Chapter 2

ECONOMICS OF EXPORT RESTRICTIONS AS APPLIED TO INDUSTRIAL RAW MATERIALS

K.C. Fung and Jane Korinek

2.1. Introduction

This chapter analyses the effects of export restrictions from a theoretical perspective, paying particular attention to the specificities of the industrial raw materials sectors. Government interventions in the industrial raw materials sectors tend to be more prevalent than in many others, and to this end, export taxes and quotas are frequently used. The main insights from this analysis can be found in the concluding section.

The literature on the economic consequences of export restrictions is quite limited, particularly compared with that on import taxes and quotas. Furthermore, much of the analysis relates to the agricultural sector, whose specificities — production decisions at fixed times, long supply lags, uncertainties linked to weather and disease — hardly match those of the industrial raw materials sectors. This chapter develops the analysis of export restrictions in the context of the industrial raw materials sectors, taking their main characteristics into account in the model specifications.

Industrial raw materials sectors exhibit their own particularities. First, natural resources in the extractive industries are often geographically concentrated. For some minerals or metals, the greater part of the world’s exploitable resources are found in just one or two countries. Moreover, for some mineral exporting countries, a few products from the extractive industries make up a large share of their total exports. Thus, export diversification is sometimes low, and domestic income, employment and government revenue are often quite dependent on the value generated by a single industry.

Firms in extractive industries are often multinationals based outside the countries where they operate and with sizeable market power. The relative scarcity of technical skills, access to funding and the ability to assume risk over the long term implies that few firms worldwide are able to compete in large mining ventures (Boadway and Keen, 2010). At the same time, these firms sometimes represent formidable potential for income generation in the countries in which they operate. In some countries, large mining or refining firms are state-owned.

Extractive industries are generally highly capital-intensive with low levels of employment creation. Downstream industries are located along the processing chain where the product is transformed from ore to concentrate to powder, mineral to metal, and finally to finished products. The further downstream a processing industry is from mineral extraction, the more sophisticated technological inputs and knowhow it tends to require and the more jobs it creates. Typically, a refining or smelting plant will be more labour-intensive than a mine, a plant producing semi-finished goods tends to be more labour-intensive than a smelter, and a factory producing finished manufactures will be even more labour-intensive.

Mineral resources are, generally speaking, relatively homogeneous goods. Although the quality and grade of extracted ores can vary, in processed form metals are quite homogeneous
across different producers. This implies that, although the cost of extraction may vary considerably, the price of the final good is similar across producing firms.

A particular characteristic of the extractive industries is the exhaustibility of the non-renewable natural resources. This does not mean that new deposits are not found, and the extent to which deposits are exploited depends on confluent factors. It means, however, that current optimal extraction rates calculated are a function of optimal extraction rates in the future: there is a trade-off between present and future production and consumption.

The analysis in this chapter takes all these characteristics of the extractive industries sector into account when specifying the theoretical model used to examine the economic effects of export restrictions. The Cournot-Nash oligopolistic model with imperfect competition most closely describes the raw materials sectors, and is used for the first time here to analyse the effect of export restrictions on the extractive industries. The model sheds light on the impacts of export taxes and quotas on domestic and foreign producers and consumers, on governments in terms of the revenue they collect and on their countries’ welfare, and on global prices and availability.

The chapter is organised as follows. The next section reviews very briefly the use of export taxes and quantitative restrictions in the minerals sector. Section 2.3 discusses the relevant literature regarding the impacts of export restrictions. Section 2.4 outlines the Cournot-Nash oligopolistic model for the case of two countries both of which produce the mineral resource and one of which is an exporter. This model is applied to investigate both export taxes and quantitative restrictions. Section 2.5 extends this model to cover three countries, one of which is a non-producing importer of the raw material. This novel extension of the model allows richer insights that can more easily be generalised to a wide range of real-world situations. Section 2.6 discusses whether export restrictions as used by trading countries have been successful in attaining their objectives. Section 2.7 explores some further implications of the foregoing analysis, and Section 2.8 concludes.

2.2. Use of export restrictions on industrial raw materials

Before examining the economic effects of export restrictions, it is useful to recall the extent and scope of the use of export restrictions on metals and minerals. Export restrictions are used more readily for products like metals and minerals than for manufactures. The industrial raw materials sectors are characterised by higher than average export restrictions but relatively low import restrictions. There is some evidence that tariff escalation, that is, higher import tariffs on semi-processed and final products than on raw materials and inputs, can also be found in these sectors.

The OECD Inventory of Restrictions on Trade in Raw Materials (see this volume, Chapter 1, Annex 1.C; Fliess and Mårå, 2012; OECD, 2014) compiles detailed data on the prevalence of export restrictions on over 80 raw materials. For each material, official government data were collected and verified for the five leading countries in terms of share of global production in the reference year. The findings of the data collection are included in Chapter 1 of this volume.

The impact of export taxes and quotas on the market for a particular mineral product is generally determined by three main factors: the concentration of production and exports of the product concerned, the prevalence of use of export restrictions and the level of tax or quota applied (Fung and Korinek, 2013).

There is great diversity in the use of export taxes and quotas across countries and across products. Export taxes are used much more often than export quotas or prohibitions, including by large exporters. In 2012, 28 countries, including 12 leading (top 5) producers, imposed export taxes on at least one exported metal or mineral (see Chapter 1 of this volume). In some cases, a substantial share of world exports is affected by export taxes. The share of world exports subject to export taxes was above 30% for a number of products: thorium (49% of world exports), tungsten (47%), barytes (40%), magnesium and vanadium (36% each), rare earths (35%) and magnesite (34%).
Markets are most distorted when a large share of world trade is affected by an export tax (either because exports are dominated by a single tax-using exporter, or because exporters responsible for a large share of exports all use taxes), and when the rate or rates of tax are high. The rate of export tax differs significantly among the minerals and metals examined. Export taxes are very high for some commodities, with maximum rates of up to 40% for unprocessed iron and steel; 30% for copper, lead and niobium; 25% for gold; and 20% for aluminium/bauxite, tungsten, molybdenum, cobalt, silver, thorium, antimony, and zinc (see Chapter 1, Figure 9a).

Export quotas are used less frequently than export taxes on industrial raw materials, possibly due to the WTO rules disciplining their use. In the period 2009-12, export quotas were used by one country, China, to control the export of certain minerals and metals. In 2012, export quotas were applied on 44 products, down from 46 products in 2009 (Chapter 1). The share of world exports subject to quantitative export restrictions was highest for antimony (44% of world exports), fire-clay (43%), tungsten (41%), rare earths (35%) and magnesite (34%). As will be shown in the following sections, export quotas generally have a more welfare-distorting import than export taxes.

Export taxes and quotas are more prevalent on raw materials than on processed and semi-processed products (Fung and Korinek, 2013).

A review of the structure of world markets for industrial raw materials shows that the conditions in many of these markets involve a small number of dominant sellers facing a much larger number of importing countries. This situation is well-represented, in stylised form, by the three-country model (two exporters, one importer) used for the analysis in Section 2.5. The review of the literature in Section 2.3 underlines the novelty of this three-country model for analysis export restrictions. Before it is deployed, however, a simpler model is used in Section 2.4 to investigate the basic mechanics of export restrictions.

2.3. Insights from recent literature

Overview

There is a small corpus of published work that explicitly models the effects of export restrictions. Some recent papers (Piermartini, 2004; WTO, 2010; Latina et al., 2011) use simple models to explore the impacts of export taxes and quantitative restrictions on domestic and world markets, and on downstream industries, for an exporting country with a significant share of world trade, which is particularly pertinent in the case of mineral resources. In the case of a small country whose policies have no effect on world prices, all impacts occur within the exporting country. These cases are shown in more detail below.

Gandolfo (1998) models export taxes in the case of a small country. He suggests that in the small country case, i.e. where there is no monopolistic power in the broad sense, there is a symmetrical relationship between the social cost of an import duty and an export duty (Lerner symmetry). In fact, Lerner symmetry means that a uniform tariff on all imports is equivalent to an equal uniform tax on all exports (Ethier, 1983). The limitation of Lerner symmetry is that it assumes an economy-wide imposition of either uniform import duties on all products or uniform export duties on all products, which is a purely theoretical case.

Some recent work examining the economics of export restrictions has been set in the context of the 2006-08 rise in agricultural product prices and subsequent restrictive policies. Mitra and Josling (2009) examine the domestic and global impacts of export bans, quotas and taxes on agricultural products. Abbott (2011) models the impact of an export tax when applied following a surge in demand in world markets. Liefert et al. (2012) examine the use of export licenses and domestic quotas as alternatives to complete export bans, and the same authors (Liefert et al., 2013) explore whether export taxes and quotas can be made less market-distorting. Martin and Anderson (2011) highlight the collective action problem associated with using export restrictions as price stabilisation policies: the use of restrictive measures by all exporters would be ineffective in stabilizing domestic prices, while magnifying international price instability. They estimate the extent
to which changes in insulating policies such as export restrictions have contributed to price surges for staple foods such as rice and wheat, finding substantial impacts during the price surges of 1973-74 and 2006-8. They estimate, for example, that insulating policies affecting the market for rice explain 45% of the increase in the international price for rice in 2006-8 (Martin and Anderson, 2011). Giordani et al. (2012) find evidence to support their hypothesis that a sudden rise in food prices prompts governments to respond by imposing export restrictions, which exacerbates the price shock and in turn induces other exporting countries to apply export restrictions. They estimate that during 2008-10, following the surge in international food prices, every 1% increase in global export restrictions added an additional average increase of 1.1% to international food prices (Giordani et al., 2012).

Bouët and Laborde (2010) examine export taxes as beggar-thy-neighbour policies that degrade terms of trade and real incomes of trading partners and elicit retaliation from importing countries. They analyse restrictive trade policy instruments in a general equilibrium game-theoretic context and find large and significant impacts due to the imposition of export restrictions by one country and the lowering of import tariffs or subsidizing of exports by a trading partner. They also estimate the effect of these policies on a small third country that is obliged to import the good. A scenario modelling the 2006-08 increase in food prices suggests that export restrictions and corresponding import tariff reductions contributed to a doubling of the initial increase in world wheat prices. Thus, beggar-thy-neighbour policies are estimated to have had as much effect on world wheat prices as the initial price surge. The authors conclude from this non-cooperative equilibrium that international cooperation in order to discipline export restrictions is crucial for offsetting the large welfare losses of small countries which cannot use such trade instruments to improve their welfare.

