Global Forum on Steel Excess Capacity (GFSEC):

Impacts of global excess capacity on the health of GFSEC steel industries

March 2024

OECD Facilitator

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Summary:
This document presents GFSEC analysis on the impacts of global excess capacity on the health of GFSEC steel industries. It is based on research conducted in 2023, and reflects comments made on previous versions. An important aim of this paper is to assess the impacts of excess capacity on steel industry profitability. This is because steel firms need to be able to invest in physical capital, R&D, and advanced know-how (e.g., artificial intelligence and blockchain) to remain competitive. They also need to be profitable to make the necessary investments in low-carbon technologies. The paper also looks at the impacts of excess capacity on the capacity utilisation, exports and import penetration of other countries.

Acknowledgements: The report was funded through the financial contributions of GFSEC members.

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Executive summary

- **Non-market excess capacity is causing significant harm on the profitability and even the viability of GFSEC steel industries.** So long as the root causes of this excess capacity are not addressed (market-distorting subsidies, other government interventions, and weak market-based conditions), GFSEC steel industries will suffer from lower profitability than would otherwise be the case. This will lead to fewer resources to invest in R&D and sustainability for a healthier future.
- **Stock prices of steel companies also shed important light on profitability.** The results from stock returns reported here indicate that, as overcapacity peaked in 2015, European firms were hit especially hard during the initial phase of the excess capacity crisis. South Korea and Türkiye also suffered significantly. While excess capacity initially did not hurt Chinese steelmakers as much as steelmakers in European countries, starting in early 2019 Chinese stock prices have averaged more than 43% below forecasted values. Thus, the Chinese steel industry has suffered recently.
- **Excess capacity "crowds out" steel production in GFSEC member countries.** GFSEC steel producers lose significant domestic market share and their capacity utilisation rates fall due to the trade effects of global excess capacity. With carbon intensities of steel production lower in many GFSEC members compared to those in sources of excess capacity, this crowding out effect can have significant negative impacts on global emissions from the steel industry.
- **A focus on high value-added and green steel can help insulate companies from the negative impacts of global excess capacity.** A lesson from the Swedish and Japanese experiences is that mastering advanced technologies to reduce carbon footprints and to produce sophisticated products can help firms survive the onslaught that arises from excess steel capacity abroad.
- **There is a need to explore other impacts.** Excess capacity can also lead to job losses and other social impacts. Bankruptcies and idling of steel plants in GFSEC member countries are also tangible consequences of excess capacity that are worthy of further study. Future work could focus on ways to shelter the industry from these negative impacts.

1. Introduction

1. The global steel industry's capacity to produce steel has increased rapidly since the early 2000s. Most of the growth in steelmaking capacity has occurred in non-GFSEC economies that have industrialised rapidly. A common observation is that countries with large net imports of steel are eventually inclined to establish and expand their domestic steel industry, with the help of government. They do so in order to offset imports and to achieve self-sufficiency in steel production. Often, this is supported by a host of government interventions, including subsidies such as below-market financing to cover the investment costs of steel companies.

2. Because the capacity expansions are often non-market in nature, they do not necessarily reflect the true risks of success or failure of the relevant investment projects, and often lead to over-investment. When steel demand eventually slows, the over-investment reveals itself as steel prices plunge and steel companies incur losses. A common reaction is then to sustain unviable firms through other forms of subsidies, such as bailouts and cash grants. This keeps inefficient capacity in the marketplace that would otherwise shut down. When this happens, steel producers in the affected economies look to export markets to sell their surplus steel, driving down the prices and profitability of steel industries in all countries. These episodes of over-investment in the steel sector have subsequently led to recurring overcapacity crises, most recently the one that emerged in 2015.

3. This document presents GFSEC research focused on the impacts of excess capacity on international steel markets. It provides an overview of preliminary work by the Facilitator to assess the impacts of steel excess capacity on the health of steel industries of GFSEC members, a description of the data collected to carry out this and future research, and thoughts about possible avenues for future analysis.

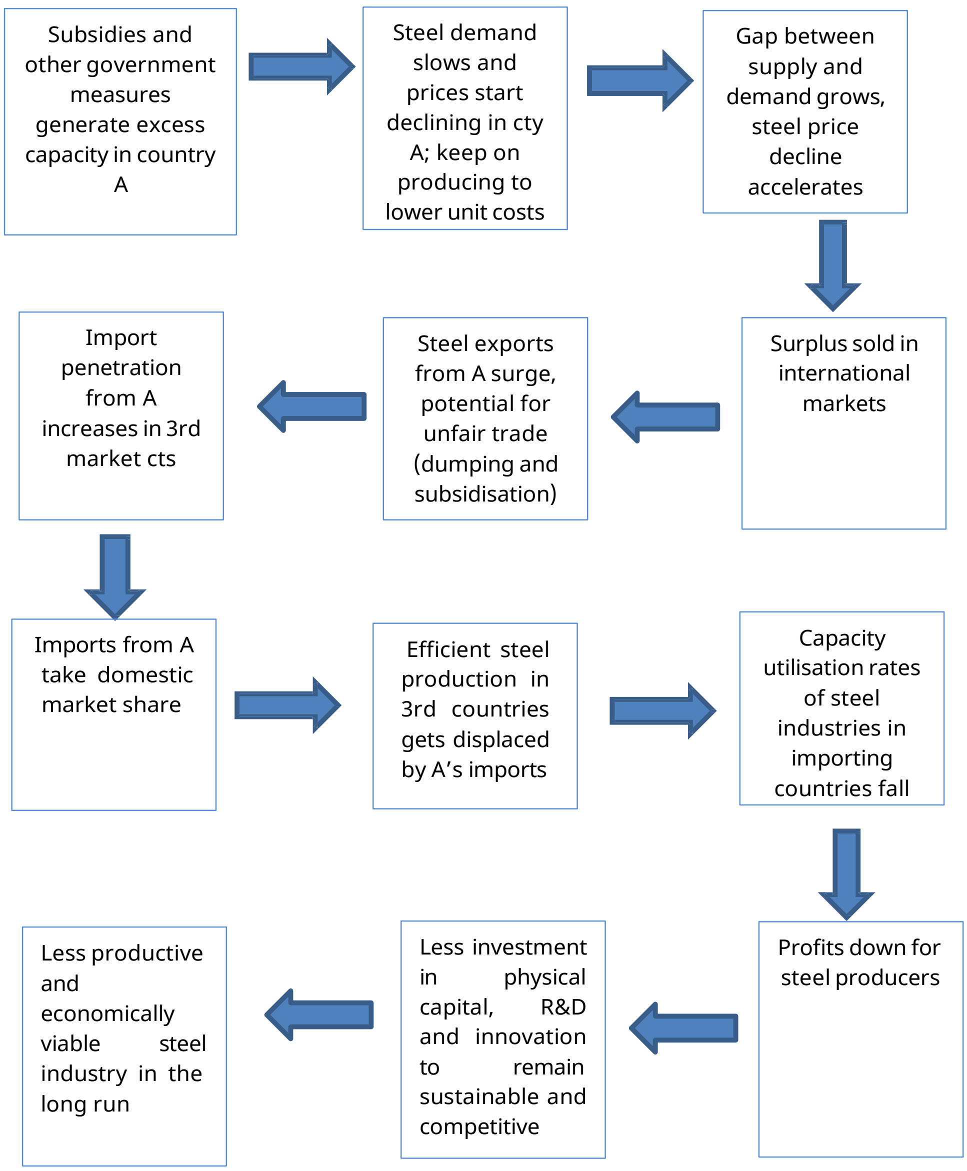
4. An important aim of this paper is to assess the impacts of excess capacity on steel industry profitability. This is because steel firms need to be able to invest in physical capital, R&D, and advanced know-how (e.g., artificial intelligence and blockchain) to remain competitive. They also need to be profitable to make the necessary investments in low-carbon technologies. The paper also looks at the impacts of excess capacity on the capacity utilisation, exports and import penetration of other countries.

2. The impacts of excess capacity: some lessons learned from the past

6. Excessive levels of steelmaking capacity have very negative impacts on the steel industry. History has shown that excess capacity is associated with surges in steel exports from countries that are the source of global excess capacity. This leads to over-supply of steel on international markets and depressed steel prices, as well as lower market shares and capacity utilisation rates for domestic steel producers in third countries that operate under market conditions. Moreover, the recent excess capacity crisis that emerged in 2015 also led to bankruptcies and localised job losses across the GFSEC's membership. Typically, no matter where the excess capacity sits, it always leads to lower profitability for steel producers everywhere. Figure 1 presents the stylised effects of non-market excess capacity in a given country on steel industries abroad.

