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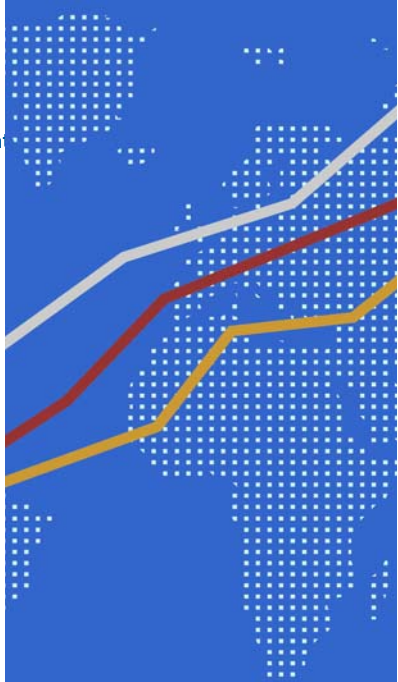

Strategic Trade Policy and Critical Raw Materials in Stainless Steel Production

Project Report

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Disclaimer

The following report was written as part of the project "Strategic Trade Policy and Critical Raw Materials in the Stainless Steel Sector" commissioned by the KMR Stainless AG, Mülheim an der Ruhr, Germany. The views expressed in this report are those of the authors and do not necessarily reflect those of the KMR Stainless AG.

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1 Introduction

Stainless steel is an ubiquitous feature of living in the 21st century: It is used to build machines, pipes, or cookware. It is applied in construction and transportation equipment or as a raw material used by modern sculptors. Its versatility and its advantageous technical properties, in particular its resistance to corrosion, have made stainless steel indispensable in our lives today. This is reflected by the growth of stainless steel production in the last decades. While only around one million metric tons were produced in the 1950s, more than 35 million tons were made in 2012.

In the domain of stainless steel, Europe is one of the most important regions worldwide: The European Union produces 21.1% of the worldwide stainless steel output, second only to China, which accounts for 45.5% of the worldwide production. For historical reasons, Europe, together with North America, also commands one of the largest stocks of stainless steel in the world, currently locked up in end-use sectors such as consumer hardware and process engineering equipment. Finally, European countries are large exporters of stainless steel scrap, a key input into stainless steel production. The EU was nevertheless a net importer of stainless steel scrap, at least up until 2012.

Despite its important role in terms of production, stock, and scrap exports of stainless steel, the EU has little access to domestic sources of the raw materials required to produce stainless steel. With the exception of scrap, it is dependent on international trade in order to bring the required inputs into stainless steel production to the production sites. This reliance on international trade for inputs has been put into sharp relief in the wake of moves in the last decade by a number of countries to erect export barriers on raw materials (Kim, 2010). There is now concern within the stainless steel sector in Europe that free access to international sources of the requisite raw materials through trade can no longer be taken for granted.

In light of the concerns about the introduction of export barriers in stainless steel inputs, a number of questions naturally arise: Which countries are imposing export restrictions and in what form? What could be the reasons for their introduction and are their consequences likely to be in line with the promoters' intentions? How are other players, such as the European Union, affected by these measures? And finally, what are the options for responding to these restrictions on free trade, and which options merit closer examination, if any? While these questions are of concern to each of the many inputs into stainless steel production, they are of particular relevance for the four most important raw materials used: Nickel, chromium, molybdenum, and stainless steel scrap.

The present study pursues three main objectives. Firstly, based on the modern theory of international trade, we want to provide a reasonably comprehensive survey of the various reasons that explain why nations might consider restricting their exports of raw materials. Secondly, on the empirical side this study aims to offer a thorough, country-by-country overview on measures impeding exports of the four key raw materials used to produce stainless steel. Thirdly, given the European position in markets for stainless steel and its inputs, we want to understand policy options available to the EU and to give some careful recommendations as to which of those appear favourable and which not.

Based on the modern theory of international trade, we are able to group countries into three main groups regarding their propensity to employ export restrictions. One group are highly diversified economies that are deeply integrated into the world economy. Despite potential market power over certain raw materials for stainless steel production, these countries typically abstain from using export restrictions in order to continue reaping the benefits of free trade. The second group are resource-rich, industrialising countries that have power in the international markets of one or more raw materials, but little comparative advantage in non-primary sectors such as manufacturing or services. These countries have an elevated propensity to exploit their market power and to erect export barriers, both in order to raise the world market price of their exports and in order to support growth in downstream industries. Finally, theory also highlights that developing countries may use some form of export restrictions even in the absence of market power for raw materials. In these cases, trade restrictions are the result of a combination of weak institutions and successful special interest policies at the domestic level. Concentrated and large sectors favour the emergence of special interest policies. In the presence of well-organised and concentrated downstream sectors that benefit from lower scrap prices, stainless steel scrap is likely to attract export restrictions when the scrap sector is dominated by small firms that lack the lobbying power of the sectors using the scrap.

Our empirical investigation yields, to our knowledge, the most comprehensive database of export restrictions currently applied on nickel, chromium, molybdenum, and stainless steel scrap. It covers export taxes, quotas, prohibitions, and licensing requirements in force between 2007 and 2012. The data includes measures applied by the most important producers of nickel, chrome, and molybdenum as well as information about restrictions on stainless scrap trade in more than 30 countries. The intransparent nature of export restrictions in many nations prevents us from claiming to have a complete dataset. Nevertheless, it is possible to derive some patterns and compare them to the theoretical predictions.

In line with theory, we find a limited number of key countries that account for most export restrictions on virgin materials used in stainless steel production. The most important one is China, which is a major producer of all four raw materials and restricts exports of all four. India is a key country for chromium and so is Zimbabwe. The South African government is currently discussing export tariffs on chromium ores and could join China, India and Zimbabwe. Additional key players are Indonesia and Russia for nickel. Russia's presence in this group is expected to be temporary, however, since it committed to abolishing its export barriers after joining the WTO in 2012. Also in line with theory, stainless steel scrap attracts export restrictions from a large number of nations, including many without any notable market power.

The Member States of the European Union looks at the emergence of export restrictions from the rare position of an important producer of stainless steel that has no major internal supplies of nickel, chrome, and molybdenum, but large supplies of stainless steel scrap. This position gives rise to a number of policy options in an increasingly restricted world market. Some of these options are already part of European raw material policies. Others are part of the current political discussion and additional options are likely to attract attention soon.

As a first step, European policy should aim to increase transparency on trade restrictions and to lower transaction costs to raw material importers. This would mean setting up a comprehensive database that contains regularly updated information on currently enacted and upcoming export restrictions. It should also consider abolishing import restrictions on chrome and molybdenum which are still in force.

As a second step, policy should consider whether public investments in research and development aimed at increasing resource efficiency are adequate. Similarly, obstacles to increasing recycling rates should be carefully examined with a view towards raising the sustainability of resources use. While less effective as short-run measures, both lower the incentives for introducing export restrictions in the long run by increasing the demand elasticity for inputs.

On a more short-term basis, Europe should continue to use the possibilities that the WTO process offers in order to enforce compliance with international agreements. WTO regulation on export restrictions is generally weak. However, some countries, including China, committed to lowering or abolishing export restrictions when joining the WTO. Such commitments offer important reference points for international negotiations.

Retaliatory tariffs are not a recommended policy option. Due to the trade pattern of imports and exports of raw materials, such actions are mostly likely to hit, if any, predominantly uninvolved third countries while being ineffective towards most of the key countries. In addition, these options come with the danger of causing harmful trade wars.

In the long run, the EU seems best advised to strive towards a multilateral agreement covering export restrictions or towards including them in the WTO regulations (as discussed by WTO's Director-General Pascal Lamy in 2011, see Lamy, 2011). Such an agreement can help abolishing welfare reducing trade restrictions without shifting burdens on third countries. Bilateral agreements can be used as a transitional solution.

The study proceeds as follows. Chapter 2 gives an overview over stainless steel and its markets. Chapter 3 provides some background on the shape and nature of various export restrictions and reports on the recent literature on the topic. In chapter 4, the economic effects of export restrictions are discussed, relying on the diagram-based analysis of trade theory. A comprehensive overview of the reasons for implementing export restrictions is provided in chapter 5. Chapter 6 displays export restrictions for the most important raw materials used in stainless steel production: Nickel, chrome, molybdenum, and stainless scrap. Chapter 7 outlines the background relevant for European policy. Policy options are discussed in chapter 8. Chapter 9 concludes.

2 Stainless Steel and its Inputs

2.1 Stainless Steel

Stainless steel is an iron-based alloy. It must not consist of more than 2.1% carbon to be classified as steel and must contain at least 10.5% chromium to be stainless. A number of other elements are added to stainless steel depending on its application. The most important alloying elements are nickel, molybdenum, titanium or niobium (sometimes called columbium). There are more than 100 grades of stainless steel available.

The most important property of stainless steel is its higher resistance to corrosion compared to conventional carbon steel and, in fact, many other metals. Stainless steel is not a very good electric conductor. Some types are magnetic, while others are not. Stainless steel is produced in electric arc furnaces using either scrap metal or virgin raw materials or a mixture thereof.

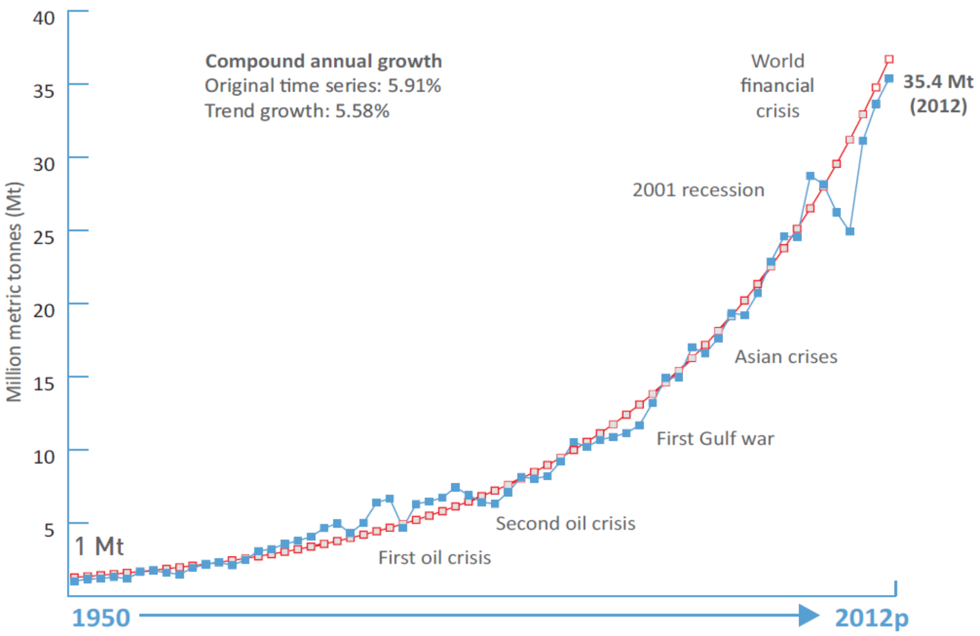

Figure 1: Growth of stainless steel demand 1950-2012
Source: International Stainless Steel Forum (2013)

There are many possible applications for stainless steel products including industrial machinery, construction, household appliances, transportations or art. Its durability and its appealing looks are appreciated in these applications. Demand for stainless steel has grown strongly since the 1950's. Production expanded from about one million tons in 1950 to 35.4 million tons in 2012 (see Figure 1).

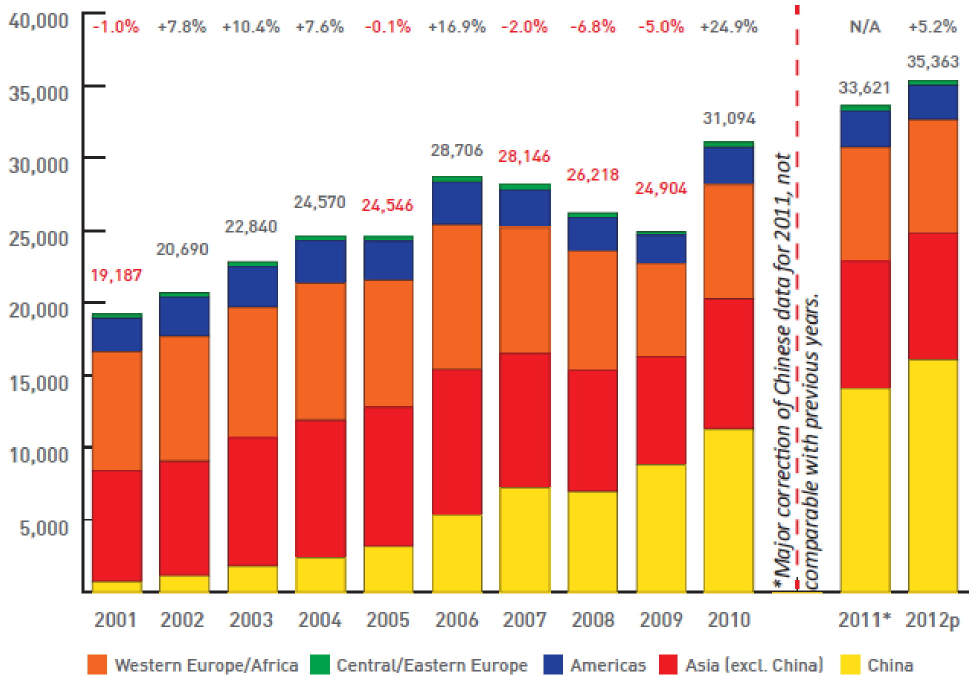

Figure 2: Stainless steel production per region in 1000 tons
Source: International Stainless Steel Forum (2013)

The location of stainless steel production has shifted dramatically from OECD countries to China in the last ten years. Figure 2 displays this development. Worldwide stainless steel production grew from 24.5 million tons in 2005 to 35.4 million tons in 2012. Chinese output alone increased from 3.2 to 16.1 million tons.[1] This corresponds to an increase in the share of world production from 12.9% in 2005 to 45.5% in 2012. Considering the six major regions displayed in Figure 2, only China and India were able to expand their production in absolute terms. While Indian output grew by 26%, Chinese stainless steel production is more than 4 times larger than it was in 2005. Similar develop-

[1] Note that major revisions in Chinese data in 2011 limit the comparability.

ments can be found for the Chinese production of other base metals as well (Stürmer & von Hagen, 2012).

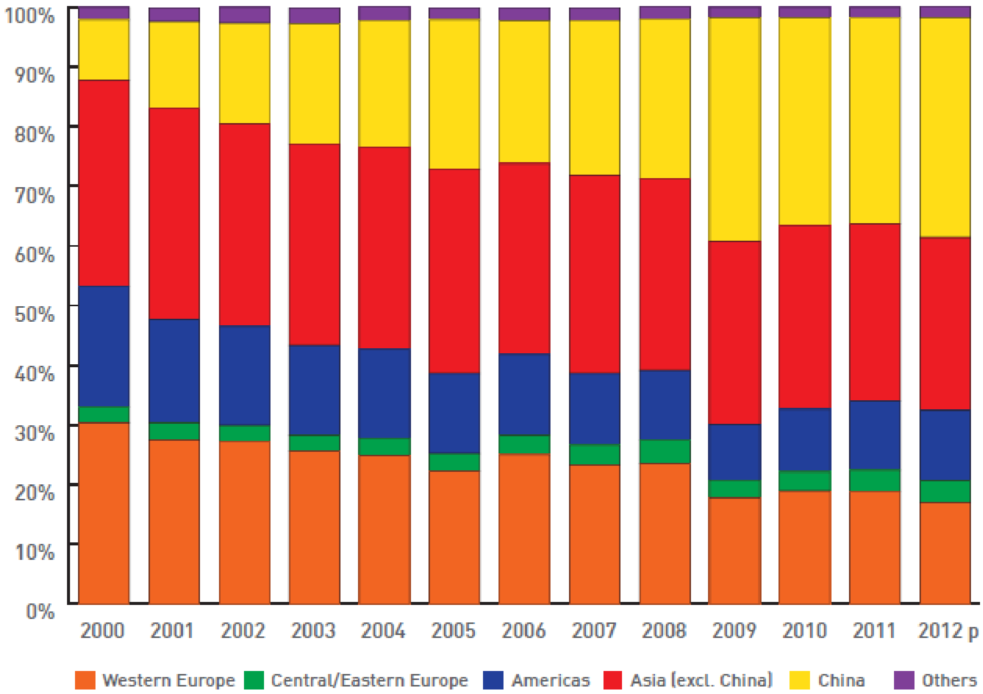

Figure 3: Shares of worldwide stainless steel consumption from 2000 to 2012
Source: International Stainless Steel Forum (2013)

China also increased its demand for stainless steel over time. While about 10% of worldwide consumption took place in China in 2000, roughly 35% of demand in 2012 was Chinese. The country is still a net exporter of stainless steel, though. Today, Asian nations are the most important consumers of stainless steel. About 65% of the demand comes from Asia.

In the following we focus on the four, in monetary terms, most important raw materials used in stainless steel production. Nickel, chromium, molybdenum and stainless steel scrap.

2.2 Nickel

The first metal investigated in our report is nickel, the 28th element in the periodic table. It is a lustrous, silvery white metal exhibiting ferromagnetic properties at room temperature. It is mostly applied in stainless steel production, which makes up about two thirds of its use, and other alloys such as superalloys needed in aerospace industry. Further applications include the production of various chemicals and coins.

Nickel’s most important role in stainless steel production is to allow the steel to form an austenitic crystal structure. Pure Iron is only able to form austenitic structures at high temperatures above 700 °C. Adding nickel decreases this temperature below room temperature. When added to stainless steels, it also increases the heat resistance and the resistance towards non-oxidising acids. While nickel only makes up about 8.2 % of the average ton of stainless steel, it accounts for more than 75 % of its raw material costs (Posch, 2011). This number changes with nickel prices, but can be seen as a rule of thumb for nickel’s importance for stainless steel’s production costs.

Primary nickel can be distinguished into two groups of products, class I and class II nickel. Class I nickel includes materials containing more than 99 % nickel. Often its purity is higher than 99.8 %, a grade at which it could be traded at the London Metal Exchange (LME). Class II materials contain less nickel. The most important class II product is ferronickel. It consists of varying degrees of the metal, ranging widely between 20 and 98 %, with the rest made up by iron and 1 to 2 % impurities. A second important class II material is nickel oxide sinter. It exhibits higher degrees of nickel, usually between 75 and 90 %, plus impurities including iron. Class II nickel is dominantly employed in stainless steel production, while pure nickel is also used in other applications which need high purities of the metal (Clow, 1992).

A comparably new form of (class II) nickel used in stainless steel production is nickel pig iron (NPI). NPI is basically a low quality ferronickel, almost exclusively produced and used in China. It is won from low grade ores originating from Indonesia and the Philippines, which are transported to China without further processing and then converted into NPI using pyrometallurgical processes. Originally produced in phased out blast furnaces for pig iron production, most NPI is now processed in electric arc furnaces, which exhibit lower costs and are less polluting (Burns, 2011; Cartman, 2012; Widmer, 2009). Production costs of nickel pig iron vary between 14.000 and 22.000 US$ per ton of nickel equivalent, making it competitive even at today’s relatively low nickel prices. In addition, capital costs are low (Lennon, 2013). The cost level is, however, highly dependent on the availability of cheap ores and energy.

Annual production and consumption of nickel has grown significantly in the last ten years. Mine production rose from 1.25 million tons in 2002 to 2.16 million tons in 2012 (see Figure 4).

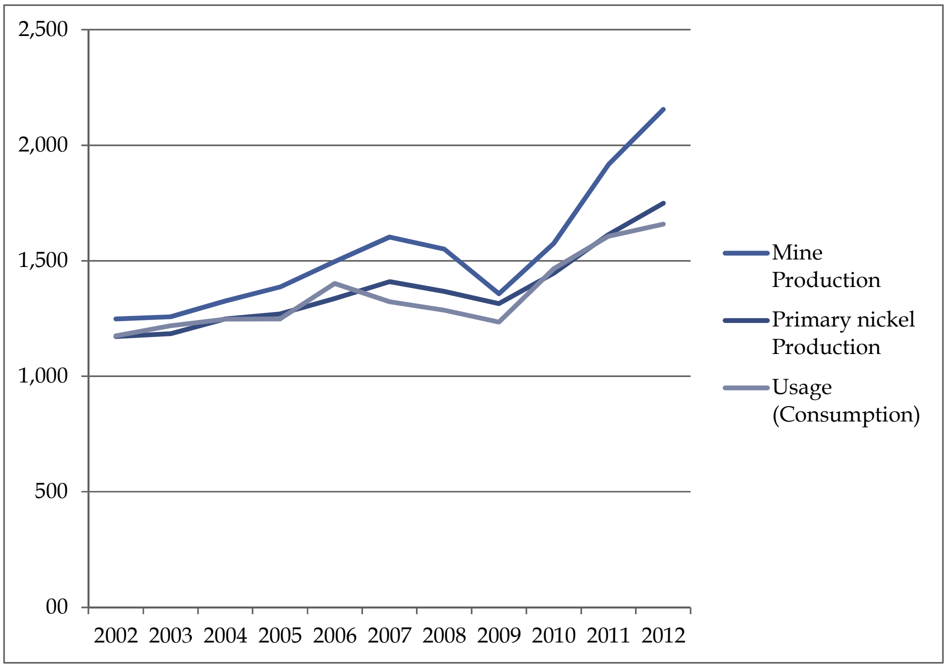

Figure 4: Nickel Production and consumption in 1000 tons
Source: International Nickel Study Group (2013)

Nickel prices exhibited four phases since 2006. The first phase was a strong price increase, resulting in a maximum price of more than 50,000 USD per ton of nickel in early 2007. Thereafter, prices have declined steadily until they reached a level of about 10,000 US$ per ton. From early 2009 until early 2011, the market recovered up to a level of about 30,000 US$ per ton. Since then, the trend is slightly decreasing again.

Figure 5: Nickel prices in US$ per ton
Source: LME

The U.S. Geological Survey (2013a) estimated worldwide nickel reserves, i.e. the deposits which are known with sufficient precision and which can be mined at current price levels, of around 75 million tons. Therefore, the extraction levels of today could theoretically be sustained for about 34 years. Note that these 34 years and the size of the reserves can only give a very rough impression about the long-term availability of a natural resource. In the short run, other factors such as capacity constraints, demand growth, political stability of supplying countries and, not least, export barriers are more important than the size of the reserves. See Finkbeiner (Finkbeiner, 2012) for an analysis of these aspects.

