intensity becomes lower in absolute terms, but remains significantly negative.[22] Second, the regressions were run

[17] Reassuringly, the main results are similar for the full sample.

[18] The panel covers 21 EU Member States, i.e. EU-28 without Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Malta and Romania.

[19] Coke, refined petroleum, and nuclear fuel industry (NACE 23) was excluded from the model, since it uses energy inputs as crude oil primarily as a feedstock rather than as an energy source. As already demonstrated in Chapter 1, its inclusion may result in distorted estimation results.

[20] When separately including the other cost shares, these are insignificant whereas energy intensity remains significantly negative.

[21] The correlation between the measure of energy intensity and that of CPA 40 cost share is relatively low (0.19), that is reassuring in terms of the effects of potential collinearity.

[22] A possible explanation for this could be that industries which climb up the value chain tend to produce less capital-

excluding capital intensity. In this case, the coefficients of labour productivity become smaller. The effects of energy intensity loose significance but the cost share coefficients remain again unaffected. It should be also noted that the coefficients of capital intensity in absolute terms are lower than or close to those for labour productivity. This can be interpreted as a positive effect of total factor productivity.

The results were tested against other robustness checks. When labour productivity and cost shares are recalculated based on value added, energy intensity becomes insignificant, whereas the cost share of CPA 40 remains significantly negative.[23] This finding also holds when a different measure of competiveness, i.e. revealed comparative advantage, is used for the total sample of industries. Interestingly, when revealed comparative advantages are measured in value added terms, the coefficient for energy intensity becomes more negative and more often significant, which might imply that industries which upgrade along value chains become less energy intensive. When including the crisis period, i.e. using data for the period 1995-2009, the main results concerning energy intensity and the cost share of Electricity gas, steam and hot water (CPA-40) still hold, with the coefficients of energy intensity being negative but insignificant, whereas the other cost share components, in some cases, become positive and significant. This might be the result of the much differentiated impact of the crisis across industries, and possibly to some substitution across energy sources (in particular, coal).

The regressions were run also for a sub-sample of energy-intensive sectors: *Chemicals and Chemical Products* (NACE Rev. 1 24), *Other Non-Metallic Minerals* (NACE Rev. 1 26) and *Basic Metals and Fabricated Metals* (NACE Rev. 1 27to28). The results point again towards a negative effect of a higher share of the cost component CPA 40 and the magnitude of the effect is similar. The coefficients for energy intensity are negative but insignificant in all specifications (columns 4-6 in Table 6.9). This counterintuitive result might be caused by the limited variation in this small subset of the sample. Furthermore, for these industries competitiveness is unrelated to the share of high and medium-skilled labour.

All in all, the analysis provide evidence that export competitiveness of manufacturing industries – as measured by export growth - is significantly related to energy intensity and to energy cost shares, particularly so for the cost share of Electricity, gas, steam and hot water (CPA-40). This last result is robust to all the specifications tried for this study. This suggests that industries that faced increases of this cost share have experienced a loss in competitiveness. However, at the level of aggregation allowed by the WIOD dataset, the observed impact is relatively small in magnitude.

The analysis is based on a relatively simple model specification and the results should be interpreted with some caution, since they are based on the developments prior to the 'shale gas revolution' in the US. It is possible that the increased energy price gap between the US and other countries may be impacting export competitiveness more strongly than what suggested by the estimates of this study. Unfortunately, these effects cannot be captured with the data used in this study. Moreover, due to data limitations, all findings are based on the NACE 2-digit level of aggregation. At a more disaggregated level, energy intensity and energy cost shares may potentially have a much greater impact on export competitiveness, especially for energy-intensive industries.

6.4.2. Energy Intensive Industries

A closer look at specific manufacturing sub-sectors generally reveals a great level of heterogeneity. This aspect ought to be considered when interpreting the results of the regressions showed in the previous section, especially the ones on the reduced sample of energy intensive industries. Unfortunately, data available from the WIOD project do not allow a more granular analysis. To cope with this limitation, additional information can be extracted from a series of specific sectoral studies undertaken by the European Commission.[24] In particular, the sectors Basic Metals, Chemicals and Other Non-Metals and Mineral Products can be considered. Because of differences in definitions and statistical methodologies, the figures provided are not meant to

intensive goods or offshore capital-intensive production processes elsewhere. An indication for the latter aspect is that when replacing export with revealed comparative advantages as competitiveness indicator, capital intensity is negatively related when measured in value added terms, but insignificant when measured in gross trade. In these cases the coefficients concerning energy intensity become significantly negative.

[23] This specification is closely linked to the analysis in European Commission (2014a), where Real Unit Energy Costs were used for sectoral and international comparisons.

[24] CEPS (2013a, 2013b, 2014a, 2014b). The results of the analysis have been delivered to Directorate General Enterprise and Industry of the European Commission. The figures provided are based on a survey. Details on the sampling technique and on the representativeness of the sample are provided in the original studies.

be exhaustive and direct comparisons with indicators calculated using WIOD should be avoided. The aim of this analysis is to provide insights into the variability of operating conditions in industrial plants across the EU. That should help in the interpretation of the results in Table 6.9.

Examining the share of energy costs on total production costs for the selected industries, reveals that the Basic Metals sector shows an average energy share of 19%, whereas the Chemicals sector is characterized by a much higher share of 60%. The Other Metals and Mineral Products sector is somewhere in between, with an average energy share of about 30%.

Table 6.9 - Energy intensity, energy cost shares, and industrial competitiveness: empirical findings

	Total industries[1]			Energy intensive industries[2]		
Dependent variable: exports	**1**	**2**	**3**	**4**	**5**	**6**
Energy intensity	-0.024*		-0.018	-0.067		-0.055
	(-1.80)		(-1.33)	(-1.63)		(-1.30)
Energy cost share		-0.008*			-0.002	
		(-1.75)			(-0.36)	
Cost share coal			0.018			0.020
			(0.74)			(0.72)
Cost share of oil and natural gas			0.003			0.010
			(0.27)			(0.87)
Cost share of coke, ref. petroleum			0.001			0.012
			(0.12)			(1.09)
Cost share of electricity, gas, steam & hot water			-0.016***			-0.017**
			(-2.63)			(-1.99)
Labour productivity (GO based)	0.329***	0.335***	0.329***	0.418***	0.444***	0.395***
	(10.56)	(10.81)	(10.54)	(4.55)	(4.89)	(4.24)
Share of high-skilled labour	0.726***	0.725***	0.717***	0.962	0.960	0.894
	(2.89)	(2.89)	(2.86)	(1.64)	(1.63)	(1.52)
Share of medium-skilled labour	-0.376*	-0.398*	-0.365*	-0.757	-0.729	-0.674
	(-1.81)	(-1.91)	(-1.75)	(-1.58)	(-1.51)	(-1.40)
Capital intensity	-0.283***	-0.282***	-0.279***	-0.443***	-0.439***	-0.405***
	(-6.90)	(-6.87)	(-6.80)	(-3.78)	(-3.73)	(-3.42)
Wage per employee	0.066	0.064	0.061	0.010	-0.003	-0.013
	(1.45)	(1.42)	(1.35)	(0.10)	(-0.03)	(-0.12)
GDP	-0.011	0.025	-0.011	0.261	0.318	0.196
	(-0.06)	(0.14)	(-0.06)	(0.66)	(0.81)	(0.49)
Constant	0.070***	0.070***	0.071***	0.066***	0.066***	0.068***
	(10.46)	(10.41)	(10.44)	(4.55)	(4.52)	(4.66)
Observations	3,094	3,094	3,094	720	720	720
R-squared	0.06	0.06	0.06	0.06	0.059	0.08
Number of i	259	259	259	60	60	60

Note:
[1] Excluding NACE 23 – Coke, refined petroleum and nuclear fuel.
[2] The sub-sample of energy-intensive sectors includes NACE 24 – Chemicals and chemical products, NACE 26 – Other non-metallic minerals, and NACE 27 to 28 – Basic metals and fabricated metals.
Source: own calculations.

Table 6.10: Energy related characteristics of selected industries (2012)			
Industry	**Share of energy costs**	**Energy Intensity – Natural Gas**	**Energy Intensity – Electricity**
Basic Metals			
Aluminium	30%	-	-
Steel	4.8-13%	0.21	0.24
Chemicals			
Ammonia	80-88%	10.8	-
Chlorine	43-45%	-	3.07
Other Non-Metals and Mineral Products			
Bricks and Roof Tiles	30-35%	0.07	0.56
Wall and Floor Tiles	25-30%	1.81	0.23

Note: Energy Intensity measured in MWh/tonne, Share of Energy Cost calculated over total production costs
Source: Data extracted from CEPS (2013a, 2013b, 2014a, 2014b).

More importantly, within-sector heterogeneity is also substantial. Aluminium and Steel are grouped together in the Basic Metals sector, despite bearing very different energy costs (30% for Aluminium and between 4.8 and 13% for Steel). A similar observation can be made for Chemicals: in the Ammonia industry, energy costs amount to 80-88% of total expenditure, whereas Chlorine's energy share is half as much, at 43-45%. The most homogeneous sector is Other Non-Metals and Mineral Products, with an average share of energy costs around 30% (See Table 6.10). This shows how important it is not to focus only on the aggregates.