7. The direct effect on profitability occurs through many channels. Two direct channels are through costs and prices. When excess capacity results in low capacity utilisation rates, this implies that economies of scale are not fully exploited and thus unit costs are higher. Excess capacity also leads to surplus steel searching for demand, thus depressing prices and often leading to dumping of steel products on international markets. The resulting higher costs and lower prices directly harm profitability. At the global level, the effects of excess capacity are transmitted through trade; as suggested by Figure 1, excess capacity can lead to export surges and market share losses for import-competing domestic producers. While not captured in the chart, non-market excess capacity and its impact on prices can also lead to producers engaging in price arbitrage. This flow chart thus does not capture all of the impacts of non-market excess capacity.

Figure 1. Simplified depiction of impacts of non-market excess capacity on third countries



Source: Facilitator's depiction.

8. The longer-term impacts on profitability are arguably more important, particularly by limiting resources available for innovation activities, advanced/skilled jobs, and other productivity-enhancing investments. Moreover, excess capacity means that scarce resources, such as labour, capital and raw materials, are being misallocated. In effect, governments that subsidise their industries or engage in behaviors that generate excess capacity are also encouraging resource allocation to potentially inefficient or unviable firms that would not otherwise be in the market. Previous OECD research from several years ago has shown that productivity developments in the steel sector have been weak relative to other industries, which may reflect weak market-based conditions or exit barriers that prevent a reallocation of resources to the most productive firms and hinder the growth prospects of more innovative firms[1].

3. Modelling the impacts of excess capacity

9. The GFSEC seeks to understand the impacts of excess capacity on international steel markets. This would involve modelling that looks in detail at the capacity growth of an exporting country which is experiencing rapid, market-distorting capacity growth. Key variables of interest include changes in domestic market share and export trends for importing countries. The data and analysis should highlight the global nature and the indirect impact of excess steel capacity on world markets, particularly for Global Forum members which are typically importing nations for steel.

10. When developing a modelling framework to assess the impacts of excess capacity, it is important to consider that excess capacity is inherently linked with *market-distorting government interventions* and weak market-based conditions. Indeed, fostering a level playing field, securing open and competitive markets, and ensuring a market-driven approach to resource allocation are crucial factors linked to excess capacity. As noted in the other substantive paper on exports, excess capacity is not simply a comparison of a country's capacity and production, or defined as a low capacity utilisation rate. A government that subsidises its steel industry heavily may see its industry enjoy a high utilisation rate, even though the plants producing that output would not be economically viable were it not for the special conditions, subsidies or support they received from the government.

11. At the same time, measuring excess capacity by the difference between capacity and demand may overlook a country's true comparative advantage that enables its steel industry to specialise in the export of certain steel products to meet demand abroad[2]. Indeed, some countries have capacity levels persistently in excess of local demand, reflecting this comparative advantage and not because of excess capacity per se.

[1] To truly understand a country's comparative advantage, it would be necessary to analyse the costs of raw materials, energy, and other inputs to steel production in each of the GFSEC countries and to compare these costs to export data.

[2] See Evaluating the Financial Health of the Steel Industry¸ available at: https://www.oecd.org/sti/ind/Evaluating-Financial-Health-Steel-Industry.pdf

Box 1. Data collected to estimate the impacts of excess capacity on steel markets

The Facilitator has collected a wealth of information to begin analysis of the impacts of excess capacity on the health of steel industries around the world. These series were taken from different sources, so additional efforts were required to achieve harmonization and matching in order to be used in empirical exercises. The details can be seen below.

International trade flows. Available information includes bilateral exports and imports flows at a detailed level of aggregation (World Harmonized System, HS 6-digit level) for the period 2000-2023, in tonnes and in US dollars. The main source corresponds to annual series from the United Nations Comtrade, complemented from 2016 onwards with bilateral HS6 steel international trade series from the International Steel Statistics Bureau (ISSB). In cases where observations were not available for a country-year pair, mirrored statistics from respective trading partners were used.

Exports and imports series were consolidated at steel products and subproducts levels, identified in turn through worldsteel HS-subproduct correspondence tables.

Series for bilateral export (import) unit values at HS6 were also computed when available as the ratio between tonnes and US dollars exported (imported). This series were aggregated at the subproduct level using as weights the corresponding total tonnage exported (imported). In order to reduce volatility in unit values, only the bilateral flows with non-zero values for the entire time period were considered.

Detailed steel production and apparent steel use. Annual and monthly series for production and apparent steel use of crude steel and finished steel products by country were obtained from worldsteel.

Capacity. Annual estimates of crude nominal steelmaking capacity at country levels provided by the OECD (OECD Steelmaking Capacity Database, 2000-2023)

Prices. The daily record of reference prices for flat and long steel products in the main trading of the world's largest steel producers was collected from the Platts platform.

Firm-level data. A panel for 46 steelmaking firms from 17 of the major steel producer countries ranging from 2005-2022 from the OECD's MAGIC database. This dataset contains information from the annual reports and consolidated financial statements for each of the firms as well as other variables of interest, such as the number of employees, credit rating, government grants and below-market borrowings, and government participation in the firm's ownership, among others.[2]

Time-series data. Daily records of stock returns for a sample of steel industry firms starting in September 1998, aggregated at a country level for a total of 14 countries, among them many of the main steelmaking economies. Data is obtained from the Datastream database.

Final datasets. Resulting datasets compile the different sources and perform a matching over product categories and countries. They comprise an aggregated country level panel dataset (72 countries over 2002-2022), a time-series dataset and a firm-level panel dataset (a cross section of steel firms over time).

[2] Annexes B and C clarify the list of variables used including the subsidies (grants and below-market borrowings) considered, comparing the levels between Chinese firms and the rest. At this time, the Facilitator does not have the detail of the corresponding granting authority and the end-use of the subsidies. However, please refer to Mercier, F. and L. Giua (2023), "Subsidies to the steel industry: Insights from the OECD data collection" (https://doi.org/10.1787/06e7c89b-en) for more detail on Chinese subsidies.

12. In this context, it is important to distinguish between *cyclical excess capacity*, for example episodes when a steel market downturn leads firms to idle their capacities while they wait for an upturn in the future, from *structural excess capacity*. Structural excess capacity is the excess that is driven by subsidisation that keeps inefficient or loss-making capacity in the market (which would normally exit under normal market conditions), or subsidies that lead firms to invest in new capacity that they normally would not invest in absent those subsidies, and weak market-based conditions. Subsidisation can include supports such as government grants to insolvent or ailing firms or lending by state banks at below-market rates to finance investments in new capacity. In both cases, the subsidies generate *non-market excess capacity*.

13. For these reasons, the Facilitator has deemed it important to make this distinction when analysing the impacts of excess capacity. In this preliminary work, the Facilitator examines the impacts of excess capacity from the major source of global excess capacity currently, i.e. China, on the health of the steel industry in other countries. To that end, the Facilitator has employed the OECD's MAGIC database, a panel dataset of 46 steelmaking firms (among which 20 are based in China). Data corresponds to extracts of the companies' annual reports and consolidated financial statements and includes subsidies received by firms in the form of direct grants and below-market financing[3] over the 2005 to 2022 time-period. The Facilitator has matched those firms with their capacity, using its own capacity database, for the purposes of the analysis here.

14. It is also important to consider that excess capacity in one country negatively impacts steel industries abroad through the *trade channel*. As suggested by Figure 1, excess capacity in one country is expected to impart negative effects on steel prices, leads to import penetration and market share losses for domestic steel industries abroad, and ultimately harms the profitability of all steel producers. Moreover, because subsidies, among other factors, are a key source of non-market excess capacity, the trade that occurs is often "unfair", in the sense that it can take the form of subsidised and/or dumped steel exports from the country which is the source of the excess capacity. In reality, the injury that domestic industries suffer as a consequence of the unfair imports goes beyond mere profitability effects, especially when it impacts steel workers and the economic fabric of local communities where the plants operate.

