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Production costs of the non-ferrous metals in the EU and other countries: Copper and zinc

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ABSTRACT

Our study compares production costs of the non-ferrous metals (NFM) industry in the European Union (EU) and other countries in order to understand whether these costs are higher in Europe. Our analysis focuses on copper and zinc, since they are considered to be the most greatly consumed non-ferrous metals after aluminium. The countries selected for comparison depend on the metal and are based on high shares of extra-EU28 trade and/or of global installed capacity. A bottom-up approach has been followed, based on information at facility level for primary production of the two metals. The analysis includes 32 copper smelters, 34 copper refineries and 23 zinc smelters, representing 72%, 58% and 30% of global production of copper anodes, cathodes and zinc slab respectively. Taking into consideration the complex structure of the industry, costs are broken down to three components: (1) Energy, (2) Labour and other costs (salaries, consumables and other on-site costs) and (3) Credits (due to co-products). Our findings suggest that although interesting observations emerge in each of these components, overall costs compare more favourably among countries than initially thought. The EU industry does not have the highest production costs. On the contrary, especially in the case of copper refineries and zinc, it has lower production costs than most of the countries included in the study.

1. Introduction

Discussions concerning the competitiveness of the European industry, both in the industry and in the European Commission, have raised the issue of cost differences between Europe and other countries. In the communication "For an European Industrial Renaissance" (European Commission, 2014a) it was acknowledged that production costs, especially energy costs, might be higher in Europe than in other competitor states.

The non-ferrous metals industry includes a number of metals distinguished from the ferrous ones thanks to their non-magnetic properties and their resistance to corrosion. Aluminium is the mostly used one, while the second and third highest usages are for copper and zinc (European Commission, 2014b). Studies usually focus on energy use and CO_2 emissions of the nonferrous metals industry (Yanjia and Chandler, 2010; Lucio et al., 2013) or generally energy-intensive industries (Makridou et al., 2016) or on the impact of environmental legislation on competitiveness (Demailly and Quirion, 2008; Meleo, 2014; Korhonen et al., 2015; Söderholm et al., 2015). Studies on economic assessment of energy-intensive industries are limited (Scholtens and Yurtsever, 2012; Ren et al., 2009). There are some studies that assess production costs of non-ferrous metals (NFM) (Figuerola-Ferretti, 2005; Adams and Duroc-Danner, 1987), all referring to aluminium, or the economics of energy policies on copper production (David and Zandi, 1979), but they are all not recent. Only one report was identified that aimed at providing the European Commission with an up-to-date understanding of the competitiveness of the EU NFM industry, that included not only aluminium, but also copper, zinc and other metals (ECORYS, 2011).

It has been observed that copper and zinc have received limited attention in literature, although together with aluminium they represent more than 85% of annual global NFM production (ECORYS, 2011). As a result, the goal of the present study was to establish the different parameters that affect production costs of both metals.

For both copper and zinc there are two processes that can be applied to produce primary metal: hydrometallurgical and pyrometallurgical. In the case of copper it is rather the latter used (80% of primary copper worldwide (Richardson, 2000)), while in the case of zinc the former accounts for about 90% to 95% of total world output (European Commission, 2014b; Schwab et al., 2015).

Excluding mining, the copper industry consists of smelters and refineries. Smelters process sulphuric concentrates of low-grade copper ores, originating from mines, and produce copper anodes,

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while refineries produce copper cathodes from copper anodes. Copper cathodes have purity between 99.97% and 99.99% and in a further step can be melted and cast in different shapes of semi-finalised products, such as billets, cakes or wide rods. The two processes can be either in the same site or in different ones.

In the zinc industry, on the other hand, both smelting and refining usually take place on the same site. Starting material is usually sulphuric zinc concentrates that in an intermediary step need to be oxidised, and the final product is zinc deposited on the cathodes, from where it is collected, melted and cast into slabs or ingots.

In 2013 global copper mine production was estimated to be about 18.3 Mt, with Chile being the largest producer, followed by China, Peru and the USA (U.S. Geological Survey (USGS), 2015), while global smelter production of copper reached 13.8 Mt if only primary production is considered (Minerals U.K., 2015) or 16.8 Mt if also secondary production is included (International Copper Study Group (ICSG), 2014). China accounted for about 27% of this production and the EU and Chile for 11% and 10%, respectively. Global refinery production of copper was 20.9 Mt, including 3.8 Mt of secondary refined production (Minerals U.K., 2015; International Copper Study Group (ICSG), 2014), 31% of which was located in China and 13% in the EU. The European Union is relying highly on imports of ores and concentrates. In 2013, the industry imported copper ore mainly from Chile, Peru and Brazil (Eurostat, 2016a), whereas Chile (44%), Peru and Zambia were the origin of imports of refined copper in the form of cathodes (Eurostat, 2016b).