For various reasons, the impacts of agricultural export restrictions used as insulating policies in reaction to surges in food prices are not directly transferable to other sectors such as industrial raw materials. In many of the models (e.g. Mitra and Josling, 2009; Liefert et al. 2012), supply is assumed to be inelastic since the situation modelled is one where export restrictions are put into place after planting decisions have been taken. Additionally, in much of the agricultural literature (e.g. Abbott, 2011; Bouët and Laborde, 2010; Liefert et al., 2012; Mitra and Josling, 2009; and Giordani et al., 2012), the assumption is that export restrictions are placed after a surge in world demand or a surge in world prices. Neither of these assumptions necessarily holds in the case of industrial raw materials. Consequently, this paper will concentrate on models that are not specifically designed to explain impacts of agricultural export restrictions although some of the considerations in that rich body of literature will be drawn upon. In particular, the paper by Fung and Korinek (2013) examines the impact of imposing export restrictions specifically in a hypothetical industrial raw material industry on variables such as prices, quantities, terms of trade, domestic welfare as well as the effects on the downstream industries, and is the main source for the analysis in Section 2.4 of this chapter.

**Export tax imposed by a “small” country**

A number of studies illustrate the effects of an export tax on domestic producers and consumers graphically (Latina et al., 2011; WTO, 2010; Mitra and Josling, 2009; Appleyard et al., 2010; Gandolfo, 1998; Abbott, 2011). The partial equilibrium case of an export tax imposed on a good by the government in a small country, defined here as a country whose exports in the restricted good are not large enough to affect the world price, is the most basic. This is well illustrated by Gandolfo (Figure 2.1).

Figure 2.1 shows the domestic demand and supply schedules for the good. At the “free trade” price, OM, the quantity FH (or \( q_1 \) minus \( q_2 \)) is exported. When an export tax equal to MN is imposed, domestic producers react to ON as the effective supply price and reduce output to \( q_3 \), since they will have to hand over MN as tax on each unit of the good exported. The domestic price falls to ON, market demand increases to \( q_2 \) and exports contract to \( F_H \) (or \( q_3 \) minus \( q_2 \)). Domestic consumers benefit by an amount equal to area MNF,F in Figure 2.1. Producers lose income equal
to the area MNH, H. Government revenue collected by the export tax is measured by the area \( F_1F'H_1H' \). The social cost of the tax is illustrated by triangles \( FF_1F' \) and \( H_1H'H \) (Gandolfo, 1998).

This analysis shows that i) for a small country with no influence on world market prices of the good on which the export tax is levied, domestic welfare in the aggregate is necessarily lower than without the export tax, ii) there is a transfer of income from domestic producers to domestic consumers due to lower prices and greater availability in the domestic market, iii) the more inelastic domestic supply and demand are, the smaller the impact of the tax, and iv) in reality, governments will overestimate the revenue generated by the tax unless they account for the lower level of exports that it will bring about.

These results are exemplified by Argentina where export taxes are imposed on virtually all agricultural products, industrial raw materials, hides and skins, oil and natural gas and their derivatives. Nogués (2008) estimates that an elimination of export barriers would increase Argentina’s GDP by 2-4%, even though temporary adjustment mechanisms would be needed to reduce the social cost of the adjustment to higher consumer prices. He estimates that eliminating Argentina’s export barriers would lead to an expansion of production and therefore employment by 300 000 jobs in the case of Argentina according to the author (Nogués, 2008). At the same time, an important source of government revenue would be eliminated, which may largely explain the plethora of export taxes in Argentina, unparalleled elsewhere in the global economy.

Figure 2.1. Effects of an export tax imposed by a small country


Export tax imposed by a “large” country

Due to the geographical concentration of mineral deposits, countries exporting industrial raw materials are often “large” in relation to the world market for their export good; in this case, when they use an export tax, world market prices are affected. When an export tax is imposed by a large country, world commodity prices change and both domestic and global market effects should be studied. This is well illustrated by Latina et al. (2011) in Figure 2.2.
As in the small country case, domestic producers reduce their supply of the good. However, in the large country case, the contraction in world supply (from $S_w$ to $S'_w$) leads to higher world prices (increasing from $p_w$ to $p'_w$). At the same time, supply to the domestic market increases as producers attempt to expand within country sales to avoid the export tax; domestic prices therefore fall (from $p_w$ to $p_1$). The price differential between the world and domestic prices ($p'_w$ minus $p_1$) equals the tax.

Income effects, or changes in welfare, imply that domestic consumers gain from the policy due to lower prices (and correspondingly greater consumption) while foreign consumers lose as they have to pay higher prices (and so consume less). Note that in some cases, domestic consumers are themselves producers of downstream products. In this way, the export tax effectively subsidises downstream industries (Latina et al., 2011). Domestic producers of the raw material lose from the policy since they face lower prices for their goods, and they have to pay the export tax. Government revenue increases by the pale blue area in Figure 2.2.

The net domestic welfare effect for the large country is therefore ambiguous. The area marked $a$ in Figure 2.2 represents the terms-of-trade gain from an increase in the world price. The domestic deadweight loss, or social cost, generated by the export tax is equal to the two shaded triangles in the left-hand panel of Figure 2.2 and represents distortions in production. The net welfare change for this country depends therefore on which of the two effects – the increase in terms of trade or the decrease in efficiency – is greater. Overall, if the terms-of-trade gain exceeds the efficiency loss, a large country may be tempted to improve its welfare by introducing an export tax (Latina et al., 2011). At the level of the world market, however, there is a clear overall welfare loss as the terms of trade gain to producers is more than offset by a loss in income for world market consumers.
Export taxes therefore have a re-distributional effect within the country imposing the tax (WTO, 2010). Raw materials producers experience negative consequences whereas downstream consumers of raw materials are indirectly subsidised. The policy actually transfers welfare from the sector producing the raw commodity to the processing industry that uses it. Raw material production is discouraged and employment and wages may fall in the sector. However, the processing industry will benefit from lower prices of its resource inputs, gain competitiveness in the international market and expand (Piermartini, 2004). If they produce intermediate or finished goods, the tax may encourage production of a good in which the country does not have a comparative advantage (WTO, 2010).

An export tax on a raw material imposed by a large country also has a re-distributional effect in the importing country. Consumers in the importing country lose since they must pay higher prices for the good, whereas producers in the importing country, if they exist, will gain from higher prices for their goods due to lower levels of supply by their competitor (Piermartini, 2004).

The precise impact of an export tax on domestic and foreign consumers and producers depends on the size of consumers’ reaction to price changes (the price elasticity of demand). In the case of high responsiveness of demand to price changes (elastic demand), welfare losses are greater than when demand is less elastic. This is because there is more distortion in the quantity of goods consumed when the tax is used (Mitra and Josling, 2009).

The above analysis is static, and explores changes to production, consumption and prices that result from the export tax alone. In practice, in the longer term, sustained high world prices create an incentive for importing countries to invest in new resource-saving technologies that reduce their natural resource inputs per unit of output (WTO, 2010). They may also invest in research in order to substitute other raw materials in the production process. In addition, mining activities may be launched that were not profitable when world prices were low but which become viable given higher world prices. There is, however, no guarantee that the distorting export policy, or the resulting artificially high world market prices, will be maintained. This creates greater uncertainty in world markets both for raw materials producers and for downstream consumers, and may have negative long-run effects (Korinek and Kim, 2010).

An export tax also affects the price and availability of the factors of production used in the production process. If production of a raw material decreases due to higher prices, industries that service the raw material production process will suffer, to the extent that they are not mobile. Input industries and services that are not mobile across sectors will necessarily be hurt by an export tax. Similarly, employment in the mining industry will fall. These issues are further discussed below.

**Export quotas**

There has been less analysis of export quotas than of export taxes. The impacts of an export quota depend on a number of factors including how restrictive the quota is and how it is administered, making it difficult to obtain unambiguous theoretical results. One way of assessing the impact of an export quota is to assume that it has the same effect as a corresponding export tax. As in the case of import quotas, at every level of quota there is theoretically a tax that introduces the same distortions. The analysis of the effect of an export quota then becomes similar to that outlined above for an export tax. Export bans are generally modelled as an extreme case of an export quota of zero. An outstanding difference between an export tax and an export quota is that government revenue is not generated in the case of the quota. However, quota rents – income transfers resulting from the artificial “shortage” of the good on the relevant market – are created.

Who gets the quota rent largely depends how the quota is administered. When the quota is auctioned by the government in the exporting country, exporting firms are willing to buy the right to trade in the good for a price up to the amount equal to the theoretically equivalent export tax (Appleyard et al., 2010). In this case, the government benefits from the quota rent much in the same way it would from levying the corresponding level of export tax. If the exporting firms organise as a single seller, however, and sell the good on the importing countries’ markets at the higher market-clearing price, the quota rent is captured by the exporting firms (Appleyard et al., 2010).
Export quotas produce larger welfare losses when demand for the restricted product is inelastic. Export taxes, on the other hand, produce bigger welfare losses when applied to products with more elastic demand, i.e. a greater responsiveness to price changes (Mitra and Josling, 2009).

In general, the exhaustibility of natural resources implies a trade-off between present and future extraction rates. For a country that exports everything it produces, establishing an export quota will generally result in higher future rates of extraction (WTO, 2010). In this case, and in principle, export quotas could be used to achieve optimal rates of extraction should private sector producers otherwise have an incentive to extract minerals faster than is optimal. Even if the country imposing the quota exports all its production in the short run, it may start to export downstream products if they become competitive due to their access to a supply of raw materials that is cheaper on the domestic market because of the price wedge created by the quota. In this case, the use of an export quota to reduce the rate of extraction will have failed to achieve its objective.

2.4. The Cournot-Nash model applied to export restrictions: The two-country model

The literature review in the previous section outlines the basic mechanisms of export taxes and quotas. These are further summarised in Annex 2.A for two competing models of the world market for natural resources. The model chosen for analysis is outlined in the next two sections; readers wishing to skip to conclusions are welcome to go to Section 2.6.

Overview of the two-country model

This section presents a basic theoretical model depicting two countries (denoted X1 and X2), both of which produce a mineral resource. The model is a static, one-shot game in a partial equilibrium framework. The world market for the natural resource is modelled as an international oligopoly rather than a perfectly competitive market, since – as documented in Chapter 1 – a traded mineral or metal is often exported by a relatively small number of countries or producers, who tend to have substantial market power.