15. To model the impacts of excess capacity, it is proposed to use panel regressions. Panel regressions incorporate both cross-sectional elements (e.g. variables for a cross section of countries, steel industries or firms at a given point in time) as well as a time series dimension (observations over time). Panel regressions thus provide a much larger number of observations for enhanced robustness. Moreover, panel regressions allow for so- called "fixed effects" which control for the unobserved differences of the cross-sectional elements that do not vary over time. For example, when analysing the impacts of excess capacity on profitability at the firm level, factors such as managerial efficiency could theoretically impact profitability, yet no such data are available in the panel. To account for this challenge, panel regressions allow for fixed effects to control for time-invariant characteristics, such as managerial efficiency, that differ across firms but not over time. In addition, panel regressions allow for year fixed effects that take into account temporal shocks that may affect profitability in a similar manner across firms, for example fluctuations in the business cycle.

[3] For thorough understanding of the methodology employed in calculating below-market financing, please refer to (OECD, 2021[1]).

16. In addition to panel regressions, this paper also presents an analysis using daily stock prices of steel firms to corroborate the results obtained of the impacts of excess capacity on steel firms' profitability from the panel regression results. As will be shown later, comparing the results of this times series analysis with those from the panel regressions provides comfort because they point to the same impacts, i.e. that global excess capacity harms the profitability of steel firms everywhere.

17. In the panel regressions employed, the aim is to examine the effects of excess capacity (broken down into its cyclical and structural, or non-market, elements) on several dependent variables of interest, i.e. the profitability, capacity utilisation, import penetration (i.e., Chinese steel imports as a share of importing countries' domestic demand for steel) and steel exports from the importing countries. Panel regressions at the country and firm-levels are used to examine the effects of Chinese excess capacity on the key variables of interest. These regressions also include control variables; so, for example, when measuring the impacts of excess capacity on profitability, the prices of steel, the costs of production, and other variables that impact profitability are accounted for in the estimations.

18. Annexes A-C provide more details of the methodological approaches used together with a descriptive analysis of the panel datasets and a full list of the variables considered. The next section aims to provide a summary of the key results obtained from this very preliminary work.

4. Preliminary empirical results of the impacts of excess capacity

19. Table 1 below provides a summary of various panel regression estimations done by the Facilitator. The table suggests that Chinese excess capacity has significant and harmful impacts on the health of the steel industry in other countries. In particular, it seems to boost import penetration, lower capacity utilisation rates, and reduce the profitability of the industry in countries that are impacted by Chinese excess capacity. It appears to have few effects on the steel exports from the impacted countries. The latter effect is curious, as one would expect impacted countries to see a decline in steel exports as a result of global excess capacity. However, as steel imports from sources of excess capacity rise to meet local demand, domestic steel producers may export the steel that is no longer needed domestically, in order to keep production running at desired levels. Thus, the effects on exports are not certain *a priori*.

20. To review the impacts, the reader can look at the dependent variables listed in the top row (i.e., the steel industry variables of countries that are being impacted by Chinese excess capacity), and read down to see the impacts of the explanatory variables listed on the left. For example, the first dependent variable in Table 1 is import penetration, i.e. the share of Chinese steel imports in the importing country's domestic demand for steel. The results are shown in the first column, indicating highly positive and significant effects from Chinese structural excess capacity, as proxied by the two measures of subsidies. Thus, structural excess capacity in China is associated with higher import penetration in other countries with a high degree of confidence. Chinese steel demand is used to capture cyclical excess capacity. The parameter on this variable is negative and highly significant. Thus, when the Chinese steel industry experiences cyclical demand slowdowns, this increases import penetration of Chinese steel products in other markets, as one would expect.

21. Table 1 also shows the effects of interaction terms, i.e. subsidy measures multiplied by the cyclical demand measure. The purpose of interaction terms is to capture the joint effects of explanatory variables. The parameters on these interaction terms are negative and significant. In other words, when steel demand in China contracts (as it did in 2014 and 2015), then the impact of subsidies on import penetration will increase. That is, Chinese structural excess capacity leads to even more import penetration when the Chinese steel market goes through episodes of demand weakness, which is also a logical result. This could be an issue in the future, in view of the risks currently facing Chinese steel demand.

22. Table 1 also shows that some explanatory variables have no effects on the dependent variables (denoted by “Nil”). That is because, regardless of the sign of the coefficient, the estimated parameters were insignificant. Hence, it can be assumed that they have no effect.

23. The remainder of this section will comment on key results for different dependent variables. It first looks at the effects of excess capacity on profitability, then import penetration, followed by steel exports from countries impacted by Chinese excess capacity, and lastly on domestic capacity utilisation rates. Brief boxes listing the key empirical results will make some interpretations of the results.

Table 1. Impacts of excess capacity over a set of market variables

Signs of the coefficients obtained and degree of significance of the estimated parameters

	Aggregated panel (72 countries)			Firm-level panel (46 firms)		
	Chinese imports / Total domestic demand	Exports / Total production	Utilisation rate	Total revenue	EBITDA / Total revenue	Export revenue / Total revenue
Cash grants ratio	+	Nil	-	-	-	Nil
Below-market borrowings ratio	+	Nil	-	-	-	Nil
Chinese steel demand	-	Nil	+			
Cash grants ratio x Chinese steel demand	-	Nil	+			
Below-market borrowings ratio x Chinese steel demand	-	Nil	+			

Note: The cells indicate the sign of the coefficient corresponding to the impact of the variables in rows over the variables shown in columns. The colour scale reflects the degree of significance of the results obtained in the different specifications. For example, the darkest shade indicates that very significant results have been found in all the different estimations (greater than 1% confidence level), the lighter shades depict generally lower confidence levels across the model specifications, albeit very significant overall. No shading indicates that the parameters estimated were insignificant, thus are assumed not to have any effect on the dependent variable (denoted “Nil”).
Source: Facilitator calculations

4.1. Profitability

24. This section starts by commenting on the preliminary results of two methodological approaches to assess the impacts of excess capacity on the profitability of steel industries. The first approach uses panel regressions at the firm level, as explained above, to see the impacts on firms’ total revenues and EBITDA/total revenues ratio. To corroborate these panel regression results, a second and novel approach, based on time series data of stock

returns, is used to assess the impacts of excess capacity on profitability.[4] This latter approach compares actual stock prices of steel companies with forecasted prices during the period when the steel excess capacity crisis emerged. Stock prices that significantly underperform their predicted returns indicate a negative impact from excess capacity on profitability (Annex A also presents a methodological description of this approach).

4.1.1. Results of the panel regressions

25. As indicated in Figure 1, excess capacity is expected to reduce the profitability of the steel industry in importing countries, through its direct effects on prices and costs of production. Import surges in importing countries can displace local production and reduce utilisation rates of domestic producers operating under market conditions (these effects are reviewed later in this section). As presented in Table 1, in all model specifications, the subsidy proxies of structural excess capacity in China have highly negative and significant parameters (one per cent confidence level or higher). The impact of Chinese excess capacity is therefore clearly negative for other steel industries. Controls are also employed in the various model specifications, including costs of goods sold, total firm assets, total number of employees, local demand for steel, exchange rates, and steel prices.

Key empirical result 1. Chinese non-market excess capacity causes serious harm on the profitability of other steel industries

The panel regressions at firm level are unequivocal in their results. Non-market excess capacity has strong and significantly negative impacts on profitability. So long as the root causes of global excess capacity are not addressed, GFSEC steel industries will suffer from lower profitability than would otherwise be the case. This will lead to fewer resources available to invest in R&D, innovation and sustainability needed to ensure a healthier future for the steel industry.

4.1.2. Using stock price data to assess the impact of excess capacity on profitability

26. The strategy here is to use steel industry stock prices to investigate how the excess capacity crisis that emerged in 2015 has affected steel industry profitability.[3] Stock prices are useful for this task since finance theory indicates that stock prices are the expected present value of future cash flows. Black (1987, p. 113) noted that, "The sector-by-sector behaviour of stocks is useful in predicting sector-by-sector changes in output, profits, or investment. When stocks in a given sector go up, more often than not that sector will show a rise in sales, earnings, and outlays for plant and equipment." Croux and Reusens (2013) employed Granger causality tests in the frequency domain over the 1991Q1 to 2010Q2 period to test if stock prices predict economic activity. They reported that the slowly moving parts of stock prices have strong predictive power for future output. McMillan (2021) employed in-sample regression techniques in the time domain over the 1973Q1 to 2017Q4 period to test if stock prices predict activity. He found that stock prices are good predictors of activity in several countries. Thus, investigating the behaviour of steel stock

[3] In future work, we hope to also include information on profitability derived from financial statements and annual reports. One drawback with stock prices is that they are affected by factors other than profitability.