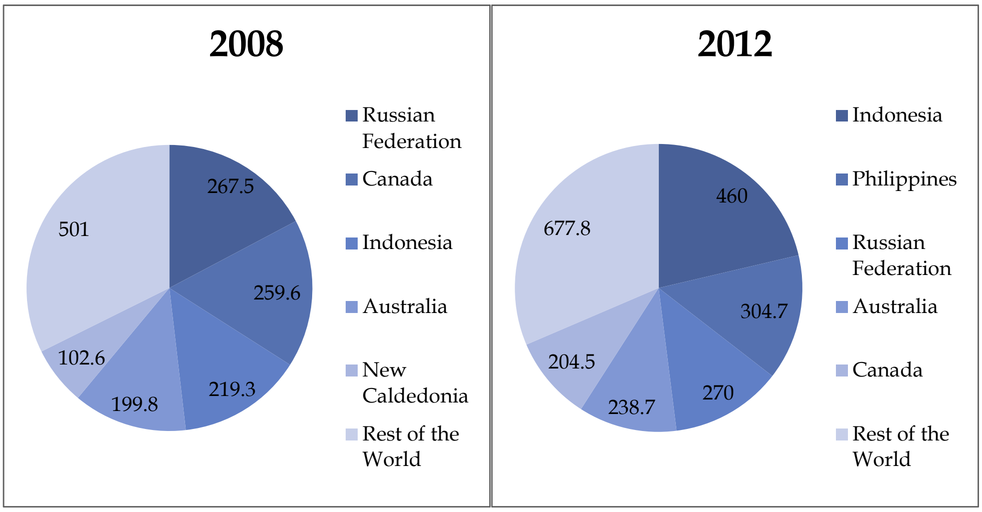

Figure 6: Mine Production of Nickel in 2008 and 2012 in 1000 t
Source: International Nickel Study Group (2013)

In 2008, Russia was the biggest country in terms of ore production with 267.500 tons of Nickel mined. Among the five most important producers were three developed countries: Canada, Australia, and New Caledonia, which is a French special collectivity. Four years later, the pattern has changed considerably. Indonesia and the Philippines are the most and third most important nations mining nickel ores. Indonesia doubled its production from 2008 to 2012, while the Philippines more than tripled it. This particularly reflects the Chinese demand for ores to produce NPI.

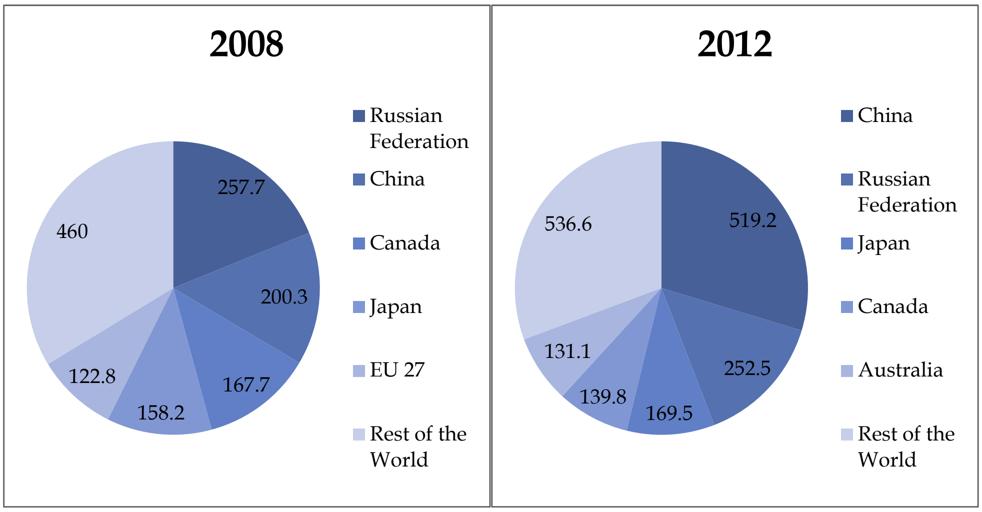

Figure 7: Production of Primary Nickel in 2008 and 2012 in 1000 t
Source: International Nickel Study Group (2013)

As can be seen in Figure 7, Russia processes similar amounts of nickel into primary products than it does mine. China is a major producer of primary nickel as well, receiving its ores and intermediates mostly from Indonesia and the Philippines, and to a lesser degree from Australia. Japan relies mostly on imports from New Caledonia, Indonesia and the Philippines for its primary production. In the EU, the sources of intermediate production are more diversified. However, a large share of its inputs comes from Canada. Canada and Australia also refine a notable amount of their ores themselves. The most important development in primary nickel production is the expansion of Chinese production, which doubled from 2008 to 2012.

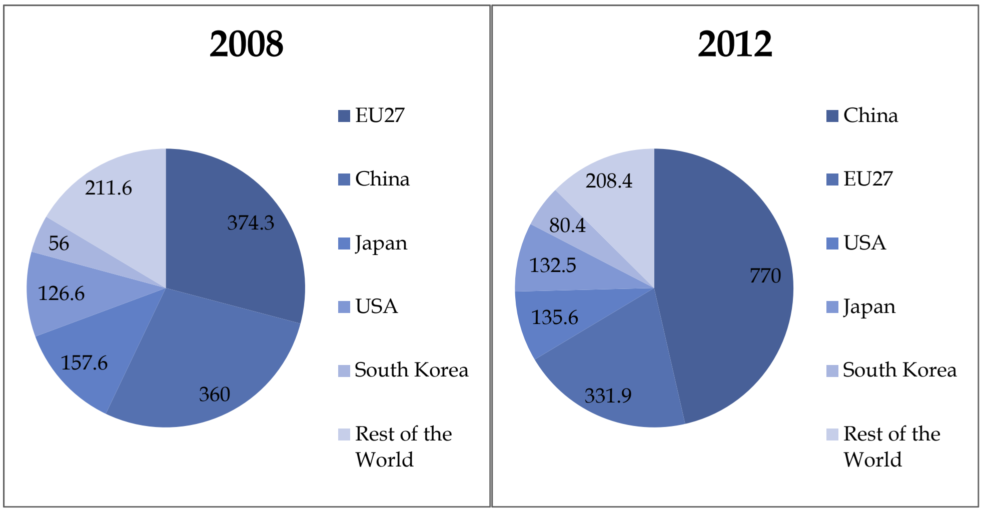

Figure 8: Nickel Consumption in 2008 and 2012 in 1000 t
Source: International Nickel Study Group (2013)

In 2008, most nickel consumption took place in Europe. The EU27 accounted for the largest share of use, with Germany and Italy being the most important countries therein. China was the second biggest nickel consumer, with Japan, the US, and South Korea following. Until 2012, a large shift occurred. China now accounts for about 770.000 tons of Nickel consumptions, which corresponds to a share of about 46 % of worldwide consumption. These numbers are highly correlated with stainless steel production trends.

2.3 Chromium

The second input into stainless steel production investigated in this study is chromium, the 24th element in the periodic table. It is a steely-grey, lustrous, hard and brittle metal. When exposed to air, it forms a thin layer of oxide protecting it from further corrosion. Many of its compounds show intensive colouring, which gave the element the name. Chromium is derived from the Greek word chroma (χρῶμα) meaning colour.

Chromium is the element in stainless steel which makes it stainless in the first place. Stainless steel by definition contains at least 10.5 % of chromium. It also forms the above mentioned protective layer when it’s added to steel. Besides that, it increases the steel’s hardness.

Metallurgical uses, including stainless steel production and nickel-based superalloys are by far the most important application of chromium, using about 90% of the worldwide production. Other applications include pigments, chemicals used in leather tanning or wood preservatives.

Chromium is added to stainless steels as ferrochrome. Pure chromium metal is not used in steelmaking due to high costs. Both pure metal and ferrochrome are produced from one type of ore: Chromite. It is a mineral containing mostly chromium, oxygen, and iron, but also aluminium and magnesium. Chromite is extracted both in open pit and underground mines. Ferrochrome is produced from the ore in a highly electricity-intensive process using electric arc furnaces and coal or coke as a reduction agent (International Chromium Development Association, 2011).

Production of chromium displayed an increasing trend over the last 10 years. It grew from about 12 million tons in 2011 to 25 million tons in 2011. With the exception of 2009, the trend was rather linear. Note that the mine production is measured in gross weight of the chromite ores not in chromium content.

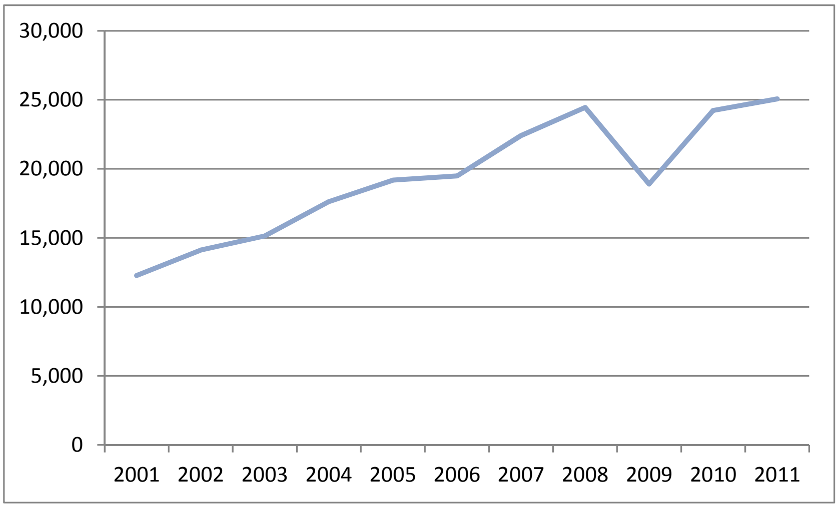

Figure 9: Annual production of chromium in 1000 tons
Source: International Chromium Development Association (2012)

Prices of ferrochrome are rather flat for most of the time between 2006 and 2013. There was, however, a large price spike in 2008, which was seen for many other metals well.

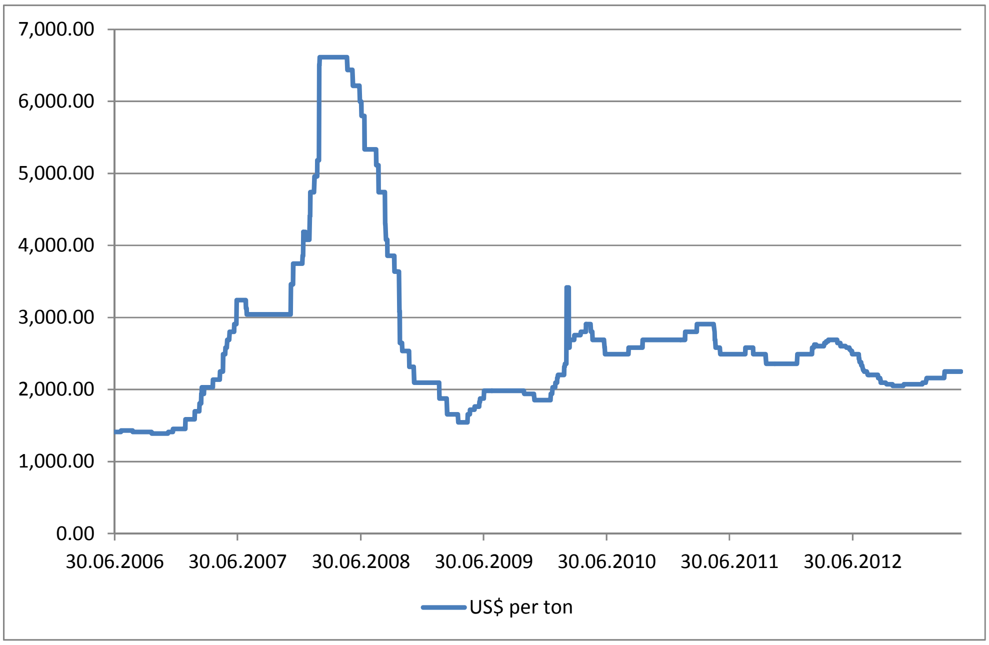

Figure 10: Prices of ferrochrome in US$ per t
Source: asianmetal.com

Worldwide reserves of chromium ores are estimated to be around 12 billion tons by the U.S. Geological Survey (2013b), stating that reserves are “sufficient to meet conceivable demand for centuries”. The largest reserves are located in South Africa and Kazakhstan.

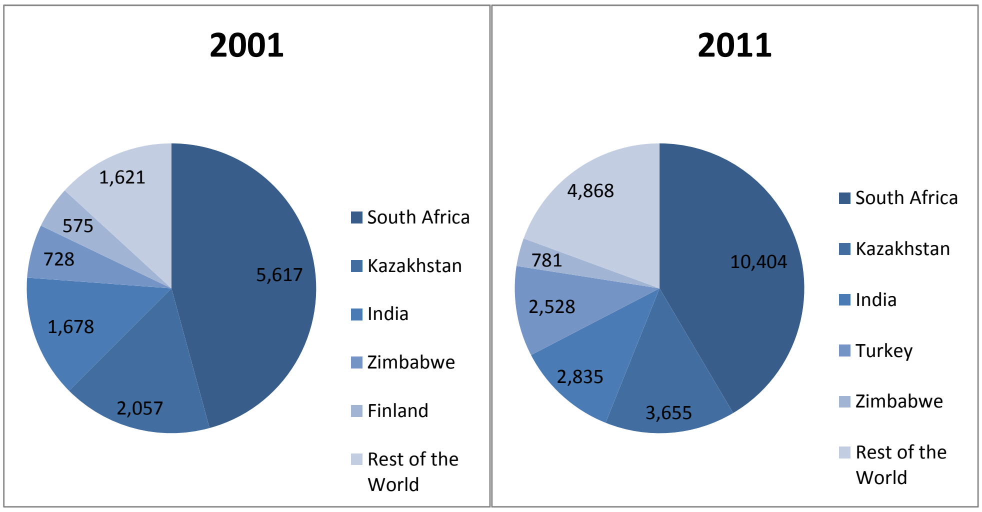

Figure 11: Mine production of Chromium 2001 and 2011 in 1000 t
Source: International Chromium Development Association (2012)

The most important country in chromite mining is South Africa. In 2001, it accounted for about 46% of worldwide chromite supply. This number shrank to 41.5% in 2011, still implying a growth of 85% in absolute output. The second and third largest producers of Chromium ores are Kazakhstan and India. Turkey exhibited a particularly large growth in production, from about 370.000 tons in 2001 to 2.5 million tons in 2011, making it the fourth most important producer of chromite.

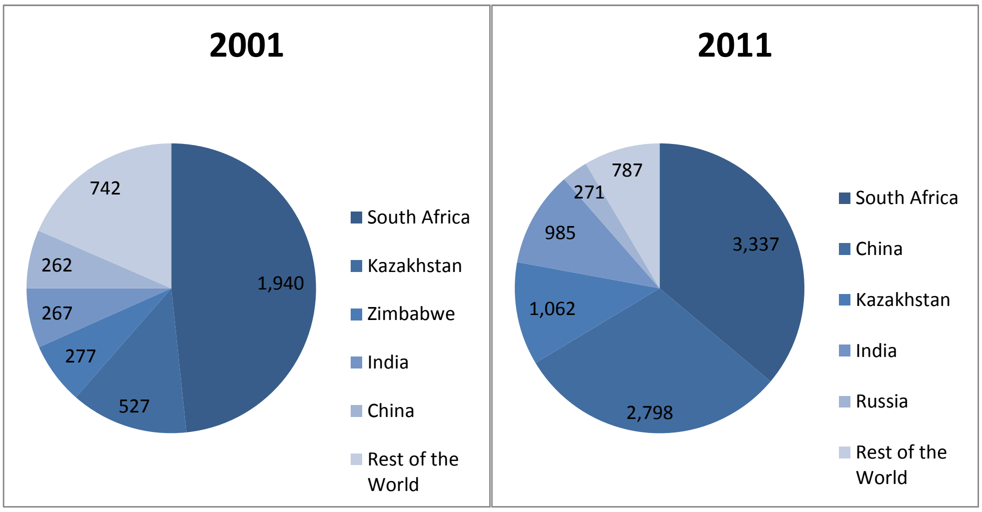

Figure 12: Production of ferrochrome (charge grade) 2001 and 2011 in 1000 t
Source: International Chromium Development Association (2012)

Figure 12 shows the most important countries in terms of charge grade ferrochrome production, a type of ferrochrome comparatively rich in carbon. It is the most important form of ferrochrome used in stainless steel production. Numbers are again shown in gross weight, not in chromium equivalent.

In 2001, South Africa accounted for almost half of the world's production of 4 million tons. While South African output of charge grade ferrochrome increased to 3.3 million tons in 2011, its relative share in world markets declined to 36 %. Chinese output in 2011 is more than ten times the numbers from 2001, making it the second biggest ferrochrome producer. Other major producers of charge grade ferrochrome in 2011 were Kazakhstan, India, and Russia.

China is different from the other main producers of ferrochrome in one respect: It does not possess major sources of domestic chromite, but is reliant on ore imports. The structure of its chromite suppliers has changed considerably in the last few years.

Figure 13 displays the shares of the most important suppliers of Chinese chromite imports. The share of South Africa grew from 32% in 2007 to 50% in 2011. In the same time span, India's import share fell from 16% to 4.7%. The absolute amount of imports from India halved between 2007 and 2011. This pattern is already influenced by the introduction of export restrictions.

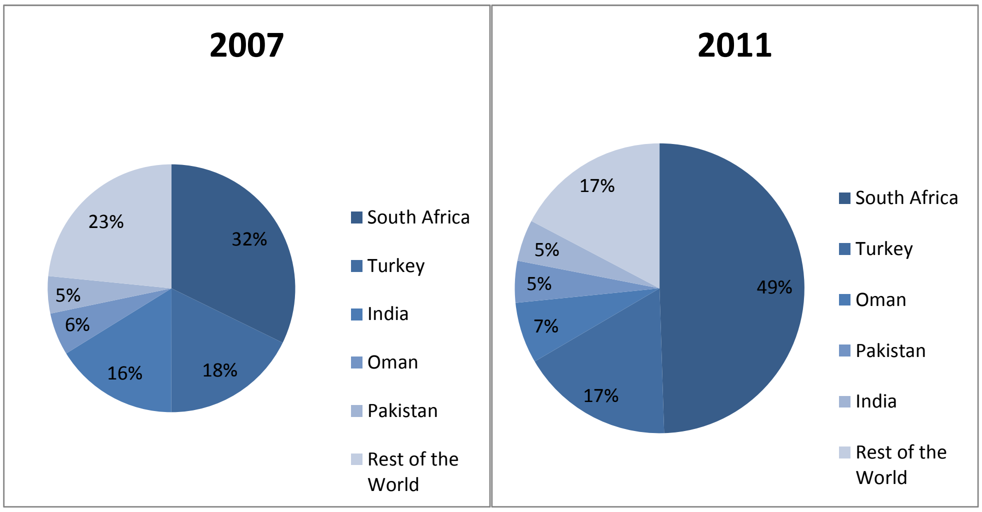

Figure 13: Shares of imports chinese chromite ores
Source: International Chromium Development Association (2012)

2.4 Molybdenum

Molybdenum is a silvery-grey transition metal with a very high melting point of 2623 °C, the sixth highest of all elements. Its atomic number is 42. Molybdenum is often associated with copper ores. Therefore, a large share of molybdenum is mined as a by-product of copper extraction.

About 70 % of molybdenum is used in steelmaking, though not necessarily in stainless steels. Other applications include nickel-based superalloys and chemicals, for example in catalysts or lubricants.

Molybdenum is added to (stainless) steel to further increase corrosion resistance, e.g. in ferritic steels. It also contributes to increasing the steel's hardenability and its strength at elevated temperatures.

The only ore commercially mined currently to win molybdenum is molybdenite (MoS_2). The ore is roasted and converted into MoO_3, also called tech oxide. Tech oxide can then be smelted together with iron ores and aluminium to produce ferromolybdenum, using an aluminothermic reaction. Ferromolybdenum contains 60 to 75 % Molybdenum, plus iron and some impurities. The tech oxide can also be further processed to produce various molybdenum-based chemicals or the pure metal. In steelmaking, mostly ferromolybdenum and tech oxide are used.[2]

From 2002 until 2012, worldwide molybdenum production increased relatively linearly from 123.000 tons to an estimate of 250.000 tons 2012. These numbers are significantly lower than production of nickel or chrome.

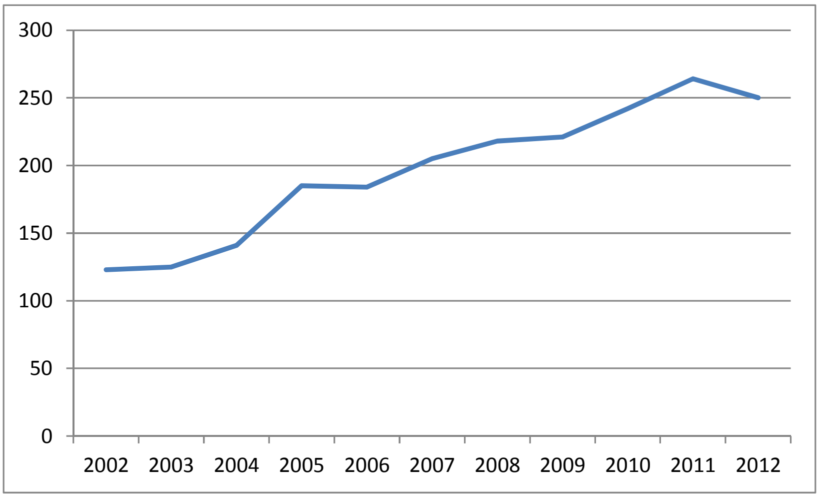

Figure 14: Molybdenum Production 2002-2012 in 1000 t
Source: USGS

Prices of molybdenum, in this case ferromolybdenum, were comparatively high until fall 2008. The price level remained above 50,000 US$ per ton of ferromolybdenum from 2005 on. Since October 2008, prices fell quickly from about 80,000 to a little more than 20,000 US$. Thereafter, prices of molybdenum remained below 2008 levels. Currently, they are below 30,000 US$.