Table 6.10 shows also energy intensities for the different industries but, different than in the rest of this study, the indicator is calculated dividing energy use by the physical output in tonnes (rather than gross output). As for the total sample, the relation between energy intensity and energy cost share is weak. The Ammonia industry is the most energy intensive, with an average of 10.8 MWh of natural gas consumed for each tonne of product, as well as the one with the highest share of energy costs. Similarly, the Steel industry is characterized by low energy intensity and low energy cost share. But the Wall and Floor Tiles industry, in which energy intensity is the second highest in the sample (1.81 MWh of natural gas per tonne of product), displays relatively low energy cost share, at approximately 30%.

These figures suggest that specific industrial sub-sector may suffer much more than others the increase of energy prices and the price gap between the EU and the rest of the world. In light of this, the results of the reduced sample regressions are particularly interesting. The fact that the electricity and gas cost share, even at a high level of aggregation, has a proven (statistically significant) negative effect on export competitiveness suggests that potentially some subsectors may be experiencing much stronger export losses.

6.5. CONCLUSIONS

The findings of this study suggest that energy is an important factor influencing industrial competitiveness. The chapter starts by highlighting the wide variation in energy price trends across countries and regions, with electricity and gas prices in the EU raising strongly relative to some of the main competitors.

It then shows that in advanced economies such as the EU, the United States and Japan, energy accounts for a relatively small fraction of production costs (measured in gross output terms). In manufacturing, if we exclude coke, petroleum and nuclear fuel, the share of energy costs is around 3%. But the aggregate figures mask wide divergence across individual manufacturing industries: in some of them, such as aluminium, selected chemical products, glass or cement production, the share of energy costs goes up to 30-40% of total production costs and even higher.

The analysis provides evidence of a general decline of energy intensity levels in the major economies over the past two decades. The primary driver of this trend has been technological improvement, but a structural shift away from energy-intensive sectors has also contributed in Central and Eastern Europe. This decline has been accompanied by a broad convergence of energy intensity levels, with the most energy-intensive economies (such as those in the EU-12) recording the greatest improvements.

Nevertheless, despite these favourable energy intensity trends, the energy cost shares have been generally on the rise, a reflection of the increasing energy prices. This issue is analysed in more details through econometric estimations in order to shed further light on the factors driving it. Essentially, the phenomenon reflects the difficulties faced by industries to respond to energy price increases with energy-saving measures and the energy-efficient technologies. While there has been a sizable reduction in energy intensity in response to higher energy prices in a number of industries, the elasticity of this reduction has been in most cases less than one. This implies that the improvements in energy efficiency have been not sufficient to fully offset the energy price increase. But there is some evidence that European industries have performed better than their main competitors in reducing their energy intensity.

Despite that, the analysis shows that the increase of energy costs, in particular for Electricity, gas, steam and hot water (CPA-40) had a significant negative impact on export competitiveness in the period 1995-2009, confirming the importance of further improving the energy efficiency of European industries to compete on international markets. Moreover, the large within-sector heterogeneity suggests that the impact may be stronger for some specific energy intensive industries and highlights the fundamental importance of further research using more disaggregate data.

All in all, while energy efficiency improvements have helped European manufacturing industries to compete in international market, there is some evidence that the uneven development of energy prices had detrimental effects on export competitiveness. Energy-intensive industries may be suffering more from this phenomenon and should be studied with more attention.

These conclusions largely confirm the findings of the European Competitiveness Report 2012. They are also in line with the results in European Commission (2014a, 2014b) despite the different variables in focus (energy intensity/energy cost shares vs. energy prices) and the different the methodologies applied (econometric estimations vs. a forward-looking modelling approach). Moreover, it is important to bear in mind that, because of data availability, the conclusions in this study are based on the time period until 2009, i.e. before the start of the ‘shale gas revolution’. The asymmetric energy price shock that resulted can potentially have had stronger effects for industrial competitiveness that this study is not able to assess.

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7.1. SECTORAL COMPETITIVENESS INDICATORS

7.1.1. Explanatory notes

Geographical coverage: all indicators refer to EU-28

Production index[25]: The production index is actually an index of final production in volume terms.

Labour productivity: this indicator is calculated by combining the indexes of production and number of persons employed or number of hours worked[26]. Therefore, this indicator measures final production per person of final production per hour worked.

Unit Labour Cost: it is calculated from the production index and the index of wages and salaries and measures labour cost per unit of production. "Wages and salaries" is defined (Eurostat) as "the total remuneration, in cash or in kind, payable to all persons counted on the payroll (including homeworkers), in return for work done during the accounting period, regardless of whether it is paid on the basis of working time, output or piecework and whether it is paid regularly wages and salaries do not include social contributions payable by the employer".

Relative Trade Balance: it is calculated, for sector "i", as $(X_i-M_i)/(X_i+M_i)$, where X_i and M_i are EU-28 exports and imports of products of sector "i" to and from the rest of the World.

Revealed Comparative Advantage (RCA):

The RCA indicator for product "i" is defined as follows:

$$RCA_i = \frac{\dfrac{X_{EU,i}}{\sum_i X_{EU,i}}}{\dfrac{X_{W,i}}{\sum_i XW_{,i}}}$$

where: X=value of exports; the reference group ('W') is the EU-28 plus 105 other countries (see list below); the source used is the UN COMTRADE database. In the calculation of RCA, X_{EU} stands for exports to the rest of the world (excluding intra-EU trade) and X_W measures exports to the rest of the world by the countries in the reference group. The latter consists of the EU-28 plus the following countries: Albania, Algeria, Azerbaijan, Argentina, Australia, Bahamas, Armenia, Bermuda, Bolivia (Plurinational State of), Bosnia Herzegovina, Brazil, Belize, Brunei Darussalam, Belarus, Cambodia, Canada, Cabo Verde, Sri Lanka, Chile, China, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Ethiopia, Fiji, French Polynesia, Georgia, State of Palestine, Ghana, Greenland, Guatemala, Guyana, Honduras, Hong Kong SAR, Iceland, Indonesia, Israel, Ivory Coast, Jamaica, Japan, Kazakhstan, Jordan, Republic of Korea, Kyrgyzstan, Lebanon, Macao SAR, Madagascar, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Other Asia, Republic of Moldova, Montenegro, Montserrat, Mozambique, Oman, Namibia, Aruba, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Russian Federation, Rwanda, Saint Vincent and the Grenadines, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, India, Singapore, Vietnam, South Africa, Zimbabwe, Sudan, Switzerland, Thailand, Togo, Tonga, Tunisia, Turkey, Turks and Caicos Islands, Uganda, Ukraine, TFYR of Macedonia, Egypt, United Republic of Tanzania, US, Uruguay, Samoa, Yemen, Zambia.

25 The data are working-day adjusted for production.
26 The data are working-day adjusted for hours worked.

Statistical nomenclatures: the indicators in Tables 7.1 to 7.6 are presented at the level of divisions of the statistical classification of economic activities in the European Community (NACE Rev. 2[27]), while those in Tables 7.7 to 7.10 are presented in terms of divisions of the statistical classification of products by activity (CPA). Table 7.11 uses extended balance of payments services classification. In terms of data sources: Tables 7.1 to 7.6 are based on Eurostat's short-term indicators data. Tables 7.7 to 7.10 are based on United Nations' COMTRADE. Table 7.11 is based on IMF balance of payments. Royalties and license fees were not included as it is not related to a special service activity.

[27] Compared to the statistical annexes of the previous publications, the new activity classification is used: NACE REV 2. The correspondence tables from NACE Rev. 2 – NACE Rev. 1.1 and from NACE Rev. 1.1 to NACE Rev. 2, are available on Eurostat: http://epp.eurostat.ec.europa.eu/portal/page/portal/nace_rev2/introduction