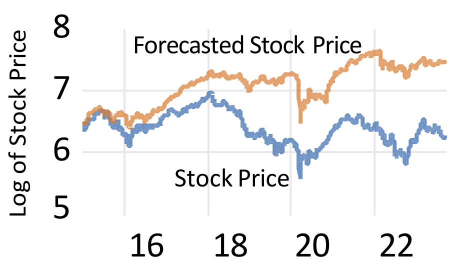
prices in the era of excess capacity can shed light on how steel industry profitability and output are being impacted.

27. The investigation of stock prices here covers not only actual steel stock prices but also predicted stock prices (see Annex A for the model). If steel stock prices fall far below their predicted values as excess capacity emerges, this indicates that excess capacity is harming profitability.

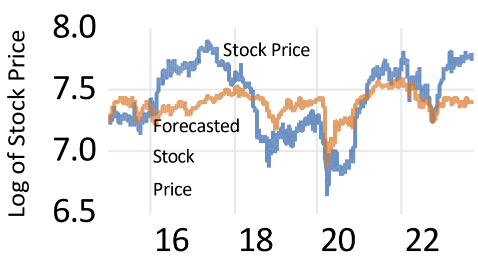
28. The model performs well, with a large share of the variation of stock returns explained by variation in the explanatory variables. Figure 2 below presents graphs for the actual and predicted stock returns between 1 January 2015 and 14 September 2023, across countries. Several items are worthy of note in Figure 2. One is that, between 1 January and 31 December 2015, several European countries performed the worst relative to predicted values. These include France, where prices were 85% below predicted values; Sweden, where prices were 69% below predicted values; the Netherlands, where prices were 60% below predicted values; Finland, where prices were 45% below predicted values; and Spain, where prices were 29% below predicted values. The other two underperformers in 2015 were South Korea, where prices were 41% below predicted values and Türkiye where prices were 29% below forecasted values. Thus, European firms were hit especially hard during the initial phase of the excess capacity crisis.

Figure 2. Actual and Predicted Steel Stock Prices

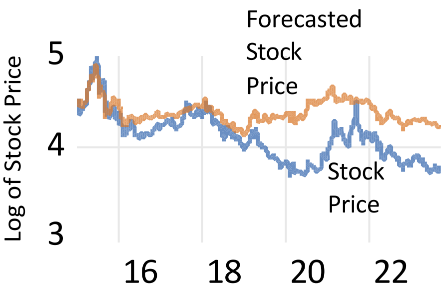
Daily stock prices beginning on 1 January 2015 until September 14 2023



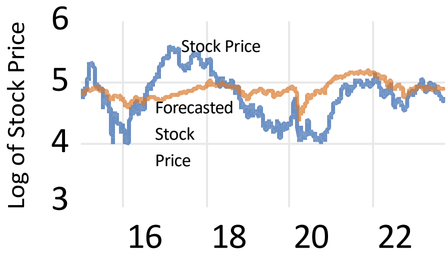
a) Austria



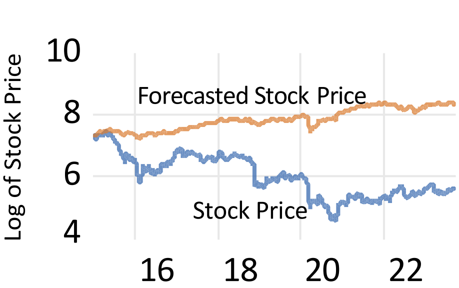
b) Belgium



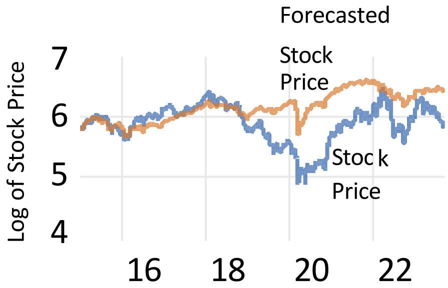
c) China



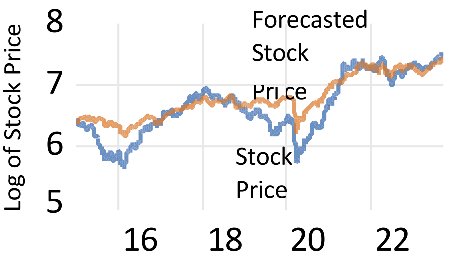
d) Finland



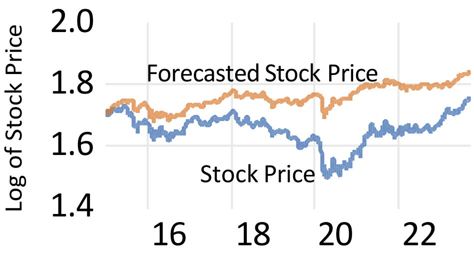
e) France



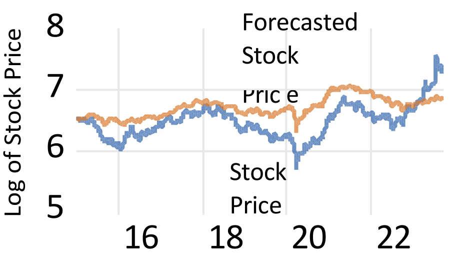
f) Germany



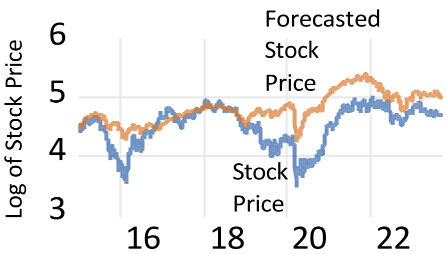
g) India



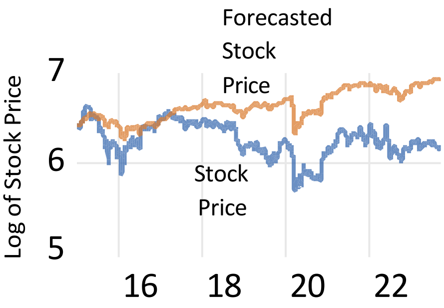
h) Japan



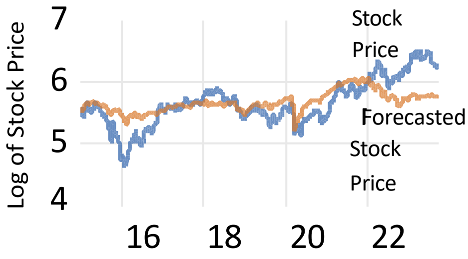
i) Korea



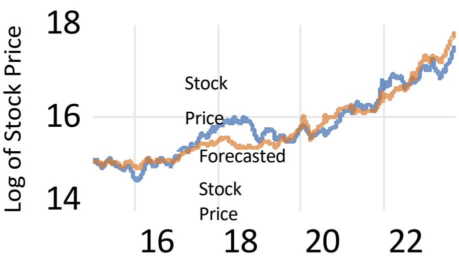
j) Netherlands



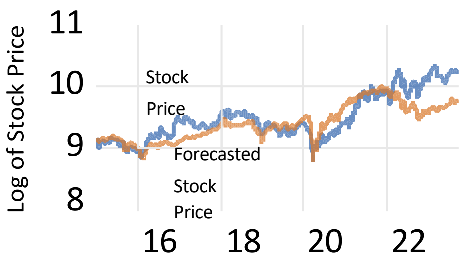
k) Spain



l) Sweden



m) Türkiye



n) U.S.

Note: The blue line represents actual steel stock prices and the orange line represents forecasted steel stock prices. Forecasted steel stock prices come from a regression of steel stock returns in a country on 1) the return on the country's aggregate, 2) the return on the world stock market, 3) the change in the log of the country's exchange rate, 4) the change in the log of the spot price of crude oil. For Japan, South Korea, Sweden and Türkiye, the real effective exchange rate is used. For India the nominal effective exchange rate is used. For Eurozone countries, China, and the U.S. exchange rates from the other two regions are used. For instance, for Eurozone countries the euro exchange rate relative to the Chinese renminbi and the U.S. dollar are used. For crude oil, the spot price for Dubai crude is used for Asian countries, the spot price of Brent crude for European countries, and the spot price of West Texas Intermediate crude for the U.S. The regressions are run over 14 September 1998 to 31 December 2014 period (or starting on the first data that data are available). Actual out-of-sample values of the right-hand side variables are then used to forecast stock prices (the orange line) over the 1 January 2015 to 14 September 2023 period.
Source: Author's calculations based on Datastream.