This simplified model assumes that each country has one mining firm, which produce a homogeneous product. Country X1 produces quantity \( q_1 \), of which \( d_1 \) is consumed in the domestic market and \( x_1 \) is exported to X2. Total mineral output in X1 is:

\[ q_1 = d_1 + x_1 \]

Country X2 produces quantity \( q_2 \) entirely for its own market. Thus, only X1 exports. Total output in the global mineral industry is:

\[ Q = q_1 + q_2. \]

Oligopolistic firms can be modelled as either Bertrand-Nash (price-setting) firms or Cournot-Nash (quantity-setting) firms. We consider that it is more natural to describe these firms as Cournot-Nash firms, because the extractive industries involve a limited number of firms that face differing cost and pricing structures and the Cournot-Nash equilibrium allows price to exceed marginal cost for some or all of them, whereas in the Bertrand equilibrium, price equals marginal cost. In the Cournot-Nash setting, firms produce identical products, but even the higher-cost firms can survive and produce positive outputs. However, it is well known in this theoretical literature that results can change when certain features of the game change. The key features to consider include price-setting versus quantity-setting behaviour, the number of producers, whether there is free entry, and identical versus differentiated products. Various theoretical studies of general stylised cases (see inter alia Brander and Spencer, 1984, Helpman and Krugman, 1985, 1989, Bhagwati et al., 1998, Bagwell and Staiger 2009a, 2009b, Fung, 1989a, 1989b, Grossman and Rogoff, 1995, and Krishna, 1989), offer valuable insights. We have drawn on this literature to develop the model and framework outlined here, which is intended to apply specifically to the case of export restrictions in the industrial raw materials sector.
Export tax

Assume that X1 imposes an export tax t. With an integrated international market, the price in the importing country, p_2, equals the price in the exporting country, p_1, plus the export tax t, i.e.

\[ p_1 + t = p_2. \]

Denoting the demand in the two countries by \( D^1(p_1) \) and \( D^2(p_2) \), respectively. Substituting X1’s price into X2’s demand schedule gives \( D^2(p_1 + t) \). Summing these demands horizontally yields total output Q. This relationship shows that X1’s price \( p_1 \) is a function of total industry output Q and the export tax t, i.e. \( P^1(Q, t) \). Furthermore, since X2’s price is simply X1’s price plus the export tax, it follows that \( P^2(Q, t) \). From this market integration feature, therefore, other things being equal, a rise in the export tax will lower the price in X1 but raise the price in X2. In other words, an export tax directly raises the export price, thereby reducing export demand. To restore equilibrium, X1’s price must fall to stimulate domestic demand.

How do these changes in the raw materials markets affect the two Cournot-Nash firms? The exporting firm’s profit consists of revenue from the domestic market \( p_x, c_x \) and from exports \( p_x x_1 \), with the costs being \( c_x, c_1, c_2, \) and \( t_1 \), where \( c_1 \) denotes the constant marginal cost of production in X1. Recognising that \( p_2 = p_1 + t \), the profit of X1’s firm can be written as:

\[ B^1 = p_1 q_1 - c_1 q_1, \]

and X2’s firm has profit \( B^2 \), which is given by \( B^2 = p_2 q_2 - c_2 q_2 \), where \( c_2 \) is the constant marginal cost of production in X2.

For a given export tax t, profit maximization by the exporting firm yields \( B^1_{q_1} = 0 \), where the subscript now denotes partial differentiation with respect to the strategic output variable \( q_1 \). \( B^1_{q_1} = 0 \) is also the exporting firm’s reaction function, which denotes this firm’s profit-maximizing choice of \( q_1 \) for any given level of \( q_2 \). As is standard, this Cournot-Nash reaction function in \( q_2 \) is downward-sloping.

Similarly, maximising the profit of X2’s firm, for a given t, yields \( B^2_{q_2} = 0 \). This first-order condition provides the reaction function of X2’s firm, with a best-reply \( q_2 \) for any \( q_1 \). For each firm’s set of conditional optima, we assume that the second-order conditions hold. In a graph with \( q_2 \) on the vertical axis and \( q_1 \) on the horizontal axis, again the Cournot reaction curve for X2’s firm, \( B^2 = 0 \), is downward-sloping. The X1 reaction function will also be steeper than the X2 reaction function, yielding a stable equilibrium.

The Cournot-Nash equilibrium occurs at the point where the two firms’ reaction functions intersect, which can be expressed as \( (q_1^{CN}, q_2^{CN}, t) \), thus determining the output levels of the two firms, given a particular rate of the export tax. An increase in the export tax shifts the X1 firm’s reaction curve towards the origin, i.e. the X1 firm produces for every level of \( q_2 \), whereas it shifts the X2 reaction curve outwards, since with a higher export tax the X2 firm will produce more for every value of the \( q_1 \).

We maintain the standard assumptions typical of this type of model, in particular that the two outputs \( q_1 \) and \( q_2 \) are strategic substitutes, and that the usual stability condition holds. With these standard conditions, the after-tax equilibrium implies less output in X1 and more output in X2 than without the tax. These outcomes hold for straight-line demand functions and other well-behaved demands. When the export tax increases and the X1 firm’s exports fall, the price of this mineral on the world market is simply the price prevailing in X2, since we assumed that X2 does not impose any trade barriers and there are no transport costs or other kinds of transaction cost. The world price, \( p_w \), is just \( p_1 + t = p_2 \). Clearly, the world price rises with an increase in the export tax.

There are various welfare implications of an export tax in this international Cournot-Nash oligopoly model. First, we consider domestic consumer surplus, bearing in mind that some consumers may be downstream firms that use these resources as production inputs. Because the domestic price falls with an increase in the export tax, domestic consumer surplus, and possibly the profit of downstream producers, rises. Another way to view this improvement in domestic welfare is...
to consider the distortions introduced by the firms with market power in our model. As it is oligopolistic, the domestic firm will typically charge a price above marginal cost, which creates a deadweight loss in the domestic economy. An increase in the export tax lowers \( p_1 \), and reduces the inefficiency due to this distortion. In addition, the world price of the exported product rises, so there is a terms-of-trade gain for the exporting country, but a deterioration in the terms of trade for the importing country. For Cournot-Nash firms, profit is positively related to output and market share, and since domestically produced output decline with an increase in or imposition of an export tax, the domestic firm's profit shrinks. By contrast, the profit of the foreign firm increases as its output increases. So profit is shifted away from the domestic firm to the foreign firm. This profit-shifting (rent-shifting) effect is standard in international oligopoly, but it is new to the literature on export restrictions of minerals or metals which has until now used models that assume perfect competition. A novel conclusion is that the government using the trade policy actually shifts rents away from its own firm and reduces its profit. Finally, the welfare implications of the new (or higher) export tax revenue are that public sector welfare, or the welfare of public spending beneficiaries, increases in the exporting country.

In summary, the export tax means that the producer in X2 gains and consumers or downstream industries in X2 lose. Assuming that the producer continues to sell only to its domestic market, there is also a terms-of-trade loss. By contrast, the X1 producer loses, consumers or downstream industry in X1 gains, there is a terms-of-trade gain and tax revenue also increases. There may be, therefore, an export tax that optimises domestic welfare (despite reducing global welfare).\(^1\) Expressing X1’s welfare as:

\[
W^1 = B^1 + S_1 + T,
\]

where \( S_1 \) is domestic consumer surplus and is a function of \( p_1 \), \( T \) is tax revenue, which is equal to \( t \), and \( B^1 \) is the profit of the domestic producer. The optimal export tax is implicitly defined by \( W^1 = 0 \), where the subscript refers to differentiation with respect to the export tax \( t \). Again, we assume that the second-order condition holds.

So far it has been assumed that there are producers and consumers in both X1 and X2. If production in X1 only and consumption takes place only in X2, an export tax imposed by X1 improves the welfare in X1, the world market price of the raw material rises and welfare in X2 falls. In general, the welfare of the global economy will decline.

A richer welfare analysis can be obtained by incorporating into the model some additional characteristics of the international mineral industry. First, suppose there is a downstream firm that uses these raw materials as inputs in its production process. We denote the profit of the downstream firm in X1 by \( V^1(z_1, p_1) \), where \( z_1 \) is the output of the downstream firm and \( p_1 \) is the price of the mineral used by the downstream firm. For a given \( p_1 \), the downstream firm maximises its profit by choosing \( z_1 \) so that \( V^1_{z_1} = 0 \). It has been shown already that an increase in export tax lowers the domestic price of this input, which increases the profit of the downstream firm, i.e. \( V^1_{p_1} < 0 \). With a lower marginal cost of production, the downstream firm expands its output and thus employment. These results still hold if there is also a downstream firm in country X2. Denoting its profit by \( V^2(z_2, p_2) \), profit maximization by this firm yields \( V^2_{z_2} = 0 \). If the two downstream firms also engage in strategic rivalry, then we have a two-stage static (one-shot) game. In the first stage, the mineral sector engages in oligopolistic rivalry, yielding Cournot-Nash equilibrium prices \( p_1 \) and \( p_2 \). Given these input prices, the two Cournot-Nash downstream firms compete, leading to equilibrium \( z_1 \) and \( z_2 \). An increase in the export tax shifts these games to a new equilibrium. This means that, in the second-stage game, X1’s downstream firm has a lower marginal cost of production. Hence, its output, employment and profit are all higher. The downstream firm in X2, by contrast, has a higher marginal cost of production, and therefore its output, employment and profit decline.

When the X1 firm is a multinational affiliate, its profit is at least partially repatriated overseas. If so, the government of X1 may not want to include the profit of the multinational firm in its welfare calculation. This situation could partly explain the willingness of some governments to impose export taxes even though these taxes shift profit away from the firm located in their country.
If jobs and employment are a major issue in X1, the government may include a labour component in its objective welfare function, i.e.

\[ W^1 = wL + B^1 + S^1 + T, \]

where \( w \) is the wage rate and \( L \) is employment. Assuming that \( w \) is fairly fixed in the short run, then the scope for improving value of the government objective function depends on employment alone. Notice that in our model, employment may be shifted downstream in the supply chain. This can be seen by noting that an increase in (or the imposition of) an export tax will increase employment in downstream firms, even though there is a drop in the employment in the upstream extraction sector. If the downstream firm is more labour-intensive, then the net impact will tend toward increasing total employment in the exporting country and decreasing employment in the importing country. The actual net effect will depend on the size of each sector.

