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Improving Serbia's copper exports: Key challenges and solutions[2]

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***Abstract**: In recent years, Serbia's copper industry has faced significant challenges related to its export structure. This analysis reveals two key issues: a shortage of skilled labour and inadequate processing capacity, both exacerbated by intensified exploitation under new ownership. Given the limited time frame before the copper mines are fully depleted, these challenges cannot be completely resolved. Thus, this research seeks to identify practical solutions to enhance the copper export structure within these constraints. By employing the Revealed Comparative Advantage (RCA) index and analysing export shares, the study identifies three copper product groups with the highest potential for export growth: 1) refined copper, 2) copper plates and sheets and 3) copper pipes. Redirecting limited processing capacities and human resources toward the production of these products would create a more favourable balance between raw ore and processed copper exports. This strategic focus is expected to yield higher profits while optimizing the use of capacities in related industries, given the significantly higher value-added nature of these products compared to raw ore.*

***Keywords**: (copper industry, copper exports, Serbia, RCA index.*

Unapređenje izvoza bakra iz Srbije: ključni izazovi i rešenja

***Apstrakt**: U poslednjih nekoliko godina, industrija bakra u Srbiji suočava se sa značajnim izazovima u vezi sa strukturom izvoza. Ova analiza otkriva dva*

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ključna problema: nedostatak kvalifikovane radne snage i nedovoljne kapacitete za preradu, dodatno pogoršane intenzivnijom eksploatacijom pod novim vlasništvom. S obzirom na ograničeno vreme pre nego što se iscrpe zalihe bakra, ovi problemi ne mogu biti u potpunosti rešeni. Stoga se ovo istraživanje fokusira na pronalaženje praktičnih rešenja za unapređenje strukture izvoza bakra u datim ograničavajućim uslovima. Korišćenjem indeksa otkrivene komparativne prednosti (RCA) i analizom udela u ukupnom izvozu, studija identifikuje tri grupe proizvoda od bakra sa najvećim potencijalom za rast izvoza: 1) rafinisani bakar, 2) bakarne ploče i limovi i 3) bakarne cevi. Usmeravanje ograničenih kapaciteta za preradu i ljudskih resursa ka proizvodnji ovih proizvoda omogućilo bi povoljniji balans između izvoza sirove rude i prerađenog bakra. Ovakva strategija bi verovatno rezultirala višim profitima, uz optimizaciju kapaciteta povezanih industrija, s obzirom na to da ovi proizvodi prolaze kroz znatno viši stepen prerade u poređenju sa sirovom rudom.

***Ključne reči**: industrija bakra, izvoz bakra, Srbija, RCA indeks.*

1. Introduction

Given the intense and adverse current trends in international trade, which have had a particularly significant negative impact on Serbia's economy (Stanojević & Kotlica, 2020), Serbian producers must make additional efforts to maintain the current volume and structure of exports. This challenge is compounded by the fact that the manufacturing industry in Serbia has struggled with a lack of continuity in growth (Nikolić & Miljković, 2023).

In the context of the copper industry, this issue is particularly pronounced. The export dynamics of Serbia’s copper sector have drawn significant attention, especially following the acquisition of the country’s largest copper producer by the Chinese company Zijin. While the volume of copper exports has surged, the export structure has deteriorated sharply, with raw ore now comprising the bulk of these exports.

Zijin's investments, especially in the extraction phase, have undoubtedly boosted ore production. However, this growth has not been accompanied by a corresponding enhancement of Serbia’s copper processing capacities. As a result, an oversupply of raw ore is exported—an expedient short-term strategy for the company, but one that diminishes the potential for value-added processing within Serbia. This shift is alarming, as it marks a departure from the previous emphasis on exporting processed copper products, which typically yield higher returns and foster economic growth.

Expanding Serbia’s copper processing capabilities and increasing the export of more refined copper products would not only benefit Serbia but also its Chinese partners. For the latter, higher-value processed products would lower transportation costs, particularly as nearly all copper ore is destined for China, thousands of kilometres away. Shipping raw, low-value ore incurs significant costs, and thus, enhancing the value of these exports could yield substantial economic advantages for both sides.