29. A second item to note is that steel stock prices for almost all countries rose beginning in the second half of 2020. This was a time when consumers during the pandemic increased their demand for goods including white goods, automobiles, bicycles, food cans, disinfectant aerosol cans, and other items that required steel. This contributed to the price of flat steel products more than doubling between June 2020 and August 2021. Steel makers across the world benefited.

30. A third item to note is that Chinese steelmakers performed almost as expected until the end of 2018. Thus, excess capacity initially did not hurt Chinese steelmakers as much as steelmakers in European countries. However, from 1 January 2019 until 14 September 2023, Chinese stock prices have averaged more than 43% below forecasted values. Thus, the Chinese steel industry has suffered recently. Trade measures, such as AD/CVD and safeguards as well as declining demand for steel may have also played a role.

31. A fourth item is that, except when the COVID-19 pandemic was depressing stock markets, Japanese steel stock prices remained on average within 10% of predicted values. Japanese steelmakers produce many high value-added steel products, and these make them relatively less exposed to excess capacity than steelmakers producing basic products.

32. A fifth item is that Swedish steel stock prices in September 2023 are outperforming predicted values by more than 50%. This notable deviation may be linked to the announcement by the Swedish company SSAB, indicating an advancement of their

decarbonisation plans by one investment cycle, shifting from 2045 to 2030. This strategic move positioned SSAB at the forefront of initiatives aimed at mitigating carbon emissions and acted as a revaluation factor for the company. Indeed, since early 2022 there have been several announcements of steel purchasers placing orders for green steel from SSAB where the higher cost of steelmaking is expected to be passed on to purchasers in the form of a green premium.

33. The results reported here indicate that, as overcapacity emerged in 2015, European steel producers initially suffered. Chinese steel producers have seriously underperformed beginning in 2019. Japanese steel producers have performed almost as expected. Swedish steel producers that have focused on reducing their carbon footprint are doing well in 2023.

4.2. Import penetration

34. Excess capacity can trigger significant trade disturbances, particularly during market downturns. As shown in Figure 1, excess capacity in China is expected to result in a surge in Chinese steel exports to third markets, thereby increasing their share of domestic-market demand in importing economies. The empirical results of the panel regressions support this assumption: the excess capacity variables (cyclical and structural) are positive and significant, after controlling for other factors that impact import penetration. That is, domestic producers (and/or exporters from third countries that ship steel products to this domestic market) lose market share and Chinese imports gain a larger portion of the domestic market.

Key empirical result 2. Domestic steel producers lose market share as a result of Chinese excess capacity

The regression results show that domestic steel producers in importing countries (or third country exporters that compete with Chinese steel producers) lose a share of domestic demand due to the trade implications of excess capacity.

4.3. Steel exports from countries impacted by global excess capacity

35. Excess capacity in China could have different effects on the steel exports of other countries. On the one hand, as steel imports from China rise to meet local demand (Key empirical result 3), domestic steel producers may export the steel that is no longer needed domestically, in order to keep production running at desired levels. On the other hand, those steel producers may also compete with Chinese exporters in third markets. China's excess capacity may crowd out the exports of those competing companies, and hence a negative effect might also be expected in these cases. However, if the affected country's exporters attempt to find markets with less competition from Chinese steel, this could support higher exports if the strategy is successful. Thus, the effect on exports is uncertain *a priori*.

36. The empirical results show that Chinese excess capacity has varying effects on the steel exports of other countries, that is, sometimes positive and sometimes negative, but the parameters are not significant in all the model specifications. Hence, one cannot say with sufficient confidence that Chinese exports have any effect on the exports of impacted country. Further work could be conducted at the country level to examine these effects further.

Key empirical result 3. The impact of Chinese excess capacity on other countries' steel exports is still inconclusive

The regression results show varying effects of Chinese excess capacity on the steel exports of other countries. This could reflect the export orientation of steel-producing countries, the sensitivity of domestic production to imports from China, and other factors that could be explored in further analysis.

Box 2. Does global excess capacity impact exchange rates?

Some countries have fixed exchange rates, others flexible exchange rates, but most have intermediate exchange rate regimes (Frankel, 2019[1]). For countries with fixed rate regimes, global steel excess capacity will not affect exchange rates. For countries with flexible exchange rates, any factor impacting demand and supply for domestic and foreign currencies will impact exchange rates.

Demand and supply are affected by both capital flows and flows of goods and services. Capital flows exert a major impact on exchange rates, driven by differing expected returns and risk characteristics of assets in different countries. Flows of goods and services also matter by impacting the current account.

Demand and supply of steel products is only one factor affecting the current account. Unless steel products weigh large in export and import baskets, their impact on exchange rates will be second order. This will be all the more true for countries with intermediate exchange rate regimes. The exchange rate is partly policy determined in these countries, and policymakers may offset the impact of steel trade to pursue desired exchange rate levels.

One indication of how global steel excess capacity may not exert first order impacts on exchange rates comes from China. As the excess capacity crisis emerged in 2015, China's steel exports soared. If steel exerted first-order effects on exchange rates, we would expect the surge in exports to cause the Chinese renminbi to appreciate. Between January 2015 and the middle of November 2023, the renminbi has depreciated 15% against the dollar. Thus, while steel trade is one factor impacting exchange rates, it may not be a crucial factor.

4.4. Domestic capacity utilisation rates

37. Chinese excess capacity appears to have displaced steel production in other countries in the past. This was observed during the initial phase of the Covid-19 pandemic, when production levels in China continued to increase rapidly, while GFSEC member countries saw their steel industries pull back on production in response to the severe market downturn.

38. The empirical results show very negative, and highly significant, effects from Chinese excess capacity on the domestic capacity utilisation rates of steel industries in other countries, after controlling for other relevant factors. The model specifications include controls for other factors that affect domestic capacity utilisation rates, including local steel demand, steel prices and exchange rates. All the excess capacity parameters are negative, and very significant.

Key empirical result 4. Chinese excess capacity "crowds out" steel production in GFSEC members, with possible environmental concerns

The regression results show clear negative effects of excess capacity on capacity utilisation rates of the steel industry of other countries. When this occurs, efficient steel producers in GFSEC countries see their steel production being crowded out by Chinese excess capacity. This can lead to localised job losses and bankruptcies. Moreover, with carbon intensities of steel production much lower in many GFSEC members as compared to China, this effect could lead to worse outcomes for the steel industry's greenhouse gas emissions, and other negative environmental outcomes. Further analyses of these effects could be conducted in the future.

Box 3. What would profitability and utilisation rates of the steel industry have looked like had Chinese excess capacity not surged like it did? A counterfactual exercise

The empirical analysis highlights significant adverse consequences of Chinese excess capacity on the global steel industry, mainly attributable to substantial government support for steel firms in China, i.e. a *structural* source of excess capacity. In times of declining demand for steel, the transfer of such funds tends to increase and cover the financial distress of the recipient companies (see Annex B for a comparison of cash grants and below-market borrowings differentiating between Chinese-based firms and other firms).

To better gauge the implications of the above empirical exercise, this box asks the question, *at what levels would profitability and capacity utilisation rates have been, had Chinese excess capacity not surged the way it did?* In other words, this box seeks to compare actual data on utilisation rates and profits over time (in the world excluding China) with hypothetical estimates resulting from a lower subsidy intensity to Chinese firms consistent with lower excess capacity. That is, in the counterfactual exercise, Chinese subsidy intensities remain at the level observed at the beginning of the period of examination (implying lower excess capacity), to see how the profitability and capacity utilisation rates in the rest of the world would have performed. Therefore, counterfactual average series of utilisation rates and profits were computed for a constant (lower) level of government support to Chinese firms over the entire period of analysis. In this way, the preliminary model results of this paper can be understood in different dimensions.

For simplicity, the 2005-2006 average for below-market borrowings (the primary source of government assistance), which accounted for an annual figure of 1.6% of average revenues for Chinese firms in that period, i.e. significantly lower than the 2016 peak of 5.2% (and still below the annual average of 0.3% obtained by other firms in the panel), was assumed to stay constant throughout the whole period of analysis in order to construct the hypothetical series.

Figure 3 below shows the comparison between the actual and hypothetical values for the variables mentioned. On the left chart, the actual capacity utilisation rate, computed as the share of crude steel production and crude capacity (in the world excluding China) is plotted against the hypothetical rate that assumes a constant level of subsidy intensity to Chinese firms at the level before China's excess capacity surged.