[2] Further information about molybdenum is available at the International Molybdenum Association (IMOA), http://www.imoa.info/.

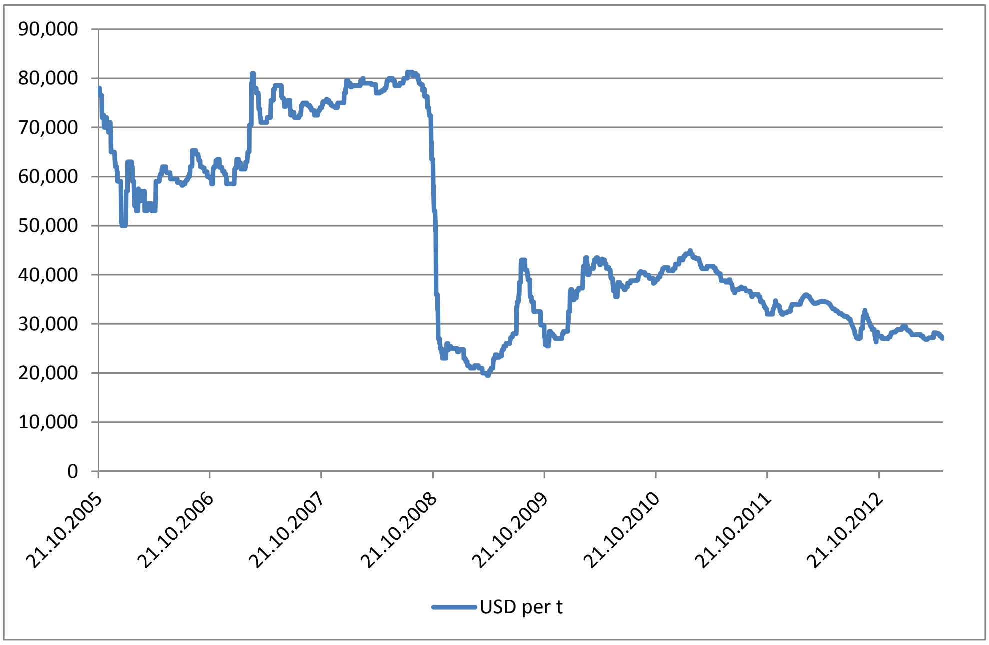

Figure 15: Prices of ferromolybdenum in USD per t
Source: asianmetal.com

According to U.S. Geological Survey (U.S. Geological Survey, 2013c), molybdenum reserves of 11 million tons are known. 4.3 million tons thereof are under Chinese soil, 2.7 million in the US and 2.3 million in Chile. This indicates no threat of exhaustion in the near future.

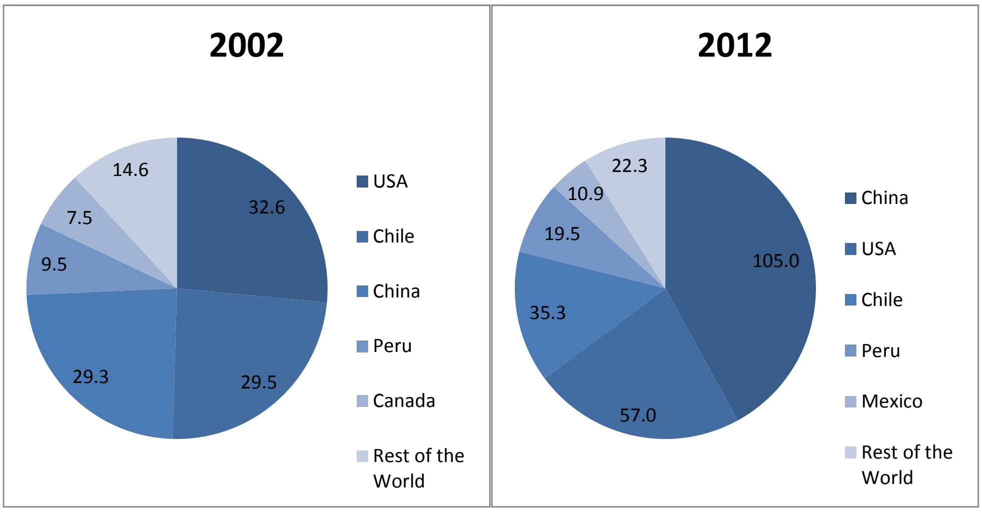

Figure 16: Production of Molybdenum 2002 and 2012 in 1000 t
Source: U.S. Geological Survey

The production of molybdenum in 2002 could be divided into quarters. The United States, Chile, and China each supplied one fourth of worldwide production, all other countries accounted for the last quarter. Until 2012, China tripled its output and is now the most important supplier of molybdenum, accounting for 42% of the world production. The other four of the five most important producers are on the Americas: The USA, Chile, Peru, and Mexico.

For Ferromolybdenum, the latest year for which data is available from the U.S. Geological Survey is 2010 (U.S. Geological Survey, 2012). According to this data, about 115.000 tons of ferromolybdenum were produced worldwide, measured in gross weight. 90.000 thereof were produced in China, 12.500 in Chile.

2.5 Stainless Steel Scrap

Stainless steel scrap is a major input in the production of new stainless steel. It is used for its contents of valuable alloying elements, and because recycling scrap needs much less energy inputs than employing primary raw materials.

The scrap is divided by two criteria. If it accrues within or outside the steel mill. And if it accrues during the production process or afterwards. Internal scrap accrues during steel production itself. It is fully reused and does usually not leave the steel mill. External scrap accrues outside steel production and can be sub-divided into new and old (or reclaimed) scrap. New scrap arises when processing the stainless steel into products. This type of scrap is basically fully recycled as well. Old or reclaimed scraps are discarded products of stainless steel. Between 60% and 80% of those are recycled (Pariser & Pariser, 2012).

Using scrap instead of virgin materials also results in large reductions of CO_2 emissions (Fraunhofer UMSICHT, 2010; Johnson, Reck, Wang, & Graedel, 2008). Johnson et al. (2008) calculate the energy needed to produce one ton of austenitic stainless steel in three scenarios. One reflects the current average mix between virgin materials and scrap[3], while the other two represent a ton solely produced from scrap and solely produced from virgin materials, respectively. They find that producing one ton of austenitic stainless steel needs energy inputs of 53 GJ over the whole lifecycle in the current scenario, emitting 3.6 tons of CO2. If only scrap is used, the value decreases to 26 GJ (1.6 t CO2). If only virgin ores are used, 79 GJ of energy are needed (5.3 t CO2).

Stainless steel scrap is collected and the contents of alloying elements are analysed. Different types of scrap are then blended according to customer specifications. These specifications are similar to the most important grades of stainless steel. If necessary, virgin materials, such as ferrochrome, are added.

While the availability of virgin materials is determined by the location of their deposits and their extraction costs, the availability of scrap reflects production and consumption patterns. Table 1 shows how much external scrap is available in some key regions. The availability is generally calculated based on actually traded scrap and therefore somewhat dependent on current market prices. Not surprisingly, large amounts of scrap are available in industrialised regions like the EU, the NAFTA, and Japan. China does catch up, however. The quantity of stainless steel scrap available increased worldwide from 6.7 million tons in 2009 to 8.7 million tons in 2012. It should be noted that most Chinese scrap is new scrap, while old scrap is much more important in the EU or the US.

[3] They assume 42% for chromium, 43% for nickel, and 67% for iron.

	2009		2012
EU	2,527	EU	3,181
NAFTA	1,152	China	1,677
China	959	NAFTA	1,338
Japan	766	Asia without China and Japan	891
Asia without China and Japan	683	Japan	734
Total	6,698	Total	8,670

Table 1: Regional external stainless steel scrap availability in 1000 t
Source: Pariser & Pariser (2012)

Prices of virgin and scrap metals are generally highly interdependent (Xiarchos & Fletcher, 2009). Prices of stainless scrap are determined by the elements it contains. Take the example of scrap of 304 stainless steel. It consists of 8-10% nickel, 18% chrome, and around 71% iron, plus 2.8% to 3% impurities. The price for this scrap is a weighted average of the prices paid for the contents of chrome, nickel, and iron. Scrap prices will, however, correlate most strongly with nickel prices.

The reference price for nickel, for example, is the LME cash price. The reference price for chrome is the charge chrome price in South Africa which is quarterly negotiated between South African chromium suppliers and their European customers and serves as a base for chromium price negotiations. Molybdenum reference prices are those for molybdenum oxide published by Platts.

Prices are usually discounted compared to their reference prices. The discount lied in a ballpark of 10% for nickel, 15% for chrome, and 30% for Molybdenum[4] in the last few years (Pariser & Pariser, 2012).

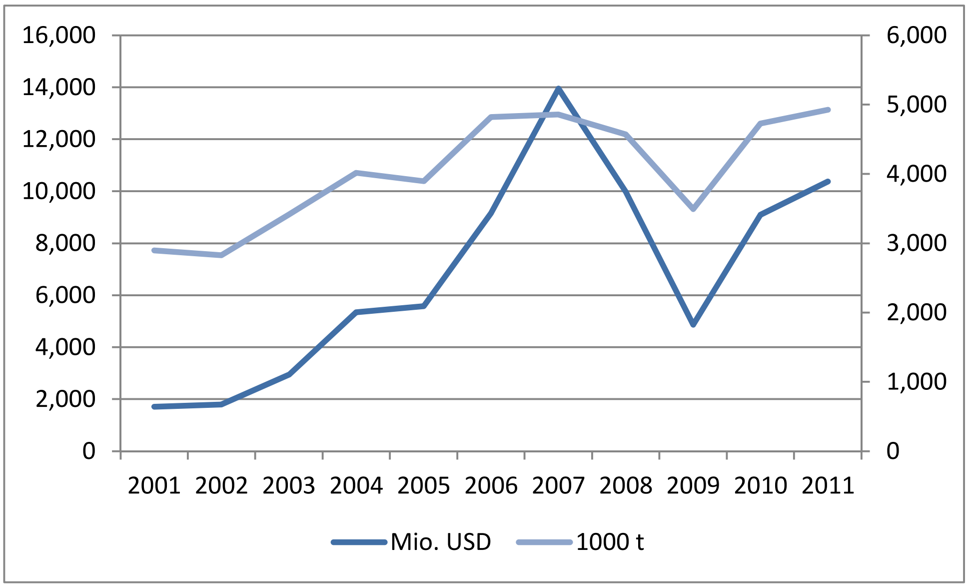

Figure 17: Trade of stainless steel scrap
Source: UN Comtrade

[4] The reference prices for molybdenum vary with the molybdenum content of the scrap. The higher the content, the lower the discount. For a molybdenum content of 2%, the discount is around 20%. If the content is lower, the discount increases.

	2001	1000 t	2011	1000 t
1	USA	343.1	Germany	527.6
2	Germany	262.2	USA	486.6
3	Russian Federation	206.2	Netherlands	323.0
4	Netherlands	165.8	France	201.3
5	Malaysia	87.9	United Kingdom	158.9

Table 2: Biggest Net Exporters of Stainless Scrap
Source: UN Comtrade

Table 2 displays the most important net exporters of stainless steel scrap. Both in 2001 and 2011, most of them were western countries such as the US or Germany. This reflects both the stocks of stainless steel accumulated over time in these countries which have been industrialised for a long time already, but also the absence of export restrictions. In 2001, Russia was one of the most important exporters of stainless steel scrap. Russian scrap exports were mostly remains of soviet industrial facilities shut down after the end of Soviet Union as well as nickel rich slags. After those materials were exported, Russia's importance declined.

	2001		2011	
		1000 t		1000 t
1	Belgium	467.3	Belgium	764.4
2	Rep. of Korea	410.1	Finland	536.2
3	Spain	356.2	India	400.3
4	Sweden	167.8	Rep. of Korea	233.7
5	Italy	90.8	Canada	164.6

Table 3: Biggest Net Importers of Stainless Scrap
Source: UN Comtrade

Table 3 shows the most important net importers of stainless steel scrap. These are usually countries with a considerable stainless steel production, but rather small availability of domestic scrap. A good example is Spain, where Acerinox's facilities demand large quantities of stainless steel scrap. Belgium, Finland, and South Korea are similar cases.

It is remarkable that China is not among the five biggest net importers of stainless scrap. Despite its dominant role in stainless steel production, its role in scrap trade is limited. The UN Comtrade database reports net imports of stainless scrap of 128.000 tons in 2011. That makes China the 8th biggest net importer behind Spain.

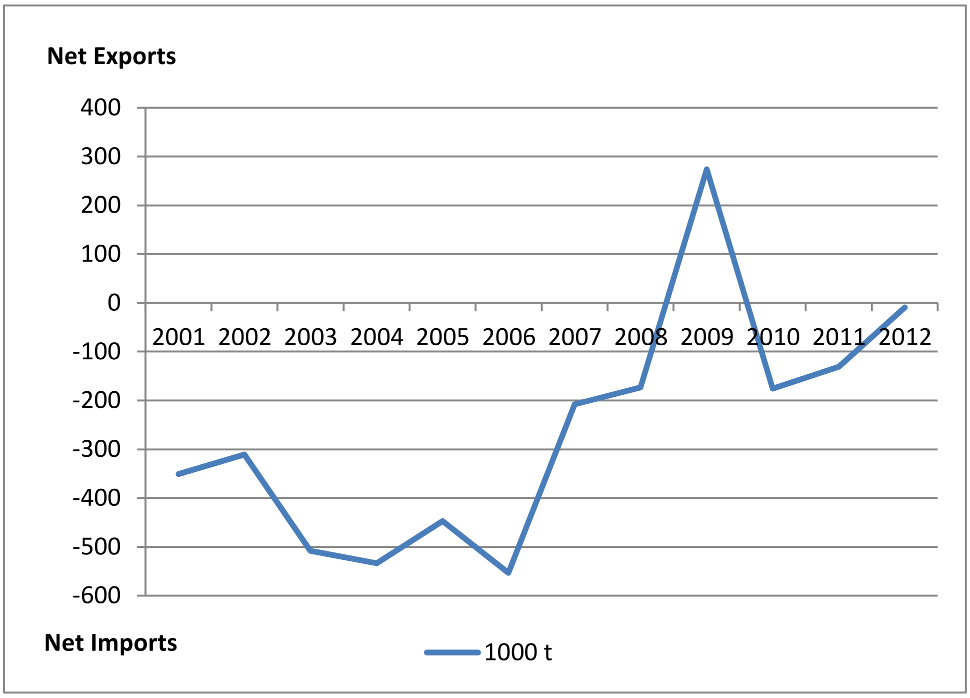

Figure 18: Net imports and exports of the EU from 2001 to 2012 in 1000 t
Source: UN Comtrade

Looking at net imports and exports of European nations can be misleading because most of the scrap trade takes place within Europe. Figure 18 shows Europe's net imports and exports of stainless scrap between 2001 and 2012. Interestingly, the EU was a net importer of stainless scrap in most of this period with the exception of 2009. There appears to be a trend towards Europe becoming a net exporter in the future. This plausibly reflects the EU's declining share in stainless steel production worldwide (see chapter 2). Another explanation can be derived from Table 2. The abundance of scrap from the former Soviet Union plausibly has contributed to the large net imports in the early 2000s.

In absolute terms, most stainless steel scrap was consumed in the EU both in 2009 and 2012 (see Table 4). Other major consumers include the US, China, and Japan. China does, again, play a rather small role in scrap consumption.

	2009		2012
EU	2,546	EU	3,574
China	1,451	China	2,088
Asia without China and Japan	1,214	Asia without China and Japan	1,650
USA	822	USA	924
Japan	608	Japan	786
Total	6,865	Total	9,295

Table 4: External stainless steel scrap consumption in 1000 t
Source: (Pariser & Pariser, 2012), own calculations

Interestingly, the share of scrap in stainless steel production varies widely between countries (see Figure 19). While stainless steel in the US, in Europe, or Taiwan consisted of 60% or more re-melted scrap, this ratio was only between 40% and 45% in Japan or South Korea. These differences are only determined partially by country specifies, but more importantly by the firms underlying the country data. For example, Posco, the most important stainless steel manufacturer in South Korea has its own ferronickel production linked to the stainless steel production and has therefore a smaller need for scrap as a substitute for primary nickel. Also, some firms have more experience in using the more heterogeneous input scrap than others.

The share of scrap in stainless steel production is particularly low in China. Reasons for this can be found in the sections above. China does restrict the exports of nickel pig iron, ferronickel, ferrochrome, and molybdenum, effectively subsidising its stainless steel production. Plausibly the most important reason is the availability of nickel pig iron. This input, which is practically only used in China, replaces the most expensive element in the scrap: nickel. That decreases the relative price of virgin materials compared to scrap. Using scrap is less cheap for Chinese than for other stainless steel producers. Therefore, Chinese steelmakers rely more on virgin metals in their production.

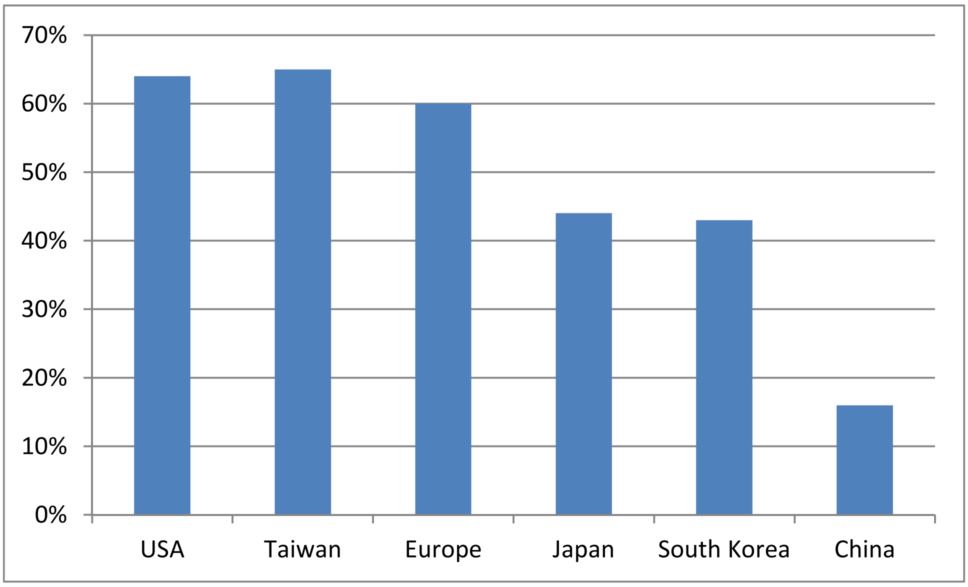

Figure 19: Ratio of external CrNi austenitic scrap in stainless steel inputs
Source: (Pariser & Pariser, 2012)

3 Basics of Export Restrictions

3.1 Definition and Types of Export Restrictions

Like many other forms of trade restrictions, export restrictions can be erected in many different ways, some of which can be fairly subtle. This complicates the definition of export restrictions. In this study, we rely on the definition adopted by the WTO panel deciding the "United States - Measures Treating Exports Restraints as Subsidies" case in 2001 (WTO, 2001a). It defines export restrictions as "a border measure that takes the form of a government law or regulation which explicitly limits the quantity of exports or places explicit conditions on the circumstances under which exports are permitted, or that takes the form of a government-imposed fee or tax on exports of the products calculated to limit the quantity of exports".

Export barriers are multifaceted and vary from case to case, but can be classified broadly into price and quantity-based instruments. Price based instruments directly and explicitly introduce a gap between domestic and foreign prices of the goods. They influence quantities exported indirectly. The most frequent form of price based instruments is an export tax.

The terms 'export taxes', 'export tariffs' or 'export duties' are used synonymously in this study. They denote duties levied on exports of a good, either ad valorem on its price or specific as a per-unit tariff. In some cases, such as the current Russian export tariffs on nickel, per-unit tariffs are adjusted regularly to the world market prices (see subsection 6.1.1). Another price-based regulation is minimum export prices defined by the government. They become binding in situations where world market prices for the good are below the minimum level defined by the government.

Price-based instruments can take unusual forms. Price and Nance (2010) present an example from India. Between November 2009 and April 2010, state-owned India Railways raised freight rates for iron ore intended for export by 50%. Because transportation costs make up about 80% of the total cost of that ore large effects of this instrument are implied.

Quantitative measures directly limit the physical amount of a good exported. Indirectly, they introduce a gap between domestic and foreign prices. The most important form of quantitative restrictions is export quotas. They set an upper limit of exports. If firms intend to export more of the good than the quota allows for, the export restriction becomes binding. The most drastic type of export quotas is a total export ban.

Export licensing requirements and other bureaucratic restrictions can work as a mix between price and quantity-based instruments. On the one hand they imply administrative costs that raise the price of exporting the good, which do not accrue if the good is traded domestically. On the other hand, they can prevent firms from exporting which are unable to attain licenses or fulfil other bureaucratic requirements.

3.2 Export Restrictions and the WTO

WTO's rules on export restrictions are, as Karapinar (2012) coins it, "an area of 'under-regulation'". Here we can only give a short overview about World Trade Organization's regulation on export restrictions. For a more in-depth discussion of the juridical aspects see Kim (2010), Karapinar (2012), Mildner and Lauster (2011) as well as Liu and Maughan (2012) for the special case of rare earths.

Quantitative export restrictions are generally prohibited. Article XI of GATT 1994 reads: "No prohibitions or restrictions other than duties, taxes or other charges, whether made effective through quotas, import or export licences or other measures, shall be instituted or maintained by any contracting party [..] on the exportation or sale for export of any product destined for the territory of any other contracting party."

There are some exemptions under which quantitative export restrictions are allowed. These exceptions are only vaguely defined. For the raw materials investigated in this study, the following articles are the most relevant. Article XI:2(a) allows quantitative export restrictions if they are "temporarily applied" to "prevent or relieve critical shortages of foodstuffs or other products essential to the exporting contracting party". Further relevant exceptions are listed in Article XX. Most important to inputs in stainless steel production are those for measures "necessary to protect human, animal or plant life or health" and those "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption".

Export duties are not generally prohibited if regulation on this issue was not part of additional agreements during the accession of a country. The most favored nation principle applies for export restrictions.