Table 7.1: EU-28 - Industry production index, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 2008-2013
B	MINING AND QUARRYING	0.7	-3.0	-1.9	-5.3	-3.1	-0.1	-3.6	-10.9	0.4	-7.3	-5.3	-2.3	-5.2
C	MANUFACTURING	-0.7	0.2	2.5	1.8	4.8	4.2	-1.9	-15.3	7.4	4.5	-2.3	-0.4	-1.5
C10	Manufacture of food products	1.9	0.5	2.2	2.4	1.3	2.0	-0.4	-1.1	2.2	1.2	-0.5	-0.2	0.3
C11	Manufacture of beverages	1.7	1.2	-2.3	1.0	3.9	1.3	-2.1	-3.2	-0.8	6.1	-3.0	-0.5	-0.3
C12	Manufacture of tobacco products	-2.3	-5.9	-11.6	-5.4	-4.8	1.5	-11.9	-0.9	-5.8	-4.9	-3.9	-6.3	-4.4
C13	Manufacture of textiles	-4.5	-3.4	-4.9	-5.9	-0.8	-1.1	-10.4	-17.9	7.9	-2.0	-5.6	0.2	-3.9
C14	Manufacture of wearing apparel	-11.5	-7.3	-5.7	-10.4	-0.5	-0.5	-7.6	-13.9	-1.0	-3.5	-5.8	-3.8	-5.7
C15	Manufacture of leather and related products	-8.3	-6.9	-10.2	-9.1	-2.9	-5.7	-8.1	-14.2	2.1	5.4	-4.6	0.4	-2.4
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.6	2.2	3.2	0.2	4.2	1.0	-9.1	-15.1	3.1	3.5	-4.8	-1.0	-3.1
C17	Manufacture of paper and paper products	3.4	1.4	2.8	-0.1	3.9	2.6	-3.2	-8.8	6.2	-0.6	-1.6	-0.5	-1.2
C18	Printing and reproduction of recorded media	-0.6	-1.3	1.4	2.3	0.2	0.7	-2.2	-7.8	-0.2	-1.9	-6.1	-3.4	-3.9
C19	Manufacture of coke and refined petroleum products	0.9	1.3	4.6	0.7	-0.7	0.2	1.0	-8.0	-2.0	-1.3	-1.8	-1.7	-3.0
C20	Manufacture of chemicals and chemical products	1.8	-0.2	3.5	2.3	3.7	3.1	-3.2	-12.2	10.6	1.9	-2.3	-0.1	-0.7
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	8.5	4.7	-0.2	4.8	5.9	0.4	0.7	2.9	4.9	1.8	-0.3	3.4	2.5
C22	Manufacture of rubber and plastic products	-0.1	1.8	1.8	0.9	3.9	4.5	-4.6	-14.0	7.5	4.2	-3.2	0.4	-1.3
C23	Manufacture of other non-metallic mineral products	-1.6	0.3	1.6	0.6	4.3	1.9	-6.8	-19.4	1.9	3.1	-8.5	-3.0	-5.6
C24	Manufacture of basic metals	-0.4	-0.5	5.3	-0.8	6.4	1.5	-3.4	-27.3	18.8	4.4	-5.1	-1.0	-3.3
C25	Manufacture of fabricated metal products, except machinery and equipment	-0.5	0.9	2.6	1.6	4.8	6.2	-3.0	-22.7	7.1	7.4	-3.3	-0.9	-3.2
C26	Manufacture of computer, electronic and optical products	-10.4	0.5	6.3	2.6	8.8	7.5	0.8	-17.4	7.2	0.8	-2.5	-2.4	-3.2
C27	Manufacture of electrical equipment	-4.3	-1.5	2.3	1.0	8.5	4.3	-0.7	-21.0	11.4	4.5	-2.9	-2.2	-2.7
C28	Manufacture of machinery and equipment n.e.c.	-1.8	-0.8	4.1	4.0	8.4	8.4	1.5	-26.9	10.6	11.8	0.4	-2.8	-2.5
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.7	1.6	4.4	1.4	3.3	6.1	-5.9	-25.1	21.6	12.1	-3.1	2.5	0.3
C30	Manufacture of other transport equipment	-4.0	0.3	0.5	2.1	8.6	4.7	3.4	-5.6	-1.0	4.6	3.1	4.1	1.0
C31	Manufacture of furniture	-5.1	-2.6	0.3	1.0	3.8	3.4	-5.0	-16.7	-0.9	2.0	-5.7	-3.7	-5.2
C32	Other manufacturing	2.9	-2.4	1.0	0.7	5.1	1.4	-1.6	-6.9	8.5	3.1	0.5	2.9	1.5
C33	Repair and installation of machinery and equipment	-4.5	-1.6	4.6	1.2	7.8	4.5	3.9	-10.3	2.9	5.0	-1.6	1.1	-0.7
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	0.9	3.0	2.2	2.0	0.8	-0.6	-0.1	-4.4	4.1	-4.3	0.1	-0.8	-1.1
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	0.3	1.7	0.7	2.8	3.4	2.7	-3.0	-7.7	-4.5	-0.4	-5.3	-2.1	-4.0

Note: N/A: Data not available
Source: Eurostat

Table 7.2: EU-28 - Number of persons employed, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 2008-2013
B	MINING AND QUARRYING	-4.6	-4.4	-4.6	-3.1	-3.7	-3.5	-1.4	-4.2	-4.1	-3.0	-0.8	-2.5	-2.9
C	MANUFACTURING	-1.9	-1.9	-1.9	-1.4	-0.7	0.5	-0.4	-7.3	-3.6	0.7	-0.5	-1.1	-2.4
C10	Manufacture of food products	-0.8	-0.3	-1.3	-0.2	-0.1	0.2	-0.2	-1.9	-0.6	0.7	-0.7	-0.4	-0.6
C11	Manufacture of beverages	-1.1	-1.8	-1.1	-1.7	-1.2	-0.1	-1.2	-6.1	-2.4	-1.7	-1.8	-0.9	-2.6
C12	Manufacture of tobacco products	-0.7	-5.1	-4.7	-2.3	-0.4	-11.2	-10.1	-7.1	-5.4	-3.3	-2.0	-2.8	-4.1
C13	Manufacture of textiles	-4.9	-7.0	-6.3	-4.6	-5.6	-5.2	-6.3	-13.0	-5.4	-3.2	-2.6	-4.3	-5.8
C14	Manufacture of wearing apparel	-3.5	-3.6	-6.0	-7.4	-5.9	-5.8	-6.0	-13.9	-7.8	-2.0	-2.4	-3.8	-6.1
C15	Manufacture of leather and related products	-0.8	-3.9	-6.5	-5.9	-3.0	-3.1	-5.0	-12.2	-3.5	3.8	-0.4	-2.9	-3.2
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-1.5	-1.5	-1.1	-0.9	-1.1	0.2	-2.5	-12.4	-2.6	-1.5	-2.0	-2.1	-4.2
C17	Manufacture of paper and paper products	-0.7	-2.9	-1.6	-2.8	-2.5	-2.9	-2.5	-5.5	-1.9	0.0	-0.9	-0.5	-1.8
C18	Printing and reproduction of recorded media	-2.0	-3.8	-1.8	-3.1	-1.3	0.1	-2.0	-6.8	-4.7	-4.8	-4.8	-2.8	-4.8
C19	Manufacture of coke and refined petroleum products	-3.2	-3.3	-1.9	-2.8	-3.3	0.6	-1.1	-3.7	-2.0	-4.7	-1.6	-2.1	-2.8
C20	Manufacture of chemicals and chemical products	-1.7	-2.6	-3.4	-2.1	-1.2	-0.7	-2.3	-4.5	-2.4	0.0	-0.5	-1.0	-1.7
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	2.2	-0.5	-2.5	-1.4	1.6	0.1	-2.4	-3.6	-0.9	-0.2	1.7	-0.8	-0.8
C22	Manufacture of rubber and plastic products	-0.9	0.2	-0.1	-0.9	-0.8	1.6	0.7	-7.1	-2.4	1.4	0.5	-0.6	-1.7
C23	Manufacture of other non-metallic mineral products	-2.2	-2.8	-2.3	-1.2	-0.6	1.3	-2.2	-10.7	-6.3	-1.2	-3.3	-3.7	-5.1
C24	Manufacture of basic metals	-3.9	-2.9	-4.1	-1.2	-1.0	-0.6	-0.6	-8.3	-5.2	1.4	-1.9	-2.4	-3.3
C25	Manufacture of fabricated metal products, except machinery and equipment	-1.1	-1.0	0.2	-0.1	1.6	3.0	2.6	-8.5	-5.1	2.1	-0.2	-1.5	-2.7
C26	Manufacture of computer, electronic and optical products	-5.5	-4.2	-2.8	-1.2	-0.7	1.3	-2.0	-8.9	-3.9	0.9	-1.2	-1.9	-3.1
C27	Manufacture of electrical equipment	-3.9	-3.9	-1.3	-0.6	0.9	2.4	1.2	-7.9	-1.9	3.7	-0.5	-0.7	-1.5
C28	Manufacture of machinery and equipment n.e.c.	-1.6	-2.2	-2.3	-0.9	0.7	2.8	1.8	-6.0	-4.9	2.9	2.0	-0.9	-1.4
C29	Manufacture of motor vehicles, trailers and semi-trailers	-1.0	-0.4	0.1	-0.7	-1.0	-0.2	0.8	-8.9	-2.9	2.8	0.7	0.7	-1.6
C30	Manufacture of other transport equipment	-1.6	-2.6	-1.8	0.3	0.8	2.7	1.6	-1.3	-4.8	0.3	0.6	-0.5	-1.2
C31	Manufacture of furniture	-3.3	0.1	-2.4	-2.5	-1.2	0.7	-2.2	-9.9	-8.6	0.2	-3.1	-2.9	-4.9
C32	Other manufacturing	-1.5	0.0	-1.0	-1.9	-0.4	0.6	-0.3	-3.1	-1.8	0.1	1.5	1.1	-0.5
C33	Repair and installation of machinery and equipment	-2.4	-2.0	-0.7	-0.6	0.5	0.6	3.1	-2.1	-2.2	-2.6	2.3	1.0	-0.7
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	-5.1	-4.8	-3.5	-2.3	-1.2	-1.5	-0.7	1.6	-0.3	-0.5	-2.0	-2.1	-0.7
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	-0.3	0.4	-0.9	-1.6	1.9	0.6	-0.9	-0.4	-0.1	0.0	1.3	0.2	0.2
F	CONSTRUCTION	-0.9	0.1	1.0	2.6	3.6	4.4	0.0	-6.7	-5.4	-2.6	-3.4	-3.6	-4.4