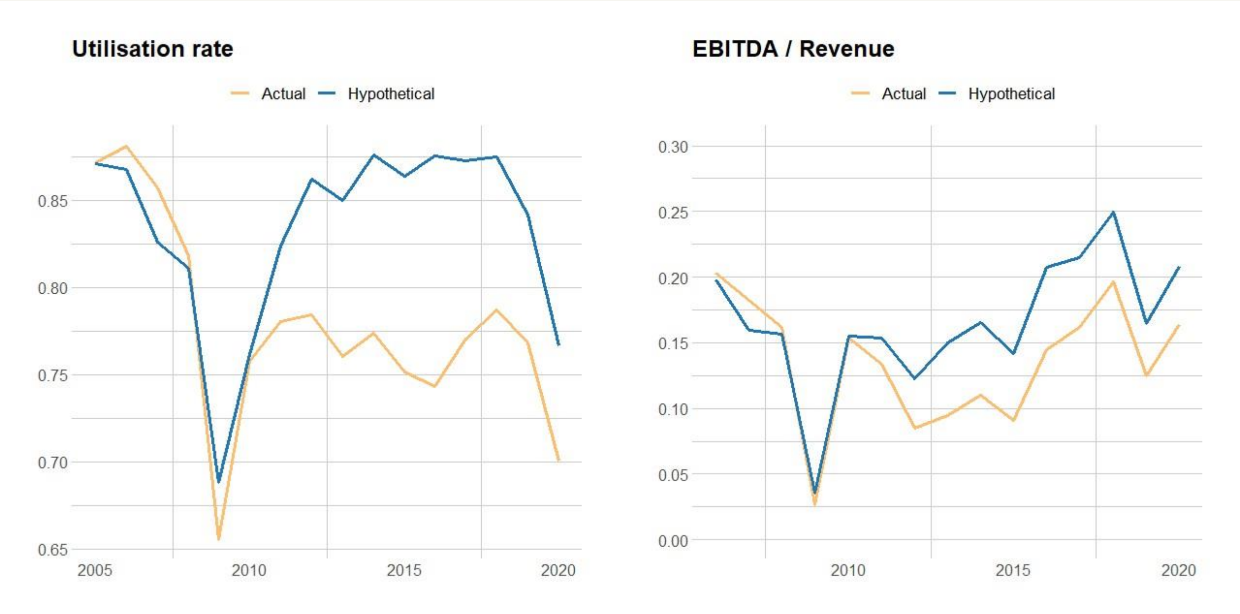
It can be observed that the actual average utilisation rate series (for the world excluding China) was above 85% in the period before the 2008/09 global financial and economic crisis. Following the financial shock, it rapidly declined to almost 65% and never fully recovered, remaining below 80%. Conversely, the hypothetical utilisation curve suggests that, had subsidies intensity remained constant for Chinese companies, utilisation levels in the rest of the world would have fully recovered by around 2013 from the drop observed during the global financial crisis.

Similarly, the right panel compares the actual average EBITDA/ total revenue ratio for non-Chinese firms with a hypothetical series that maintains a constant ratio of below-market borrowings to revenues for Chinese firms. The negative effect of Chinese subsidisation and the consequent impact on excess capacity is also evident by the disparity between the two series. In fact, profitability levels in the rest of the world would have been at much healthier, and sustainable, levels. Clearly, global excess capacity harms the steel industries of impacted countries.

Lastly, it is evident that, in both cases, the gap between the actual and hypothetical values widens around 2015-2016, a period characterised by peak subsidy levels for Chinese firms.

Figure 3. Actual versus hypothetical series

Global utilisation rates (left) and average profits (EBITDA as share of total revenues)



Note: The utilisation rate was computed as the cross-country average share of world crude steel production and crude capacity excluding China. The profits indicator (EBITDA / Revenue) corresponds to the annual average share computed for the sample of non-Chinese firms.

The predictions of the models that were found to be significant were used to construct the hypothetical curves. The specifications of the models consider for the corresponding control variables according to the methodology in Annex A. The calculation of hypothetical curves was done in two steps. First, the gap between the in-sample predictions and those arising for a constant level of subsidy intensity at 1.6% for below-market borrowings was obtained. Finally, the gap, in percentage points, was added to the actual data series.
Series end in 2020 in the charts above due to missing observations for some firms in the panel for the last two years (2021 and 2022) that distort the computation of averages.
Source: Facilitator calculations

These results are based on estimates of coefficients associated with the variables in the model and should be interpreted cautiously. They arise from partial equations that overlook second-order effects in supply and price conditions resulting from reduced subsidies to the Chinese steel industry.

5. Conclusions and next steps

39. Global excess capacity continues to increase. While some GFSEC members have employed have made use of existing tools (e.g., AD/CVD, safeguards) in recent years, the excess capacity problem continues to worsen. This highlights the need to address the root causes of excess capacity.

40. This paper analyses the effects of Chinese excess capacity of interest to delegations, including the impacts on their steel industries' profitability, capacity utilisation, exports and import penetration. The results of this very preliminary analysis show that global excess capacity has considerably harmful effects on the steel industries of GFSEC members. At the same time, this work also provides some positive takeaways; notably, the analysis of stock prices revealed that mastering advanced technologies to reduce carbon footprints and to produce sophisticated products can help firms survive the onslaught that arises from excess steel capacity abroad.

41. Avenues for future research could be to examine the impacts of excess capacity on the sector's employment, as well as other tangible factors such the idling or closures of steel plants in GFSEC member economies that are suffering from the impacts of global excess capacity. Further avenues of research could also exploit a recently developed trade remedy database to assess the extent to which importing countries resort to trade defense to address unfairly-traded imports resulting from excess capacity elsewhere.

42. In future work, we also hope to also include information on profitability derived from financial statements and annual reports. One drawback with stock prices as employed in this paper is that they are affected by factors other than profitability.

Annex A. Methodological Annex

43. This section presents the overall strategy to evaluate the impact of excess capacity over the steel market and describes how the different steps of the process fit together. Those steps and the methodologies underlying the different methodologies are detailed in the subsequent sections.

The impact of excess capacity over the steel market

Panel approach

44. In the case of the steel industry, excess capacity originated in some economies as a consequence of direct government intervention which, in an attempt to guarantee the domestic supply of steel at low prices for use in other industries, supported and financed investment projects to expand rapidly the steelmaking capacity of the country. This sometimes created a significant gap between demand requirements and productive capacity levels.

45. The resulting excess capacity had an impact not only on the domestic market but also on third markets mainly through the international trade channel. This promoted an increase in the exports of low-priced steel products, boosting, in turn, their share in foreign markets and harming profits in firms in other countries.

46. In this empirical exercise, the objective is to assess the impacts of excess capacity developments by looking at its effect on countries' trade flows and measures of the health of firms and steel markets. In this first stage, the aim is not to identify causal effects, i.e. provide an estimate of the actual causal direct and indirect effect of excess capacity in third markets, given that such assessments would require addressing all the potential sources of endogeneity in the relation of interest. Rather, the aim is to measure the aggregated total effects (causal or not) of excess capacity on third markets.

47. The first problem that arises when trying to estimate the effect of excess capacity is how to get a correct estimate for this variable. This is related to two different aspects, on the one hand, which countries to consider given that cycles of excess capacity started at different times for different countries, and secondly, how to measure excess capacity in a way that avoids common endogeneity problems in regressions.

48. To address the first aspect, the Chinese steel industry will be considered as a starting point. Given that it is the world's largest steel producer it should have a significant impact on third markets. In addition, the cycle of expansion of steel production capacity and the subsequent demand slowdown began in the early 2000s and continues today, which increases the observations in the identification strategy.

49. For the second aspect of measuring excess capacity, government subsidies to firms in the form of grants and below market borrowings will be used to try to capture the different sources of government support to firms. Indeed, Chinese government support was directly related to the investment of new capital equipment and capacity expansions, as well as direct cash grants used to compensate the losses and finance the high fixed costs of Chinese firms. In this way, these sources of government support are directly related to non-

market government interventions and excess steelmaking capacity and can hence be used to identify the effects on third markets.

50. Government subsidies are therefore used as a proxy for structural excess capacity given that a typical ratio of utilisation rates in China or the difference between crude steel capacity and domestic production or demand would create endogenous sources of variability in regressions, invalidating the results. However, it is important to note that there are other proxies for structural excess capacity, related to the extent to which the playing field is level, how competitive markets are, and whether market-driven approaches to resource allocation are in place.