Addressing this issue requires a strategic pivot toward greater investment in processing capacities and the promotion of value-added production. By fostering the production and export of processed copper goods, Serbia stands to unlock the full potential of its copper reserves, diversify its economy, and reduce the risks associated with over-reliance on raw material exports.

This research seeks to identify the underlying causes of the shift in Serbia's copper export structure and explore viable solutions to mitigate its negative impacts. Irrespective of these causes, the core objective of this study, particularly in its quantitative analysis, is to identify copper products (processed) that hold significant competitive advantages in the global market. To this end, the Revealed Comparative Advantage (RCA) index, or Balassa index (Balassa, 1965), will be employed. Products with notable competitive advantages will then be assessed based on their share in total exports, with those exhibiting low export values being excluded from further consideration. This approach ensures that the focus remains on products with the greatest potential to enhance Serbia’s copper industry export performance.

By pinpointing the most competitive companies and critical product groups within Serbia's copper sector, this research aims to inform targeted efforts by policymakers—ranging from the Serbian government and relevant ministries to Chinese stakeholders interested in maximizing profitability.

2. Background: the negative shift in export structure of the Serbian copper industry

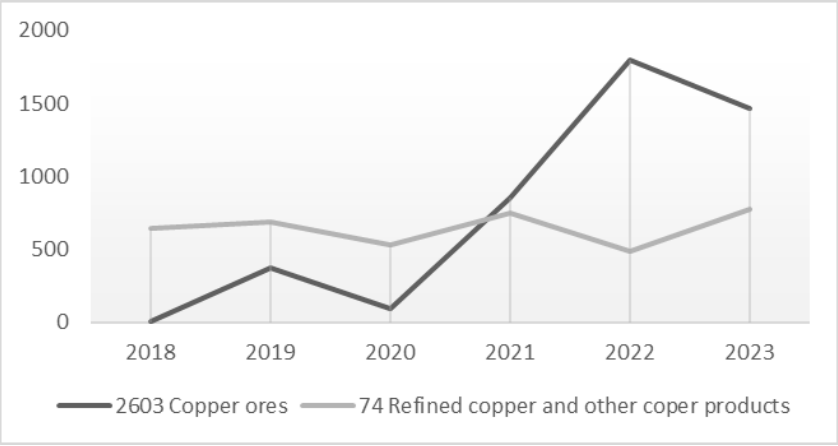
Until 2020, copper ore held minimal significance in Serbia's total exports. Ores in general (classified under HS code 26) didn't even rank within Serbia's top 50 export sectors until 2020. Processed forms, such as plates, strips, wires, and pipes, commanded higher export prices, incurred lower transportation costs, and contributed more significantly to added value, employment, and overall economic development.

At the end of 2018, a majority stake (63%) in RTB Bor, Serbia's largest producer of copper and gold was bought by the Chinese company Zijin. In

2020, the export structure underwent a significant shift, primarily due to the remarkable surge in copper ore exports. By the end of 2020, copper ore exports had risen to 30th place, and by 2021, they had skyrocketed to 7th place in Serbia's total export portfolio. In 2021 Zijin's significant investments in the construction and operation of the "Čukaru Peki" copper and gold mine began to yield results in the form of a huge increase in the exploitation of copper ore and its export in raw form. Copper ore exports have more than doubled in just one year, to 2022 (figure 1).

Since assuming management, Zijin has overseen a tenfold increase in both the quantity and value of copper ore exports within just three years (2019-2022). With processing capacities in Bor limited to 400,000 tons annually, the surge in exploitation has far outstripped processing capabilities, resulting in nearly triple value of ore being exported compared to what is processed domestically. The total export value of copper ore saw a remarkable escalation from a mere $2-3 million in 2020, primarily involving Montenegro, to $92 million in 2021, $1.88 billion in 2022, and a slight decrease to $1.35 billion in 2023 (figure 1).