Note: N/A: Data not available
Source: Eurostat

Table 7.3: EU-28 - Number of hours worked, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 2008-2013
B	MINING AND QUARRYING	-4.6	-5.3	-3.7	-2.8	-5.0	-3.5	-1.2	-5.9	-3.1	-1.9	0.2	-0.9	-2.3
C	MANUFACTURING	-2.4	-2.4	-1.5	-1.8	-0.2	0.3	-0.7	-10.3	-1.2	1.5	-1.0	-0.8	-2.5
C10	Manufacture of food products	-1.7	-1.6	-0.1	-0.6	0.0	-0.2	0.0	-2.6	0.3	0.4	-0.8	-0.4	-0.6
C11	Manufacture of beverages	-3.4	0.1	0.8	-3.2	-3.9	-1.1	-1.7	-4.7	-4.7	-0.6	-1.9	-1.4	-2.7
C12	Manufacture of tobacco products	-2.7	-9.9	-1.7	-3.7	-8.7	-2.9	-10.9	-7.0	-3.2	-2.2	0.9	-3.7	-3.1
C13	Manufacture of textiles	-6.1	-7.7	-8.3	-6.2	-6.2	-3.8	-7.1	-17.0	-3.9	-0.5	-2.7	-1.2	-5.3
C14	Manufacture of wearing apparel	-2.5	-2.9	-4.2	-6.0	-4.4	-5.8	-6.4	-16.9	-8.9	0.1	-4.2	-2.8	-6.7
C15	Manufacture of leather and related products	-0.6	-1.8	-4.4	-5.9	-1.6	-4.1	-6.3	-14.1	-1.2	4.6	0.8	0.9	-2.0
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-1.0	-1.3	-1.3	-2.5	-0.3	0.4	-3.0	-14.8	-0.7	0.0	-2.4	-3.4	-4.4
C17	Manufacture of paper and paper products	-0.4	-2.9	-1.9	-2.2	-1.1	-1.1	-4.5	-8.2	-0.6	0.7	-1.7	-1.9	-2.4
C18	Printing and reproduction of recorded media	-3.3	-3.7	-3.9	-2.8	0.0	0.2	-1.9	-6.7	-4.6	-3.4	-6.2	-2.2	-4.6
C19	Manufacture of coke and refined petroleum products	-4.1	-2.3	-1.1	0.3	-4.4	0.3	1.4	-8.8	-2.1	-1.3	0.7	-3.8	-3.1
C20	Manufacture of chemicals and chemical products	-2.4	-2.7	-2.1	-3.2	-1.3	-1.7	-2.2	-5.8	-1.9	1.0	0.6	-1.8	-1.6
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	2.5	0.2	-0.7	-2.0	0.5	0.5	-0.2	-2.4	-1.3	-0.3	1.4	1.5	-0.2
C22	Manufacture of rubber and plastic products	-1.8	-1.5	-0.4	-1.6	1.6	1.0	-0.3	-10.0	0.4	2.4	0.1	0.2	-1.5
C23	Manufacture of other non-metallic mineral products	-3.3	-2.7	-1.4	-1.2	-0.6	0.4	-3.0	-13.0	-3.2	-1.0	-4.6	-4.2	-5.3
C24	Manufacture of basic metals	-3.3	-4.7	-2.1	-2.3	-0.1	-0.5	-1.1	-13.5	1.3	2.7	-2.6	-3.3	-3.3
C25	Manufacture of fabricated metal products, except machinery and equipment	-1.3	-1.6	-0.1	-1.0	1.8	3.0	3.5	-13.2	-1.6	2.1	-0.3	-0.7	-2.9
C26	Manufacture of computer, electronic and optical products	-5.1	-4.3	-3.4	-1.8	-1.1	0.2	-1.2	-12.9	-3.3	0.5	-0.2	-2.8	-3.9
C27	Manufacture of electrical equipment	-3.2	-3.7	-1.5	-2.1	2.2	1.7	0.5	-13.7	3.2	3.5	-1.9	-2.0	-2.4
C28	Manufacture of machinery and equipment n.e.c.	-2.4	-2.1	-1.5	-1.6	1.6	2.9	1.7	-11.6	-0.8	4.9	1.2	-0.4	-1.5
C29	Manufacture of motor vehicles, trailers and semi-trailers	-2.2	-1.2	0.2	-0.2	-0.6	0.8	-1.5	-14.6	4.7	4.1	-0.9	1.6	-1.3
C30	Manufacture of other transport equipment	-1.9	-2.0	-2.2	0.7	0.5	1.0	1.1	-1.4	-6.1	0.5	0.2	-2.1	-1.8
C31	Manufacture of furniture	-3.8	-2.6	-1.7	-3.2	0.6	-0.1	-3.1	-12.6	-6.5	-0.6	-3.8	-2.5	-5.3
C32	Other manufacturing	-3.2	-2.5	0.2	-2.9	-0.9	0.8	0.0	-6.2	-0.1	2.1	0.9	0.1	-0.7
C33	Repair and installation of machinery and equipment	-2.5	-2.7	-1.9	0.1	1.2	0.8	2.2	-2.2	-3.9	0.7	0.4	0.3	-1.0
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	-5.3	-4.8	-2.3	-0.5	-1.5	-1.2	-0.2	-0.7	-0.4	0.4	-3.2	-1.2	-1.0
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	-0.8	-0.3	1.6	-1.6	0.0	0.8	0.7	-2.6	0.3	0.2	1.5	-1.3	-0.4
F	CONSTRUCTION	-2.2	0.7	0.4	5.6	3.4	3.6	-1.0	-9.9	-7.9	-1.3	-2.8	-2.6	-5.0

Note: N/A: Data not available
Source: Eurostat

Table 7.4: EU-28 - Labour productivity per person employed, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 2008-2013
B	MINING AND QUARRYING	5.5	1.4	2.8	-2.3	0.6	3.5	-2.3	-7.0	4.7	-4.4	-4.5	0.2	-2.3
C	MANUFACTURING	1.2	2.1	4.5	3.3	5.6	3.7	-1.5	-8.6	11.4	3.7	-1.8	0.7	0.9
C10	Manufacture of food products	2.7	0.8	3.6	2.6	1.4	1.8	-0.2	0.8	2.8	0.5	0.2	0.3	0.9
C11	Manufacture of beverages	2.9	3.1	-1.2	2.7	5.2	1.4	-0.9	3.1	1.6	7.9	-1.2	0.4	2.3
C12	Manufacture of tobacco products	-1.7	-0.8	-7.2	-3.2	-4.4	14.4	-2.0	6.6	-0.4	-1.6	-2.0	-3.6	-0.3
C13	Manufacture of textiles	0.4	3.9	1.5	-1.4	5.1	4.4	-4.4	-5.6	14.1	1.2	-3.1	4.6	2.0
C14	Manufacture of wearing apparel	-8.3	-3.8	0.3	-3.2	5.7	5.6	-1.7	0.0	7.3	-1.5	-3.5	0.0	0.4
C15	Manufacture of leather and related products	-7.6	-3.1	-4.0	-3.4	0.1	-2.6	-3.2	-2.3	5.8	1.6	-4.2	3.4	0.8
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	2.1	3.8	4.4	1.1	5.4	0.8	-6.7	-3.1	5.8	5.1	-2.9	1.1	1.2
C17	Manufacture of paper and paper products	4.1	4.4	4.5	2.7	6.5	5.6	-0.8	-3.5	8.2	-0.6	-0.7	0.0	0.6
C18	Printing and reproduction of recorded media	1.4	2.6	3.3	5.5	1.6	0.6	-0.2	-1.0	4.7	3.0	-1.3	-0.6	0.9
C19	Manufacture of coke and refined petroleum products	4.2	4.7	6.6	3.6	2.7	-0.4	2.1	-4.4	0.0	3.6	-0.2	0.4	-0.2
C20	Manufacture of chemicals and chemical products	3.6	2.5	7.1	4.5	4.9	3.8	-0.9	-8.1	13.3	1.9	-1.8	0.9	1.0
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	6.2	5.2	2.4	6.3	4.3	0.3	3.1	6.7	5.8	2.0	-1.9	4.2	3.3
C22	Manufacture of rubber and plastic products	0.8	1.6	1.9	1.8	4.7	2.8	-5.3	-7.4	10.2	2.8	-3.7	1.0	0.4
C23	Manufacture of other non-metallic mineral products	0.7	3.2	3.9	1.9	4.9	0.6	-4.7	-9.7	8.8	4.4	-5.4	0.7	-0.5
C24	Manufacture of basic metals	3.6	2.5	9.8	0.4	7.4	2.1	-2.8	-20.7	25.3	2.9	-3.2	1.4	0.1
C25	Manufacture of fabricated metal products, except machinery and equipment	0.6	2.0	2.4	1.7	3.2	3.1	-5.5	-15.5	12.9	5.2	-3.1	0.6	-0.5
C26	Manufacture of computer, electronic and optical products	-5.2	4.9	9.4	3.9	9.6	6.1	2.8	-9.3	11.6	-0.1	-1.3	-0.5	-0.1
C27	Manufacture of electrical equipment	-0.5	2.5	3.6	1.6	7.6	1.9	-1.9	-14.3	13.6	0.8	-2.4	-1.5	-1.2
C28	Manufacture of machinery and equipment n.e.c.	-0.2	1.4	6.6	5.0	7.6	5.4	-0.3	-22.3	16.3	8.7	-1.6	-2.0	-1.1
C29	Manufacture of motor vehicles, trailers and semi-trailers	1.8	2.0	4.3	2.1	4.3	6.4	-6.6	-17.8	25.2	9.1	-3.8	1.8	1.9
C30	Manufacture of other transport equipment	-2.4	3.0	2.3	1.8	7.8	1.9	1.8	-4.4	4.0	4.3	2.5	4.6	2.1
C31	Manufacture of furniture	-1.8	-2.7	2.8	3.6	5.1	2.7	-2.9	-7.5	8.4	1.8	-2.7	-0.9	-0.3
C32	Other manufacturing	4.5	-2.4	2.0	2.6	5.5	0.8	-1.3	-4.0	10.5	3.0	-1.0	1.7	2.0
C33	Repair and installation of machinery and equipment	-2.2	0.4	5.3	1.8	7.3	3.8	0.7	-8.4	5.2	7.8	-3.8	0.1	0.0
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	6.3	8.2	5.9	4.4	2.0	1.0	0.6	-5.9	4.5	-3.8	2.1	1.4	-0.4
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	1.2	1.6	-0.3	0.2	-0.2	-1.6	-3.0	-1.1	1.0	2.3	-2.0	1.6	0.3