51. This happens because excess capacity may create incentives for firms to increase production. When a firm operates with excess capacity its production is located at a suboptimal level in which marginal costs are below average costs. The firm can then increase production to decrease losses. This could potentially produce a co-movement between a variable measuring excess capacity such as the gap between capacity and demand and utilisation rates and other controls in the equation involving market variables such as output or demand, creating endogeneity. Therefore, the subsidies received by firms allow to better capture the effect of interest since they are not directly related to the firm's production strategy.

52. The effects of government grants and below market borrowings on selected third market variables will be evaluated using the aggregated and firms' datasets. Additionally, a time-series approach will be performed to study directly the impacts on profitability using high-frequency data.

53. Therefore, the equation to estimate at aggregate level for c (countries) and t (years) is the following:

Equation 1

$$Y_{ct} = \gamma EC_t + \mu D_t + \sigma(EC_t x D_t) + \varphi X_{ct} + \theta_c + v_{ct}$$

54. Where Y_{ct} corresponds to the third market variables: i) import penetration, measured as Chinese steel products imports as a share of domestic apparent crude steel use, ii) export orientation, measured as the share of steel products exports as a share of total domestic crude steel production, iii) utilisation rates, measured as firms total crude steel production as a share of nominal crude steel capacity[5].

55. EC_t denotes the two variables chosen as proxies of the excess capacity of China, namely cash grants and below-market borrowings measured in terms of total firm revenues. These variables correspond to the simple yearly aggregation of the Chinese firms' subsidies in the abovementioned firm panel dataset. These are 20 of the largest steel producers in China, in which the government has a significant share of the total ownership in many cases. By evaluating the impacts of EC_t one can capture the influence of non-market government interventions related to the Chinese excess capacity. The associated coefficient is expected to be positive for import penetration and exports, and negative for domestic utilisation rates.

56. D_t represents Chinese steel apparent use and the term $EC_t \, x \, D_t$ is an interaction effect that is used to capture the link between Chinese demand and excess capacity proxies. It could potentially capture a differential elasticity of grants and below-market borrowings for different levels of Chinese demand.

57. X_{ct} represents relevant covariates. In this case, different regressors are used based on the dependent variable. They include demand market variables (domestic apparent crude

[5] For the full list of variables used in the analysis please see Annex C.

steel use and world apparent crude steel use); bilateral exchange rates against China; and steel prices (average flat products prices for a set of major steelmaking economies).

58. θ_c corresponds to country fixed effects, v_{ct} is the error term and γ, μ and σ and φ are coefficients. The equation is estimated in natural logarithms; therefore, the coefficients can be interpreted as elasticities.

59. A similar equation is estimated using the firms' panel dataset:

Equation 2

$$Y_{fct} = \gamma EC_{fct} + \varphi X_{fct} + \theta_f + \theta_t + v_{fct}$$

60. Where Y_{fct} in this case corresponds to steel firms' variables in third markets: i) revenue, measured as total revenue from sales in USD millions, ii) EBITDA as a share of total revenue from sales, iii) export orientation, measured as revenue from export sales as a share of total revenue.

61. EC_{fct} is for this equation constructed so as to allow for variability at the firm and country levels as well through time. Corresponds to the difference between the aggregated subsample of Chinese firms' cash grants and below-market borrowings as a share of revenue received in the year and a third country firm f cash grants and below-market borrowings as share of revenue received in the same year. Similarly, as before, a positive gap between aggregated Chinese and third market subsidies will be indicating a stronger government support from Chinese firms that could be having negative effects on third markets. Annex B shows descriptive statistics comparing the average grants and below market borrowings received by firms based in China and the rest of firms.

62. X_{ct}, in turn, shows the relevant covariates at the firm level. Analogous to the previous case, different regressors were used depending on the regressing variable. They include firm level covariates: costs of the goods sold and firm assets, in USD millions, and the total number of employees. They also include previous used covariates for market demand, exchange rates and prices for the specifications that do not include firm or time fixed effects.

63. θ_f and θ_t corresponds to firm and time fixed effects and v_{fct} is the error term. This equation was estimated in both in logs and log-differences. The last one, commonly named first difference estimator in the literature, was used in some specifications to control for unobserved heterogeneity at the firm level when not considering firm fixed effects.

Time series approach

64. A time-series approach was performed to study directly the impacts on profits using high-frequency stock prices data.

65. To predict stock prices a four-factor macroeconomic model is used, where steel stock prices in a country depend on the return on the country's stock market, the return on the world stock market, the exchange rate, and the price of crude oil. There is a long tradition in finance of using the return on the country's aggregate stock market to capture the effect of a country's macroeconomic environment on stock returns (see, e.g., Brown and Warner, 1985, and Coutts et al., 1994). Analogously, the return on the world's aggregate stock market is used to capture the effect of the world's macroeconomic environment on stock returns. There is also a long tradition of capturing firms' exposure

to exchange rates (see, e.g., Bodner and Gentry, 1993). Oil prices also have a significant impact on stock prices for many sectors (see, e.g., Ready, 2018).

66. Chen et al. (1986), examining the relationship between portfolio stock returns and macroeconomic variables, argued that, to a first approximation, macroeconomic variables can be viewed as exogenous relative to individual portfolios. Therefore, the assumption made is that causality flows from the macroeconomic explanatory variables to the country steel industry portfolios and that any causality flowing in the other direction is second order.

Equation 3

$$\Delta R_{i,t} = \alpha_0 + \alpha_1 \Delta R_{m,i,t} + \alpha_2 \Delta R_{m,World,t} + \alpha_3 \Delta er_{i,t} + \alpha_4 Oil_t$$

67. Where $\Delta R_{i,t}$ is the daily stock return for the steel industry in country i, $\Delta R_{m,i,t}$is the change in the log of the price index for country i's aggregate stock market, $\Delta R_{m,World,t}$ is the change in the log of the price index for the world stock market, $er_{i,t}$ represents the change in the log of the exchange rate, and Oil_t represents the change in the log of crude oil prices.

68. To determine firms in each country that are in the steel industry Datastream uses the Refinitiv Business Classification method. This method begins with all listed companies in a country and then employs company filings, news articles, and other information to classify companies into their respective industries. Datastream also provides data on country aggregate stock returns, world aggregate stock returns, exchange rates, and crude oil prices. For exchange rates, when we can find data on the real effective exchange rate in Datastream we use these. This is the case for Japan, Korea, Sweden and Türkiye. For India we employ the nominal effective exchange rate. For Eurozone countries, China, and the U.S. we use exchange rates for the other two regions. For instance, for Eurozone countries we use the euro exchange rate relative to the Chinese renminbi and the U.S. dollar. The results do not appear to be sensitive to changes in the exchange rates used. For crude oil, we use spot prices for Dubai crude for Asian countries, Brent crude for European countries, and West Texas Intermediate crude for the U.S.

Annex B. Descriptive statistics

Descriptive statistics

69. In examining the primary descriptive statistics of the firm panel dataset for Chinese firms compared to those of other countries, several noteworthy elements emerge.

70. Chinese firms within the panel dataset, predominantly state-owned enterprises[6], received a notably higher average of subsidies compared to their counterparts (Table 3 Firm-level panel statistics). The primary source of financing was below-market borrowings, accounting for an annual average of 2.7% of total revenues (USD 465 million), significantly surpassing the 0.3% observed for other firms (USD 29 million). Conversely, direct government grants played a comparatively minor role.

71. The analysis of subsidy sources reveals a substantial increase in the amounts received by Chinese firms, particularly post-2010, peaking in 2016 at 6.5% of total revenue.

72. In addition, while various profit measures exhibit a robust co-movement between Chinese firms and their counterparts in other countries, an intriguing observation is the inverse correlation between subsidies and profits for Chinese firms. Specifically, subsidies increased during periods of profit decline, as depicted in Figure 4.

Table 2. Basic statistics. Aggregated panel (72 countries)

Variable	Variable name	mean	sd	min	3rd quartile	max
Exports / Total production	share_steel_exports	0.364	0.241	0	0.565	0.998
Chinese imports / Total domestic demand	market_share_china	0.046	0.065	0	0.06	0.402
Utilisation rate (production / capacity)	ut_rate	0.661	0.203	0.023	0.819	0.996

Note: The numbers in the table refer to the corresponding statistic computed at the year level.
Source: Facilitator's calculations

[6] Of the 19 Chinese companies in the panel in 2016, 13 had a government shareholding of more than 50% and only 4 had a government shareholding of less than 10%.