Article X of GATT 1994 requires members to publish data about trade related laws and regulations. This generally includes export restrictions as well. There is, however, no comprehensive database available for export restrictions.

3.3 Empirical Literature on Export Restrictions

While the literature on export restrictions on stainless steel inputs is thin, a number of scientific papers and reports have analysed export restrictions on natural resources more generally. Probably the most important example is the WTO's World Trade Report of 2010, which dealt with trade in natural resources, including export barriers on those (WTO, 2010). An overview about export restrictions on raw materials can also be found in Piermartini (2004) and Latina et al. (2011). Kim (2010) provides information about a large number of export restrictions and shows an increasing prevalence of export barriers from 2003 to 2009. Price et al. (2008) review export restrictions as well as other raw materials related policies in China, Russia, India, and the Ukraine.

The closest papers to our study with respect to the empirics are Korinek and Kim (2010), and Price and Nance (2010). Korinek and Kim (2010) analyse export restrictions applied on chromium, molybdenum, and rare earths. Price and Nance (2010) investigate export restrictions on inputs in steel production. They focus on iron ore, coke, and steel scrap, which are needed to produce carbon steel. Fliess and Mård (2012) analyse the OECD's inventory on export restrictions covering 2009 and 2010. The paper is insofar related that their data also forms the point of departure for our empirical research.

Research analysing the effects of export restrictions, either ex-post or ex-ante, is mostly restricted to agricultural goods. Some case studies can be found in Piermartini (2004). Other papers include Martin and Anderson (2011) as well as Warr (2001).

4 Economic Effects of Export Restrictions

4.1 Basic Framework

In this section, we harness modern trade theory to explain the effects of export barriers as a first step towards understanding the incentive to use them. We discuss them using the simple diagrams that are the theorist's tool of choice. This basic analysis already allows to deduct some important incentives to restrict exports.

Figure 20 depicts the domestic market in a country called 'home' for a good and its interaction with the world market. The good, which we call g for the sake of brevity, can represent nickel, chrome, stainless scrap, or some other input in stainless steel production. We will use the same framework of analysis in the whole chapter.

In Figure 20 as well as the following figures in this chapter, p represents prices for good g and q the quantities produced and consumed, respectively. ex is the amount of g exported. If ex is negative, the good is imported.

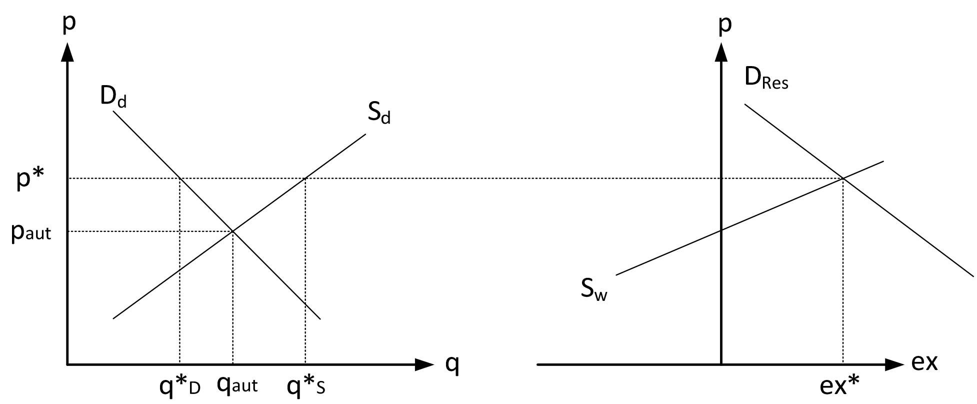

Figure 20: Comparison between free trade and autarky

The left side of Figure 20 shows the domestic supply curve S_d and the domestic demand curve D_d. Both depend on price level p. If no international trade takes place, the intersection of supply and demand marks the equilibrium in autarky p_{aut} and q_{aut}.

The interaction between domestic and world market is shown on the right side of Figure 20. For each price greater than p_{aut}, domestic supply produces more of good g than domestic demand wants to consume. The country exports to the world market. If prices are lower, domestic supply does not satisfy demand and country d is a net importer. The export supply curve S_w is derived from these considerations. It denotes the difference between domestic supply and domestic demand for each price p. There is a positive supply to the world market for $p > p_{aut}$ and a negative one for $p < p_{aut}$. Export supply faces a residual demand from the world market, depicted by the curve D_{Res}. It shows how much nickel, chrome, or scrap a country can export for any given price.

Figure 4 is a meaningful representation of international trade in goods for which trade costs are relatively small. In such a case, the so-called 'law of one price' holds and the local prices are close to the world market price. The free trade equilibrium is given by the intersection of export supply and residual demand. Price p*, domestically consumed quantity q^*_D and domestically produced quantity q^*_S form the equilibrium. The country is a net exporter with the amount of exports denoted by ex*.

4.2 Export Restrictions in Large and Small Countries

What are the effects of introducing an export tax of t per unit of the raw material exported? When discussing the effects of an export tax, trade theory reminds us that two cases have to be differentiated: the large country and the small country.

The terms large and small country should not be interpreted as the size or the number of inhabitants of that nation. A country is termed 'large' if it possesses a nickel, chrome, molybdenum, or scrap sector that is large enough such that the sector's behaviour has effects on world market prices. Technically speaking, it faces a less than perfectly elastic residual demand.

A country is termed 'small', on the other hand, if its export or import decisions do not affect world market prices. Its residual demand curve is horizontal, it can only decide to supply for a given world market price or abstain from doing so.

We first discuss what happens if a large country implements an export tax of t. Now buyers on the world market do not only have to pay what the domestic producer receives, but also the tax. This shifts the export supply curve S_w up to S_w'. The world market exhibits a new equilibrium with quantity ex' exported at an international price of p_w'. The former is lower than under free trade, while the latter is higher. Domestic prices lie below world market levels. The difference must equal t, otherwise there would be room for arbitrage. The new domestic price p_D' lies below the free trade price. Consumption in d is expanding to q_D', while production of the good g is decreasing to q_S'. The grey area is the government revenue generated by the export tax.

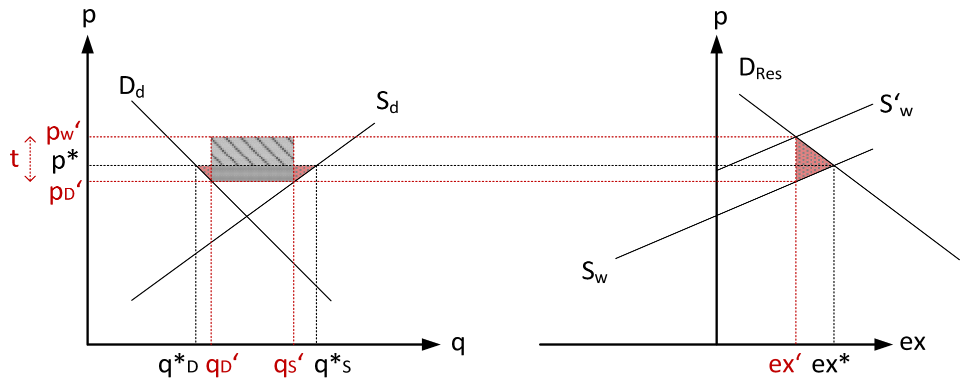

Figure 21: Effects of an export tax for a large country

When evaluating the welfare effects of an export tax, two things need to be compared. The reddish triangles on the left side of Figure 21 equal the deadweight loss introduced by the export tax. A too large quantity of the raw material is used, which means the stainless steel sector expands beyond optimal levels. The quantity of raw materials produced is too small. The so-called 'deadweight loss' is a loss of welfare in the country introducing the tax. It is 'deadweight' since no other country benefits from this domestic welfare loss.

The hatched area displays the terms-of-trade effect. The terms-of-trade are defined as the prices that a country receives for its exports divided by the prices of its imports. An export tax on q increases home's exports prices. That means the exporting country can buy a greater amount of goods abroad for what it receives for its exports. This represents a welfare gain for country d. If the terms-of-trade effect is larger than the deadweight losses, home enjoys welfare gains from the export tax.

The rest of the world unambiguously loses from the introduction of an export tax. It faces a higher world market price and the implied deadweight loss. Gains in the exporting nation are generated at the expenses of the rest of the world.

Against the background of the ‘large’ country case, we now compare this to the effects that the introduction of an export tax has in a small country. Recall that a small country’s supply is not large enough to influence world market prices. Its residual demand curve D_{Res} is horizontal.

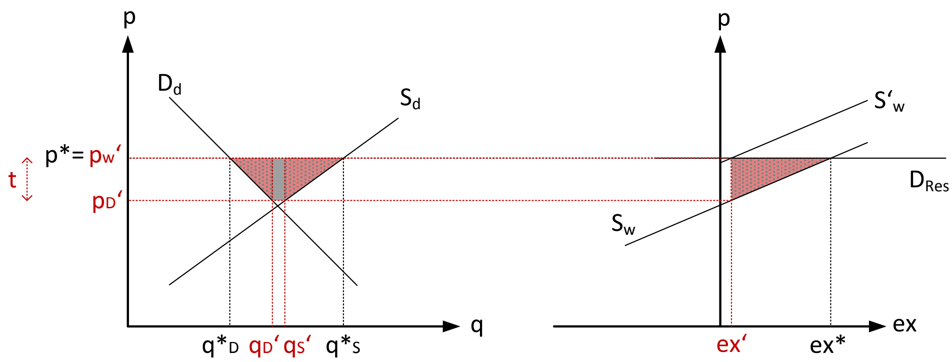

Figure 22: Effects of an export tax for a small country

Figure 22 depicts the small country case. As it will turn out later, many export barriers on scrap metals in developing countries are such cases. The small country is not able to change the world market price, so the immediate effect of its export tax is a drastic reduction of exports, from ex* to ex’. The unaffected world market prices also mean that country d will not enjoy gains in terms-of-trade. Since exports dwindle, tax revenue is small. What basically happens is a domestic redistribution of wealth from the suppliers of the resource to its domestic consumers, plus notable deadweight losses due to implied inefficiencies. It is apparent that a small country does not have the possibility to increase its welfare using export restrictions based on arguments derived from this model.

4.3 Winners and Losers

Irrespective of whether a country can achieve overall welfare gains from export restrictions or not, their introduction always gives rise to a redistributive element. Some sectors lose from trade restrictions, some benefit, both within and between countries.

In the country implementing an export tax the domestic demand side benefits from the export restriction. If an exporting country erects barriers for exporting chromium ores, it is the ferrochrome sector which benefits. If ferrochrome exports are hindered, it is the stainless steel sector which gains from facing lower prices and expanding production. The consumer surplus is larger due to the export restriction. The supply side has to bear parts of the costs or, in case of a small country, the whole costs. It receives a lower price and produces less than under free trade.

The division of costs between the domestic supply side and foreign firms depends strongly on the market power a nation has. If a country has strong market power and its residual demand is inelastic, costs are imposed on the rest of the world. If it does possess weak market power, domestic supply bears most of the cost.

An export restriction on a raw material is an indirect subsidy for downstream firms, in our case stainless steel producing firms. This subsidy also affects further downstream sectors. Stainless steel production in that country is subsidised and the output gets cheaper. This lowers the costs of manufacturing firms using stainless steel. The subsidy is passed through the value chain. If trade is not perfectly costless, domestic sectors benefit disproportionately. It is, however, challenging to quantify these effects empirically.

Figure 23 shows who wins and who loses in an importing country if exports of an input in stainless steel production are restricted. Let's use stainless steel scrap as an example. Effects are a mirror-image to what happens in the exporting country. The introduction of an export tax increases the world market price from p^* to p_W. The stainless steel sector reacts by lowering its production, leading to a welfare loss. Domestic scrap owners and traders benefit. The scrap collecting sector expands beyond optimal levels. The magnitude of this effect depends on how elastic scrap demand and supply reacts on the export barriers.

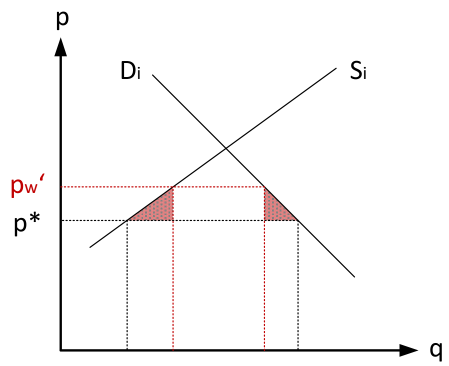

Figure 23: Effects of the tax in an importing country

Importing countries might not be endowed with the raw material on which the export restrictions are applied. In this case, only the demand side will be affected. This resembles the European situation for nickel, chrome, and molybdenum.

Factors of production are affected by export taxes as well. Mobile factors will move to the sector which benefits from the restriction (the steel sector in the domestic country, mining, or recycling sectors abroad). Immobile factors are not able to move to other sectors and will be affected more strongly. Owners of mining licenses in the domestic country or to owners of capital specific to steelmaking abroad will suffer from devaluation.

4.4 Taxes and Quantitative Restrictions

So far, only taxes restricting exports were part of our analysis. Quantitative limitations to exports, such as quotas, non-automatic licensing, or export prohibitions, play an important role in practice as well. In this subsection, we compare the effect of a quantitative export restriction with those of a tax.

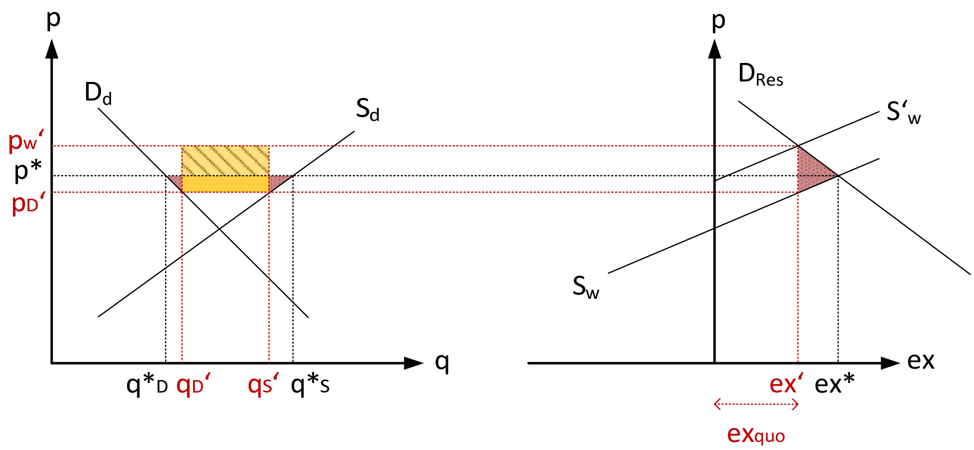

Figure 24: Export quota

Figure 24 displays the effect of an export quota of ex_{quo}. When carefully comparing Figure 24 to Figure 21, one can see that the export quota ex_{quo} yields the same exports, price differentials and terms-of-trade effects than the tariff t in Figure 21. This is a more general result. For each tariff t, there is an equivalent quota which yields the same implicit tariff (Baghwati, 1965).

The theoretical equivalence is based on the very strong assumptions of perfect competition in supply, demand, and auctioning of the quotas. Otherwise, tariffs are preferable from an efficiency standpoint because they leave less room for manipulating the prices.

If an export quota represents a binding restriction, a shadow price is implied. In figure 5 the shadow price equals the tariff t in figure 2. The implied rent is the yellow area.

A general problem is the mechanisms used to allocate the licenses or the quota and to specific firms. This is often done in an intransparent manner leaving room for corruption and nepotism.

4.5 Why Export Restrictions Became More Prevalent after 2002

The number of export restriction applied to natural resources has increased significantly after 2002 (Kim, 2010). This can be explained by increased incentives for introducing them after 2002, when the market turned from a buyers' to a sellers' market, in particular because of China's dynamic growth (Stürmer, 2008).

Figure 25 and Figure 26 show why there are more incentives to introduce export restrictions after 2002 than there were before. Figure 25 depicts the situation before 2003. Sufficient capacities were available for many natural resources – including those needed in steel production – to satisfy the respective demand. This means export reductions by a country could easily be absorbed by supply in the rest of the world. Exporting countries face an elastic residual demand.

Figure 26 corresponds to the situation where Chinese demand growth increased the utilisation of capacities. If home country's export supply changes now, other countries find it much harder to adjust their production, leading to an inelastic residual demand for d's exports.

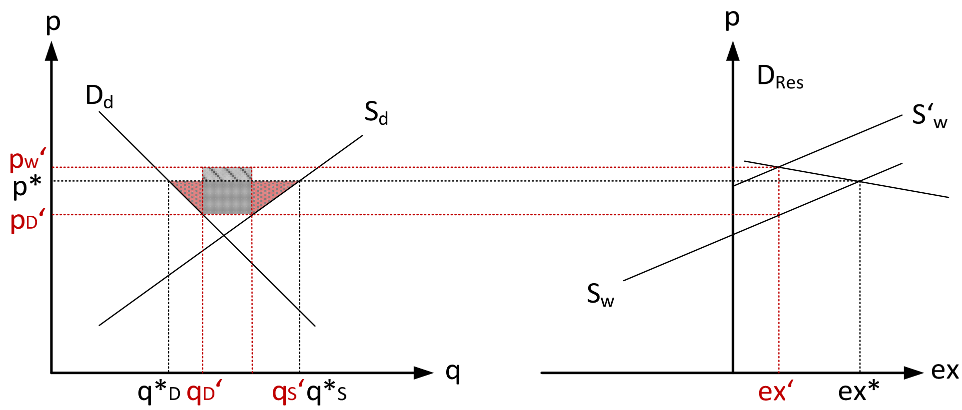

Figure 25: Elastic residual demand

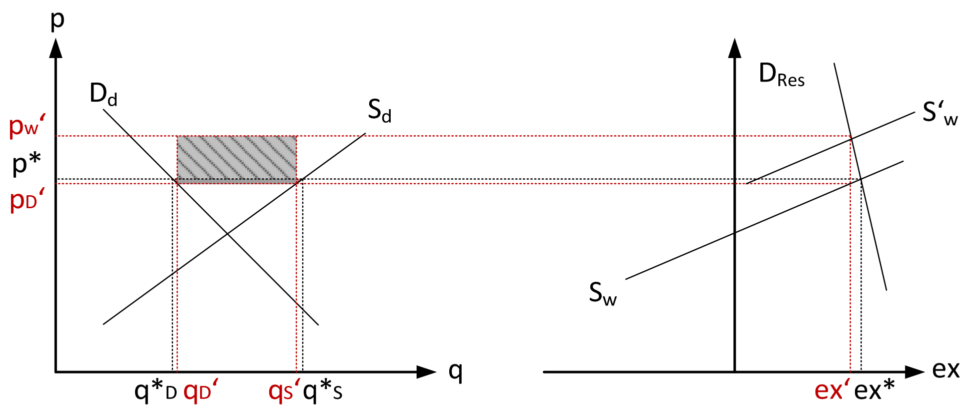

Figure 26: Inelastic residual demand

As can be seen, welfare effects are distinctively different in both situations. With an inelastic residual demand, the terms-of-trade effect is large and so is the amount of taxes collected. The deadweight loss is small. Costs of the export tax are borne by foreign countries. Contrariwise, when facing an elastic residual demand, the tax mostly chokes exports. Terms-of-trade effects and tax revenues are small. Two reasons for introducing export taxes are rendered ineffective in a market situation like this.

Redistribution of welfare within the country implementing the export tax is very different in both situations. In a sellers' market depicted in Figure 25, the government is unable to burden the costs of their export duties on the rest of the world. The domestic supply sector bears a large share of the costs. Figure 26 reveals that domestic suppliers are rather unaffected by the tariff in a sellers' market. Costs are largely borne by the rest of the world in that case, while the government benefits from the high tax income.

4.6 On the Dynamic Effects of Export Restrictions

In the previous discussion, we always compared equilibria without taking into account how the dynamics are working in the markets. This might be acceptable if capacities and stocks are large enough to adapt to the introduction of export restrictions easily. If capacities are utilised close to full capacity and stocks are small, the dynamics become important. This is the case in particular for resources and steel markets, where notable investment is needed to adjust capacities and the adjustment can take years.

Export restrictions can contribute to price spikes on world markets in periods when capacities are highly utilised. They decrease supply on the world market leaving it more vulnerable to shocks. Martin and Anderson (2011) have analysed this effect for the food price surge between 2005 and 2008 for rice and wheat. They find that more than 45% of the international price increases were induced by trade restrictions for rice and about 29% for wheat.

Investment decisions themselves are also distorted. If capacities are built up according to the incentives generated by trade restrictions, their profitability will be reduced if the restrictions are dropped again. Stranded investments can occur. This is particularly problematic because parts of these investments are sunk and cannot be transferred to other activities.

Additional problems are implied if investment decisions are made under somewhat myopic expectations. Let us assume that the steel sector outside of the home country faces increased prices due to an export tariff on one of its inputs. Now every firm faces the decision to either pay a higher price for this intermediate good or to invest in a technology reducing the need for that input. If firms do not take into account that other steelmakers face the same decision, the overall investment in the technology to replace the input will be too high. Prices are driven down to a level that is too low for many investments to be profitable ex post. The same can happen on the supply side. The same can happen to on the supply side. If raw material prices are driven up by trade restrictions, incentives for new mining investments grow. This can lead to a “gold rush” and overinvestment.

5 Why Do Countries Restrict Exports?

Chapter 4 outlined effects of export restrictions on raw materials using the tools of graphic analysis. Export restrictions lower domestic price levels for the resource and, if the country has market power, raise the world market price. Domestically, the lower prices benefit those sectors that consume the raw material while the suppliers suffer. The result of the export restriction is a distortion in the resource market, with levels of consumption that are too high and levels of supply that are too low. Internationally, export restrictions on raw materials change the so-called ‘terms-of-trade’: International prices for exports of the raw material rise. The country thus receives higher prices for its exports and can buy more foreign goods in return.