Note: N/A: Data not available
Source: Eurostat

Table 7.5: EU-28 - Labour productivity per hour worked, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 2008-2013
B	MINING AND QUARRYING	5.6	2.4	1.9	-2.6	2.0	3.6	-2.4	-5.3	3.6	-5.5	-5.5	-1.4	-2.9
C	MANUFACTURING	1.8	2.6	4.1	3.6	5.0	3.9	-1.2	-5.6	8.7	3.0	-1.3	0.4	0.9
C10	Manufacture of food products	3.7	2.1	2.3	3.0	1.3	2.2	-0.4	1.5	1.9	0.8	0.3	0.2	0.9
C11	Manufacture of beverages	5.3	1.1	-3.0	4.3	8.1	2.4	-0.4	1.6	4.1	6.8	-1.1	0.9	2.4
C12	Manufacture of tobacco products	0.4	4.5	-10.0	-1.8	4.2	4.6	-1.1	6.6	-2.7	-2.7	-4.7	-2.7	-1.3
C13	Manufacture of textiles	1.7	4.6	3.7	0.3	5.8	2.8	-3.6	-1.1	12.3	-1.5	-3.0	1.4	1.5
C14	Manufacture of wearing apparel	-9.2	-4.5	-1.6	-4.7	4.1	5.6	-1.3	3.6	8.6	-3.6	-1.7	-1.1	1.1
C15	Manufacture of leather and related products	-7.7	-5.2	-6.1	-3.4	-1.3	-1.6	-1.9	-0.1	3.4	0.7	-5.4	-0.5	-0.4
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.7	3.5	4.6	2.8	4.5	0.6	-6.3	-0.4	3.9	3.5	-2.4	2.5	1.4
C17	Manufacture of paper and paper products	3.8	4.4	4.8	2.1	5.0	3.7	1.4	-0.7	6.8	-1.3	0.1	1.5	1.2
C18	Printing and reproduction of recorded media	2.8	2.5	5.5	5.3	0.2	0.5	-0.4	-1.2	4.6	1.6	0.1	-1.2	0.7
C19	Manufacture of coke and refined petroleum products	5.2	3.7	5.7	0.4	3.9	-0.1	-0.4	0.8	0.1	0.0	-2.5	2.2	0.1
C20	Manufacture of chemicals and chemical products	4.3	2.6	5.8	5.7	5.1	4.9	-1.0	-6.7	12.7	0.9	-2.9	1.7	0.9
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	5.9	4.5	0.5	6.9	5.4	-0.1	0.9	5.4	6.3	2.1	-1.7	1.9	2.8
C22	Manufacture of rubber and plastic products	1.7	3.3	2.2	2.6	2.2	3.5	-4.3	-4.4	7.1	1.7	-3.3	0.2	0.2
C23	Manufacture of other non-metallic mineral products	1.7	3.1	3.0	1.8	4.9	1.5	-3.9	-7.4	5.2	4.1	-4.1	1.2	-0.3
C24	Manufacture of basic metals	3.0	4.4	7.6	1.5	6.5	2.0	-2.4	-15.9	17.3	1.7	-2.6	2.4	0.0
C25	Manufacture of fabricated metal products, except machinery and equipment	0.8	2.5	2.8	2.6	2.9	3.1	-6.3	-10.9	8.8	5.2	-3.0	-0.2	-0.3
C26	Manufacture of computer, electronic and optical products	-5.5	5.0	10.0	4.5	10.0	7.2	2.1	-5.2	10.8	0.3	-2.3	0.5	0.7
C27	Manufacture of electrical equipment	-1.2	2.2	3.9	3.1	6.2	2.6	-1.2	-8.4	7.9	1.0	-1.0	-0.2	-0.3
C28	Manufacture of machinery and equipment n.e.c.	0.6	1.4	5.7	5.7	6.7	5.4	-0.2	-17.3	11.5	6.6	-0.8	-2.4	-1.0
C29	Manufacture of motor vehicles, trailers and semi-trailers	3.0	2.9	4.2	1.6	3.9	5.3	-4.5	-12.3	16.2	7.6	-2.2	0.9	1.6
C30	Manufacture of other transport equipment	-2.2	2.4	2.8	1.4	8.0	3.7	2.2	-4.3	5.4	4.1	2.9	6.3	2.8
C31	Manufacture of furniture	-1.4	0.0	2.0	4.4	3.2	3.5	-2.0	-4.7	6.0	2.6	-2.0	-1.3	0.1
C32	Other manufacturing	6.3	0.1	0.8	3.7	6.1	0.6	-1.6	-0.7	8.6	1.0	-0.4	2.8	2.2
C33	Repair and installation of machinery and equipment	-2.0	1.1	6.6	1.1	6.6	3.7	1.7	-8.3	7.1	4.3	-2.0	0.8	0.2
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	6.5	8.2	4.6	2.5	2.4	0.6	0.1	-3.7	4.5	-4.7	3.4	0.4	-0.1
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	2.6	1.0	0.3	-2.7	0.0	-0.9	-2.0	2.4	3.7	0.9	-2.6	0.5	1.0

Note: N/A: Data not available
Source: Eurostat

Table 7.6: EU-28 - Unit labour cost, annual growth rate (%)

Code (NACE Rev. 2)	Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 2008-2013
B	MINING AND QUARRYING	-0.9	6.5	4.2	-1.0	6.6	4.8	10.9	11.9	0.9	10.4	8.5	4.8	7.2
C	MANUFACTURING	1.6	0.4	-1.2	-0.6	-2.2	-0.1	6.0	10.6	-6.4	-0.6	4.6	2.0	1.9
C10	Manufacture of food products	0.9	2.2	-0.8	-0.7	0.5	1.4	4.8	1.3	-0.1	0.5	2.0	2.0	1.1
C11	Manufacture of beverages	-1.2	3.0	3.5	-1.3	-3.9	1.0	4.6	2.2	-0.9	-3.4	3.5	2.5	0.7
C12	Manufacture of tobacco products	2.4	5.9	19.3	7.5	2.2	-1.8	8.3	-3.1	1.5	-2.2	7.0	5.0	1.6
C13	Manufacture of textiles	3.0	0.5	0.9	2.9	-2.3	0.5	9.8	6.2	-8.7	2.0	4.8	-1.4	0.4
C14	Manufacture of wearing apparel	10.9	4.1	2.3	5.5	-0.8	2.0	8.4	4.8	-3.8	4.3	4.1	3.3	2.5
C15	Manufacture of leather and related products	8.2	4.3	8.1	6.0	5.9	9.2	10.9	5.8	-0.1	0.4	8.9	1.4	3.2
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-1.3	-1.8	-0.6	0.7	-0.3	4.7	12.5	5.8	-4.1	-1.4	3.1	-1.2	0.4
C17	Manufacture of paper and paper products	-2.5	-1.5	-1.4	0.7	-3.5	-1.3	3.7	4.0	-5.2	1.9	2.1	1.4	0.8
C18	Printing and reproduction of recorded media	0.3	-1.4	-1.5	-2.2	-0.5	0.4	4.6	2.3	-4.7	-1.2	2.3	-0.4	-0.4
C19	Manufacture of coke and refined petroleum products	4.9	-4.4	-0.5	2.3	3.7	2.5	5.1	6.5	3.7	2.2	2.6	4.0	3.8
C20	Manufacture of chemicals and chemical products	-1.0	1.8	-3.6	-1.2	-3.7	-0.2	5.3	10.8	-9.2	3.9	4.6	1.9	2.2
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	-2.5	0.2	1.5	-2.8	-2.6	5.1	0.8	-2.4	-3.6	0.0	4.7	-1.5	-0.6
C22	Manufacture of rubber and plastic products	1.4	-0.1	0.6	0.1	-2.3	-0.6	8.1	8.4	-5.0	0.5	5.9	1.8	2.2
C23	Manufacture of other non-metallic mineral products	2.6	0.4	-0.7	0.4	-1.8	2.7	9.4	13.1	-2.9	-2.4	7.4	0.7	3.0
C24	Manufacture of basic metals	-0.8	0.5	-3.9	3.2	-3.0	2.8	7.0	24.0	-14.2	0.7	6.3	0.7	2.8
C25	Manufacture of fabricated metal products, except machinery and equipment	1.7	-0.2	0.1	0.0	-0.9	0.8	10.8	16.2	-6.7	-2.9	5.9	1.7	2.6
C26	Manufacture of computer, electronic and optical products	8.2	-4.5	-6.1	-2.5	-7.5	-4.1	2.4	11.7	-8.1	1.6	4.7	3.9	2.6
C27	Manufacture of electrical equipment	3.5	-0.6	-0.5	-0.5	-4.3	1.2	5.9	12.7	-8.4	2.2	5.0	3.7	2.8
C28	Manufacture of machinery and equipment n.e.c.	2.5	1.7	-1.9	-2.6	-3.7	-1.5	4.3	28.1	-8.8	-3.9	4.1	5.3	4.2
C29	Manufacture of motor vehicles, trailers and semi-trailers	1.0	0.9	-2.0	0.1	-0.1	-5.2	9.3	17.6	-15.4	-3.5	7.2	1.8	0.9
C30	Manufacture of other transport equipment	8.2	1.8	-1.2	0.9	-4.7	0.2	3.0	7.9	2.5	-1.8	3.8	0.9	2.6
C31	Manufacture of furniture	4.7	-0.6	-0.9	-0.6	-0.8	0.2	7.8	10.6	-3.7	-2.4	3.9	2.0	2.0
C32	Other manufacturing	-1.2	3.5	1.4	-1.1	-2.8	4.5	4.3	4.4	-5.7	0.4	2.2	0.3	0.3
C33	Repair and installation of machinery and equipment	5.9	1.4	-2.7	1.6	-4.3	-0.2	3.5	14.1	-6.1	-4.1	4.6	2.1	1.9
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	1.6	-1.7	-1.3	0.1	4.1	4.8	4.6	8.3	-1.7	6.7	1.5	2.8	3.4
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	CONSTRUCTION	3.0	0.3	1.6	5.7	3.1	6.5	6.9	0.8	-1.7	1.7	4.6	1.2	1.3