Figure 1. Export of copper ores and processed copper of Serbia 2013-2023 (million USD)



Source: author according ITC and Statistic service of RS

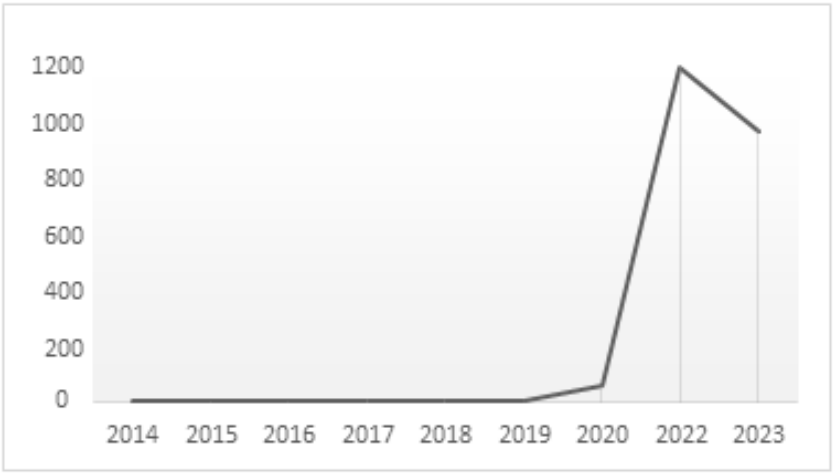
Group HS 74 encompasses all forms of processed copper, including: 7403 (refined copper), 7409 (plates, sheets, and strips), 7404 (waste and scrap), 7411 (copper tubes and pipes), 7407 (bars, rods, and profiles), 7406 (powders and flakes), and 7408 (copper wire). Despite the presence of these

various processed forms, the export of all processed copper products, including refined copper, has been stagnating.

The ratio of ore exports to processed copper exports has increasingly deteriorated up to 2022. Although there was a notable improvement in 2023, this should not be seen as a definitive positive change, as it reflects only a single year's data (see figure 1).

Moreover, the quantitative data on copper ore and product exports reveals a more severe decline in export structure compared to value-based presentations (see figure 2). This discrepancy is largely due to rising global market prices.

Figure 2. Exports of copper ore (in thousand tons) 2014-2023



Source: author according ITC and Statistic service of RS

The apparent stagnation in copper product exports, as shown in figure 1, masks a more troubling reality. Even excluding the export of raw ore, there has been a notable degradation in the export structure of processed copper. Specifically, since Zijin's acquisition of the Bor mines, there has been a significant decline in the export of copper tubes and pipes (HS 7411)—formerly the second-highest export category for Serbia. Additionally, exports of refined copper (HS 7403) have also decreased (see figure 3).

This indicates a decline in the export of processed copper overall. The stagnation in export figures is deceptive, as it is partly attributed to the increase in copper prices on the global market rather than a genuine stabilization in export volumes.

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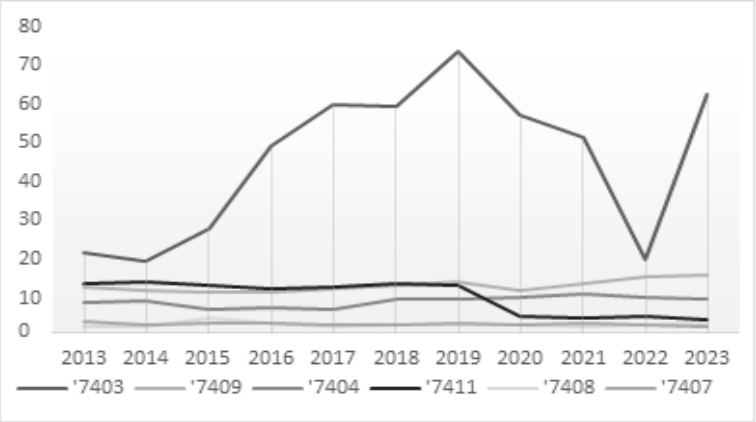
Figure 3. Export of copper products (thousand tonnes) 2014-2023



Source: author according ITC and Statistic service of RS

Exporting raw ore instead of processed copper products presents several significant challenges.

Firstly, raw ore exports generate lower revenue compared to processed copper products. The value-added nature of processed copper means that it commands higher prices and contributes more substantially to export earnings.

Secondly, focusing on raw ore exports, despite potentially high volumes, does not foster the development of more technologically advanced production activities. This lack of investment in processing infrastructure and advanced technologies can impede overall economic growth and industrial advancement.