Why do countries introduce export restrictions they result in distortions? The above summary of the main effects of such restrictions points to many of the current explanations in the literature for their use. This chapter will make these explanations more explicit. We will find, for example, that if welfare gains from the terms-of-trade effect are larger than the welfare losses from distorted markets, export restrictions are beneficial for a country. Such an outcome is more likely, for instance, if supply for the raw material operates close to capacity constraints and if demand does not react elastically on price changes. This and additional arguments are compiled and applied to the markets of nickel, chrome, molybdenum, and stainless steel scrap. Jointly, the arguments enable us to characterise three groups of countries regarding their propensity to employ export restrictions.

The summary of arguments first fixes a reference point in the form of the free trade benchmark. We then show how export restrictions can sometimes be justified even at the global level as second-best instruments in the presence of externalities. Moving on to the national level, we present the reasons why governments might find it in their narrow national interest to pursue export restrictions. Finally, export restrictions might not be motivated so much by national interest, but by special interest group politics. These political economy factors give rise to the final set of arguments that explain the presence and shape of export restrictions.

5.1 Free Trade Benchmark

An analysis of the merits, or not, of trade restrictions naturally starts from the benchmark of free trade. The reason is a central result in trade theory that under a set of fairly general conditions, global society would choose a system of free trade as the organising principle of the international exchange of goods and services. Under free trade, each country specialises in producing those goods for which it has a comparative advantage. By specialising in a limited number of goods sold on large markets, economies of scale can be realised. Free trade also ensures competition on a worldwide scale, thereby encouraging efficient use of resources and innovation. The existence and general acceptance of this benchmark is what underpins the global efforts towards a universal regime of free trade.

What this chapter will show in detail is that the difficult historical path towards a universal regime of free trade highlights the two main obstacles standing in the way of a global free trade regime. One obstacle is that there are instances where deviations from free trade are advantageous even from a global perspective. One such instance is the presence of **externalities** that can stem, for example, from learning effects in developing countries or from environmental damages connected with the extraction and processing of raw materials. If better instruments to cope with these problems are unavailable, export restrictions can sometimes be justified as a so-called 'second-best' instrument. Another instance is a situation where governments are not able, for example due to weak institutions, to generate the fiscal revenues for necessary public services with less distorting sources of revenues. In such cases, the conditions under which free trade is globally optimal are violated, and export restrictions can conceivably improve on the outcome. At the same time, they can also do more damage. A case-by-case analysis is required.

The second, and politically more salient, obstacle to universal free trade is its **prisoners' dilemma** nature: While globally advantageous, countries as a whole or politically powerful groups within countries can find that they individually prefer to restrict trade, particularly when most other countries are trading freely. This pursuit of narrow national policy interests can generate its own negative externalities: A country can increase its citizens' welfare at the expenses of others'. The terms-of-trade effect found in chapter 4 is a first example for a type of policies commonly referred to in the trade literature as 'beggar-thy-neighbour'.

The likelihood of retaliatory measures by other countries is a main reason why 'beggar-thy-neighbour' has become less popular among governments that take a broad national interest. Its pursuit is typically not in their interest if gains in one sector have to be accomplished at the expense of losses in many others. For reasons of **political economy**, however, governments often weigh gains and losses differently in different sectors. For example, a government that does not only consider national welfare, but also benefits from support by special interest groups, can find trade restrictions an attractive tool for furthering the interests of powerful industries or groups of people at the expense of others. These interest group effects create another form of externalities, with the negative effects arising either in other sectors of their own country or abroad.

5.2 Export Restrictions as Second Best Instruments

5.2.1 Government Revenues

Some export barriers yield government revenues. This is the case for export taxes and tariffs, but also for export quotas, if they are sold or auctioned to exporting firms.

Income from export taxes are a small to negligible source of revenues for most governments. A notable exception is Russia. Between 2006 and 2010, export tax revenues comprised a share of more than 20% of federal government revenues (International Trade Centre, 2012).

Export duties can be a convenient way to generate government revenues, particularly in developing countries. If these nations lack infrastructure and institutions necessary to collect income or consumption-based taxes, they need some other source of income. If the country exports goods which have to be shipped abroad or transported by trains, exports can be monitored well and transaction costs of collecting taxes are comparatively low.[5]

[5] Piermartini et al. (2004) points out that monitoring export taxes is not without pitfalls either.

A major drawback of relying on export tax revenue for budgetary purposes is their volatility. If raw materials' prices are high, the government will see large tax revenues. When they are low, tax income collapses. This is usually the case when the world economy is on a downturn. Export tariffs tend to amplify business cycles. This can be prevented by setting up buffer funds, but these funds didn't prove to be working well in the past for many nations (Piermartini, 2004).

5.2.2 State of Development

Export restrictions act as an indirect subsidy for downstream sectors using the good whose exports are hindered as an intermediate input. The subsidies might be directed towards stainless steel production, but can also aim at more upstream firms. The proposed South African export restrictions on chromium ore is explicitly meant to protect domestic ferrochrome production (Seccombe, 2012) which, in turn, is an input to stainless steel production.

The most widely cited reason justifying these subsidies is the infant industry argument. The basic idea is that developing countries are specialised in industries lacking value added or dynamic development. They cannot extend their production to sectors exhibiting higher value added or dynamics because they lack experiences in producing the respective goods. Thus, they are stuck in an industry structure preventing higher growth rates (see Melitz (2005) for trade restrictions as a measure to protect infant industries).

Firms could overcome this handicap in a learning-by-doing manner. The more they produce, the more they learn, and the less are their costs. If learning occurs not only within firms, but also spills over to other firms in the industry, an externality arises. Firms do not fully internalise the knowledge they generate and produce at suboptimal levels. The country is stuck in a situation where the industry does not start producing because of high initial costs and the externality.

This theory gives a normative argument for intervention. The first best instrument is a subsidy on production which internalises the learning externality. Subsidising an input of this industry using export restriction is only a second best instrument. It does not only subsidise production but also biases the relative prices of inputs towards the raw material. This leads to an increased use of the resource, which is not intended.

There are reasons why direct subsidies on production are unavailable. Developing countries might, for instance, face liquidity constraints preventing the implementation of direct subsidies on production. Tariffs on imports of the respective goods might be restricted by trade agreements.

It should be noted, however, that the infant industry argument is not without controversy. It always involves the danger of generating dependency on subsidies instead of internationally competitive industries. It is also doubtable whether the government is able to quantify the learning externality correctly or to know in advance which industries will be exhibiting large value added or dynamics in the future.

The infant industry argument appears valid mostly for developing countries. It does not seem evident for nations which are already industrialising and producing stainless steel, such as South Africa, India, or China. A reason explaining export restrictions by these countries can be derived from economies of agglomeration (Amiti, 2005).

The basic idea of this argument is as follows. If firms decide where to produce, they face two incentives which might be opposing. The first one is to set up their production in a country where they encounter low prices for their factors of production. This force drags labour-intensive sectors into countries with low wages and resource-intensive sectors into resource rich nations. The second force stems from costs of trade. The closer a company locates its production to its consumers or to the suppliers of its intermediates, the less trade costs it incurs. That force makes firms and sectors agglomerate. The economics of agglomeration exhibit an externality. Firms do not account for the productivity spillovers they provide to other firms and do not include them in location decisions. It might be the case that the force of agglomeration dragging production together dominates the incentive to specialise according to factor costs. This depends on a variety of determinates, in particular on trade costs.

Subsidising stainless steel production can be interpreted as an attempt to overcome path dependencies in agglomeration structures. The government in a country perceives the agglomerative structure of the industry as a result of comparative advantages in the past. If it also perceives that these structures are preserved merely by agglomerative advantages, while the industry has comparative advantages in its own country today, export restrictions can be an instrument to break up these structures and make firms relocate.

This reasoning is, however, subject to similar critique as the infant industry argument. Does a country really know that it possesses a comparative advantage in a sector? And do the implicit subsidies create industries dependent on protection? Do the gains from attracting a sector overcompensate the costs of subsidising it?

5.2.3 Environmental Problems

Mining and processing metals causes a wide range of environmental damages, from water and air pollution, land use and destruction of ecosystems, to greenhouse gas emissions (Dudka & Adriano, 1997). Environmental protection is sometimes cited explicitly to justify export barriers, for example in China and South Africa (Fliess & Mård, 2012). The severity of damages crucially depends on the regulations mining companies face and on the government's ability to enforce these regulations.

Externalities from environmental damages of mining do justify government intervention. So do the greenhouse gases emitted when transporting raw materials. In the former case, regulations on the mining sector appear as the first best policy instrument. In the latter one, a carbon tax or an emission trading system would be a preferable instrument.

Export restrictions are a second-best instrument again. They decrease the supply of raw materials domestically (and plausibly also worldwide, at least in the short run) and they reduce trade. The environmental effects are, however, caused by the extraction or by the transport, not by trade itself. Applying instruments targeting the sources of environmental damages directly is the first-best instrument and would be less distorting.

There might be situations where regulating mining activities is not efficient or not possible. This can be the case if the costs of monitoring regulations at the mine site are prohibitively high. Or if local policy makers and regulatory bodies have an incentive to disregard the regulation because they benefit from the mining activities. If exports can be monitored well, restrictions on them can serve as a second-best instrument. This is (or was) potentially the case for rare earths' mining in China, for example (Tse, 2011). The welfare gains must, however, still be greater than the welfare losses from distorting national and international markets.

The environmental argument does not apply well to steel scrap. Using scrap metal rather than virgin metals decreases the energy intensity and avoids environmental damages associated with mining.[6]

A trade-off arises if both the environmental and the development argument apply. While the production of the raw material is decreased by export restrictions in the short run, downstream industry is sheltered from foreign competition and grows over time. In this case, domestic demand for the raw material will grow as well and might eventually be bigger than without the export restriction.

5.2.4 Conservation of Exhaustible Resources

Another reason often cited for export restrictions is the conservation of exhaustible natural resources. It has a different character than environmental protection. The environmental argument is about the externalities from extracting raw materials. The conservation of resources argument is about when to extract them.

It is reasonable to assume that a firm owning a metal deposit will take into account that its deposit has a limited size and can only be extracted once. The interest rate the company faces is of major importance for how quick the extraction takes place. The higher the interest rate, the more important are today's revenues for a company and the faster it will extract its resources. If the government faces a lower social discount rate and wants to slow down production, it can use export restrictions as an instrument to achieve this goal.

[6] Damages for human health and the environment due to recycling activities are probably most relevant for e-wastes. Discarded electric and electronic appliances are recycled in developing countries using improper processes such as burning plastic parts to gain access to valuable metals. This problem is much less important in case of stainless steel, where the metal is easily accessible and not contaminated with hazardous substances in many applications.

Additional problems arise when the property rights for the deposit are not defined clearly. This happens if a company is confronted with the risk of being expropriated or in case of illegal mining. Firms have an incentive to extract the resource suboptimally fast.

Export restrictions work, again, as a second-best instrument. The government wants to decrease today's extraction and should therefore regulate extraction accordingly. Additionally, it is not evident that profits generated from extraction today are less favourable for future generations than leaving the resource in the ground for them. It is crucial what happens to these profits.

5.3 Problems Arising in National Policy Making

5.3.1 Incentives for Beggar-thy-Neighbour Policies

The justifications for export restrictions listed so far were based on technical externalities. Some economic subjects do not bear the full social costs or enjoy the full benefits of their behaviour. Therefore, they do not behave in an optimal manner. The beggar-thy-neighbour policies have a different background. They arise if national policy makers focus on the welfare of their own citizens and have instruments whose costs they can impose on other countries.

A first type of beggar-thy-neighbour policy could already be observed in chapter 4 in the discussion about export restrictions' effects. Governments can use export barriers in order to increase world market prices and thereby their terms-of-trade. The implied costs are partly shifted to other countries. This is what Latina et al. (2011) call the terms-of-trade externality.

A similar effect concerns locational decisions of manufacturing industries. A government can use trade policy to incentivise the growth of downstream industries. This can take different forms, including introducing import tariffs for manufacturing products or subsidies by export restrictions on their inputs. In both cases, profits of domestic firms are increased and profits of the foreign ones are reduced, implying firms entering at home and leaving the market abroad. In terms of Latina et al. (2011), a production relocation externality arises.

Further incentives for beggar-thy-neighbour policies arise if the mining sector is under foreign ownership. The exhaustibility of natural resources induces rents. If the mining firms foreign, these rents might be transferred abroad. In this case export restrictions shift parts of the rents to the government budget and to the domestic steel sector. The transfer of wealth is thereby prevented.

5.3.2 (Unilateral) Caveats

Even without taking potential countermeasures by other countries into account, beggar-thy-neighbour type of policies exhibit both theoretical and empirical problems. Take the terms-of-trade externality as an example.

Increasing domestic terms-of-trade using export restrictions works the following way. There are a large number of small firms in an industry. None of these firms holds market power. The industry as a whole, however, has some margin to influence world market prices. If the country introduces export taxes, it substitutes for the lack of market power by its domestic firms. The optimal tariff in that case eventually mimics the behaviour of one supplier with market power (Helpman & Krugman, 1989). The rule of thumb is that the tax should be set as the inverse of the absolute price elasticity of demand.

Assuming for an atomistic industry structure appears not very realistic in mining or steel sectors. Firms are often large enough to enjoy market power and market power changes the rationale of optimum tariffs. Companies internalise some degree of the industry's market power. Therefore, the more concentrated an industry is, the smaller is the optimal tariff (Helpman & Krugman, 1989). Rodrik (1989) reviews this result taking into account asymmetric firm size. He shows that tariffs should actually differ by size of the exporting firm. Since larger firms have more market power, their exports should be taxed at a lower rate than those of smaller firms. The consideration gets even more complicated when taking into account other aspects like endogenous firm (De Santis, 2000) or sellers' market power (Oladi & Gilbert, 2012). Picking the optimal tariff is obviously a challenge from the theoretical perspective.

Empirical problems add up to the theoretical ones. Firstly, governments need to understand the structure of both resources and steel sectors well enough to choose the right model. Then there is the problem of estimating the demand elasticity correctly. For example, Warr (2001) lists estimates for the demand for rice exports from Thailand in a range from -4 to -1.07. If perfect competition is assumed for both on the supply and demand side, the implied optimal tariffs ranges between 25% and 93.5%.

5.3.3 Prisoners' Dilemmas and Multilateral Agreements

Countries face the possibility to increase their citizens' welfare on others' expenses by manipulating terms-of-trade or by relocating industries using trade restrictions. These incentives exist for all countries, turning it into a strategic problem. If all countries introduce trade barriers, the restrictions will offset each other. Then, nobody is able to gain relative to other nations, but overall trade is at inefficiently low levels. This is a typical prisoners' dilemma situation.

The General Agreement on Tariffs and Trade (GATT) and later the World Trade Organization (WTO) were created to overcome the strategic problem of these beggar-thy-neighbour policies. There are two main characteristics making them so successful (Bagwell & Staiger, 1999; Ossa, 2011). The principle of reciprocity and the most favoured nation principle.

Reciprocity means that reductions in trade restrictions are designed to leave relative trade flows unchanged when renegotiating trade barriers. This avoids possibilities for countries to exploit each other in trade negotiations. The most favoured nation principle codifies non-discrimination between trade partners. It means that the lowest tariff a country has with one trade partner needs to be applied to all other trade partners as well. This avoids distortions imposed on third-party countries.

The mechanisms of GATT and WTO have worked well in the case of import tariffs. But as seen before, export restrictions are only dealt with insufficiently. The current framework leaves ambiguities about the rules. Countries can feel free to explore the loopholes. It appears that there is a margin allowing countries with market power in resources markets to implement beggar-thy-neighbour policies.

5.4 Political Economy of Export Restrictions

5.4.1 Idea of and Conditions for Successful Lobbying

The beggar-thy-neighbour type of policies is not only possible between, but also within countries. Groups of people or industries can use partisan policy and lobbying to increase their welfare on the expenses of others.

Policy makers do not only benefit from maximising the welfare of their people, but they can also gain from specifically turn towards particular groups which return the favour by what Grossman and Helpman (1994) term “contributions”. Which form these contributions take is of minor importance for the discussion. One can imagine everything from support of electoral campaigns to bribery. The objective of a policy maker can then be interpreted as the weighted sum of the overall welfare and these contributions.

There are some characteristics of countries and industries making it more probable to find successful lobbying activities. One of those is industry concentration. It is more likely to see lobbying in industries which are concentrated. In a sector with many small firms, a firm investing into influencing policy in favour of its sector will only benefit to a negligible degree from its efforts. The other firms can free-ride. The more concentrated an industry is, the more each firm internalises the benefits of its lobbying activities. That increases incentives for lobbying.

Large industries should see more protection than small ones. They represent a larger share of the population and thereby voters and should find it more easy to lobby for measures in their favour.

When the government weighs the welfare of its citizens and contributions by lobbying groups, the weightings become important for how much incentive exists for lobbying. One can argue that democratic governments, for which the welfare of their population is more directly important than for dictatorships, will put higher weight on the overall welfare. This is empirically confirmed by Mitra et al. (2002) in the case of Turkey.

A last aspect is competition between lobbying groups. Grossman and Helpman (1994) show that, in the extreme case in which every industry is represented by a lobbying group, these activities offset each other leading to free trade.

Mining and stainless steel production are both capital-intensive sectors. Restrictions on nickel, chrome, molybdenum, or scrap exports benefit stainless steel producers. They have an incentive to lobby in favour of such measures. Mining companies will plausibly have lobbying power themselves, counteracting steelmakers. Scrap sectors, however, do often consist of a large number of small firm and exhibit less possibilities to lobby in their favour. Export barriers on scrap metals should therefore be encountered more often than on virgin metals.

5.4.2 Choice of Instruments

Export restrictions are, in many cases, only a second-best instrument. Also for a lobby group, a direct subsidy appears to be the preferable way to appropriate wealth at first glance. Nonetheless, export restrictions could be preferable instruments for lobby groups. Firstly, transfers through export restrictions are rather intransparent and leave room for rent sharing between government officials and lobby groups. Secondly, export restrictions can be justified using patriotic arguments. "Our country suffers from the environmental damages of extraction, therefore we should consume the metals ourselves" or "We should not sell our national wealth in resources" can be communicated to the public more easily than a direct subsidy.

Not only the existence or the tightness of export restrictions might be subject to lobbying activities, but also the choice of instruments. As seen before, binding quantitative export restrictions create rents. These rents do not necessarily accrue to the government. Particularly in countries with weak institutions, it is plausible that these rents form another channel to transfer welfare towards specific groups. We therefore hypothesise that countries with weak institutions are more likely to introduce quantitative export restrictions than taxes and particularly more intransparent mechanisms to allocate these quotas.

5.5 Intermediate Conclusions

5.5.1 Three Country Prototypes

In this section, we outlined arguments speaking in favour of export restrictions. These reasons can be grouped into three types of arguments. The first type is externalities that even a benevolent worldwide planner would have to deal with. Countries need some source of government revenue, they might be stuck in a low development level because of learning externalities or they suffer from environmental consequences of mining. It becomes clear that export restrictions are, in all cases, second-best instruments which should only be chosen if better policy measures are unavailable. This is plausibly only the case in countries with weak institutions.

A second group of arguments stems from national policy making. Governments might be able to use instruments which increase their people's welfare while imposing parts of their instruments' costs on other countries. The rules of the WTO, which limit the possibilities for import restrictions, do not work as well for export tariffs and quotas. Arguments for strategic trade policy apply mostly to countries exhibiting market power. Determining an optimal tariff level is both theoretically and empirically challenging, however.

A third group of reasons explaining export restrictions is lobbying activities. It might be the case that export barriers are perceived as the line of least resistance for groups seeking transfers favouring themselves. Successful lobbying is most probable where a large and concentrated steel sector encounters an unconcentrated resources or scrap collection sector and weak institutions.

This discussion shows that incentives for countries to restrict exports of inputs into stainless steel production depend on several factors. They include the industrial structure of the steel industry, the institutional quality of a country, or the state of development. We condense this reasoning into three country prototypes which represent groups of nations sharing similar characteristics. These prototypes are useful when interpreting the empirical results in the following chapters.

5.5.2 The Developed Country

The 'developed country' is, as the name suggests, a nation exhibiting high levels of GDP per capita. Most nations in this group do not exhibit market power in virgin metal markets. Many developed countries possess large stocks of scrap metal potentially giving them some market power on scrap markets. The developed country's economy is highly diversified. That reduces its dependency on basic industrial sectors and on tariffs as a source of revenues. Institutions are strong in the developed country. The government is able to counteract environmental damages due to mining and resources use well. Good institutional quality also limits the possibilities for special interest policies. We expect the developed countries to typically abstain from using export restrictions in order to continue reaping the benefits of free trade.

5.5.3 The Resource-rich, Industrialising Country

The 'resource-rich, industrialising country' exhibits a medium level of income and GDP per capita. It does have power in one or more raw material markets, but less in scrap markets. It has limited comparative advantage in downstream industries and services sectors, but export restrictions on primary goods are perceived as an instrument to generate those. The resource-rich, industrialising country does not need export taxes as a major source of government revenue. Environmental regulation exists, but is less strict and less strongly enforced than in developed countries. The combination of market power and agglomeration problems yields strong incentives for beggar-thy-neighbour policies. Resource-rich industrialising countries are expected to have an elevated propensity to exploit their market power, both in order to increase world market price of their exports and to support growth in downstream sectors.

5.5.4 The Developing Country

Per capita income and GDP are low in the developing country. It does hold market power neither in resource markets nor in scrap markets. Export tax revenue contributes a non-negligible part to the government budget. Both environmental and learning-by-doing externalities are present, while good instruments to internalise them are unavailable. The lack of market power limits incentives for restricting exports. Developing countries might still use export barriers. In these cases, they are caused by a combination of weak institutions and successful special interest policies at the domestic level.

6 Export Restrictions on Inputs in Stainless Steel Production

This chapter investigates export restrictions for the most important raw materials used in stainless steel production empirically: nickel (Ni), chromium (Cr), molybdenum (Mo), and stainless steel scrap. These four inputs together account for a share of 98.2% of the monetary value of raw materials used in stainless steel production (Posch, 2011).

Our basic source of data is the OECD's inventory of restrictions on exports of raw materials (Fliess & Mård, 2012). The data is updated to include information for 2011 to 2013. Further export barriers are added to the data. It should be noted that we do not claim to present a complete dataset of export restrictions for 2007 to 2012. A large number of export restrictions are not readily available. To our knowledge, this database is still the most comprehensive overview over export restrictions applied on the four most important raw materials used in stainless steel production.