Note: N/A: Data not available
Source: Eurostat

Table 7.7: EU-28 - Revealed comparative advantage index

Code (NACE Rev. 2)	Sector	2007	2008	2009	2010	2011	2012
C10	Manufacture of food products	0.72	0.66	0.63	0.66	0.65	0.66
C11	Manufacture of beverages	2.33	2.01	1.96	2.12	2.22	2.25
C12	Manufacture of tobacco products	0.77	0.88	0.92	0.98	1.02	1.11
C13	Manufacture of textiles	0.73	0.69	0.62	0.59	0.56	0.54
C14	Manufacture of wearing apparel	0.55	0.57	0.51	0.48	0.49	0.52
C15	Manufacture of leather and related products	0.93	0.88	0.80	0.77	0.82	0.81
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.88	0.94	0.95	0.94	0.93	0.95
C17	Manufacture of paper and paper products	0.96	0.98	0.99	1.00	1.00	1.00
C18	Printing and reproduction of recorded media	1.61	1.51	1.61	1.50	1.30	1.32
C19	Manufacture of coke and refined petroleum products	0.88	0.85	0.80	0.79	0.76	0.86
C20	Manufacture of chemicals and chemical products	1.07	1.02	1.16	1.10	1.02	1.03
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	1.83	1.80	1.69	1.87	1.95	1.96
C22	Manufacture of rubber and plastic products	0.85	0.85	0.81	0.83	0.82	0.79
C23	Manufacture of other non-metallic mineral products	1.20	1.14	1.10	1.08	1.05	1.02
C24	Manufacture of basic metals	0.71	0.70	0.74	0.77	0.71	0.74
C25	Manufacture of fabricated metal products, except machinery and equipment	1.06	1.07	1.07	1.08	1.03	1.01
C26	Manufacture of computer, electronic and optical products	0.63	0.63	0.58	0.55	0.59	0.55
C27	Manufacture of electrical equipment	1.06	1.09	1.08	1.02	1.03	0.98
C28	Manufacture of machinery and equipment n.e.c.	1.57	1.63	1.68	1.66	1.67	1.62
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.99	1.03	1.00	1.15	1.24	1.28
C30	Manufacture of other transport equipment	1.48	1.50	1.88	1.92	1.79	1.92
C31	Manufacture of furniture	1.04	1.04	0.95	0.88	0.91	0.84
C32	Other manufacturing	1.06	0.98	0.89	0.92	0.87	0.85

Note: There was a transition from NACE Rev. 1 to NACE Rev. 2, therefore the data are only available from 2007
Source: Own calculations using Comtrade data

Table 7.8: EU-28 - Relative trade balance (X-M)/(X+M)

Code (NACE Rev. 2)	Sector	2007	2008	2009	2010	2011	2012
C10	Manufacture of food products	-0.15	-0.15	-0.13	-0.08	-0.11	-0.03
C11	Manufacture of beverages	0.58	0.59	0.57	0.60	0.62	0.67
C12	Manufacture of tobacco products	0.69	0.75	0.76	0.79	0.79	0.83
C13	Manufacture of textiles	-0.10	-0.10	-0.13	-0.16	-0.22	-0.14
C14	Manufacture of wearing apparel	-0.54	-0.53	-0.58	-0.58	-0.58	-0.50
C15	Manufacture of leather and related products	-0.27	-0.27	-0.30	-0.30	-0.28	-0.20
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0.11	-0.07	0.00	0.01	-0.02	0.13
C17	Manufacture of paper and paper products	0.21	0.23	0.25	0.24	0.22	0.31
C18	Printing and reproduction of recorded media	0.20	0.20	0.26	0.17	0.15	0.34
C19	Manufacture of coke and refined petroleum products	-0.10	-0.08	-0.10	-0.10	-0.16	-0.02
C20	Manufacture of chemicals and chemical products	0.15	0.16	0.25	0.20	0.13	0.19
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.28	0.30	0.26	0.30	0.24	0.28
C22	Manufacture of rubber and plastic products	0.06	0.06	0.07	0.06	0.02	0.09
C23	Manufacture of other non-metallic mineral products	0.19	0.19	0.21	0.18	0.16	0.25
C24	Manufacture of basic metals	-0.23	-0.15	-0.01	-0.15	-0.10	-0.14
C25	Manufacture of fabricated metal products, except machinery and equipment	0.16	0.17	0.19	0.18	0.12	0.20
C26	Manufacture of computer, electronic and optical products	-0.28	-0.28	-0.29	-0.32	-0.30	-0.25
C27	Manufacture of electrical equipment	0.13	0.16	0.16	0.12	0.08	0.14
C28	Manufacture of machinery and equipment n.e.c.	0.37	0.40	0.44	0.42	0.40	0.46
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.36	0.40	0.38	0.48	0.48	0.56
C30	Manufacture of other transport equipment	0.13	0.17	0.12	0.14	0.16	0.22
C31	Manufacture of furniture	-0.04	-0.01	-0.04	-0.08	-0.05	0.03
C32	Other manufacturing	-0.13	-0.13	-0.13	-0.10	-0.13	-0.03

Note: There was a transition from NACE Rev. 1 to NACE Rev. 2, therefore the data are only available from 2007
Source: Own calculations using Comtrade data

Table 7.9: Revealed comparative advantage index in manufacturing industries in 2012 - EU countries, US and Japan, Brazil, China, India and Russia