Most critically, the accelerated exploitation of raw ore exacerbates the rate of resource depletion. For instance, the Čukaru Peki mine, which announced a production plan of 3.3 million tons of copper ore annually at the time of the company takeover, has total reserves of just under 37 million tons. This implies that the upper deposit will be depleted within approximately ten years. Meanwhile, the lower zone of the Čukaru Peki mine, which began exploitation in 2024, is expected to be exhausted in about 40 years. Rapid exploitation not only hastens the depletion of valuable resources but also reduces the long-term sustainability of mining operations.

3. Causes of deterioration of the export structure of the copper industry

To address the excessive export of raw materials and the deterioration of the copper industry's export structure, it's essential to identify the underlying causes. Several economic factors contribute to the export of raw ore rather than processed forms:

- Limited Domestic Processing Capacity: This may result from historical or current underinvestment in processing facilities and technology (Stiglitz, 2002; Sachs, 2006; Collier, 2007).
- Financial Constraints: Establishing and operating processing facilities might not be financially viable if the cost outweighs the potential profits from processed materials (Stiglitz, 2002; Rodrik, 2004).
- Labor Shortages: A lack of skilled workers for advanced industrial processing may stem from regional depopulation and insufficient training (Becker, 1993; Frogner, 2002; Moretti, 2012; Barnow et al., 2013; Shah & Burke, 2014).
- Trade Agreements and Tariffs: If tariffs or trade barriers make exporting processed goods more expensive, exporters may prefer raw materials (Krueger, 1997; Irwin, 2020).
- Speculative Trading: Anticipating future price increases might lead to exporting raw materials while prices are low (Gilbert, 2008).

A notable concern is that about 50% of Serbia's copper ore exports go to China (ITC, 2024), despite the high transport costs relative to ore prices. This suggests two primary issues:

1. Labour Shortage: The Eastern Serbian region, where the copper mines are located, faces significant depopulation, leading to a shortage of skilled labour. Despite increased wages and attempts to attract workers from other regions, the shortage persists, affecting the ability to process ore domestically.

2. Limited Production Capacity: The Copper Smelter and Refinery (TIR) currently processes only 400,000 tons of copper concentrate annually, while significantly more ore is extracted. The planned expansions and investments may improve capacity but are limited relative to the scale of production and depletion rates.

These factors collectively constrain the export of higher-processed copper products. To improve the export structure, efforts should focus on increasing the production and export of more processed copper products. This approach could enhance export revenues and stimulate economic activity in Eastern Serbia.

Understanding these constraints is crucial for developing effective policies to address the issues in Serbia's copper export structure. Policymakers should consider human resource and production capacity limitations when designing strategies to improve the industry's export performance.

3.1. Labor shortage in East Serbia

Depopulation in Serbia, often viewed through a national lens, is more accurately a regional issue, particularly in Eastern Serbia, where the copper mines are located. This region, including the towns of Bor and Majdanpek, faces severe depopulation with a population density below 25 inhabitants per square kilometres and a declining population rate of 10% to 15% annually (Arsenović & Nikitović, 2022; Statistical Service of RS).

The influx of investments aimed at boosting copper extraction has highlighted a significant labour shortage. Zijin Copper Serbia, which manages these operations, has struggled to find sufficient skilled workers since its acquisition of the mines. Despite increasing the workforce by approximately 1,600 employees to a total of 7,000 by the end of 2023, the company continues to face shortages in specialized fields such as electronics, mechanical engineering, and mining. Additionally, the shortage extends to lower-skilled roles, including machine operators, foundry workers, and civil engineers, which are scarce throughout Serbia (Ist Media, 2021).

Efforts to attract labour from other regions by offering higher wages, which have risen by 50% compared to the national average, have only partially alleviated the problem. Although these measures have led to a decrease in raw ore exports and an increase in copper product exports from $480 million to $770 million in 2023, the shortage remains a critical issue.

Considering the persistent labour shortage, Zijin is exploring the possibility of importing workers from less developed countries or China. As of late 2023, about 97% of the workforce comprises Serbian citizens, with around 200 Chinese workers. This ratio may change if domestic labour supply remains insufficient. Both relying on imported labour and continuing the export of unprocessed ore pose challenges for Serbia's broader economic health.