**Export quotas**

Using the same model as for the export tax, we examine the impacts of an export quota and compare them with those of the export tax. We assume that the X1 firm pays the government of X1 for a license to export. Specifically, it pays a maximum of \( (p_2 - p_1)x_1 \) for a licence to export up to the limit of the quota.\(^{12}\) The firm’s profit can be written:

\[ B^1 = p_1d_1 - c_1d_1 + p_2x_1 - c_1x_1 - (p_2 - p_1)x_1 = (p_1 - c_1)q_1, \]

which corresponds exactly to the payoffs under the export tax case. The profit of the firm in X2 is also the same as in the export tax case, given as:

\[ B^2 = p_2q_2 - c_2q_2. \]

If \( x_1 \) is fixed at the level given by an export quota (which corresponds to the after-tax level of output in the previous export tax case), and assuming that \( q_2 \) is at \( q_2^{CN} \), the best response of the X1 firm is to choose \( d_1 \) so that \( q_1 = d_1 + x_1 \), which equals \( q_1^{CN} \). Similarly, if the X1 firm chooses \( q_1^{CN} \), then the best response by the firm in X2 is \( q_2^{CN} \). Since these quantities are mutually optimal, we obtain a Cournot-Nash equilibrium. Thus, with an export quota that limits exports to the same extent as a given level of export tax, the resulting Cournot-Nash equilibrium will yield the same output levels. Apart from the costs of administration and the distribution of the quota rents, the welfare implications are also the same. For X2, price increases and output is higher. The profit of the X2 producer rises and X2 consumers lose, as in the case of the export tax. If there is a downstream firm in X2, it loses competitiveness since the price of the mineral input in X2 is higher. Thus, the profit and employment of the downstream firm in X2 are reduced by the export quota.

The economic impacts of the export tax and export quota on producers and consumers of the raw material in the Cournot-Nash oligopolistic theoretical model are therefore broadly similar. The surplus created by the quota rent, however, may not be distributed in the same way as the tax revenue. In the case of the export tax, the tax revenue goes to the government that has introduced it. The recipient of the quota rent depends how the quota is attributed or administered. The quota, or license to export, may be auctioned in an open bidding process or may be attributed according to firms’ previous export shares or some other criterion. When firms compete to buy a share of the quota, in theory they bid the price of the license up to the level of the corresponding export tax, and the quota rent goes entirely to the authority administering the policy. If, however, the quota is attributed according to firms’ export shares in the past, for example, or according to another criterion, the quota rent may be distributed among all exporting firms or a subset of them, or shared between firms and the government authority.

So far, we have assumed that the quantity-setting Cournot-Nash model is more typical of trade in mineral resources. However, there may be some specific product markets where other types of behaviour – and hence other models – apply. In these situations, an export quota can be more distorting than an export tax. There are two known situations where this may occur. First, if there is an unexpected increase in the demand for the raw material in the importing country, an export tax will allow an increase in exports as a response. In the case of a binding export quota,
however, there will be no change in exports. The higher unmet demand will push the price of the raw material up further and create a greater distortion in the world market.

In the second example, under certain market conditions, an export quota creates a potential for collusive behaviour between oligopolistic market participants. This may occur if firms compete on the basis of price (i.e. Bertrand-Nash duopoly) rather than quantity as in the Cournot-Nash case outlined here. It is well established in the literature that in Bertrand-Nash international duopoly models, a quantitative restriction can serve as a “facilitating practice” or a “collusive device” (see Krishna 1989, Grossman and Rogoff 1995, p. 1435). In the Bertrand-Nash case, as firms compete on the basis of price, their prices are driven down close to their marginal cost. Their profits are therefore theoretically close to zero. The effect of a trade restraint is to draw the oligopolistic firms into a collusive partnership as a reaction to an unsustainable drop in profit. A quantitative restriction will therefore generate more distortions than a tax in the case of a price-competing oligopoly.

Bertrand-Nash equilibria in oligopolistic international trade have been studied in the literature, albeit in the context of import—not export—restrictions. Nevertheless, some insight can be drawn. The “collusive” properties associated with quotas are well documented in the literature. If the firms are Bertrand players, Krishna (1989) has shown that an import quota can yield a mixed strategy equilibrium. As elaborated in Helpman and Krugman (1989), with the quota imposed by the importing country, the home firm can opt to charge a higher price, taking advantage of the protection. But if the exporting firm chooses to raise its price sufficiently, the home firm will switch to adopt an aggressive strategy and charge a much lower price to undercut the rival. At equilibrium, both firms’ profits are higher so the quota acts like a “collusive” or “facilitating” device.

In some cases, if the export tax is set high enough, exports will cease and the tax acts like an export ban. Empirically, the threshold level at which an export tax becomes an export ban varies in different raw material industries. One relevant factor is the elasticity of demand for the industrial material: if consumers react strongly to price changes (i.e. the elasticity of demand is high), then imposing an export tax will lower demand more sharply and the rate of tax at which export flows cease is lower than when demand elasticity is low.

It is well established in the literature that an import tax is equivalent to an import quota in models of perfect competition. Once we deviate from perfect competition, the “equivalence” result does not necessarily hold. In the case of a domestic monopoly, for example, an import quota leads to a higher domestic price and lower domestic output compared with an equivalent import tariff (see, for example, Helpman and Krugman, 1989, p.33). Where the domestic firm faces a foreign monopoly, import quotas are also worse than import tariffs for the home country (see Helpman and Krugman 1989, p.56).

These established results concerning import taxes and import quotas can provide some general insights as to why export quotas may be welfare-inferior to export taxes. For example, where a monopoly in the importing country is faced with a perfectly competitive world market, both export taxes and export quotas can shield the monopoly from competition and increase the monopolistic power of the firm. For export quotas, they allow the competitive threats to be eliminated and allow the firm in the importing country the freedom to choose its monopolistic price. With effective export taxes, on the other hand, the implicit “threats” of imports that will swamp the importing market still exist and under some conditions the firm restrains its behaviour. Export quotas will create more distortions than export taxes. In particular, quotas will lead to a higher price and lower quantity consumed in the importing country.

Taking another example, where an exporting country has an export monopoly, the monopoly firm when faced with an export quota can charge a higher export price (such that what is demanded at this price coincides with the quota limit) and thereby capture all the quota rent. In contrast, an export tax that yields the same level of exports will provide the government in the exporting country with tax revenue equivalent to the quota rent.

In sum, there are numerous instances where quantitative restrictions on trade flows are more distorting than border taxes. For example, in the case of an increase in the demand for the raw material, an export tax will allow an increase in exports as a response, thereby alleviating pressure
2.4 The Cournot-Nash model applied to export restrictions: The three-country model

The basic three-country model

This section extends the two-country model already presented. It describes and applies a theoretical model that highlights the implications of an export restriction on a globally traded industrial raw material in a three-country context, where countries X1 and X2 both produce, consume and export their mineral resource, whereas country M has no domestic production and must rely on imports. This model allows a greater range of insights than in the previous model, which did not include a non-producing country.

As before, the model is a static, one-shot game in a partial equilibrium framework, representing an international oligopoly. Since mineral ores tend to be homogeneous, the upstream sector is considered to produce identical products. The structure and assumptions of the model are inspired by the global chromite industry, where Indian and South African producers (countries X1 and X2 respectively) extract the mineral ore for domestic consumption as well as for export, with a large share of exports going to China. The main use of chromite is in the production of ferrochrome. India began imposing export restrictions on its chromite in 2006. For more details, see Fung and Korinek (2013, Box 2, p.28). In China (country M), domestic production of chromite is virtually nonexistent.

In country X1, the firm produces $d_1$ for home consumption and $x_1$ for export to country M. Total production of mineral ore from country X1 is $q_1 = d_1 + x_1$. Similarly, the firm in country X2 produces $d_2$ for domestic use and $x_2$ for export to M. Total production in X2 is $q_2 = d_2 + x_2$. Mineral ore $q_1$ and $q_2$ are assumed to be identical. This reflects the general observation that most industrial raw materials are undifferentiated. The international market for the mineral ore clears so that total global supply equals total global demand. The world price of the mineral ore is $p_W$, while the domestic price in X1 is $p_1$ and the domestic price in X2 is $p_2$. With perfect arbitrage, $p_1 + t_1 = p_W$ and $p_2 + t_2 = p_W$, where $t_1$ is the export tax imposed by country X1 and $t_2$ is the export tax adopted by country X2, which is assumed to be set to zero for most of the analysis below. Assuming that there are no trade measures in country M, the world price $p_W$ is the domestic price in M. Taking the export taxes into account, the law of one price applies to the mineral ore upstream sector.

Each firm’s marginal production cost is assumed to be constant. As in the previous model, the firms in each country behave like Cournot-Nash producers, setting outputs so as to maximise profit. Output-setting behaviour is less competitive, and more feasible, for the firms than setting prices (Bertrand behaviour). In the Cournot-Nash setting with firms producing identical products, even the higher-cost firms can survive and produce positive outputs.

In the context of this model, when X1 imposes or increases an export tax, it effectively adds to the marginal cost of the firm in X1, thereby reducing the competitiveness of its own firm. Other things being equal, ore production from country X1 goes down and production in country X2, the competitive exporting country, goes up. The world price rises, the domestic price in country X1 declines, and exports from country X1 fall. X2’s raw materials exports to country M rise, while the domestic price of the raw material in X2 increases.

Thus, a rise in an export tax in one exporting country displaces the source of the non-producing country’s imports to its competitor. Profit falls for the ore producer in X1 and rises for the producer in X2. Economic rent is thus shifted from the producer in the country imposing the tax to the producer in the other country. This can be illustrated using a reaction curve that shows the optimal or profit-maximizing output responses of a firm for any given output decision implemented by a rival firm. The export tax shifts the reaction curve of the firm in X1 towards the origin and shifts the reaction curve of the firm in X2 outwards from the origin, resulting in lower production in X1 and higher production in X2 (Figure 2.3).
The higher output of the firm in X2 leads to a rise in its profit while the lower output of X1’s firm results in a smaller profit. These results are similar to those in Fung and Korinek (2013). In this extended and modified three-country export competition scenario, however, there are also some new results regarding prices and quantities that cannot be generated in the two-country context. With the three-country model, we see that X1’s export tax has spillover effects on the competing exporting country. The domestic price of the mineral ore in the other exporting country rises, exports and total output rise and the profit of the upstream mineral ore firm rise as well. The world price of the mineral ore also increases. The terms of trade improve for both the raw materials exporters and worsen for the importing country.

Like the mineral ore sector, many processed or refined downstream metals sectors are also dominated by a few global producers. It again seems appropriate to adopt an imperfectly competitive market structure for downstream activity. This implies three oligopolistic downstream producers, one in each of the three countries. The processing firms in X1 and X2 export to country M, while the processing firm in M competes in its domestic market with imports from both X1 and X2. The downstream outputs are assumed to have different grades since different types of processing are performed on the mineral ore in different countries.

This set-up parallels the current global ferrochrome situation. Despite having no home production of chromite, China (M) has substantial domestic production of ferrochrome. Although it is now the world’s largest single producer of ferrochrome, China is still a net importer. South Africa and India both export ferrochrome to the Chinese domestic market. The grades of ferrochrome vary, depending on whether it is processed in South Africa, India or China. Theoretically, this is a three-stage game. In the first stage, the Indian government sets the export restriction. In the second stage, the upstream ore producers in India and South Africa set their outputs. The market clearing prices in the first-stage game become the input prices for the downstream processed mineral sector. In the third stage, the three international downstream firms set the quantities they will produce to compete in the import market in country M.
As before, downstream firms compete in a quantity-driven fashion. In this theoretical setting, an increase in the export tax by country X1 in the upstream ore sector lowers the input price to the downstream firm in country X1 while increasing the input price for the downstream firms in countries X2 and M. It follows that in the third stage of the game, X1’s processed metal exports increase, exports of the processed metal decrease from X2 and M’s domestic output of the processed mineral is reduced. Downstream industry profit is higher in country X1, but lower in X2 and in M.