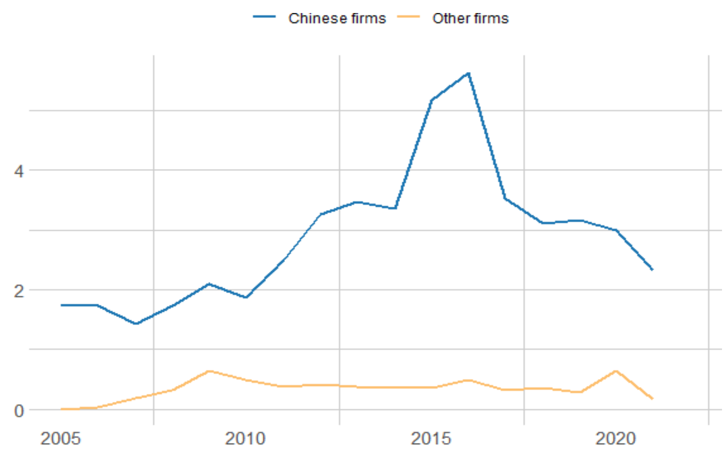
Table 3. Basic statistics. Firm-level panel (46 firms)

	Variable	Variable name	mean	sd	min	3rd quartile	max
Other firms (26)	EBITDA / Total revenue	ebitda_ratio	0.181	0.239	-0.581	0.228	3.434
	Export revenue / Total revenue	share_exports	0.337	0.485	0	0.598	0.86
	Cash grants ratio	grants_rev	0.001	0.003	0	0.00021	0.028
	Below-market borrowings ratio	BMB_rev	0.003	0.007	0	0.002	0.038
	Revenue (USD million)	revenue	19,299.63	19,559.74	350.38	22,954	124,936
	Cash grants (USD million)	grants	11.06	31.48	0	4.80	213.89
	Below-market borrowings (USD million)	BMB_imp	29.07	74.07	0	25.09	800
Chinese firms (20)	EBITDA / Total revenue	ebitda_ratio	0.103	0.054	-0.158	0.132	0.429
	Export revenue / Total revenue	share_exports	0.126	0.097	0.01	0.203	0.358
	Cash grants ratio	grants_rev	0.003	0.006	0	0.004	0.078
	Below-market borrowings ratio	BMB_rev	0.027	0.023	0	0.036	0.151
	Revenue (USD million)	revenue	15,276.56	16,319.56	177.474	20,526.60	150,761.61
	Cash grants (USD million)	grants	51.26	90.84	0	55.17	686.82
	Below-market borrowings (USD million)	BMB_imp	464.47	599.95	0	611.35	3,135.09

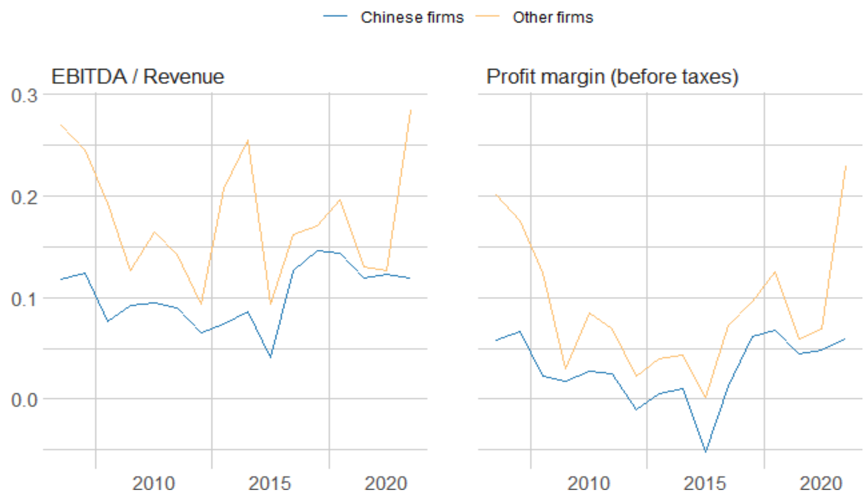
Note: The numbers in the table refer to the corresponding statistic computed at the year level.
Source: Facilitator calculations

Figure 4. Higher subsidies for Chinese firms

Evolution of government grants and Below-market-borrowings as a share of revenue for Chinese versus other firms



Different profit indicators for Chinese versus other firms



Source: Facilitator calculations based on OECD MAGIC Database

Annex C. Data sources

Table 4. List of variables used

Variable	Unit	Variable name	Dependent or explanatory variable	Source	Dimension	Dataset
Imports from CHN (crude steel equivalent)	tonnes	imports_chn	Explanatory	UN Comtrade, ISSB	Country	Aggregated panel
Apparent steel use (crude steel equivalent)	tonnes	asu	Explanatory	Worldsteel	Country	Aggregated panel
Global apparent steel use (crude steel equivalent)	tonnes	asu_world	Explanatory	Worldsteel	Global	Aggregated panel
Nominal crude steel capacity	tonnes	cap	Explanatory	Worldsteel	Country	Aggregated panel
Total production of crude steel	tonnes	prod_crude	Explanatory	Worldsteel	Country	Aggregated panel
Total exports (crude steel equivalent)	tonnes	exports_crude	Explanatory	Worldsteel	Country	Aggregated panel
Rebar prices in China	USD / tonne	price_rebar_china	Explanatory	Platts S&P Global	Country	Aggregated panel
Rebar prices (5 major steelmaking economies average)	USD / tonne	price_rebar_global	Explanatory	Platts S&P Global	Country	Aggregated panel
Flat prices in China	USD / tonne	price_flat_china	Explanatory	Platts S&P Global	Country	Aggregated panel
Flat prices (5 major steelmaking economies average)	USD / tonne	price_flat_global	Explanatory	Platts S&P Global	Country	Aggregated panel
Bilateral exchange rates	NCU / USD	CCUSMA02	Explanatory	OECD Main Economic Indicators	Country	Aggregated panel
Utilisation rate: (prod_crude / cap)	%	ut_rate	Dependent	UN Comtrade, ISSB	Country	Aggregated panel
Chinese market share in other economies: (imports_chn / asu) (crude steel equivalent)	%	market_share_china	Dependent	UN Comtrade, ISSB	Country	Aggregated panel
Exports of steel as a share of production: (exports_crude / prod_crude)	%	share_steel_exports	Dependent	UN Comtrade, ISSB	Country	Aggregated panel
Government grants, % of revenue	%	grants_rev	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Government grants	USD millions	grants	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Below-market borrowings	USD millions	BMB_imp	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Below-market borrowings, % of revenue	%	BMB_rev	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Total assets	USD millions	asset	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Cost of goods sold	USD millions	cogs	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Total equity	USD millions	equity	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Net income after tax	USD millions	inc_at	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Research and development spending	USD millions	r_d	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Total number of employees	number of people	staff	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Government-ownership category, from 1 (<10% govt ownership) to 4 (>=50% govt o	0-1	soe_cat	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel

% of government ownership (D = home-country govt; F = foreign govt), as of 2	%	soe_share	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Net profit margin	%	profit_margin	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Net profit margin, using profit before tax	%	profit_margin_bt	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Firm nominal crude steel capacity	tonnes	capacity_firm	Explanatory	OECD	Firm	Firm-level panel
Domestic sales revenue	USD millions	dom_revenue	Explanatory	OECD (MAGIC Database)	Firm	Firm-level panel
Sales revenue	USD millions	revenue	Dependent	OECD (MAGIC Database)	Firm	Firm-level panel
Exports revenue as a share of total revenue: (revenue-dom_revenue) / revenue	%	share_steel_exports	Dependent	OECD (MAGIC Database)	Firm	Firm-level panel
EBITDA (re-calculated by the OECD for consistency)	USD millions	ebitda_ca	Dependent	OECD (MAGIC Database)	Firm	Firm-level panel
EBITDA / Revenue	%	ebitda_ratio	Dependent	OECD (MAGIC Database)	Firm	Firm-level panel
Bilateral daily exchange rates	NCU / USD		Explanatory	Datastream	Country	Time-series
Crude oil prices (Dubai, Brent crude, and West Texas Intermediate)	USD per barrel		Explanatory	Datastream	Country	Time-series
Aggregate stock market price index	index		Explanatory	Datastream	Country	Time-series
World aggregate stock market price index	Index		Explanatory	Datastream	Global	Time-series
Daily stock return for the steel industry	%		Dependent	Datastream	Country	Time-series

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