3.2. Limited production capacity

Limited production capacity can severely impact the ability to export higher-value processed goods. When industries cannot scale up production effectively, they may fail to meet international demand, resulting in lost market opportunities and diminished competitive advantage (Cohen & Klepper, 1996; Hansen & Turner, 2019; Schmidt & Wilhelm, 2020). This often forces companies to concentrate on domestic markets or lower-value exports, restricting their growth in global trade of more sophisticated products (Martin & Olney, 2021).

The Copper Smelter and Refinery (TIR) is a crucial part of Zijin Serbia, handling the processing of ore and concentrate from the copper mine. After flotation, the ore is transported to the TIR plant for further processing into the final product. Currently, TIR has the capacity to process 400,000 tons of copper concentrate annually (Zijin TIR, 2024), while about 1,200,000 tons of ore are exported. Although there is potential for capacity expansion, Chinese partners have pledged $3.8 billion for technical upgrades, expansion, and new metallurgical facilities. These improvements aim to boost smelter capacity to produce 180,000 tons of cathode copper and three to five tons of gold annually (Zijin TIR, 2024).

Despite these potential enhancements in processing capacity and human resources, the scale of these projects may still fall short compared to the overall depletion of the mine. To improve the copper export structure, it is essential to focus on specific product groups. By increasing the production and export of more processed copper, the reliance on exporting unprocessed ore can be reduced, leading to higher export revenues and better utilization of production capacities. This approach could also stimulate economic activity in Eastern Serbia.

Understanding the structural issues affecting copper exports requires a thorough analysis of production constraints. By identifying these limitations, policymakers can develop more effective strategies. Addressing constraints related to human resources and production capacities is crucial for formulating realistic and impactful economic policies, emphasizing the need to adapt development strategies to current limitations.

4. Identifying the comparative advantages of the products of the Serbian copper industry

The quantitative component of the research focuses on a detailed assessment of the export potential inherent in more complex copper products. The objective is to pinpoint specific products within the Serbian copper industry that hold the greatest promise for export growth. By identifying these products, policymakers can prioritize limited production and human capacities towards areas with the highest potential for success. This targeted approach allows for a more efficient allocation of resources, maximizing the impact of policy interventions and facilitating the sustainable development of the copper industry.

4.1. Methodology

The standard method for identifying products or groups of products with the highest international competitiveness is the Revealed Comparative Advantage (RCA) index. This index has been widely utilized in assessing the potential for increased exports of industrial goods, providing insights into a country's strengths and weaknesses in global trade (Balassa, 1986; Vollrath, 1991; Laursen, 2015). This index is applied to groups with a lower degree of aggregation, typically using 4-digit codes according to the Harmonized System (HS) of International Trade Centre (ITC, 2024). The RCA index is calculated as the ratio of the share of a certain group of products in the total export of the analysed country to the share of the world export of the same goods in the total world export, and is represented by the equation:

$$RCAsw = \frac{Xps/Xs}{Xpw/Xw} \qquad (1)$$

Where:

- Xps represents the export of Serbian products in group p;
- Xs represents the total export of Serbia;
- Xpw represents the world export of product p;
- Xw represents the total world exports.

A country is considered to have a comparative advantage if the index value is greater than 1. Therefore, further research focuses solely on these product groups

For data on world exports and Serbia's exports, the five-year average for the period 2019-2023 was used due to large annual fluctuations, as well as unusual values of certain product groups for 2020 and partially 2021, due to the Covid-19 pandemic.

To ensure the robustness of our analysis, we include an additional criterion focusing on the share of each product in total exports. This criterion is crucial because, while a product may exhibit a high RCA index, its overall impact on the country's export success is limited if it constitutes only a small portion of total exports. By incorporating this measure, we prioritize products that not only demonstrate comparative advantage but also contribute significantly to the export volume. This approach helps in identifying key products that can drive meaningful improvements in the Serbian copper industry's export performance. Hence, the export share criterion is essential for accurately assessing the potential impact of prioritizing certain products.