Thus, the export restriction imposed by country X1 in the upstream ore sector shifts rents from the upstream firm in X1 towards the upstream firm in X2. At the same time, the export tax increases profit of the downstream firm in X1 at the expense of the downstream firms in X2 and in M. This suggests that India’s export tax harms its upstream chromium ore industry, but helps its downstream ferrochrome industry. In South Africa, the upstream chromium ore sector profits from the Indian export restriction but its downstream ferrochrome industry is hurt, as is the Chinese ferrochrome sector as a result of the Indian export restriction (see also Fung and Korinek, 2013; Fung 1995, 2002).

Now we consider an export quota imposed by country X1 on its mineral ore sector. For ease of comparison, we assume that the quota restricts the mineral ore export to the same level as does a given export tax. Starting from the initial Cournot-Nash equilibrium, the domestic output of mineral ore in country X1 is affected in exactly the same way as with the export tax, and the resulting Cournot-Nash equilibrium outputs remain the same for either policy for all players. As in the two-country model, however, an important difference is the administration and ownership of the quota rents. The possibilities have been discussed in the previous section.

Since outputs are the same for either an export tax or an export quota, prices also change in the same way, as do profits. Profit declines in X1’s upstream mineral ore industry, and in downstream processing industries of X2 and M, whereas profit rises in X1’s downstream processing industry and in X2’s upstream mineral ore industry. Nonetheless, although an export quota is broadly equivalent to an export tax, there are many instances where an export quota can be more distortionary than an export tax as elaborated in Fung and Korinek (2013).

In particular, the rents associated with a quantitative export restriction in country X1 accrue largely to the exporting firm in country X2 due to higher world prices, whereas in the case of an export tax, they generally accrue to the public administration in country X1 through tax revenue (Fung and Korinek, 2013). In addition, the imposition of a quantitative restriction on raw materials may imply a higher world price than the use of an equivalent export tax. In an oligopolistic model, raw materials exporters in X2, shielded from competition by exporters in X1 regardless of the level of the world price, may sell their materials at a higher price since they will not need to compete against raw materials producers in X1 over and above the exports included in X1’s quota. They may therefore take advantage of their position as sole exporter to raise prices further in the face of rising demand.

Race to the bottom: Competitive export restriction strategies

When country X1 imposes an export tax, as described in the previous section, simply adjusting output according to its outward-shifted reaction function is not the only action open to X2. If the downstream processed metal sector is more important to X2 than its primary sector, it has an incentive to respond to its competitor's export restriction policy with a similar policy change. Indeed, after India imposed an export tariff on chromite exports in 2006 (and then increased it in 2008), the South African government seriously considered imposing a tax on its own chromite exports in response, but finally decided against it at the time (Korinek and Kim, 2010; Fung and Korinek, 2013). Imposing an export tax as a response would have lowered the input ore price in South Africa and potentially raised its national welfare, mitigating the negative beggar-thy-neighbour effects of the Indian export tax on its own downstream sector.

In general, such a reaction is not a straightforward option. There may be legal consequences in the case of quantitative export restrictions that are not allowed under WTO rules, although exceptional situations exist where quantitative export restrictions are permitted. In the case of
export taxes, some countries are bound by recent accession agreements to the WTO (Chapter 5 of this volume; Karapinar, 2011). Legal or economic consequences to the use of export taxes may also be felt in cases where export taxes are prohibited or regulated in a preferential trade agreement. In the case of the United States, export taxes are prohibited in the Constitution.

Leaving these considerations aside, our model allows us to study the optimal response by country X2 to a restriction placed by X1 on its raw materials exports. We assume that each country, X1 and X2, sets its export tax rate so as to maximise its own economic welfare. Following the standard literature, and simplifying for the purposes of this model, total welfare of country X1, W1, is defined as the sum of the profit of the upstream ore firm B1, plus that of the downstream processing firm V1, plus the export tax revenue T1 (Bagwell and Staiger, 2009a, 2009b). It was shown above that all three components are functions of X1’s tax rate (B1 falls, whereas V1 and T1 rise, when X1’s export tax rate increases). We denote by t1* the optimal tax rate that maximises W1. Similarly, t2* denotes the export tax that maximises the national economic welfare of country X2.

If the downstream firm is more important to X2’s government, a rise in t1 will negatively affect W2, since a rise in t1 raises the ore input price in country X2. Note that both countries have vertically linked firms, each with market power. From the standpoint of economic efficiency throughout the value chain, the input ore price is excessively high given that this is an oligopolistic situation. In other words, the input is provided at a price above marginal cost. An increase of the ore price in X2 due to X1’s export tax exacerbates the existing inefficiency due to imperfect competition, moving the input price still further away from marginal cost and lowering the total economic efficiency of the value chain. Thus, W2 can be negatively affected by increasing t1. Similarly, in the contrary case, the welfare of country X1 would decrease if country X2 imposed or increased an export tax. This particular case highlights the potential for strategic export policy interdependence. This is a situation where each country’s own welfare increases with the imposition or increase of its own export tax, but the welfare of the competing exporting country declines. Relative to a free trade equilibrium situation, an export tax is thus a beggar-thy-neighbour policy, where the national welfare of each exporting country rises with its own export tax and declines with the export tax of its competitor.

Now consider the following three-stage game: in the first stage, the governments in both X1 and X2 set their export taxes t1 and t2 independently, each maximizing its own national economic welfare W1 and W2. In the second stage, for given export taxes t1* and t2*, each upstream industrial raw material ore firm chooses its own output, maximising its profits B1 and B2. The equilibrium prices of the mineral ores in the second stage become the input prices for the processed metal sectors. Given these input prices, in the last stage the downstream processed metal firms set their output levels, maximizing their respective profits in countries X1, X2 and M.

When the two governments in X1 and X2 set their export taxes independently, each ignoring the impact of its export tax on the other, it is a non-cooperative export tax game. This game is structurally similar to the prisoners’ dilemma game, and as in that case, there exists a co-operative outcome in which both countries would be better off. In theory, governments X1 and X2 can escape the non-cooperative suboptimal outcome through negotiated agreement which would include a maximum level of export tax allowed by each country. If the agreement is considered to be legally binding the outcome can be characterised by Nash bargaining. The Nashian arbitrator can be seen as choosing the level of export taxes in order to maximise weighted joint welfare \((W1)\alpha(W2)\beta\), where \(\alpha\) is the bargaining power of country X1 and \(\beta\) is the bargaining power of country X2. Cooperation in the form of adopting cooperative export taxes would raise both countries’ welfare. Co-operative export taxes would normally involve maximizing joint national welfare of both countries.

This raises the question as to the potential form of agreement or collusive negotiation. In some cases, export restrictions are disciplined in regional or preferential trade agreements (see Chapter 5 for a full discussion of options currently used to discipline export restrictions in regional trade agreements). In order for a trade agreement to be binding under WTO rules on preferential trade agreements, however, it must include a substantial amount of each country’s trade, which would go well beyond the scope of one product or sector. Alternatively, a smaller, commercial agreement between two firms or governments may be difficult to obtain since the raw materials producers in the two countries are competitors as are the downstream, processed product
exporters. Such agreements may not be fully legally binding nor are such collusive practices accepted in many countries. Therefore, in the real world, the cooperative solution may not be feasible, and when it is available, each country will be strongly tempted to revert to a non-cooperative export tax, increasing its national welfare at the expense of the other, while its partner continues to behave co-operatively. In a static, one-shot game (Figure 2.4), it is more probable that each government applies its non-cooperative export tax, ignoring the welfare of the other country.

![Figure 2.4. Cooperative and non-cooperative outcomes in the case of an export tax](image)

One way that a sub-optimal “export tax war” can be avoided is if the commercial agreement is self-enforcing. For a self-enforcing agreement to work, the static game characterization of the export tax is extended to a situation where the game is played repeatedly. For simplicity, in this infinitely repeated game, governments set their export taxes in each period over an infinite time horizon. Here too, one outcome is for the governments to set the non-cooperative export taxes \( t_1^* \) and \( t_2^* \) in each period forever. This will yield non-cooperative national welfares \( W_1(t_1^*, t_2^*) \) and \( W_2(t_1^*, t_2^*) \), which are sub-optimal for each period.

If, on the other hand, both governments choose their cooperative export taxes \( t_1^C \) and \( t_2^C \) to maximise the joint welfare \( W_1 + W_2 \), their cooperative national welfares will be \( W_1(t_1^C, t_2^C) \) and \( W_2(t_1^C, t_2^C) \), which are higher than their respective non-cooperative welfares. Furthermore the case when country X1 cheats while the other country cooperates can be characterised as country X1 choosing \( t_1 \) to maximise \( W_1 \) given that the export tax of the country X2 is at \( t_2^C \). The export tax chosen in the cheating situation is denoted as \( t_1^{CH} \). Similarly the cheating export tax for country X2 is \( t_2^{CH} \). For the trade agreement to be self-enforcing, it is necessary that \( W_1(t_1^{CH}, t_2^C) - W_1(t_1^C, t_2^C) < 1/r_1 \), \( W_2(t_1^C, t_2^{CH}) - W_2(t_1^C, t_2^C) < 1/r_2 \), where \( r_1 \) and \( r_2 \) are the discount rates for country X1 and country X2. In other words, in order to
escape the sub-optimal equilibrium, the one-time gain of cheating needs to be dominated by the future discounted loss of cooperation, or alternatively the future discounted punishment.

In summary, an export tax by country X1 negatively affects the national economic welfare of country X2; similarly, an export tax by country X2 affects negatively the economic welfare of country X1. Country M, the importer of raw materials, experiences lower welfare due to the actions of both exporters. Non-cooperative export tax rates lead to a sub-optimal outcome. Trade or commercial agreements that are legally binding or are self-enforcing can in principle be designed to escape this prisoner’s dilemma situation, leading to higher cooperative national welfare for both countries. However, in practice, trade and commercial agreements may be difficult to obtain. In the longer term, it is mainly the threat of future discounted lack of cooperation either through retaliation or a “punishing” reaction on the part of trading partners that may mitigate the sub-optimal policy outcome. In any case, such collusive export taxes would, however, harm third countries and would move the world market farther from a free trade equilibrium in raw materials trade.