6.1 Nickel

6.1.1 Current Export Restrictions

Table 5 displays export restrictions on nickel ores, concentrates, and intermediates from 2007 to 2012. The first column lists the specific good and its corresponding Harmonized System (HS) code. The second column shows the country applying the measure, the third one which type of measure is used. Export barriers imposed by countries which are among the top five producers are highlighted with a red frame. The other tables displaying export restrictions have the same formats.

Ores, Concentrates and Intermediates								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Nickel ores and concentrates (260400)	China[7]	Export tariff	10%	15%	15%	15%	15%	15%
	China	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes
	Dominican Republic	Export tariff	5%	5%	5%	5%	5%	5%
	Indonesia[8]	Export tariff	-	-	-	-	-	20%
	Indonesia	Licensing requirement	No	No	No	No	No	Yes
	Philippines	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes
	Grenada[9]	Licensing requirement	NA	NA	NA	NA	NA	NA
Nickel mattes (750110)	Russia	Export tax	5%	5%	5%	5%	5%	5%

Table 5: Export restrictions on nickel ores, concentrates, and intermediates

Prior to 2012, Russia was the only one of the top five nickel mining countries making use of export barriers. Canada, Australia, and France (New Caledonia) do not employ restrictions. The most important change in 2012 is the introduction of an export licensing system and export taxes in Indonesia. These measures are part of a larger plan eventually prohibiting the exports of nickel ores and concentrates completely. It is discussed in greater detail in the sec-

[7] Data from Metal-Pages (2013).

[8] Jensen & Chatterjee (2012).

[9] The export restrictions on ores in Granada are listed in the OECD Database, but no details are available.

tion on future developments. China also restricts its exports of nickel ores, but its production is comparatively small.

Class I Nickel								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Nickel, not alloyed (750210)	China	Licensing require-ment	Yes	Yes	Yes	Yes	Yes	Yes
	Russia	Export tax	5%	5%	-	5%	10%	2.117,8 / 1245.5 / 1447.6 USD/t
Nickel powders and flakes (750400)	Viet Nam	Export tax	5%	5%	5%	5%	5%	5%

Table 6: Export restrictions on Class I Nickel

Class II Nickel								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Ferronickel (720260)	China	Export tax	10%	20%	20%	20%	20%	20%
	China	Licensing requirement	No	No	No	Yes	No	No
	Argentina	Export tax	5%	5%	5%	5%	5%	5%
Nickel oxide sinters and other … (750120)	China	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
	Russia	Export tax	5%	5%	5%	5%	5%	5%

Table 7: Export restrictions on Class II Nickel

Table 6 and Table 7 display export restrictions on class I and class II primary nickel. Argentina does apply taxes on the exports of a large set of raw materials and will therefore appear in the tables for other metals as well. It does, however, not play a major role in any of the markets analysed in this study.

While China does not produce a large amount of nickel ores, it is important in producing ferronickel (and NPI) and plausibly exhibits market power in the market for this input in stainless steel production. China introduces the measure at the level where it starts possessing market power.

Russia does not tax exports of ores and concentrates except for mattes, but class I and class II nickel products. While most export tariffs remained constant over time, the taxes on non-alloyed nickel were changed several times between 2007 and 2012 (see Table 8). The export tax started at a rate of 5% in 2007, but was abolished in January 2009, allegedly to curb losses of the Russian nickel industry, in particular Norilsk Nickel (Burns, 2009). An export tax of 5% was reintroduced in December that year and raised to 10% one year later. In April 2011, a new system of taxing nickel exports was introduced (Government of the Russian Federation, 2011a). Export duties are levied per ton. The tax rate is bound to the LME price and revised regularly. Under this new system, taxes were changed in December 2011, March 2012, and June 2012. Currently Norilsk again seeks a tax exemption, which the company justifies by weak metal markets. It is, according to media reports, unlikely that the Russian Government will follow their arguments (Devitt & Prentice, 2013).

In force since	Tax rate	Source
January 2007	5%	Government of the Russian Federation (2006)
January 2009	0%	Government of the Russian Federation (2009a)
December 2009	5%	Government of the Russian Federation (2009b)
December 2010	10%	Government of the Russian Federation (2010)
December 2011	2.117,8 USD/t (≈ 12%)[10]	Government of the Russian Federation (2011b)
March 2012	1245.5 USD/t (≈ 7%)[11]	Government of the Russian Federation (2012a)
June 2012	1447.6 USD/t (≈ 9%)[12]	Government of the Russian Federation (2012b)

Table 8: Russian export taxes on non-alloyed nickel from 2007 to 2012

6.1.2 Outlook

The most important events concern Indonesia. On May 6th 2012, the world's biggest producer of nickel ores introduced a new regulation which excludes all mining firms from exporting their ores unless they submit plans to construct smelting and processing facilities. Additionally, a 20% export tax is levied on ore exports. 14 minerals, including nickel ores, are part of that regulation. The export of minerals is announced to be banned completely in 2014 (Jensen & Chatterjee, 2012). The prohibition may be delayed to 2015 or 2016, depending on the progress in construction of smelters. The lower bound of purity is cited to be a 70% nickel matte (International Nickel Study Group, 2012). The regulation was motivated by the aim to move up the value chain and not only export ores and intermediate products, but also pure metals. It will particularly affect the Chinese NPI Production, which relies heavily on Indonesian ore imports. Also Japan, which imports large shares of its Nickel ores from Indonesia, will be directly affected by the export barriers.

[10] Compared to the LME price in December 2011

[11] Compared to the LME price in March 2012

[12] Compared to the LME price in June 2012

6.2 Chromium

6.2.1 Current Export Restrictions

Ores and Concentrates								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Chromium ores and concentrates (261000)	China	Export tax	10%	15%	15%	15%	15%	15%
	Dominican Republic	Export tax	5%	5%	5%	5%	5%	5%
	Grenada[13]	Licensing requirement	NA	NA	NA	NA	NA	NA
	India	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
	India	Export tax	3000 Rs/t[14]	3000 Rs/t	3000 Rs/t	3000 Rs/t	30%	30%
		Other export measures: Congestion charge	-	-	-	20%	20%	-
	Philippines	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes
	Zimbabwe[15]	Export tax	-	-	-	15% / 20%	20%	-
	Zimbabwe	Export prohibition	Yes	Yes	Yes	No	Yes	Yes

Table 9: Export restrictions on chromium ore and concentrates

Two of the five most important producers of chromite ores – India and Zimbabwe – have introduced restrictions on their exports. Kazakhstan, South Africa and Turkey refrained from such measures so far. There were some debates in

[13] The export restrictions on ores in Granada are listed in the OECD Database, but no details are available.

[14] An export tax of 3,000 RS / t is in act since 1st of March 2007 (WTO, 2011a).

[15] The export tax on Chromium was set at 15% from January to August 2010, and raised to 20% thereafter (WTO, 2011b).

Kazakhstan about extending the export taxes on oil onto minerals in the past (Foster, 2010).

India implemented export taxes on chromium ores and concentrates in 2007 at a level of Rs 2,000 per ton (Korinek & Kim, 2010) and raised them to a level of Rs 3,000 per ton in March 2007 (WTO, 2011a). In 2011, the taxation was changed to an ad valorem tariff of 30% (Central Board of Excise and Customs, 2011). The effects of the export tariffs can be seen in the decline of chromite exports to China described above, but starting already in 2007. Korinek and Kim (2010) report that the introduction of export restrictions resulted in a shift from foreign to domestic demand, rather than in a decline of Indian chromium production.

Zimbabwe also restricts exports of chromium ores. While there was a ban on exports of unprocessed ores in place since 1996, it did not seem to have a major effect. In 2010, an export tax of 15% was introduced and in the same year raised to 20%. In April 2011, exports were prohibited again (WTO, 2011b). This ban is rumoured to be abolished in 2013 (Zinyuke, 2013).

Ferrochrome								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Ferrochromium (720241, 720249, 720250)	Argentina	Export tax	5%	5%	5%	5%	5%	5%
	China[16]	Export tax	10%	20%	20%	20%	20%	20%
	China	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: Export restrictions on ferrochrome

[16] Data for current tax rates from (Metal-Pages, 2013).

Chromium Metal								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Chromium Unwrought; powders (811221)	China	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
	South Africa	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes

Table 11: Export restrictions chromium metal

China is the only major producer of ferrochrome restricting the exports of this good. One can see a similar pattern as for the ferronickel. China does not have major sources of the ore, but is an important producer of ferrochrome. It does restrict the export of the material, introducing an element of subsidies for these inputs in stainless steel production.

6.2.2 Outlook

The introduction of export restrictions on chromium ores by India has allegedly shifted trade flows significantly. Indian exports to China declined after their introduction, both in relative and absolute terms. South African chromite replaced the Indian exports. The implied price rise in South Africa put a burden on domestic ferrochromium and steel producers. This led to a debate about the introduction of export restrictions in South Africa, counteracting the Indian ones. The debate is on-going for some years already (Korinek & Kim, 2010). Currently, an export tax of 100 USD/t is discussed.

It should be mentioned, however, that South African ferrochrome producers do not only suffer from high prices of their raw material, but also from cost disadvantages due to unstable and expensive electricity supply (Seccombe, 2012) and insufficient transportation infrastructure.

6.3 Molybdenum

6.3.1 Current Export Restrictions

Ores and Concentrates								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Molybdenum ores and concentrates (261310, 261390)	China[17]	Export tax	10%	15%	15%	15%	15%	15%
	China	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
	China[18]	Export quota	-	33.9 kt	33.9 kt	33.9 kt	33.9 kt	33.2 kt
	Dominican Republic	Export tax	5%	5%	5%	5%	5%	5%
	Grenada[19]	Licensing requirement	NA	NA	NA	NA	NA	NA
	Philippines	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes
	Russia[20]	Export tax	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%

Table 12: Export restrictions on molybdenum ores and concentrates

[17] Data for 2007 from Korinek and Kim (Korinek & Kim, 2010).

[18] Shared quota for ores and concentrates as well as Ferromolybdenum with a total amount of about 33,900 tons (Fliess & Mård, 2012).

[19] The export restrictions on ores in Granada are listed in the OECD Database, but no details are available.

[20] Only for non-roasted ores and concentrates (Fliess & Mård, 2012).

Ferromolybdenum								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Ferro-molybdenum (720270)	Argentina	Export tax	5%	5%	5%	5%	5%	5%
	China[21]	Export tax	10%	20%	20%	20%	20%	20%
	China	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
	China[22]	Export quota	-	33.9 kt	33.9 kt	33.9 kt	33.9 kt	33.2 kt

Table 13: Export restrictions on ferromolybdenum

Molybdenum Metal								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Molybdenum Metal: Powders (810210); Unwrought (810294)	China[23]	Export tax	15%	15%	10%	5%	5%	5%
	China	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
	China[24]	Export quota	-	4.340 t	2,300 t	3,830 t	3,830 t	3,750 t
	Russia	Export tax	NA	NA	NA	NA	6.5%	6.5%
	Viet Nam	Export tax	5%	5%	5%	5%	5%	5%

Table 14: Export restrictions on molybdenum metal

Export restrictions on molybdenum are mostly a Chinese phenomenon (see Table 12, Table 13, and Table 14). There are export taxes on molybdenum ore in Russia, but the Russian output does only account for 1.6% of worldwide production (U.S. Geological Survey, 2013c). Argentina has export taxes on fer-

[21] Data for current tax rates from (Metal-Pages, 2013)

[22] Shared quota for ores and concentrates as well as ferromolybdenum (Fliess & Mård, 2012).

[23] Data for current tax rates from (Metal-Pages, 2013).

[24] Shared quota for molybdenum powders, unwrought molybdenum and molybdenum scrap (Fliess & Mård, 2012).

romolybdenum, but is not a major producer of that good either. The other countries supplying a large share of world markets, such as the US, Chile, and Peru, do not employ export restriction on it.

Chinese export restrictions on molybdenum were implemented in 2007 and tightened over time (Korinek & Kim, 2010). They mainly consist of two elements: an export tax and an export quota system. The taxes differ between molybdenum products and vary over time. Two export quotas are in place. One covers ores, concentrates, and ferromolybdenum and the other one pure metals and scrap of molybdenum. Export licenses are allocated by the Ministry of Commerce (MOFCOM), which further limits the exports and allows for some discretion when deciding which firms are allowed to export (Price et al., 2008).

6.3.2 Outlook

The comprehensive export restrictions on molybdenum employed China have led to countermeasures by importing countries. In March 2012, the EU, the US, and Japan jointly requested consultations about Chinese export restrictions at the WTO. Since the consultations did not lead to an agreement, a panel was established to resolve the conflict. The dispute not only concerns molybdenum, but also tungsten and the rare earth elements. Future export restrictions by China could be heavily influenced by the WTO's decision on this case.

6.4 Stainless Steel Scrap

6.4.1 Current Export Restrictions

Stainless Steel Scrap (720421)							
Country	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Algeria	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
Argentina	Export tax	5%	5%	5%	5%	5%	5%
Argentina[25]	Export prohibition	No	No	No	Yes	Yes	Yes
Azerbaijan	Export prohibition	Yes	Yes	Yes	NA	NA	NA
Belarus	Export quota	No	No	No	Yes	Yes	Yes
Burundi[26]	Export prohibition	No	No	No	Yes	Yes	Yes
China[27]	Export tax	-	-	40%	40%	40%	40%
Dominican Republic	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
Egypt	Export tax	1500 LE/t	1500 LE/t	1500 LE/t	1500 LE/t	1500 LE/t	1500 LE/t
Ghana	Export prohibition	Yes	No	No	No	No	No
Guinea	Export tax	25000 GNF/t	25000 GNF/t	25000 GNF/t	25000 GNF/t	NA	NA
Guyana	Export prohibition	No	No	No	Yes	No	No
Guyana	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
Iran[28]	Export tax	-	30%	NA	50%/ 70%	70%	70%

[25] The export ban mentioned in the OECD Inventory of Restrictions on Exports of Raw Materials ended in 2011. In 2012, an export ban was (re-)introduced (Ministerio de Industria, 2012).

[26] East African Community (2010).

[27] Chinese export tax in 2007 from American Scrap Coalition (2008).

[28] In 2008, Iran implemented an export tax on scrap (Fars News Agency, 2008). According to OECD (2010), it was increased to 50% by 2010. In 2010, the tax was raised again to 70% (Steel Orbis, 2010).

Stainless Steel Scrap (720421)							
India[29]	Export tax	NA	15%	15%	15%	20%	20%
Indonesia	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
Jamaica	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
Kenya	Export prohibition	No	No	No	Yes	Yes	Yes
Kuwait[30]	Licensing requirement	NA	NA	NA	NA	NA	Yes
Malaysia	Export prohibition	Yes	Yes	No	No	No	No
Malaysia	Export tax	10%	10%	10%	10%	10%	10%
Malaysia	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes
Morocco[31]	Licensing requirement	No	No	Yes	Yes	Yes	Yes
Nigeria	Export prohibition	NA	NA	Yes	Yes	Yes	Yes
Pakistan	Export tax	25%	25%	25%	25%	25%	25%
Paraguay	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes
Russia[32]	Export tax	15%	15%	15%	15%	15%	12.5%
Rwanda	Export prohibition	No	No	No	Yes	Yes	Yes
South Africa	Licensing requirement	No	Yes	Yes	Yes	Yes	Yes
Sri Lanka	Export tax	10%	10%	10%	10%	10%	10%
Sri Lanka	Licensing requirement	No	No	Yes	Yes	Yes	Yes
Tanzania	Export prohibition	No	No	No	Yes	Yes	Yes
Uganda	Export prohibition	No	No	No	Yes	Yes	Yes

[29] Central Board of Excise and Customs (2011).

[30] According to WTO (2012a). It is unclear, when the measure was implemented.

[31] The licensing system covers a larger number of scrap metals, including steel scrap (Ministere du Commerce Exterieur, 2009).

[32] Russia reduced its export tax on ferrous scrap after accession to the WTO in 2012 (WTO, 2011d).

Stainless Steel Scrap (720421)							
Ukraine[33 34]	Export tax	30%, min 0.4 €/kg	30%, min 0.4 €/kg	27%, min 0.36 €/kg	24%, min 0.32 €/kg	21%, min 0.28 €/kg	18%, min 0.24 €/kg
United Arab Emirates	Export tax	Dh 250 / t	Dh 250 / t	Dh 250 / t	Dh 250 / t	Dh 250 / t	Dh 250 / t
Uruguay[35]	Export prohibition	Yes	Yes	Yes	Yes	Yes	Yes
Zambia	Export tax	25%	25%	25%	25%	25%	25%
Zimbabwe[36]	Export prohibition	NA	NA	NA	Yes	Yes	Yes
Viet Nam[37]	Export tax	45%	40%	37%	33%	29%	22%

Table 15: Export restrictions on stainless steel scrap

Table 15 lists export barriers on stainless steel scrap. It is striking how many export restrictions are implemented on scrap metal. More than 30 countries make use of instruments limiting exports of stainless steel scrap. Most of these countries are lower-middle-income economies (13 of 34) or upper-middle-income economies (10 of 34) according to the World Bank's classification. Seven of the countries implementing export restrictions are low-income economies. Four are high-income countries (Kuwait, Russia, the United Arab Emirates, and Uruguay). The low-income economies are particularly strict, six of the seven ban stainless steel exports completely. Figure 27 highlights all countries which are part of our database of nations restricting exports of stainless steel scrap.

[33] According to the report of the accession to the WTO, where decreasing export taxes on scrap were agreed upon (WTO, 2008). Note that stainless steel scrap (HS code 720421) is listed two twice with different export taxes.

[34] Ukraine does not levy export taxes on chromium and molybdenum scrap (WTO, 2008).

[35] WTO (2012b).

[36] WTO (2011b).

[37] According to the WTO Accession Protocol (WTO, 2006).

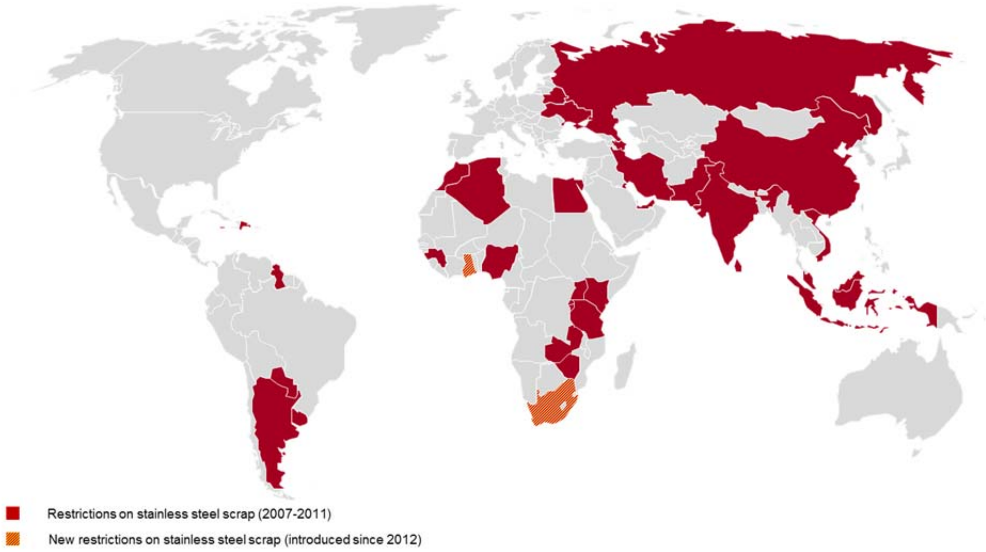

Figure 27: Export restrictions on stainless steel scrap[38]

Export restrictions on stainless steel scrap are often part of more general export barriers for scrap metals. Some countries implement additional barriers on the exports of nickel, chromium or molybdenum scrap. Table 16 displays (further) export restrictions applied on scrap of nickel, chrome and molybdenum. Argentina has a higher export tax on this type of scrap metals, and so has Sri Lanka. Russia has a higher export tax on nickel, but a lower one for chromium and molybdenum scrap. China particularly restricts exports of molybdenum scrap.

[38] The authors thank Katja Mehlan for preparing this figure.

Specific Regulations on Scrap of Nickel, Chromium, and Molybdenum								
Commodity	**Country**	**Measure**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Nickel waste and scrap (750300)	Argentina	Export tax	40%	40%	40%	40%	40%	40%
	China	Export tax	-	10%	10%	10%	10%	10%
	Mauritius[39]	Licensing requirement	No	No	Yes	Yes	Yes	Yes
	Russia	Export tax	30%	30%	30%	30%	30%	30%
	Sri Lanka	Export tax	25%	25%	25%	25%	25%	25%
Chromium Waste and scrap (811222)	Argentina	Export Tax	40%	40%	40%	40%	40%	40%
	Mauritius	Licensing requirement	No	No	Yes	Yes	Yes	Yes
	Russia	Export tax	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
	Sri Lanka	Export tax	25%	25%	25%	25%	25%	25%
Molybdenum Waste and scrap (810297)	Argentina	Export tax	40%	40%	40%	40%	40%	40%
	China	Export tax	15%	15%	15%	15%	15%	15%
	China	Licensing requirement	Yes	Yes	Yes	Yes	Yes	Yes
	China[40]	Export quota	-	4,340 t	2,300 t	3,830 t	3,830 t	3,750 t
	Mauritius	Licensing requirement	No	No	Yes	Yes	Yes	Yes
	Russia	Export tax	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
	Sri Lanka	Export tax	25%	25%	25%	25%	25%	25%

Table 16: Export restrictions on nickel, chromium, and molybdenum scrap

[39] The Consumer Protection (Scrap Metal) Regulations 2007 list the metals affected in detail. Interestingly, stainless steel scrap (HS code 720421) is not among them (Ministry of Industry, 2007).

[40] Shared quota for molybdenum powders, unwrought molybdenum and molybdenum scrap (Fliess & Mård, 2012).

6.4.2 Outlook

It appears as if the already large number of export restrictions on scrap metals will increase even further in the near future. An example where the new regulation is already in effect is Ghana. In 2013, the African country introduced a new law prohibiting the export of ferrous scrap (Ministry of Trade & Industry, 2013). From 2002 on, a temporary export ban on ferrous scrap was in place. In 2008, a more flexible licensing system was introduced (GNA, 2013). This system is now abolished in favour of an export prohibition again.