	Food	Bevarages	Tobacco	Textiles	Clothing	Leather & footwear	Wood & wood products	Paper	Printing	Refined petroleum	Chemicals	Pharma-ceuticals	Rubber & plastics	Non-metallic mineral products	Basic metals	Metal products	Computers electronic & optical	Electrical equipment	Machinery	Motor vehicles	Other transport	Furniture	Other manu-facturing
	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32
Austria	0.88	2.24	0.00	0.68	0.54	0.68	4.26	2.32	1.40	0.27	0.53	1.66	1.23	1.29	1.30	2.22	0.43	1.30	1.47	1.25	0.78	0.95	0.66
Belgium	1.30	1.15	1.12	0.76	0.68	0.98	0.82	1.01	7.69	1.30	2.30	3.23	0.95	0.96	1.01	0.64	0.21	0.40	0.72	1.09	0.19	0.43	1.18
Bulgaria	1.32	0.88	6.79	1.12	2.73	0.98	1.69	0.83	0.15	2.06	0.56	0.96	0.97	2.32	2.52	0.79	0.24	1.19	0.86	0.32	0.28	1.34	0.38
Croatia	1.39	2.00	3.47	0.50	1.65	2.10	5.84	1.12	1.33	2.00	0.78	1.34	0.64	3.14	0.65	2.17	0.19	1.54	0.76	0.21	2.38	2.69	0.17
Cyprus	2.24	2.04	23.15	0.18	0.52	1.01	0.13	0.26	0.00	0.00	1.14	6.88	0.45	0.90	1.12	0.63	0.49	0.78	0.47	0.31	1.23	0.97	0.58
Czech Republic	0.51	0.59	1.73	0.86	0.33	0.51	1.38	0.96	1.82	0.20	0.56	0.30	1.65	1.58	0.66	2.12	1.06	1.70	1.16	1.99	0.41	1.39	0.76
Denmark	3.04	1.45	1.25	0.72	1.62	0.71	0.99	0.74	1.13	0.95	0.65	1.69	1.12	0.94	0.30	1.58	0.54	1.01	1.64	0.32	0.25	2.53	0.72
Estonia	1.08	2.33	0.20	1.44	1.04	0.98	7.54	0.79	0.70	2.16	0.69	0.10	1.36	1.18	0.51	1.81	0.88	1.42	0.87	0.52	0.21	2.46	0.49
Finland	0.36	0.47	0.02	0.26	0.22	0.22	5.35	10.23	0.68	1.82	0.86	0.58	0.88	0.76	1.57	1.05	0.41	1.34	1.47	0.26	0.55	0.20	0.54
France	1.16	4.72	0.62	0.52	0.70	1.26	0.62	1.01	1.83	0.51	1.33	1.86	1.04	0.93	0.70	0.87	0.45	0.84	0.88	1.04	4.59	0.45	0.76
Germany	0.75	0.65	1.93	0.52	0.49	0.36	0.76	1.22	2.47	0.23	1.05	1.40	1.25	0.96	0.72	1.29	0.56	1.16	1.61	1.90	1.58	0.78	0.55
Greece	2.03	1.28	4.64	0.83	1.21	0.44	0.47	0.59	0.88	5.94	0.64	1.15	0.86	1.42	1.46	0.68	0.18	0.65	0.26	0.09	0.38	0.17	0.28
Hungary	0.95	0.44	0.50	0.38	0.25	0.52	0.75	0.99	0.03	0.45	0.65	1.23	1.55	1.20	0.34	0.85	1.39	1.86	0.91	1.89	0.15	1.07	0.30
Ireland	1.46	1.75	0.49	0.09	0.15	0.09	0.46	0.13	0.00	0.26	2.82	9.46	0.34	0.27	0.08	0.26	0.67	0.22	0.32	0.03	0.39	0.09	1.55
Italy	0.88	2.29	0.03	1.30	1.61	3.09	0.54	1.07	1.28	0.80	0.72	1.20	1.28	1.86	1.14	1.62	0.21	0.98	1.84	0.70	0.75	2.20	0.96
Latvia	1.56	7.89	1.47	0.95	1.09	0.35	18.47	0.90	2.07	0.97	0.57	0.89	0.92	1.98	1.47	1.48	0.53	0.76	0.45	0.57	0.29	2.23	0.42
Lithuania	1.63	1.79	6.47	0.95	1.10	0.38	3.36	1.20	0.27	4.00	1.32	0.41	1.11	0.99	0.19	1.05	0.23	0.60	0.66	0.63	0.23	5.70	0.44
Luxembourg	1.10	1.02	6.54	2.33	0.36	0.25	2.27	2.11	0.01	0.02	0.57	0.14	4.38	2.50	3.55	1.33	0.28	0.63	0.82	0.64	0.66	0.11	0.24
Malta	0.63	0.28	2.68	0.81	0.14	0.15	0.02	0.03	1.55	5.42	0.17	1.99	0.91	0.18	0.04	0.19	1.56	0.87	0.20	0.06	1.79	0.06	1.52
Netherlands	1.91	1.30	4.86	0.44	0.59	0.64	0.30	0.87	0.34	2.29	1.73	1.10	0.77	0.47	0.57	0.76	0.99	0.54	0.93	0.37	0.34	0.40	0.83
Poland	1.55	0.44	5.25	0.60	0.70	0.45	2.33	1.86	0.69	0.60	0.81	0.35	1.82	1.56	0.95	1.80	0.59	1.32	0.65	1.45	1.18	4.59	0.30
Portugal	1.12	3.61	4.03	1.82	2.11	3.01	4.23	3.29	0.73	0.77	0.78	0.45	1.83	3.02	0.71	2.08	0.29	1.09	0.49	1.25	0.20	2.62	0.31
Romania	0.48	0.27	5.81	1.10	2.21	2.26	4.86	0.37	2.07	0.83	0.59	0.57	1.69	0.54	0.93	1.15	0.42	1.55	0.84	1.91	0.87	3.62	0.22
Slovakia	0.57	0.50	0.01	0.37	0.51	1.09	1.17	1.08	0.57	0.73	0.38	0.13	1.42	1.10	1.04	1.47	1.28	0.88	0.74	2.67	0.17	1.32	0.26
Slovenia	0.50	0.61	0.00	0.86	0.33	0.58	3.12	1.85	0.27	0.58	0.94	2.75	1.71	1.53	0.98	2.05	0.22	2.20	1.00	1.35	0.23	2.39	0.42
Spain	1.67	2.50	0.55	0.78	1.36	1.17	0.77	1.42	0.64	0.86	1.13	1.40	1.13	2.12	1.07	1.24	0.15	0.93	0.72	1.93	1.10	0.70	0.37
Sweden	0.52	0.88	0.68	0.30	0.40	0.23	3.64	5.78	0.20	1.31	0.73	1.42	0.86	0.62	1.08	1.12	0.69	1.03	1.30	1.21	0.33	1.50	0.44
United Kingdom	0.66	3.87	0.58	0.50	0.68	0.51	0.17	0.67	2.30	1.22	1.20	2.59	0.86	0.67	0.79	0.71	0.59	0.71	1.16	1.32	1.76	0.37	1.05
EU-28	0.66	2.25	1.11	0.54	0.52	0.81	0.95	1.00	1.32	0.86	1.03	1.96	0.79	1.02	0.74	1.01	0.55	0.98	1.62	1.28	1.92	0.84	0.85
US	0.89	0.77	0.22	0.50	0.16	0.20	0.60	1.18	0.56	1.30	1.38	0.99	0.97	0.69	0.79	0.92	0.94	0.87	1.39	1.08	0.51	0.48	1.46
Japan	0.07	0.07	0.06	0.44	0.02	0.02	0.02	0.27	0.21	0.26	0.96	0.16	1.07	1.00	1.07	0.79	1.08	1.09	2.00	2.25	1.26	0.14	0.36
Brazil	5.04	0.12	0.57	0.35	0.04	1.64	1.79	3.06	0.42	0.46	1.01	0.38	0.68	0.98	1.68	0.85	0.08	0.46	0.86	0.96	1.75	0.49	0.16
China	0.35	0.10	0.16	2.47	2.66	2.51	0.93	0.48	0.19	0.18	0.49	0.22	1.11	1.67	0.48	1.34	1.87	1.48	0.74	0.27	0.74	2.30	1.46
India	1.73	0.11	0.46	2.82	1.81	1.11	0.13	0.24	0.67	3.00	1.04	1.13	0.63	0.74	0.77	1.02	0.17	0.36	0.42	0.37	0.81	0.31	4.60
Russia	0.62	0.29	1.48	0.07	0.04	0.13	3.03	0.93	0.15	7.11	1.41	0.08	0.29	0.54	2.71	0.33	0.10	0.22	0.17	0.14	0.71	0.13	0.31

Source: Own calculations using COMTRADE data

Table 7.10: Relative trade balance (X-M)/(X+M) in manufacturing industries in 2012 - EU countries, US and Japan, Brazil, China, India and Russia