Note that an export tax by either country raises the world price of the mineral ore, which confers a terms-of-trade gain on the exporters. It also represents an increase in the input price to the downstream firm in country M, the importing country. The terms-of-trade loss by country M leads to lower economic welfare in country M. Moreover, if the downstream firms in country M relocate to a raw-materials exporting country in order to access raw material inputs more easily, the welfare losses for country M will be even greater than described above. As mentioned earlier, caution should be exercised when applying simplified models to actual situations. The model can, however, provide some insights and can contribute to understanding the complex impacts of exports restrictions as applied to global industrial raw materials markets.

**Alternative reactions available to countries that face export restrictions**

The previous sub-section focuses on trade policy responses to export restrictions by competing exporting countries. This sub-section considers what reactions if any are available to countries like country M, characterised as an importer of the raw material with no domestic production of the mineral resource, but with a downstream industry that uses the mineral as an input. As seen above, export restrictions raise world prices and reduce the global supply of raw materials, thus affecting trading partners that previously imported the raw material in question. In the past, trading partners that have experienced diminished access to supply, or access to raw materials at higher prices due to restrictive export policies, have contemplated various actions in order to counter their distortive effects. Some of the options that have been discussed in different fora are outlined below:

- Reduce or remove any remaining import tariffs on the raw materials that are subject to export restrictions.
- Promote and fund research into alternative technologies with the objective of using a more diversified set of minerals and metals as inputs in strategic industries.
- Facilitate exploration of new sources of raw materials that are subject to export restrictions, for example in regions that are potential exporters.
- Facilitate the development of technologies that recycle metals from discarded final-use products.
- Increase cooperation between producers and consumers affected by restrictions to facilitate information flows, improve access to existing supply channels and alleviate short-term supply disruptions.
- Develop measures to alleviate the most distorting effects of export restrictions in a multilateral context. Some suggestions as regards the agriculture sector have been put forward including “using multilaterally agreed definitions and criteria … to interpret the meaning and scope of exceptions” to the ban on export quotas” (Howse and Josling, 2012), implementing disciplines on food aid such as those outlined in DDA discussions, and outlining a
mechanism for identifying and evaluating the appropriateness of the use of export restrictions in the context of a critical shortage of supply (Howse and Josling, 2012).

- Integrate export restrictions provisions in plurilateral agreements among producers and consumers to ensure access to supply and to markets. This may include agreements among market participants to ensure access to supply and open markets, or negotiating disciplines on export restrictions. Some existing regional trade agreements include such clauses (see Chapter 5).

An example of a situation where alternative strategies have been actively sought, and the difficulties of doing so, can be found in Korinek and Kim (2010). It concerns restrictions on exports of rare earths elements by China, which is responsible for over 90% of their production and holds a substantial share of the world’s reserves. Although export restrictions began in 2000, consuming countries did not react strongly to world market price increases, since these essential inputs are used in extremely small amounts in manufactured goods, so price changes could be absorbed by the final product market. However, when quotas began to introduce supply shortages in the second half of the last decade, importing countries began to implement a number of the strategies outlined above.

2.6. How successful are export restrictions in accomplishing their objectives?

Export restrictions are currently used to achieve a range of stated or implicit policy objectives. This section draws on the theoretical analysis and the ensuing discussion in previous sections to examine how successfully each of these policy objectives may be met. Clearly, a detailed empirical analysis would be required if the aim were to provide a quantified answer to the question posed for a particular country’s use of restrictions in a given sector. We focus on five commonly cited objectives.

1. Export restrictions provide indirect subsidies to downstream industries

Export restrictions are sometimes used by large countries to subsidise their downstream industries. At first glance, this industrial strategy may be valid in the case of a large country with market power on the world market. Imposing export restrictions on the raw material producers raises the world market price for the input purchased by foreign downstream industries while reducing the price for domestic downstream producers, thereby creating an indirect subsidy to their production process. This may be enough in the short run to increase the profitability in such industries so that they can develop to a position of global competitiveness and potentially capture markets abroad.

As with all policy instruments, however, problems such as the creation of vested interest may arise. Once an export restriction is in place, it may be difficult to remove it. A downstream firm that has been indirectly subsidised will lobby to keep the subsidy in place. It will also be in the interest of foreign raw materials suppliers that the policy be kept in place as they will also benefit from higher world prices. In addition, domestic downstream firms that use subsidised inputs will use them more intensively and adopt technologies that are more intensive in the input. Eventually, the economy as a whole will become more dependent on the raw materials.

In the longer term, using an export restriction to provide an indirect subsidy to downstream industries may incur significant costs in terms of the competitiveness of the country using the policy. Raw materials producers will incur an overall welfare loss. This may not be of particular concern to policy makers, in particular if the firm is foreign-owned. Even if it is a state-owned enterprise (SOE), the firm may pursue other societal objectives and not be strictly oriented towards profit and growth. The welfare of the raw materials producing sectors may be considered less important to policymakers because they are generally less labour-intensive. It should be noted, however, that the longer term impact of the policy will depend in part on the extent to which foreign raw materials producers can make up the difference in production levels.
In the country imposing the export restriction, the incentive for raw materials producers will be to limit exploration, technological improvements and innovation. This will have a significant effect in the long term on their productivity. If they continue to produce at similar levels, the overall impact of the export restrictions will depend on the potential of foreign raw materials producers to capture existing markets. If domestic raw materials producers lose significantly in competitiveness due to lower levels of investment, they may reduce production to the point where the country becomes a net importer of the raw material. Their impact on world markets would therefore be lost as would be the potential to subsidise input prices for downstream firms.

The potential impact of cheaper inputs on the downstream industry depends on the share of the input in the production process. The advantage of having access to a cheaper raw material may be significant when considering a downstream user that processes the raw material directly, for example, a smelter that transforms ore into metal or a facility that refines extracted ore. It will probably not provide significant assistance to most manufacturing industries further down the value chain that use the raw material in their final products, since the price advantage of the cheaper raw material will be diluted and will not bring a strong advantage.

The potential impact of export restrictions will only be felt as long as viable substitute products are not found. In the face of a price increase for an industrial raw material that is expected to be sustained over the medium-to-long term, whether the cause is an export restriction or other factors, users will seek alternative production methods using less of the restricted export, or substituting it altogether. In the short term this may be difficult but in the longer term it may be successful. There are many cases in economic history of such alternatives being developed when world market prices became relatively higher or producers were incapable of adequately supplying world markets.

Examples of alternatives to export restrictions for increasing the potential for spillovers into other sectors of the economy are presented in Chapter 7. Both Chile and Botswana have put considerable efforts into their industrial strategies without resorting to export restrictions.

2. Export restrictions generate government revenue

A significant number of countries use export taxes to generate government revenue. Some use them extensively for this purpose by applying substantial levels of tax on a wide variety of exported products. Indeed, in some countries export taxes are a major source of government revenue. The effects of export taxes on the raw materials sector have been outlined in previous sections: production and exports fall. Very often, when considering applying an export tax, policymakers mistakenly assume that present levels of production and exports will continue. It should be kept in mind that levels will drop, and therefore tax revenue may be less than expected. Indeed, Chapter 1 (Table 1.8) suggests that, exception in a few cases, export restrictions have not produced a substantial revenue for the government.

Tax revenue may also be less than expected in the longer term due to lower production levels if raw materials producers invest less in their operations and in exploration of new deposits. In this case, government revenue will fall short of expectations based on performance and there will be an incentive to apply export taxes on other products or find alternative methods of funding government expenditure. Revenue from taxation of the minerals sector is often best collected through a profit tax or a royalty, although this method of revenue collection requires more sophisticated institutions and adequate levels of governance (see Otto et al., 2006, for a detailed overview of the policy alternatives in the area of taxation of the extractive industries).

Export taxes are sometimes used to generate revenue for the government by countries that have difficulty collecting taxes in another way, such as property taxes, income taxes and corporate profits taxes. Reasons for this may include a lack of qualified personnel in tax administration, under-developed institutional capacity, or wider governance shortcomings. One important underlying issue is transparency. Although not put into place for the purpose of collecting taxes, implementation of the Extractive Industries Transparency Initiative (EITI)\textsuperscript{16} can help to make transfers of funds from the private to public sectors more transparent and accountable.
3. Export restrictions help to conserve natural resources

A common reason given for using export taxes and quotas is to conserve the non-renewable natural resources that are the products of the extractive industries. Indeed, in some cases, private firms may have incentives to extract minerals at higher levels than optimal. There is a trade-off between extraction in the present period and potential future extraction. It should be noted, however, that the imposition of an export tax or quota that is expected to continue over time may dampen exploration and therefore lower future minerals extraction, possibly for many years.

Nonetheless, export restrictions will not necessarily help to achieve optimal extraction rates; they may actually exacerbate problems of over-exploitation. As already shown, the tax creates a price wedge between the domestic and world market price, encouraging domestic use. If as a result more of the products of the mining industry are sold on the domestic market, production may not be significantly lower, depending on the size of the domestic market. Downstream industries that avail themselves of cheaper raw materials due to the export restrictions may use materials more intensively. It is more desirable therefore to manage the total production level of the scarce resource, for example using a minerals tax or royalty, rather than to tax exports. A similar concern sometimes occurs with respect to environmental protection. Export restrictions are not the best way to increase disciplines in this area: emissions standards and environmental regulation of the sector are far superior.

4. Export restrictions monitor or control export activity, or control illegal export activity

Export taxes and quotas are not the best way to monitor export activity or control illegal exports. Chapter 7 includes an overview of some of the complex issues that are related to illegal production and export of metals and minerals in South America. Controlling exports can be done better by issuing export licenses. Monitoring of export activity and controlling illegal exports of metal products can be done better by adequate screening of exports and automatic procedures by which to check shipments. Trade facilitation reforms can also play a key role (see, for example, OECD, 2003).

Moreover, stopping illegal trade is best done in a plurilateral context. When a mechanism is in place for peer reviewing compliance with defined norms, an incentive is created for both importers and exporters to reduce or eliminate illegal trade. Within the context of the CITES convention, for example, some processes have been put in place to enforce mutual compliance so as to eliminate trade in certain animal and plant species (see OECD (2012) for a discussion of this issue).

Many countries ban the export of some of the waste products of the mining industry. Bans or heavy taxes on the export of waste and scrap may be in place to guard against the export of minerals masked as waste and scrap or the export of illegally obtained metal products. This is a well-documented concern in a number of countries. Waste and scrap are subjected to almost as many documented export restrictions as all metals and minerals combined (see Chapter 1). The analysis in this paper does not cover the export restrictions applied to waste and scrap, which is a somewhat separate issue. Given the nature of the product, it is likely to require a different model specification.