Concerning zinc, global slab production in 2013 reached 13.2 Mt (Minerals U.K., 2015), with China being the largest producer both in mining and smelting. China's share of slab production was 40% and the EU's 15%. In the same year, total extra-EU imports of refined zinc were 0.16 Mt and exports 0.38 Mt (Eurostat, 2016b). Most of refined zinc was imported from Norway and Namibia, while historically Russia and Kazakhstan have also had high percentages of trade with the EU.

2. Methodology

2.1. Boundaries and method

As already mentioned, in this analysis we assessed if production costs of copper and zinc in Europe are higher than in other competing countries. For this comparison the chosen countries were based on EU imports data (Eurostat, 2016a, 2016b). For copper the countries selected were China, Chile, Peru and Zambia, while for zinc the comparison was done among the EU, China, Russia, Kazakhstan, Norway and Namibia. China was also included because of its leading position as global producer, even if it had a low trading share with the EU.

In order to evaluate the costs of manufacturing processes, we follow a bottom-up approach based on information at facility level provided by Wood Mackenzie (Wood Mackenzie, 2015a). The database covers more than 90% of total primary production from copper smelters worldwide and about 93% of the Chinese copper production in 2013 (Wood Mackenzie, 2015b). In the case of zinc, the global coverage is over 80%, including all of China with the exception of very small smelters, resulting in about 65% total production coverage in this country (Wood Mackenzie, 2015c). The analysis was done for 2012 and 2013.

The facilities covered fall with classes 24.43 and 24.44 of the NACE REV.2 classification. The boundaries of our study were at the gate of smelters or refineries. This means that we included neither mining and preparation of ores, nor casting carried out after manufacturing of copper cathodes and zinc slab or ingot. We also did not include any copper produced at the mine-site following the hydrometallurgical route, which as mentioned before represents about 20% of global primary copper (Richardson, 2000). The analysis was based mainly on primary production of the metals. Even if the European recycling industry is among the most advanced in the world and the savings compared to primary route could reach up to 85% in the case of copper (Grimes et al., 2008), both energy consumption and costs in secondary production are strongly depending on the quality of the scrap. In addition, there is no commercial or public information available about global recycling of zinc and copper with the required degree of detail. Because of these two reasons, we excluded secondary production costs from the comparison. It should be noted that other studies (ECORYS, 2011) also reported difficulties in distinguishing between energy costs for primary and secondary processing.

Table 1 shows the number of facilities included in the database and therefore in this study. The differences between 2012 and 2013 were that a new copper smelter started operating in China adding 0.5 Mt in the total capacity of the country, one copper refinery closed down but another started also in China incrementing Chinese total refinery capacity 0.4 Mt and a zinc smelter in Bulgaria closed down.

2.2. Components of the cost

Our analysis did not include depreciation and was focused entirely on production costs of the primary route. Costs in this study were broken down to three components:

a. Energy
b. Labour & other costs
c. Credits (due to the value of co-products)

Energy costs include electricity and other fuels such as natural gas, fuel oil, coal or coke used in the facilities. Copper smelters are high consumers of energy, although to a much lesser extent than the aluminium ones. Copper refineries are also power intensive processes. The major source of energy in electrolytic zinc smelters is electricity.

Labour and other costs consist of salaries for supervision, operation and maintenance, as well as maintenance items, consumable and other on-site costs. Maintenance items generally refer to everything used to keep the smelter operational, while consumables to everything used to operate the smelter. The range of items covered is wide and depends on the technology used. Other on-site costs include services such as water and communications, rates and property taxes and infrastructure costs such as general site maintenance. These costs usually depend on local factors and are not necessarily proportional to capacity.

Valuable co-products were taken into consideration as credits, which were deducted from total expenses. For copper, credits originate from sulphur by-products in the case of smelters and from nickel salts and cathode premiums in the case of refineries.

The most common copper ores are sulphuric, with sulphur contents varying significantly. High sulphur content may have impact on the energy balance of the smelter, affecting its operation. Nevertheless, the driving force behind producing sulphuric by-products (mainly sulphuric acid, but in some cases also gypsum and liquid SO_2) in the industry is environmental regulations rather than economic factors. Environmental legislation in Latin America has become more stringent in recent years. Europe has in general high total sulphur collection efficiencies, reflecting the stringency of environmental legislation. Global trends in the base years of the study (2012 and 2013) were that sulphur prices were decreasing. The acid selling price for individual smelters was almost entirely based on the region in which the smelter is located.