The introduction of an export tax on scrap exports is currently discussed in Brazil. The debate mainly takes place between the steel industry and the scrap collectors, a sector consisting of many small scale firms in Brazil (Parra-Bernal, 2012).

A complex system for restricting exports of metal scrap was discussed in South Africa. It is set up as a price preference system. Before firms can receive a license to export, they are obligated to offer the scrap to domestic buyers at a price 20% below the relevant reference prices. Only if no domestic customer is willing to buy the scrap within 15 working days, the firm is allowed to export. The measure is explicitly aiming to “counter de-industrialisation”, “improve the competitiveness of downstream industries”, and to “create decent jobs”. This measure will apply not only to steel scrap (including stainless scrap) but also to nickel, molybdenum, aluminium, and copper, among others (International Trade Administration Commission of South Africa, 2013a, 2013b, 2013c). The export preference system was announced to come into force in September 2013 (Markram, 2013a) and legally challenged shortly the announcement by the South African Metal Recyclers Association (Markram, 2013b).

7 Background for European Policy Decisions

7.1 Intermediate Results from Theory and Empirics

The analysis of export restrictions enacted on the four most important inputs in stainless steel production shows that each of the materials has its own 'story'. In the case of nickel, it is the question how Indonesian restrictions on ore exports will affect future nickel markets and nickel pig iron production in particular. For chromium, it will be important if South Africa eventually introduces export restrictions on its ore exports. The WTO currently plays the most important role for molybdenum deciding if China has to abolish or to relax its export barriers. In the case of scrap, it seems as the world is getting closer to a classical prisoner's dilemma situation with an already large and further increasing number of restrictions in place.

Beyond the specific stories, the data in chapter 6 confirms the theory presented in chapter 5.

Nations best described by the developed country prototype do not implement export restrictions. The only high-income countries appearing in the data are Kuwait and the United Arab Emirates. Nations such as the USA, Japan, or the EU member states do not restrict exports of inputs in stainless steel production.

Exports of nickel, chromium, and molybdenum are almost exclusively in force in resource-rich, industrialising countries.[41] The picture is distinctively different for scrap metals. While a lot of industrialising countries hinder scrap exports, we also find export restrictions in many developing nations. Altogether, the largest number of export barriers is found for scrap metals.

It should be noted that not all nations matching the resource-rich, industrialising country prototype make use of export restrictions. Chile and Peru are examples for nations within this group choosing not to restrict exports.

[41] Both Grenada and the Dominican Republic restrict ore exports but do not possess notable production of the metals in the scope of this study.

Having more countries erecting barriers on scrap exports was another theoretical prediction which is confirmed by the data. One the one hand, scrap metals are available almost everywhere, at least in minor quantities. On the other hand, scrap collection sectors often consist of a large number of small firms, particularly in developing countries. These firms lack the lobbying power of a concentrated mining sector which counteracts lobbying activities of concentrated and well-organised scrap consuming firms.

7.2 Key Countries

Based on the data it is possible to identify six key countries. We define key countries as those nations which are among the top five producers of an input in stainless steel production and implement export restrictions beyond licensing requirements (or which might to do so in the near future). Being in the top five productions is a proxy for market power, i.e. for being a large country (see section 4.2) Thereby we want to focus our discussion on those nations which might exhibit the possibility to manipulate world market prices. Table 17 lists the six key countries in alphabetical order and Figure 28 displays them graphically.

Country	Raw Material
China	Nickel, Chromium, Molybdenum, Scrap metals
India	Chromium
Indonesia	Nickel
Russia	Nickel
(South Africa)	(Chromium)
Zimbabwe	Chromium

Table 17: Key Countries

Of those six countries, mostly China and India possess large stainless steel production on a worldwide scale. In 2012, China accounted for 45.5% and India for 6.4% of the total stainless steel output. South African production was

1.42% and the Russian 0.32% of the worldwide production (International Stainless Steel Forum, 2013).

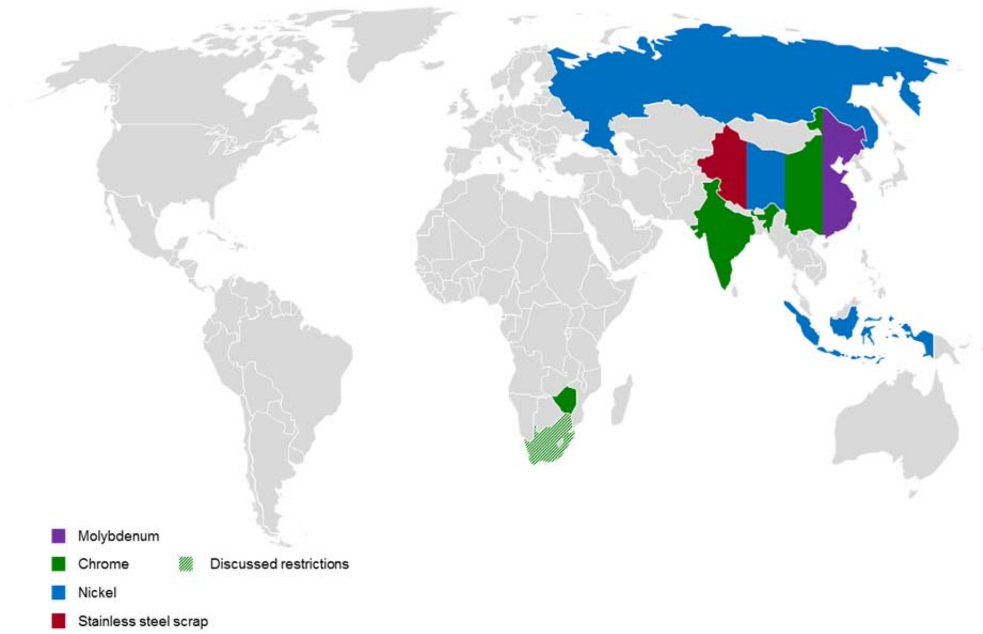

Figure 28: Key countries[42]

China is the most important one of the key countries. It possesses the largest stainless steel production worldwide and restricts exports of all major inputs, at least at some point in the value chain. It should be noted, however, that China itself is dependent on imports of nickel and chromium ores.

India is plausibly the second most important key country. It is among them mostly because of its export restrictions on chromium ores, though export taxes on scrap metals are in force as well.

Indonesia is a key country because of the already implemented export taxes and the announced export bans on nickel ores. These measures affect mostly the trade within Asia, in particular between Indonesia and China.

Export taxes on nickel are the reason why Russia is listed as a key country. The Russian government agreed to abolish export taxes on nickel and molyb-

[42] The authors thank Katja Mehlan for preparing this figure.

denum within four years after the accession of the country to the WTO (WTO, 2011c). Therefore, Russia is expected to be in this group temporarily.

South Africa is the only key country falling into this category because of potential export restrictions. The South African government discusses export duties on chromium ores. If implemented, these trade restrictions might have strong effects on chromium markets.

Zimbabwe is the only developing nation among the key countries. It is still a top five producer of chromium ores, but its production has stagnated in absolute terms and its importance declined in relative terms over the last decade.

7.3 Indication for the Effectiveness of Export Restrictions

A number of export restrictions restrain international sales of all four inputs in stainless steel production investigated in this study. This does not automatically imply that the restrictions have an influence on world markets for those inputs.

Conducting in-depth research on the causal effects of export restrictions on the markets for nickel, chrome, molybdenum, or stainless scrap is beyond the scope of this study. We only display and discuss some data which must only be interpreted as an indication for the effectiveness of export restrictions. Before conducting in-depth quantitative research on export barriers in these markets, all results must be interpreted as indicative and with greatest care.

A first indication of the effectiveness of export restrictions can be found in the markets for class I nickel. Figure 29 shows the prices of nickel at the LME and in China. It can be seen that prices outside China are somewhat higher than inside. On average, they are 2.6% above LME prices. The evidence matches the fact that the People's Republic applies licensing requirements on class I nickel (see Table 6), which are a comparatively soft barrier to exports.

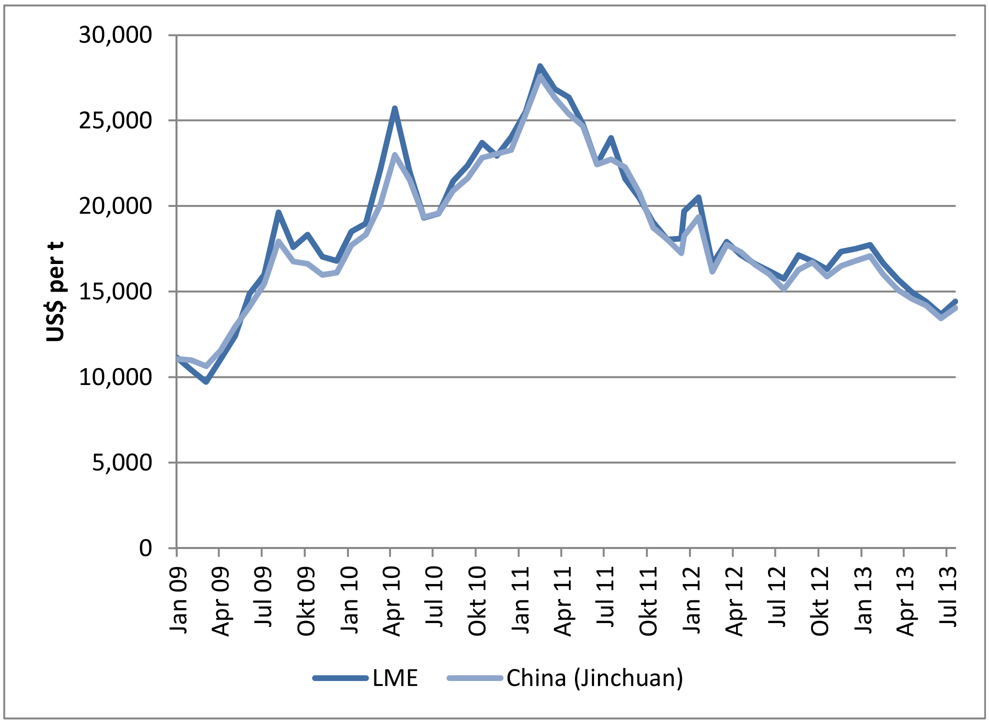

Figure 29: Class I nickel prices at the LME and in China
Source: SMM

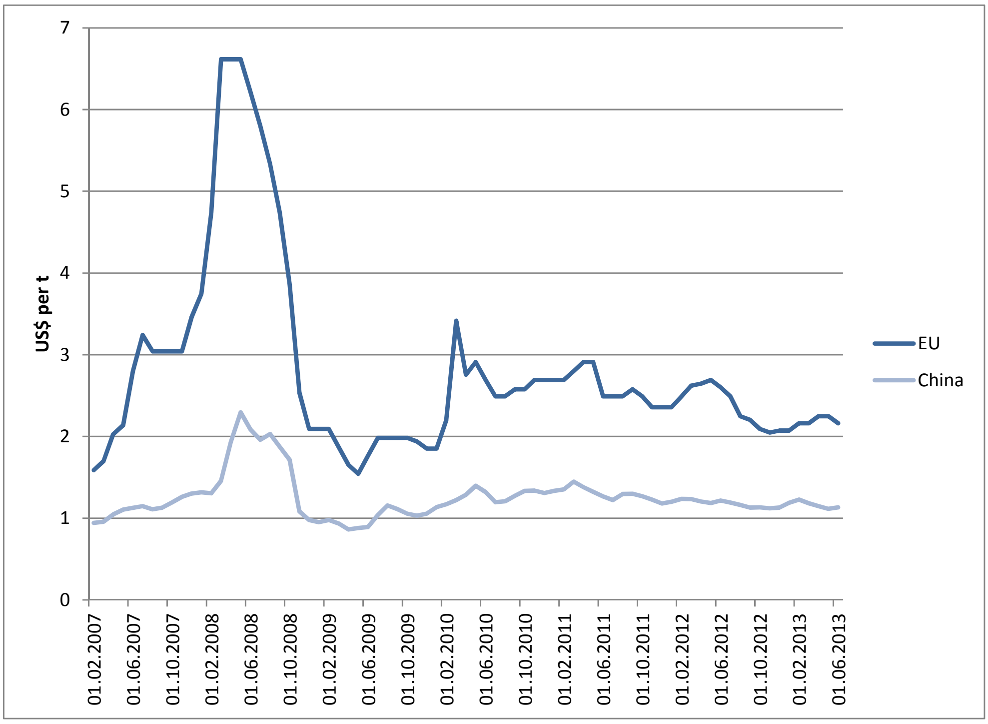

Figure 30: Ferrochrome prices in the EU and China in 1000 US$ per t
Source: asianmetal.com

Figure 30 displays the prices of ferrochrome in the European Union and China in 1000 US$ per ton. Chinese prices are lower over the whole period displayed here. The differences are particularly large during the price spike of 2007 and 2008. In absolute terms, a ton of ferrochrome costs about 1,000 US$ more in the EU than in China. This can only be partly explained by transport costs. In 2007, for example, the OECD's database on maritime transport costs shows costs of 35 US$ per ton of dirty bulk goods shipped from China to Europe.[43]

The data displayed in Figure 30 might be interpreted as an indication that Chinese export restrictions drive a wedge between domestic prices and foreign prices. The price difference could, however, also be influenced by other factors. These include trade restrictions of other countries (e.g. chromite ore ex-

[43] Note that transport costs were particularly high in 2007. They ranged between 22 US$ per ton in 2004 and 14 US$ in 2006. Unfortunately, the OECD's database does not contain more recent data.

ports from India), European import tariffs (see section 8.1.2), or trade costs other than transportation costs. Only an in-depth quantitative assessment can reveal causal effects.

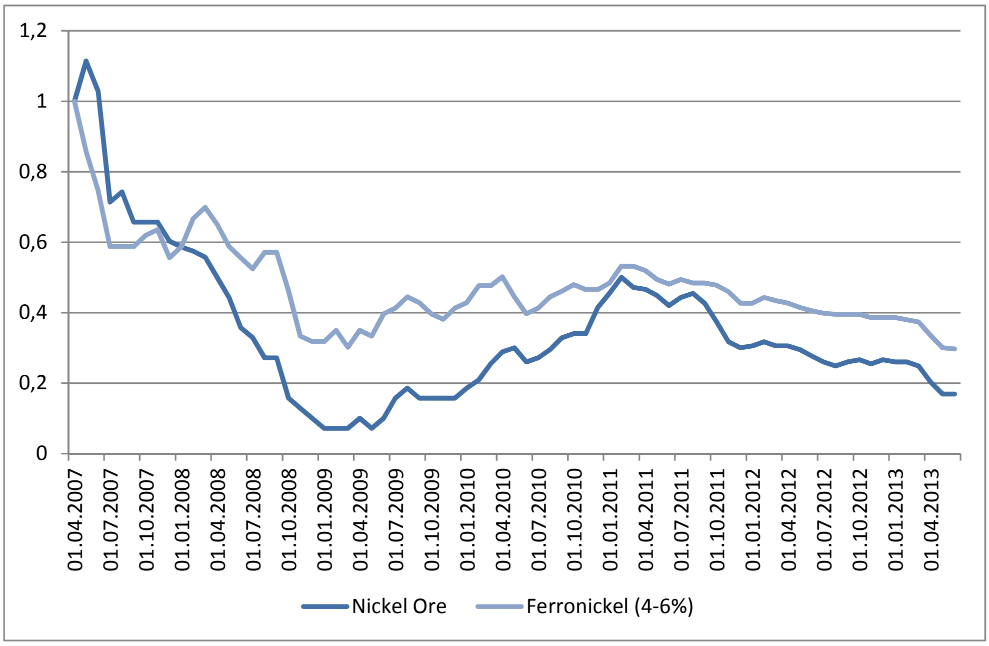

Figure 31: Prices of nickel ore and ferronickel (4-6%) in China rel. to April 2007
Source: asianmetal.com, own calculations

Figure 31 shows the prices of nickel ore and low quality ferronickel, i.e. nickel pig iron, in China. Numbers are normalised to April 2007, the first month for which data is available. Prices are strongly correlated. They fall until early 2009 and remain mostly flat afterwards. In May 2012, the Indonesian government imposed its export tax on nickel ores. No significant movement of prices is visible following this event. Again, this cannot be interpreted as a proof of ineffectiveness of this measure because it is not clear how prices would have evolved without the tax in act. It could, for example, also be the case that buyers and sellers on the market adapted to the new regime before the measure came into force.

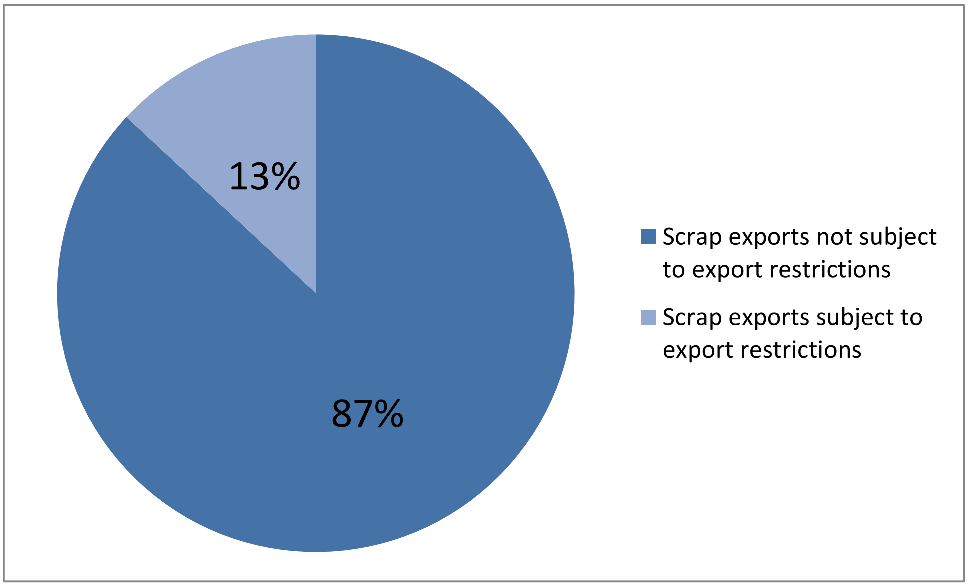

Figure 32: Share of stainless scrap exports subject to export restrictions
Source: UN Comtrade, own calculations

Figure 32 shall give an idea about the importance of export restrictions in stainless scrap markets. It shows which share of gross stainless scrap exports in 2011 came from countries applying export restrictions. Intra-EU trade is excluded from the calculations. Only 13% of all stainless scrap originates from nations restricting their exports.

Again, this graph needs to be interpreted with care. It shows an equilibrium where the export barriers are already in place and it is not obvious how trade flows would look like under free trade. This depends crucially on how elastic trade flows react on changes of trade costs. Without further analysis, the effects of export restrictions cannot be determined reliably.

7.4 The EU's Role in the Markets for Stainless Steel and its Inputs

The EU accounts for a notable share of worldwide stainless steel production. In 2012, 7.5 million tons of stainless steel were produced in the EU, which corresponds to 21.1% of worldwide output.

Europe does not possess notable market power for virgin materials used in stainless steel production. The EU accounts for less than 5% of worldwide nickel and chromium ore production as well as ferrochrome output. These numbers are slightly higher for primary nickel (International Chromium Development Association, 2012; International Nickel Study Group, 2013). There is no notable molybdenum or ferromolybdenum production in the EU (U.S. Geological Survey, 2012).

In the case of stainless scrap, the EU is a major player. 38.7% of the scrap available worldwide comes from the European Union. Up until 2012, the EU was usually a net importer of stainless scrap. Whether or not Europe will become a net exporter of stainless scrap in the future has important policy implications. As long as the EU remains a net importer, it is exposed to foreign export barriers of this input. Without the restrictions, Europe might import even more stainless scrap at lower prices. However, it remains unclear how strong these effects are quantitatively.

It should be noted that Europe is already actively pursuing strategies for raw material issues. A key document is the EU Commission's communication published in 2001 (EU Commission, 2011a, 2011b), outlining the European approach. It rests on three pillars: "1) Fair and sustainable supply of raw materials from international markets. 2) Fostering sustainable supply within the EU. 3) Boosting resource efficiency and promote recycling." (EU Commission, 2008). In 2010, the German Federal Government published a raw materials strategy exhibiting similarities with its European counterpart (BMWi, 2011a). Many of the policy options outlined in the following chapter are considered in these strategies.

8 Policy Options for the EU

8.1 Policies Reducing Impacts of Export Restrictions in Europe

8.1.1 Increasing Transparency

Export restrictions do not only increase the costs of international trade directly, but also imply higher transaction costs. Firms involved in international trade have to inform themselves about regulations in act. In case of export restrictions, data is scarce and scattered. There is a number of reports and scientific papers listing regulations for specific sectors or in specific countries (e.g. Korinek & Kim, 2010b; Price et al., 2008; Price & Nance, 2010; WTO, 2011a). No database provides regularly updated information about export restrictions, however.

European policy can contribute to increasing transparency and lower trade costs by setting up such a database. It could also foster quantitative research on the effects of export restrictions. The work could be allocated to an international organisation such as the WTO. Costs for constructing and maintaining such a database appear limited. We therefore support such a measure.

8.1.2 Abolishing Import Tariffs

An aspect rarely taken into consideration in the debate about trade restrictions on raw materials and import dependency of European industries is tariffs on raw material imports. Both the EU and the USA do indeed levy import duties on chromium and molybdenum. Table 18 lists the import taxes on different forms of these metals in the EU and the US.

Note that the tariffs in Table 18 are general ones. Some countries face lower tariffs due to bilateral trade agreements or due to lower tariffs on imports from developing countries. In the European case, mainly imports from China, the US, and, from 2014 on, Russia are affected by tariffs.[44]

[44] Russia will no longer be part of the EU's Generalised Scheme of Preferences from 2014 on.