5. Export restrictions control flows of foreign exchange and manage the exchange rate

For some countries, exports of minerals or metals are the primary source of foreign currency denominated revenue. Mineral exports may in part determine the value of their exchange rate. For this reason, some central governments attempt to manage their exchange flows using export restrictions. The impact of export restrictions on the exchange rate is outside the scope of our theoretical analysis here and requires a different model specification. However, export restrictions are an inexact tool with which to manage the flow of foreign exchange, and doing so may be contrary to other development objectives. Export restrictions seem to be used less and less for controlling foreign exchange (see Chapter 1, Table 7). Chapter 7 discusses alternative policies other than export restrictions for achieving fiscal and exchange rate stability in the context of recent
experience in Chile, where the mining sector contributes 50% or more of the value of its exports (see also Korinek, 2013).

2.6. **Some further implications of the theoretical analysis of export taxes and quotas**

It has been shown that an export tax or quota in a large producing country implies a shift in welfare and in profits from domestic raw materials producers and foreign downstream producers to domestic downstream producers and foreign raw materials producers. Unless domestic downstream producers fully make up the loss of foreign sales, domestic raw materials producers move to lower production levels. Whether or not this occurs, the profit of domestic raw materials firms is lower, which induces a fall in their rate of investment. Downstream producers will increase production and their use of other inputs. In some cases, the downstream producer is a subsidiary or partner of the raw materials-producing firm. In this case, a within-firm reallocation of resources occurs. In mining, the downstream sector is generally more labour-intensive. Therefore, a net shift within the country imposing the restriction will occur toward greater investment in the downstream technology and toward job creation in the labour-intensive industry. It should be noted, however, that an export tax or quota causes a fall in employment in the mining of the raw material in the country imposing the policy. This may give rise to particular challenges, since many mines are located in geographically remote areas with few alternatives for employment.

Abroad, raw materials producers gain from higher world prices and lower exports of the firm(s) in the country that is subject to a tax or quota. Raw materials producers in countries that are not subject to the export restrictions therefore increase production. They may start exporting if not doing so already. Higher world market prices for their goods increase their profits. They may use the higher revenue to increase their investment, although the extent to which they do so will depend on the length of time they think the policy will be in place. Due to the uncertainty of the policy, they will engage in less investment than they normally would if they were responding to sustainable changes in market conditions rather than a policy that may be altered. Foreign downstream producers lose out because of higher prices for their inputs. They invest and produce less due to their lower profit margins. If their original margins were low, some firms may exit the market. Jobs will tend to decrease in countries not subject to the export restriction since the downstream industries tend to be more labour intensive.

Some downstream producing firms in the mining sector use proprietary technological processes. When this is the case, the downstream industry in the country imposing the export restriction is not necessarily able to take advantage of the more favourable market conditions due to the lower prices of its inputs. It will therefore look to foreign investment and transfers of technology in order to expand or initiate production. Issues of process patents are relevant here. Downstream foreign firms (i.e. firms outside the country imposing the export restriction on raw materials), hit by higher prices of inputs, may be willing to outsource some of their production to firms in the country where the export restriction is imposed. They may also be willing to sell some of their know-how or proprietary processes if they can no longer produce profitably. The government imposing the export restriction may use its position to create an incentive for greater investment in its downstream industry by competing foreign firms.

In the longer term, however, technological innovation in downstream production processes could suffer overall. This is because the returns to such innovation will have fallen in all countries outside the one imposing the export restriction. One area in which technological innovation will be fostered is in finding alternative materials, or ways in which to use less of the raw material whose export is restricted. If such a breakthrough occurs, the export restrictive policy will have been self-defeating, and all producers of the raw material will become less profitable due to lower demand for their goods and the subsequent fall in prices. In this case, downstream producers will be relatively less affected as they will adapt to a change in input (in the case of the foreign firms) or may continue to use the original input mix (in the case of the domestic firm). But if the domestic downstream firm is a subsidiary or partner to the raw materials producer, that firm will lose significantly.
Ultimately, the outcome depends on specific market conditions. In some cases, foreign producers will increase production, and exports and market conditions will be restored close to their original levels. This is more likely when supply is not scarce or geographically located in a small area, and when the firm(s) located in countries not using export restrictions are able to produce at a similar cost to those in the country using the restriction. In other cases, use of an export restriction in one country may lead other countries to adopt a similar policy. In the case of an export tax, the impact of the measure will be diminished if other countries apply similar measures. Section 2.5 explored the question of an optimal set of export taxes that jointly maximise the welfare of exporting countries that wish to restrict their exports. It was stressed that the inter-country cooperation required to implement a collectively agreed policy would be difficult to achieve, and in any case the welfare of countries outside the agreement (including non-producing importing countries) would still be diminished.

The impact of an export tax or quota depends in part on the ownership of the raw materials firm in the country using the restriction. Lower profit levels due to the restriction may induce multinational raw materials producers to shift investment away from the country imposing the restriction to its mining operations elsewhere in order to benefit from higher world prices and avoid the restrictive measure. A state-owned raw materials producing firm may be less likely to focus exclusively on profit maximization and more mindful of economy-wide employment objectives than a privately owned firm, and so may not react as strongly to the imposition of the restriction. If so, the state-owned raw materials producer may reduce production, and even exports, less than a private firm would have done in order to supply government revenue through the tax or help achieve other societal goals, such as employment goals, for which a quota may have been placed.

A government considering implementing an export restriction may also take into account the ownership of the raw materials firm in its choice of policy instrument. When the raw materials firm is multinational with foreign headquarters, it may be more likely to use an export tax than an export quota to curb exports in order to collect revenue from the foreign-owned firm. By contrast, if an export quota were used, the multinational firm could well capture a substantial share of the quota rent. A government that is managing exports by colluding with a state-owned raw materials producer, however, may prefer to use a quota, allowing the SOE to capture the quota rent while the downstream industry is able to access their inputs at a lower price.

This reasoning may well dominate the choice of instrument when the main objective of export taxes is the collection of government revenue. When the revenue from export taxes is a significant part of total government revenue, and especially if income from raw materials exports is a significant share of GDP, export taxes rather than quotas will be a trade policy instrument of choice since they create revenue for the government. The choice becomes more clear-cut when the producing firm is foreign-owned and the downstream processing firms are domestically owned, since the export tax also implies a shift of welfare (and profit) from the foreign-owned firm producing domestically to downstream producers. However, this may not always occur. When the downstream industry is relatively weak or does not possess the necessary technology or growth potential to take advantage of the situation, imposition of an export tax will shift welfare away from the extractive industries firm but—in the domestic arena—only the government will benefit (through export tax revenue). Political economy factors could make the policy setting unstable. If the mining firms have a strong political voice within the country, they may use their influence to do away with the export restriction or limit its implementation.

Not only are foreign and domestic producers of the raw materials and their downstream products affected by an export restriction; so too are producers and consumers of complementary and substitute products. This is a particularly important issue in the metals sector since many rare and precious metals are alloyed with steel to produce materials with precise characteristics. In the country using the restriction, demand for complementary inputs (i.e. that are used together with the raw material) will increase, while demand for substitutes (that can be used instead of the raw material) will fall. On the world market, however, the reverse is true. Complementary products will suffer from imposition of the restriction, whereas substitutes, when they exist, will experience higher demand.
There is a further complication in metals and minerals markets due to the fact that some mining products are in part by-products of extraction of other minerals. One example is copper and molybdenum. Molybdenum is obtained from two different types of mines: primary molybdenum mines and copper mines. At primary mines, its recovery is the prime target of the mining operation. It is also mined as a by-product of copper extraction in some countries and regions. If the price of copper falls due to an export restriction, firms producing copper will reduce their production levels. In that case, their production of molybdenum will also fall, and once stockpiles of the unrefined by-product are exhausted, the domestic price of molybdenum will rise. If the copper-producing firms are significant global producers of molybdenum, the world price of molybdenum will also rise as a result of the export restriction on copper, other things remaining equal. If, however, the export restriction is placed on the by-product (molybdenum) rather than the main metal extracted (copper), production of the main product will continue while the by-product will probably be stockpiled as long as its price remains low. Hence, the impact of an export restriction on a product such as molybdenum may be quite complex, depending on a number of factors such as the type of production (primary or by-product), developments in related minerals markets (in this case, copper) and reactions of foreign producers in both primary and secondary markets.

The industrial raw materials that are produced from extractive industries are by nature non-renewable natural resources. Their supply, however, is not fixed in the medium term, nor is it always known. In many countries, new deposits are found regularly and information concerning existing deposits is revised. Imposing an export tax, and to an even greater extent an export quota, will negatively affect future production by reducing firms' incentives to undertake new exploration. Exploration is a costly and high-risk activity, and most exploration ventures are unsuccessful. Firms are likely to reduce their exploration activities in countries imposing export restrictions, which then strongly compromises their future production possibilities. Given that exploration is a necessary activity in the extractive industries, the effects of export restrictions could be negatively felt in the domestic industry for many years.

It has been seen that some of the impacts of export restrictions are potentially stronger in the case of an export quota than with an export tax, although production levels and changes in world prices may be similar. With quotas, the incentive to capture the quota rent may lead to more collusive behaviour on the part of participating firms. The potential of collusion to fix prices is strong particularly in the case of a price-setting duopoly or small number of participating firms. This implies that governments implementing quantitative restrictions on exports need be mindful of such incentives to participating firms.

The impact of an export quota on economic actors is somewhat harder to ascertain due to potential differences in quota administration. In the case that export quotas are auctioned in an open-bidding process, their impact is potentially similar to that of a tax – the quota could in principle be sold at a price that would provide the government with the same amount of revenue as would be provided by a tax. However, the outcome could be quite different: competing firms or a single firm with substantial market power could obtain the quota rent and increase its profits while limiting production. Moreover, the amount of revenue generated by auctioning the export quota is generally thought to be less than the full quota rent in practice so the welfare shift from the exporting firms to the government in the case of the quota will probably be smaller than the potential maximum.

In reality, export restrictions have sometimes been justified as a way to counter a surge in the demand for a raw material due to an increase in demand for the processed product. As demand for both the raw material and the processed product rise, the quantitative restriction – assuming it is binding – reveals itself to be a more distorting trade policy instrument than an export tax, as the country using the quota maintains the same level of exports regardless of the international price of the product. International prices for the raw material will rise further in the case of a quantitative export restriction, relative to an equivalent export tax, and impacts on the downstream processing industry will be felt more strongly, i.e. downstream producers in both countries that have not imposed the export restriction will be hit harder whereas downstream producers in the country imposing the restriction will be more heavily subsidised, albeit indirectly.
In the special case where international demand for the resource is completely inelastic, the export tax is unlikely to affect demand, and hence the quantity exported will not fall. World market price will increase by the amount of the tax. On the other hand, the export quota will restrict the physical volume of the good coming onto the world market, with steeply rising prices as importers compete for insufficient supplies. This explains the developments in the world markets for rare earths, for example, nearly all of which is supplied by China. Reaction from trading partners to China’s export tax introduced in 2000 was muted, but markets responded strongly when export quotas were subsequently introduced.  