	Food	Bevarages	Tobacco	Textiles	Clothing	Leather & footwear	Wood & wood products	Paper	Printing	Refined petroleum	Chemicals	Pharma-ceuticals	Rubber & plastics	Non-metallic mineral products	Basic metals	Metal products	Computers electronic & optical	Electrical equipment	Machinery	Motor vehicles	Other transport	Furniture	Other manu-facturing
	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32
Austria	-0.08	0.53	-1.00	-0.01	-0.42	-0.20	0.40	0.22	-0.29	-0.52	-0.23	0.08	-0.04	-0.04	0.09	0.13	-0.11	0.08	0.09	0.01	0.19	-0.28	-0.12
Belgium	0.14	0.01	0.05	0.24	-0.04	0.14	-0.01	-0.03	0.06	0.05	0.13	0.09	0.04	0.09	0.19	-0.04	-0.18	-0.08	0.05	-0.02	-0.13	-0.23	0.02
Bulgaria	-0.11	-0.17	0.55	-0.43	0.54	0.03	0.24	-0.34	-0.82	0.22	-0.39	-0.18	-0.21	0.24	0.40	-0.24	-0.48	-0.02	-0.09	-0.30	-0.43	0.32	-0.11
Croatia	-0.34	0.11	0.07	-0.57	-0.08	0.00	0.40	-0.47	-0.46	-0.03	-0.40	-0.22	-0.58	0.10	-0.39	-0.01	-0.54	0.04	-0.30	-0.59	0.22	0.02	-0.68
Cyprus	-0.66	-0.80	-0.38	-0.87	-0.89	-0.75	-0.96	-0.93	-1.00	-1.00	-0.56	0.00	-0.85	-0.82	-0.29	-0.76	-0.60	-0.64	-0.65	-0.83	0.12	-0.81	-0.74
Czech Rep.	-0.14	0.07	0.27	0.10	-0.15	-0.07	0.32	-0.04	0.04	-0.18	-0.18	-0.39	0.04	0.19	-0.17	0.21	0.02	0.17	0.17	0.34	0.33	0.25	0.21
Denmark	0.25	-0.06	0.24	-0.03	-0.08	-0.25	-0.37	-0.33	-0.24	-0.06	-0.11	0.19	-0.07	-0.14	-0.35	0.06	-0.15	-0.03	0.24	-0.36	-0.44	0.23	-0.09
Estonia	0.02	-0.20	-0.75	0.18	0.12	0.11	0.43	-0.18	-0.52	-0.15	-0.20	-0.71	-0.07	0.05	-0.14	0.21	0.00	0.04	-0.04	-0.15	-0.58	0.62	0.06
Finland	-0.46	-0.38	-0.95	-0.36	-0.63	-0.46	0.57	0.80	-0.54	0.31	-0.07	-0.23	-0.02	-0.13	0.44	0.03	-0.20	0.16	0.23	-0.45	-0.02	-0.64	-0.01
France	-0.06	0.64	-0.60	-0.14	-0.36	-0.08	-0.32	-0.19	0.26	-0.42	0.02	0.06	-0.13	-0.17	-0.06	-0.14	-0.20	-0.07	-0.03	-0.04	0.24	-0.53	-0.13
Germany	0.07	-0.04	0.56	0.04	-0.29	-0.28	0.05	0.14	0.42	-0.31	0.14	0.17	0.21	0.18	0.04	0.23	-0.01	0.20	0.41	0.41	0.22	-0.07	0.06
Greece	-0.25	-0.16	0.11	-0.13	-0.27	-0.64	-0.44	-0.64	-0.65	0.44	-0.46	-0.52	-0.19	0.05	0.15	-0.16	-0.64	-0.24	-0.44	-0.67	-0.80	-0.74	-0.55
Hungary	0.20	0.10	-0.23	-0.14	-0.09	-0.04	0.15	0.01	-0.92	0.08	-0.08	0.09	0.09	0.19	-0.30	-0.13	0.06	0.18	-0.06	0.44	0.14	0.45	0.10
Ireland	0.21	0.20	0.05	-0.35	-0.59	-0.59	0.13	-0.67	-1.00	-0.36	0.62	0.73	-0.22	-0.16	-0.32	-0.10	0.30	-0.15	-0.07	-0.76	-0.17	-0.56	0.53
Italy	-0.09	0.64	-0.98	0.23	0.17	0.32	-0.34	-0.01	0.06	0.31	-0.20	-0.08	0.27	0.46	0.03	0.45	-0.34	0.21	0.51	0.01	0.26	0.68	0.20
Latvia	-0.20	0.38	-0.39	-0.09	-0.10	-0.47	0.78	-0.38	-0.46	-0.51	-0.33	-0.20	-0.29	0.02	0.17	0.02	-0.13	-0.15	-0.45	-0.28	-0.40	0.23	-0.29
Lithuania	0.13	-0.13	0.52	-0.07	0.28	-0.15	0.26	-0.16	-0.64	0.66	0.03	-0.35	0.03	-0.02	-0.38	0.08	-0.21	0.01	-0.02	-0.13	-0.09	0.83	0.10
Luxembourg	-0.26	-0.57	-0.07	0.54	-0.53	-0.53	0.09	-0.08	-0.98	-0.99	-0.46	-0.71	0.31	0.00	0.34	-0.12	-0.36	-0.25	-0.01	-0.49	-0.80	-0.90	-0.43
Malta	-0.50	-0.77	-0.28	0.39	-0.66	-0.62	-0.95	-0.96	-0.48	-0.39	-0.69	0.33	-0.09	-0.80	-0.74	-0.56	0.13	0.13	-0.48	-0.68	-0.40	-0.91	0.33
Netherlands	0.22	0.13	0.62	0.08	-0.12	-0.05	-0.44	-0.05	-0.23	0.14	0.22	0.09	0.01	-0.15	-0.01	0.05	0.00	-0.01	0.15	-0.13	0.07	-0.26	0.07
Poland	0.20	-0.12	0.82	-0.27	-0.03	-0.26	0.45	0.02	-0.14	0.21	-0.21	-0.40	0.11	0.22	0.00	0.16	-0.17	0.16	-0.16	0.25	0.11	0.76	-0.17
Portugal	-0.31	0.48	0.46	0.10	0.21	0.25	0.50	0.30	-0.22	0.07	-0.34	-0.52	0.17	0.46	-0.10	0.30	-0.30	0.10	-0.16	0.06	-0.27	0.40	-0.37
Romania	-0.43	-0.47	0.58	-0.46	0.51	0.10	0.65	-0.60	-0.12	0.01	-0.37	-0.47	-0.12	-0.41	-0.09	-0.26	-0.29	-0.09	-0.23	0.29	0.55	0.65	-0.29
Slovakia	0.03	0.05	-0.98	-0.11	0.06	0.14	0.31	0.21	0.23	0.43	-0.15	-0.57	0.11	0.16	0.29	0.09	0.09	0.00	0.08	0.34	0.10	0.20	0.02
Slovenia	-0.36	-0.12	-1.00	0.10	-0.34	-0.34	0.16	0.07	-0.62	-0.54	-0.15	0.42	0.14	0.07	-0.07	0.14	-0.18	0.35	0.14	0.09	-0.08	0.36	-0.07
Spain	0.09	0.34	-0.72	-0.01	-0.18	-0.07	0.04	0.03	-0.40	-0.06	-0.09	-0.07	0.03	0.44	0.21	0.16	-0.54	0.07	0.03	0.19	0.39	-0.13	-0.32
Sweden	-0.33	-0.12	0.18	-0.22	-0.39	-0.45	0.53	0.70	-0.64	0.26	-0.13	0.30	-0.09	-0.21	0.20	0.09	-0.08	0.05	0.15	0.10	-0.19	0.11	-0.09
United Kingdo	-0.45	0.13	-0.39	-0.31	-0.55	-0.55	-0.81	-0.46	0.46	0.01	-0.05	0.10	-0.22	-0.25	-0.22	-0.24	-0.28	-0.22	0.02	-0.13	0.14	-0.66	-0.14
EU-28	-0.03	0.67	0.83	-0.14	-0.50	-0.20	0.13	0.31	0.34	-0.02	0.19	0.28	0.09	0.25	-0.14	0.20	-0.25	0.14	0.46	0.56	0.22	0.03	-0.03
US	-0.03	-0.45	-0.25	-0.35	-0.87	-0.82	-0.44	0.05	0.54	0.05	0.13	-0.23	-0.18	-0.26	-0.13	-0.17	-0.28	-0.25	-0.03	-0.33	-0.41	-0.69	-0.16
Japan	-0.88	-0.82	-0.97	-0.20	-0.97	-0.96	-0.98	-0.30	0.42	-0.56	0.18	-0.70	0.31	0.27	0.37	0.19	0.09	0.29	0.61	0.74	0.40	-0.69	-0.38
Brazil	0.76	-0.79	0.92	-0.55	-0.87	0.49	0.83	0.53	-0.19	-0.61	-0.45	-0.62	-0.33	-0.12	0.33	-0.17	-0.88	-0.44	-0.38	-0.24	0.12	0.19	-0.59
China	0.04	-0.44	0.69	0.71	0.95	0.82	0.29	-0.03	0.38	-0.22	-0.23	0.07	0.49	0.62	-0.02	0.65	0.23	0.41	0.11	-0.16	0.31	0.93	0.78
India	0.36	-0.20	0.82	0.64	0.94	0.62	-0.41	-0.52	-0.34	0.58	-0.27	0.51	0.16	0.01	-0.64	0.19	-0.64	-0.30	-0.42	0.23	-0.16	0.08	0.50
Russia	-0.47	-0.73	0.54	-0.86	-0.95	-0.85	0.53	-0.20	-0.88	0.95	0.13	-0.91	-0.69	-0.50	0.56	-0.69	-0.82	-0.76	-0.84	-0.88	-0.31	-0.82	-0.49

Source: Own calculations using COMTRADE data

Table 7.11: Revealed comparative advantage index in service industries in 2012 - EU countries, US and Japan, Brazil, China, India and Russia.

Country name	Telecommunications, computer and information	Construction	Finance	Insurance and pension	Other business services	Personal, cultural and recreational	Transport	Travel
Austria	0.69	0.46	0.34	1.00	1.09	0.72	1.11	1.14
Belgium	0.87	0.82	0.66	0.57	1.57	0.77	1.17	0.44
Bulgaria	1.01	1.24	0.13	0.99	0.59	0.77	0.88	1.76
Croatia	0.41	0.26	0.10	0.13	0.45	0.40	0.47	2.53
Cyprus	0.17	0.33	1.66	0.26	1.07	0.45	1.17	1.26
Czech Republic	1.04	1.25	0.04	0.67	1.17	1.08	1.00	1.05
Denmark	0.41	0.10	0.17	0.30	0.85	0.72	2.74	0.35
Estonia	0.83	1.95	0.27	0.08	0.81	0.54	1.72	0.76
Finland	2.34	3.24	0.46	0.30	0.93	0.21	0.58	0.53
France	0.66	0.83	0.59	0.81	1.18	2.52	1.01	0.93
Germany	0.89	1.44	0.95	1.06	1.15	0.37	1.00	0.48
Greece	0.24	0.68	0.07	0.78	0.25	0.60	2.19	1.31
Hungary	0.67	0.58	0.13	0.07	0.95	5.71	0.94	0.75
Ireland	4.30	0.00	1.56	5.47	1.04	0.31	0.25	0.13
Italy	0.75	0.27	0.49	1.46	1.22	0.17	0.63	1.39
Latvia	0.65	0.95	1.17	0.21	0.64	0.32	2.22	0.56
Lithuania	0.28	1.05	0.15	0.00	0.28	0.43	2.43	0.70
Luxembourg	0.67	0.16	9.85	2.24	0.78	4.76	0.23	0.22
Malta	0.32	0.00	1.07	0.37	0.44	43.87	0.42	0.87
Netherlands	1.09	1.00	0.24	0.33	1.57	0.70	1.26	0.46
Poland	0.77	1.47	0.22	0.49	1.19	1.04	1.33	1.01
Portugal	0.49	1.03	0.22	0.27	0.59	1.48	1.28	1.57
Romania	1.54	1.01	0.45	0.65	0.99	0.75	1.15	0.40
Slovak Republic	0.99	1.59	0.10	0.41	0.99	1.11	1.29	1.15
Slovenia	0.82	1.59	0.11	0.81	0.63	1.36	1.22	1.47
Spain	0.63	1.30	0.57	0.63	1.10	1.72	0.74	1.46
Sweden	1.51	0.43	0.44	0.67	1.41	0.90	0.82	0.60
United Kingdom	0.81	0.28	3.64	4.10	1.47	1.82	0.53	0.43
EU-28	1.17	0.73	1.18	1.24	1.11	1.38	1.01	0.81
US	0.48	0.18	2.16	1.26	0.79	0.46	0.58	0.87
Japan	0.17	3.04	0.63	0.15	0.87	0.14	1.35	0.38
Brazil	0.23	0.02	1.24	0.69	2.45	0.11	0.62	0.58
China	0.82	2.20	0.18	0.87	1.22	0.07	0.90	0.89
India	4.55	0.22	0.67	0.79	0.90	0.54	0.54	0.43
Russia	0.55	2.67	0.39	0.35	1.21	0.91	1.39	0.61

Source: Own calculations based on IMF and OECD data