	Commodity	HS Code	Import Duty EU (Third country)	Import Duty US (General)
Chromium	Ferrochromium	720241	4.0%	1.9%
		72024910	7.0%	1.9%
		72024950	7.0%	3.1%
		720250	2.7%	10.0%
	Chromium Unwrought; powders	81122110	0.0%	3.0%
		81122190	3.0%	3.0%
Molybdenum	Molybdenum ores and concentrates	261310	0.0%	12.8¢/kg on molybdenum content + 1.8%
		261390	0.0%	17.8¢/kg on molybdenum content
	Ferromolybdenum	720270	2.7%	4.5%
	Molybdenum Metal: Powders	810210	4.0%	9.1¢/kg on molybdenum content + 1.2%
	Molybdenum Metal: Unwrought	810294	3.0%	13.9¢/kg on molybdenum content + 1.9%

Table 18: Import tariffs on chromium and molybdenum in the EU and the US
Source: Taric database, US Harmonized Tariff Schedule

The import tariffs work mirror-image to export taxes. They increase domestic prices for chrome and molybdenum, which benefits the domestic supply at the expenses of the stainless steel sector. Since the EU is an important consumer of these metals, some part of the burden is imposed on the rest of the world. Domestic and international marktes are distorted by the import restrictions.

Welfare effects are detemined analogously to the export restrictions. If Europe exhibits power on chrome and molybdenum markets, it can manipulate the terms-of-trade in its own favor and might also be able to relocate firms producing ferrochrome or ferromolybdenum into the EU. Both production of ferrochrome and ferromolybdenum is limited in Europe, however. Other normative reasons to restrict imports, like environmental or infant industry arguments, do not seem to be of major importance.

Import tariffs can be used as a mechanism to extract resource rents which otherwise accrue in the supplying countries. It is, however, unclear how important these rents are quantitatively. Tariffs might also be used as bargaining chips in future trade negotiations.

It is not clear from qualitative reasoning whether import tariffs on chrome and molybdenum are welfare enhancing for the EU. Therefore, we recommend to analyse them quantiatively and decide on their continuation or abolishment based on that research.

8.2 Policies Reducing Incentives for Export Restrictions Indirectly

8.2.1 Increasing Resource Efficiency and Recycling Rates

Measures increasing resource efficiency and recycling rates are among the most important goals in both the European and German resources strategies (BMWi, 2011a; EU Commission, 2011b). Instruments to achieve these aims include taxes and subsidies, public research or subsidies on private R&D. We will not review them in detail, but outline why they generate incentives to lower foreign export restrictions.

Figure 33 displays the market for an input in stainless steel production. Lets use nickel as an example. In this case, we examine the market from the perspecitve of an importing region like the EU. The international market where it imports from is shown on the left side of Figure 33, whereas the domestic market is on the right side.

D_d0 on the right is the domestic demand before policy intervention, S_d is domestic supply. S_{Res} on the left is the residual supply, the amount of nickel supplied by world markets for every world market price. D_W0 denotes Europe's import demand for nickel. The intersection of S_{Res} and the country's import demand D_W0 is the equilibrium before policy intervention. The country imports an amout of nickel im0 from the world market.

Note that the demand curve is steep. The demand does not react very elastically on price changes, at least in the short run. This matches metals markets well. Take copper as an example. Agostini (2006) presents estimates of the demand price elasticity for copper. The numbers range from -0.19 to -0.47. They are consistently below -1. This means, a 1 % increase in copper prices leads a less than 1 % decrease in copper demand. It is very likely that nickel, chromium, or molybdenum demand behaves similarly.

Assume now that Europe introduces a new technology which makes the use of nickel more efficient. It reduces the demand for the metal. We can assume that it will be used more intensively if prices are high, so the new demand curve D_d1 also turns left. That implies a flatter (more elastic) demand for imports, D_W1.

Recall how incentives to introduce export restrictions depend on the elasticity of demand for imports (see e.g. section 4.5). An elastic (flat) demand curve means that exporting nations impose the costs of their trade barriers on importers and domestic suppliers will bear them. Making import demand in Europe more flexible makes export restrictions in the key countries more costly. This is how increased recycling rates and resource efficency indirectly reduce export barriers.

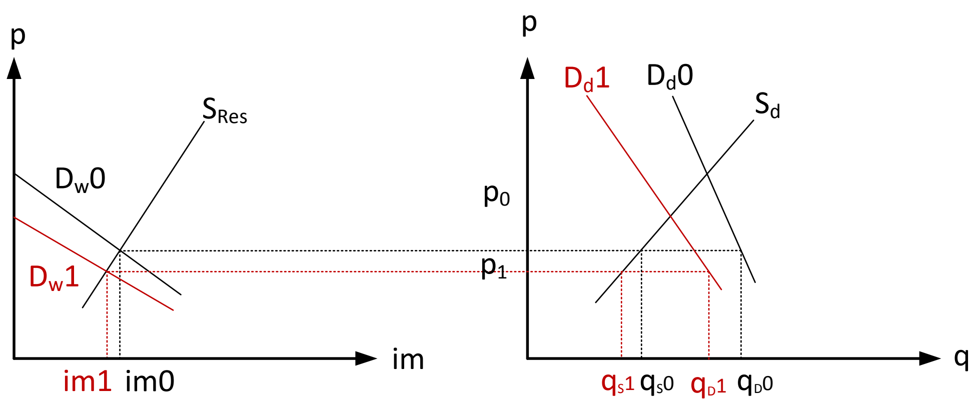

Figure 33: Effects of a Resource Efficiency Policy on Incentives for Export restrictions

Raw materials are costly inputs into production. Private firms have an incentive to use them efficiently. The higher the prices for virgin metals, the larger the incentive not to waste them and to recycle. It is not immedately clear why government intervention is justified to increase resource efficiency and recycling rates. Environmental reasons provide an argument for that.

Measures aiming at resource efficiency and more recycling reduce the necessity to mine and process virgin ores and thereby lower enviromental burdens, including emissions of greenhouse gases (Fraunhofer UMSICHT, 2010; Johnson et al., 2008). Economic justification for intervention is predominantly from market failures due to environmental damages. Implications on trade policies can be seen as a side effect.

Instruments raising resource efficiency and recycling rates can be subject to a rebound effect. Take again the example of a technology reducing nickel inputs in Europe. Saving nickel also saves costs. European industries then can sell their products at lower prices, inducing more demand for those goods. Demand for nickel increases again, because more is produced. The overall nickel demand falls less than the gain in efficiency.

In case of stainless steel, recycling rates are already high today. Between 66% and 70% of stainless steel scrap was reused in the production of stainless steel in the early 2000s, according to Reck et al. (2010). Low hanging fruits are picked already. It is also important to remember that stainless scrap is subject to trade restrictions as well.

R&D is of particular importance among the instruments used to increase resource efficiency and recycling rates. Innovation and research is a key element in both the European and the German raw material strategies. The EU commission states thate there is the “need for innovation along the entire value chain, including extraction, sustainable processing, eco-design, recycling, new materials, substitution, resource efficiency and land use planning” (EU Commission, 2011a). The establishment and of an European Innovation Partnership (EIP) on raw materials and the foundation of the Helmholtz Institute Freiberg for Resource Technology in Germany exemplify policy actions.

We recommend considering public investments in R&D and other measures aimed at increasing resource efficiency. Potential obstacals to higher recycling rates should carefully be examined as well. They gain their economic justification mainly from their effects on more sustainable resource use. Despite being less effective in the short-run, they both lower incentives for introducing export restrictions in the long run by increasing the demand elasticity for inputs.

8.2.2 Fostering Mining in Europe

Another regularly discussed approach to counteract foreign export restrictions on raw materials is increasing mining activities in Europe. When announcing its new European Innovation Partnership on raw materials, the EU Commission stated that it wants to promote mining to "reduce European industry's dependence on non-EU virgin raw materials" (EU Commission, 2013).

Whether mining can contribute to counteracting foreign export restrictions on raw materials is first and foremost a business question. If low cost deposits exist and prices are high enough to make their exploitation profitable, firms will be willing to invest in mining projects.

Policy can influence investment decisions by streamlining licensing processes or by providing information about deposits in Europe. It could also relax environmental regulations. But these regulations reflect the voters' preferences for environmental quality which makes it implausible that regulations will change considerably. It should also be taken into consideration that building-up mining capacities is a time-consuming task. Increased mining will not be effective in the short run.

Providing knowledge about raw material deposits in Europe can be justified by the public good nature of such information. Reducing bureaucratic barriers to investment makes the mining sectors more efficient. Other than that, European policy has only limited influence and no obvious justification for further intervention into the mining sector. There are no obvious market failures justifying such actions. Private firms are likely to be better judges of the commercial viability of resuming mining activities in the EU or its member states.

8.3 Enforcing WTO Rules

As outlined in section 3.2, the WTO rules on export restrictions are weak or, as Karapinar (2012) calls it, "an area of 'under-regulation'". Nonetheless, in some cases WTO regulations might help counteracting export restrictions.

A number of countries committed themselves to confine or to abolish export restrictions when joining the World Trade Organization. These countries include Viet Nam (WTO, 2006), Ukraine (WTO, 2008), and two of the key countries: Russia (WTO, 2011c) and China (WTO, 2001b).

Russia agreed on abolishing export taxes on both nickel and molybdenum four years after its accession. It is still free to levy taxes on export of several scrap metals, including stainless scrap.

China agreed to abolish all export taxes other than those listed in annex 6 of its accession protocol. This list includes most notably ferrochrome, unwrought nickel, and stainless steel scrap. Molybdenum, for example, is not part of it.

European policy can make use of the WTO regulation and enforce contracts already in act to counteract export restrictions which violate these agreements. The 'China - Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum' case which was started jointly by the EU, the US, and Japan is an example of this approach. Such commitments offer important reference points for international negotiations.

8.4 Retaliatory Tariffs

Europe can react on export restrictions confrontatively using countervailing tariffs. The EU could rely on import taxes on stainless steel or export restrictions imposed on European exports.

Levying import tarrifs on stainless steel to retaliate against foreign export restrictions would be problematic from judicial point of view. In its decisions on the "US – Measures Treating Export Restrictions as Subsidies" case, the WTO decided that export restrictions on raw materials cannot be treated as subsidies for downstream sectors and do not justify countervailing tariffs (Karapinar, 2012; WTO, 2001a). Given this precedent, it appears realistic that import tariffs on stainless steel are inconsistent with WTO regulation as well.

The EU could also impose export restrictions itself. The European Union does not possess notable supply of nickel, chromium, or molybdenum. Therefore, export restrictions would plausibly be implemented on scrap metals. Antonioli (2012) reports that European steelmakers are indeed calling for export restrictions on scrap metals.

Even though the EU exports large quantities of stainless steel scrap, it has been a net importer of this good in the past. As long as Europe remains a net importer, export restrictions will not be effective. Further discussion is based on the assumption that the EU will become a net exporter of stainless steel scrap in the future.

European export tariffs affect scrap markets as described in chapter 3. If the EU has market power on stainless scrap, it can enjoy gains from increased terms-of-trade. Sectors demanding scrap will enjoy lower prices, which could offset higher prices of virgin materials in Europe, while scrap collecting firms suffer from lower prices. How this would effect welfare in Europe is not clear from a qualitative assessment. Some problems of export tariffs on scrap metals need to be mentioned.

If the export tariffs are used to retaliate against trade restrictions already in place, policy makers should take into consideration that they will also burden third-party nations. China – the most important of the key countries - will plausibly be effected only to a limited degree. The availability of nickel pig iron as a cheap source of nickel reduces the importance of scrap metal inputs (see section 2.2 and 2.5). Countries without domestic stainless steel production, and thus no demand for stainless scrap, will not be affected as well.

If Europe implements export taxes, less scrap will be shipped out of Europe. If the European steelmakers' elasticity of substitution between virgin materials and scrap is not large enough such that this addional supply will be used within the Union, recycling rates fall. This can eventually lead to a higher use of virgin materials, increased environmental damages from mining and higher greenhouse gas emissions.

Retaliatory tariffs are politically dangerous. If the EU implemented export restrictions on scrap metal, it would be the first group of industrialised countries to do so. This can encourage other - industrialised and industrialising - nations to follow the European example.

If retaliation is directed against important trading partners, it comes with a risk of triggering a harmful trade war. This holds true both for import tariffs on stainless steel and export tariffs on stainless scrap. The current conflict about European import tariffs on Chinese solar panels or the struggle about American duties on steel in 2002 and 2003 show how quickly affected parties can react by introducing further retaliatory measures.

Conducting a quantitative analysis of retailiatory tariffs is beyond the scope of this study. The qualitative discussion points out a number of reasons why such measure are politically dangerous and, in particular in case of the export tariffs, also likely to be ineffective. Therefore we do not recommend retaliatory measures.

8.5 International Agreements on Raw Materials Exports

8.5.1 Negotiating Bilaterally

The EU can rely on bilateral contracts to ensure access to raw materials. An example for those bilateral agreements are the 'raw material partnerships' Germany initiated with Mongolia (BMWi, 2011b) and Kazakhstan (BMWi, 2012). The agreements enable the German industry access to raw materials "without discrimination and under transparent and fair conditions" (BMWi, 2011b). In return, Germany commits itself to give guarantees on investment and to support training of workers and technology transfer.

Only a small number of nations possess market power for raw materials used in stainless steel production. Only five of those make use of export restrictions currently. This limits the number of nations to negotiate with and reduces the costs and complexities of negotiating bilaterally. Agreements can be tailored to match both sides' needs. Therefore, bilateral negotiations with exporters of raw materials are a comparatively quick and low-cost approach to abolish export barriers and the implied distortions for Europe.

The German raw material partnerships show how contracts can be tailored. Both Mongolia and Kazakhstan are in a state of development where they benefit from a transfer of technology and knowledge, while Germany enjoys access to raw materials. Both contracts have a long-term perspective. They aim specifically at building-up mining infrastructure and not only at preventing the implementation of export restrictions. It is questionable, however, if this approach can be adopted wholesale to larger and more industrialised countries such as China or India.

Most developing countries do not possess market power in metals or scrap metal markets. Some do still restrict scrap exports. Bilateral agreements about export barriers with those nations do not promise large welfare gains for

Europe. Therefore, incentives to negotiate are rather small. Developing countries will likely be neglected if Europe chooses a strategy of bilateral negotiations to deal with foreign export restrictions. They might uphold their restrictions which are, as outlined in chapter 5, plausibly the result of welfare-decreasing special interest policies.

If Europe abolishes export barriers with some if its suppliers of raw materials bilaterally, they still might be in act towards other nations. Third countries will suffer from distortions in international trade. This can be a side-effect of the bilateral approach. In particular developing countries lacking the negotiating power of the EU, the US, or Japan will probably be unable to reduce them via bilateral agreements.

8.5.2 Negotiating Multilaterally

The WTO and GATT are the most notable examples of multilateral trade agreements. They have proved to be very effective reducing import restrictions in the last decades.

Using multilateral agreements, for example within the WTO, avoids burdens for third parties while still reducing or abolishing export restrictions. A further advantage of trade agreements is that they can be used by governments to committ themselves to free trade vis-à-vis domestic special interest groups (see Bagwell & Staiger, 2010 for an overview). This should be particularly beneficial for those nations which would be neglected in a bilateral approach.

Aiming for a more comprehensive multilateral trade agreement including export restrictions can also help integrating key countries for which it might prove to be challanging to negotiate bilaterally.

Negotiating between a large number of nations – the WTO has 159 members currently – involves higher transaction costs and will be much more time-consuming. Additionally, many developed countries do not use export restrictions which they could reduce in multilateral negotiations. They have to offer other benefits for their trading partners. Therefore, multilateral contracts on export restriction will realistically come into effect only in the long run.

8.6 Intermediate Conclusions

In this chapter we discussed a number of policy options and carefully gave recommendations regarding their advantageousness. Some of these options stem from the discussion in economic literature. Others reflect current political discussions.

Table 19 displays the policy options analysed in this report. We do recommend setting up a database for export restrictions, utilising existing WTO regulation on export restrictions, and aiming at international agreements on export barriers, preferably multilateral ones. Further research is needed to decide whether abolishing import duties on chrome and molybdenum is welfare enhancing.

Measures increasing resource efficiency and recycling rates should be considered. Both are policy goals themselves with a large number of potential measures to achieve them. Evaluating their costs and benefits in detail is beyond the scope of this study. We recommend undertaking further studies assessing them.

Whether or not mining in Europe will increase in the future is rather a business and less a policy question. We do not recommend using retaliatory measures.

Approach	Measure	Recommendation	Comment
Reducing impacts	Increasing transparency	Yes	
	Abolishing import tariffs	Consider	Quantitative research needed
Indirect approach	Increasing resource efficiency	Consider	Environmental aspects important
	Increasing recycling rates	Consider	Environmental aspects important
	Fostering mining in Europe	No explicit mining policy	Private sector decision
Enforcing WTO rules	Enforcing WTO rules	Yes	
Retaliatory tariffs	Import barriers on stainless steel	No	High probability of being counter-productive
	Export barriers on stainless scrap	No	Meaningless if EU remains net importer
International Agreements	Negotiating bilaterally	Yes	Short- to medium run measure
	Negotiating multilaterally	Yes	Long-run measure

Table 19: Overview over policy options

9 Conclusions

Stainless steel is one of the most inportant materials used in modern industrial, construction, and household applications. This is reflected by growth rates of production of more than 5.5% on average in the last decades.

Europe is one of the most important regions worldwide in stainless steel production. 21.1% of stainless steel output worldwide is produced in the EU. The only nation making more stainless steel is China accounting for 45.5% of the worldwide production. The EU is, however, almost fully dependent on imports of nickel, chromium and molybdenum. With large amounts of products made from stainless steel in use in Europe, the EU is comparatively well supplied with scrap metals. The EU was, however, a net importer of stainless scrap at least until 2012.

This study pursued three main targets. Firstly, we want to provide a reasonably comprehensive survey of the reasons why nations restrict their exports of raw materials. Secondly, the study aims to compile and to present a thorough, country-by-country overview over measures impeding exports of the four key raw materials used to produce stainless steel. Thirdly, given the European position in markets for stainless steel and its inputs, we want to analyse policy options available to the EU and to give some careful recommendations which of those appear favourable and which not.

Based on our analysis of modern literature on international trade, we distinguished three main groups of nations regarding their propensity to erect export barriers. The first group is 'developed countries' with diversified economies. Even if they exhibit market power on inputs in stainless steel production, they refrain from exploiting it and rather rely on free trade policy. The second group is 'resource-rich, industrialising countries'. These nations have power in international markets for one or more raw materials, but tend to lack comparative advantage in downstream industry or services sectors. These nations have an elevated propensity to use export restrictions exploiting their market power. This behavior is plausibly explained by the attempt to raise international prices for their exports and to support growth of downstream industries. The last group of nations is 'developing countries'. Theory points out that these nations might implement export barriers even in the absence of market power. Their existence can be explained by a combination of weak institutions and successful special interest policies. If a concentrated and well-organised sector employing scrap metals encounters a scrap sector dominated by small firms lacking lobbying power, stainless steel scrap is likely to attract export restrictions.

The empirical investigations yields the, to our knowledge, most comprehensive database of export restrictions currently applied on the most important raw materials used in stainless steel production: nickel, chrome, molybdenum, and stainless scrap. It covers export tariffs, quotas, prohibitions, and licensing requirements in force between 2007 and 2012, plus some measures currently discussed or recently announced. It includes information about policies used by the most important producers of nickel, chromium, and molybdenum. Export barriers of more than 30 nations could be compiled for stainless steel scrap. While the intransparent nature of export restrictions in many countries prevents us from claiming to have a complete dataset, it is possible to derive some patterns and compare them with the theoretical predictions.

As proposed by the theory, we find that a small number of key countries account for most export barriers in force for nickel, chrome, and molybdenum. The most important key country is China. It is a major producer of all four raw materials and erected export barriers for all of them. India and Zimbabwe are key countries for the case of chrome. Export tariffs on chromium ores are discussed in South Africa. They would turn the African nation into a key country for chrome. Additional players are Russia and Indonesia, both for nickel. After Russia committed to abolishing its export barriers on nickel after joining the WTO in 2012, its presence in this group is expected to be temporary. In line with the theory, stainless steel scrap export restrictions are in force in a large number of nations, including many without any notable market power.

The European Union faces the growing number of export barriers from the position of an important producer of stainless steel without major supplies of nickel, chrome, and molybdenum. The EU has imported more stainless scrap than it exported for many years, but it might become a net exporter in the future. This position gives rise to a number of policy options. Some of these options are already part of European raw material policies. Others are part of the current political discussion and additional options are likely to attract attention soon.

As a first step, the EU should set up a comprehensive database containing regularly updated information about currently enacted and upcoming export restrictions. This increases transparency and lowers transaction costs of raw material importers. It should also consider abolishing the European import restrictions on chrome and molybdenum.

A second step for European policy makers should be considering whether public investments in research and development aimed at raising resource efficiency are adequate. Similarly, obstacles to increasing recycling rates should be carefully examined. Both goals can economically be justified because they contribute to a more sustainable resource use in Europe, but have side effects on trade policy as well. While less effective in the short-run, they increase the demand elasticity for raw material imports and thereby lower incentives to introduce export restrictions in the long run.

A policy option available in the short run is using the possibilities the WTO offers to enforce compliance with international agreements. WTO regulations on export restrictions are generally weak. However, a number of nations, including China, committed to lowering or abolishing export barriers when joining the WTO. These commitments offer important reference points for bilateral and multilateral negotiations.

We do not recommend retaliatory tariffs as a policy option. Due to the trade flows of imports and exports of the raw materials subject to this study, such measures are likely to hit, if any, predominantly third countries which do not implement export barriers themselves. Towards most of the key countries they are plausibly ineffective. They additionally come with the danger of triggering harmful trade wars.

In the long run, the best option for the EU seems to be striving towards a multilateral agreement covering export restrictions or towards including those in the WTO regulation (Lamy, 2011). An international agreement on export restriction can help abolishing welfare reducing trade barriers without shifting burdens on third countries. Bilateral agreements can serve as a transitional solution.

The study unveiled further research needs, particularly on the empirical side. While we compiled an extensive database of export restrictions, analysing their effects quantitatively was beyond the scope of this study. An in-depth quantiative assessment is necessary to decide whether an export restriction is welfare-enhancing or not in the individual case. Therefore, future research should cover the effects of specific export barriers on raw materials markets both ex-post or ex-ante. Not least, the effects of export restrictions on European stainless steel production should be investigated quantitatively.

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