2.7. Conclusions

This chapter has presented the economic theory underlying the functioning of export taxes and quotas, first in a 2-country setting, where both countries are producers of the raw material resource, and then in a 3-country model where the two producing countries are joined by a non-producing, importing country. The Cournot-Nash oligopolistic model selected for the analysis corresponds well to the situation in mineral and metal resource industries, where a relatively small number of countries produce a substantial share of world output, which is then widely traded. The theoretical analysis is exploited to obtain insights into the complex pattern of price and welfare changes, and shifts in profitability and employment, that export restrictions unleash. Moreover, the similarities and differences between the two restrictive instruments – taxes and quotas – are fully explored, as well as the reasons governments may have for preferring one to the other. Whether and if so, in what circumstances, it is appropriate for a country to respond to an export restriction imposed by a trading partner or competitor by introducing a restrictive measure of its own is also examined, as well as other alternative reactions (which are the only possibilities for non-producing non-exporting countries for whom an export restriction is not an option). The theory also provides a valuable basis against which to evaluate the claims made by countries using export restrictions concerning their objectives and motivation. In most cases, the arguments put forward as justification are revealed to be partial or misguided, or in need of careful qualification.

The chapter has teased out some of the implications of the situation where the use of an export restriction by one country encourages a second exporter to do the same. Indeed, the analysis in the three country model (with two exporters and one, non-producing importer) suggests that both exporters will implement export restrictions in order to shield their processing sectors from competition. These policies could become further entrenched as time goes on and governments review their export restrictions in place. An outcome where both exporters use export restrictions is sub-optimal for both exporters and harmful for the importing country that does not produce the raw material. The theory indicates, however, that both exporters will act in this counter-productive fashion, characterised as a “prisoner’s dilemma” situation.

Policy makers in exporting countries will undoubtedly attempt to counteract the negative impact on welfare of this sub-optimal situation. One way to move forward is via an international agreement in which both exporting countries agree to reduce or eliminate their use of export restrictions. This might be attempted in the context of a regional or preferential trade agreement (RTA). In order to be recognised as such within the WTO, however, an RTA must diminish, not increase trade barriers. An RTA must also eliminate the duties and other restrictive regulations of commerce on “substantially all the trade” (GATT Article XXIV). Negotiating a ceiling to or the elimination of export taxes on a range of industrial raw materials would presumably need to be part of a wider-ranging package of trade policies in order to qualify as a preferential trade agreement. This may in practice be difficult to achieve.

The two exporting countries could otherwise try to come to a collusive agreement. In order to be effective, however, the agreement must be considered legally binding by both parties, and it is doubtful it would stand up against a dispute panel. Ostensibly, the outcome of the export restriction “repeated game” is therefore the sub-optimal one of imposition of an export restriction by both exporting countries. According to the theory, it is a repetitive outcome, i.e. exporting countries continue to use an export tax, other things being equal, and may even further reduce global welfare
by increasing their tax rates thereby bringing about a situation of competitive regulatory export barriers.

A possible reaction by the importing country is to retaliate in some way, either by imposing export restrictions of its own on a product it exports, or some other measure. Although this scenario is outside the confines of the two-sector, three-country model outlined here, it is a real option for the importing country which is doubly hit by the export restrictions placed by both raw materials exporters. If the importing country takes retaliatory measures, the welfare of both raw material exporters falls further, and global welfare is lower than it was before the importing country’s response.

The analysis here indicates that the outcome of the “repeated game” of export restrictions depends on the future discounted loss of cooperation, or alternatively the future discounted punishment. Moreover, the bargaining outcome is weighted by the market power of each player. In this way, larger players with greater market share may retaliate more credibly when faced with export restrictions that harm their producers. Smaller players will be less able to credibly retaliate in a non-cooperative situation.

WTO disciplines are much weaker as regards export restrictions compared with more “traditional” areas of international trade policymaking such as import restrictions, subsidies and non-cooperative trade practices. Attempts to introduce disciplines in this area in international negotiating fora have not met with overall success although disciplining export restrictions in agriculture has met with somewhat more consensus. The outcomes described above indicate that the use of export restrictions leads by default to a situation of lower global welfare. Insofar as this can be considered a market failure, an international regulatory response may be envisaged to discipline export restrictions on raw materials, in particular those that can be produced in a finite number of locations. Inasmuch as such disciplines would represent a regulatory response to an international market failure, they would represent a public good.

This chapter has illustrated the negative impact on welfare of the imposition of export restrictions and any subsequent reactive measures. In the case of a global welfare reducing measure, a remedy at the multilateral level would seem optimal. Similarly, large regional agreements could include the issue of export restrictions and some prominent existing RTAs have done so (see Chapter 5 of this volume). Export restrictions could also be at the forefront of newly-styled negotiations on disciplines necessary for supply-chain trade to flourish, as suggested by Richard Baldwin (Baldwin, 2012). If export restrictions were to be disciplined at a plurilateral level, it remains to be seen what the appropriate venue would be. An issue such as export restrictions could be discussed in a sectoral fashion similar to an ITA (Information Technology Agreement) for metals and minerals. This type of discussion has proven successful partly because it is of narrow enough scope to focus participants on the sector and the issues that are most important in governing it. As with the ITA, such negotiations are often discussed among a limited but substantial group and applied to all trade in the sector, i.e. multi-lateralised. Alternatively, discussions on export restrictions disciplines could be part of a single undertaking. Although such negotiations have proven difficult in the recent past, this may be the most logical from an economic standpoint.

Notes

1 K.C. Fung is Professor of Economics at the University of California at Santa Cruz and Jane Korinekis is a Trade Policy Analyst in the OECD’s Trade and Agriculture Directorate. The authors are grateful for comments and discussions on earlier versions of this chapter by Frank van Tongeren and Barbara Fliess of the OECD Secretariat, Roberta Piermartini of the WTO Secretariat, and Tim Josling, Professor Emeritus of Stanford University. Statistical assistance was provided by Tarja Mård. The final report benefitted from discussions in the OECD Working Party of the Trade Committee, which has agreed to make the study more widely available through declassification on its responsibility.
2. Much of this chapter has been published separately as an OECD Policy Paper (Fung and Korinek, 2013). The basic model developed there is supplemented by the 3-country model included here in section 2.5.

3. [www.oecd.org/tad/ntm/oecd_tad_methodologyinventoryexportrestrictionsrawmaterials.pdf](http://www.oecd.org/tad/ntm/oecd_tad_methodologyinventoryexportrestrictionsrawmaterials.pdf) provides a methodological note outlining the criteria used to compile the data, product and country coverage, etc. See also Fliess and Mård (2012).

4. More detail is given in Chapter 1. These are conservative estimates, since the criteria used for including countries in the Inventory mean that not all export restrictions in force for each product have been identified. Moreover, since export restrictions dampen trade flows, trade in products subject to export restrictions are lower than they would have been without the restrictions.

5. This is not to suggest that industrial raw materials supply is particularly elastic. In the short to medium term, however, many mining facilities can increase their levels of production somewhat. It would therefore, be inappropriate to illustrate these sectors using a perfectly vertical supply curve as is done in some of the analysis of the agriculture sector.

6. In particular, there appears to be no study that looks at the optimal path of export taxes on exhaustible resources (WTO, 2010, p. 148).

7. This is particularly likely for an industrial raw material that is a key input used in a sophisticated manufacturing supply chain.

8. It is unclear in the theoretical literature whether this is a significant issue. Stiglitz (1976) suggests that the rate of exploitation of exhaustible natural resources by a profit-maximizing monopolist is not higher than that in a competitive market.

9. This occurred with striking results for molybdenum after China implemented a series of export restrictive measures (see Korinek and Kim, 2010; Fung and Korinek, 2013, p.28, Box 2).

10. Details of how this model is solved can be found in Fung and Korinek (2013), Appendix.

11. For more on the issue of an optimal export tax in the raw materials sectors, see Tarr (2010), p. 139.

12. This would also be the case if the domestic resource firm is state-owned, in which case the quota rents are technically also owned by the government.


15. Which are used in trace amounts in some high technology and environmental goods (hybrid vehicles, cell phones, computers, televisions, energy-efficient light bulbs and wind turbines).

16. This initiative was launched in 2003 to promote and oversee the EITI standard. Any country can observe this standard, but there are currently just 26 countries with the status “EITI compliant”, indicating that their relevant procedures have been validated.

17. An indication of the importance of export taxes in government revenue in some countries can be found in Chapter 1.

18. For more details, see Fung and Korinek (2013), p.31, Box 3.

19. “The purpose of a customs union or of a free-trade area should be to facilitate trade between the constituent territories and not to raise barriers to the trade of other contracting parties with such territories”, GATT Article XXIV, [http://www.wto.org/english/tratop_e/region_e/region_e.htm](http://www.wto.org/english/tratop_e/region_e/region_e.htm).

20. Disciplines and procedures that have been used in different international fora to regulate export restrictions are outlined in Chapter 5 of this volume.
References


Annex 2.A.

Comparison of impacts of an export tax in the perfectly competitive case with the oligopolistic case

The model outlined in this annex assumes an oligopoly as this seems to most accurately reflect the minerals sector. Other models are possible, however, and the table below summarises the aggregate impacts of an export tax in two different ones.

<table>
<thead>
<tr>
<th>Impact of export tax</th>
<th>Perfect competition, large country</th>
<th>Oligopoly</th>
</tr>
</thead>
<tbody>
<tr>
<td>World price</td>
<td>Increases</td>
<td>Increases</td>
</tr>
<tr>
<td>Domestic price of exporting country</td>
<td>Decreases</td>
<td>Decreases</td>
</tr>
<tr>
<td>Terms of trade of exporting country</td>
<td>Improves</td>
<td>Improves</td>
</tr>
<tr>
<td>Domestic consumer surplus</td>
<td>Increases</td>
<td>Increases</td>
</tr>
<tr>
<td>Domestic producer surplus</td>
<td>Decreases</td>
<td>NA</td>
</tr>
<tr>
<td>Domestic economic rent</td>
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<td>Decreases</td>
</tr>
<tr>
<td>Domestic reaction curve</td>
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<td>Shifts in</td>
</tr>
<tr>
<td>Domestic output</td>
<td>Increases</td>
<td>Increases</td>
</tr>
<tr>
<td>Export</td>
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