4.2. Results

The product group "Copper and articles thereof" (HS 74) constitutes approximately 2.5% of Serbia's total exports, positioning it ninth among export products. This is noteworthy, given that these products generally undergo minimal processing. As a result, a high coefficient of comparative advantage (RCA) was anticipated. This product group includes several subcategories based on the degree of processing, each with varying impacts and significance for exports. Serbia notably produces and exports copper rods and profiles (HS 7407), plates, sheets, and strips (HS 7409), copper pipes (HS 7411), and copper wire (HS 7408). However, significant imports are observed in the latter category.

Table 1 provides estimates for products within this group that meet two criteria: a) demonstrating significant competitive advantage in the global market, and b) holding a notable share in total exports. The data reflect a three-year average from 2021 to 2023.

Most copper products exported by Serbia show a significant RCA, indicating strong global competitiveness. However, copper wire (HS 7408), which was important before the breakup of the SFRY, no longer commands a substantial share of exports or competitive advantage. The product group "Bars, rods, and profiles" (HS 7407) demonstrates a noteworthy competitive advantage,

but its relatively small export value of approximately USD 18 million limits its potential for focusing scarce resources and capacities.

Table 1. Comparative advantage and share of copper products in Serbian exports

HS code	Product	Value ($ mill)	Share in total	RCA
7403	Copper, refined, unwrought	385.40	1.36	4.62
7409	Plates, sheets and strip	133.33	0.4	10.74
7404	Waste and scrap of copper	63.53	0.2	2.28
7411	Copper tubes and pipes	30.14	0.1	2.99
7407	Bars, rods and profiles	18.60	0.06	2.39
7408	Copper wire	18.93	0.06	0.64

Source: author calculation

The remaining four product groups, while exhibiting high RCA values, have disproportionately small export shares relative to their competitive advantages. These include refined copper (HS 7403), plates, sheets, and strips (HS 7409), and copper tubes and pipes (HS 7411). Waste and scrap of copper (HS 7404) was excluded from further consideration as it is a byproduct of the aforementioned products and does not warrant targeted investment.

Among these, refined copper (HS 7403) and plates, sheets, and strips (HS 7409) stand out as the most promising for enhancing Serbia's export structure. Copper tubes and pipes (HS 7411) also present potential for export improvement. These product groups should be prioritized for the allocation of limited production capacities, human resources, and planned investments (2025-2030). Although not the most processed, focusing on these products would provide a more favourable balance in Serbia’s copper export portfolio compared to raw copper ore exports.

5. Conclusion

The analysis of the deteriorated export structure of Serbia’s copper industry, marked by a shift from processed copper to raw ore exports, highlights two main issues: a significant shortage of skilled labour and insufficient processing capacity, exacerbated by increased exploitation under the new ownership of Bor Mines by Zijin Copper Serbia.

Resolving these issues fully within a reasonable timeframe is challenging. Depopulation in Eastern Serbia, where the copper deposits are located, contributes to the labour shortage. Efforts to attract workers from other regions of Serbia are underway, and in the future, importing labo8ur may be necessary.

In contrast, addressing the limited processing capacities presents a more promising solution. Initially, these capacities were adequate for the pre-acquisition level of exploitation. Moreover, increasing investment in processing infrastructure—both domestic and foreign—could help mitigate some negative impacts. Zijin Copper Serbia has also committed to further investments in processing. However, these planned improvements are insufficient to restore the previous export structure focused solely on processed products.

This research aims to find solutions to improve the copper export structure within the constraints of limited human capital. Quantitative analysis was conducted to identify copper products with the highest export potential and profitability. Using the Revealed Comparative Advantage (RCA) index, competitiveness of six copper product groups was assessed, including their share in total exports.

The analysis identified three products with the greatest potential for enhancing copper export quality: refined copper (HS7403), plates, sheets, and strips (HS7409), and copper tubes and pipes (HS7411). Concentrating existing processing capacities (currently limited to one smelter), human resources, and future increases in smelting capacity on these products could improve the balance between raw ore and processed copper exports. This targeted approach is likely to result in higher profits and better utilization of associated processing capacities, given the significantly higher value-added nature of these products compared to raw ore.

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