Tariffs and Steel: The US Safeguard Actions

By

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Agricultural and Resource Economics,
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Abstract

This paper presents a multi-product price linked spatial equilibrium model of world steel trade. The model is used to analyse the impacts of the safeguard trade barriers brought about by the United States in order to protect their domestic industry from so called unfair competition. Emphasis is placed on the likely effect to the Australian industry and possible policy responses available to the industry. A case study is made on Australia's three largest export products, namely slab, hot-rolled and cold-rolled steel, which share some substitutability in supply and demand due to the nature of the industry.

Keywords: Trade, spatial equilibrium model, steel.

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1. Introduction

Trade protection is often viewed as an inefficient means to achieve a domestic policy outcome. Further, trade policies aimed at protecting or improving domestic employment and encouraging structural reform rarely succeed due to the lack of consideration given to other sectors of the economy. The benefits from trade, to both importing and exporting countries are significant, with many countries advocating free trade so that the global economy can maximise these benefits. It is interesting then, that a country such as the United States — a traditional supporter of free trade in the manufacturing sector — has advocated a policy which restricts trade to achieve a domestic policy outcome.

On the 6th of March 2002, President George W Bush announced a series of punitive tariff barriers on imported steel into the United States. The measures included a range of tariffs on processed steel products, which had the potential to affect Australia's exports to the United States by the value of $400 million (Davis and Collins 2002). Australia's largest steel export to the United States — slab steel — was relatively un-effected with the implementation of a global tariff quota of 5.4 million tonnes. Further, a concession on Australia hot-rolled steel products was granted such that 250kt of exports would be exempted from the new barriers. Recently, the World Trade organisation has ruled the safeguard measures illegal; however the United States government has rejected the finding. As such, it is unclear whether the US will remove the tariffs, or face retaliation from steel exporting nations.

President Bush blamed trade-distorting subsidies from steel producing nations for the increase in imports to the United States. Bush reasoned that the subsidies provided to overseas steel producers lead to excess capacity in the global steel industry, with excess stocks being 'dumped' on the US market (Bush 2002). The temporary protection measures were aimed at restoring market forces in the US steel market. This would allow steel producers to restructure their operations in order to re-gain a comparative advantage. Coupled with the tariff barriers, President Bush indicated that he wished to expand the National Grants Programme in order to help re-train workers whose jobs would be lost due to structural reform. He also planned to provide direct assistance to help firms with health care costs, which have led too much of the inefficiencies experienced (Bush 2002).

The aim of the study is to investigate the motives and effects that the US safeguard tariffs and quotas, placed by the United States on the importation of steel products, would have on the Australian, and world steel industries. Further, even those these barriers may be removed, the study will examine the use of trade policy to achieve a domestic policy objective. The structure of this paper follows; an overview of the world steel market presented in section 2 with the history and motives behind the current protectionist measures imposed by the United States, in section 3 details of the spatial equilibrium used to model the industry are given, section 4 defines the assumptions of the empirical model with results and policy implications discussed in sections 5 and 6. The impacts to be assessed in this study are the likely changes in volume and direction of trade flows caused by the implementation of the tariffs and the subsequent changes in consumer and producer surplus calculated as a change in net revenue for producers and a change in total benefit less the price paid for steel consumed by consumers.

2. The world steel environment

Steel consumption in terms of finished product equivalent fell amongst OECD member nations from 1997 to 1998 (OECD 1999, p. 11). However, during this period the United States experienced an increase in demand due to strong economic growth. During this period, global stocks of steel rose. This increase in stocks placed downward pressure on prices in the following years.

The increase in stocks was partly brought about by falls in steel prices and was the reason for maintaining lower prices in 1999. Steel stocks were expected to decrease in 1999 and in 2000 but remained higher than pre 1998 levels (OECD 1999, p. 11). The high levels of stocks kept steel prices low over the following years, increasing the competitiveness of imports on the world market. Production levels also fell during 1998 by just under 3 percent (OECD 1999, p. 12).

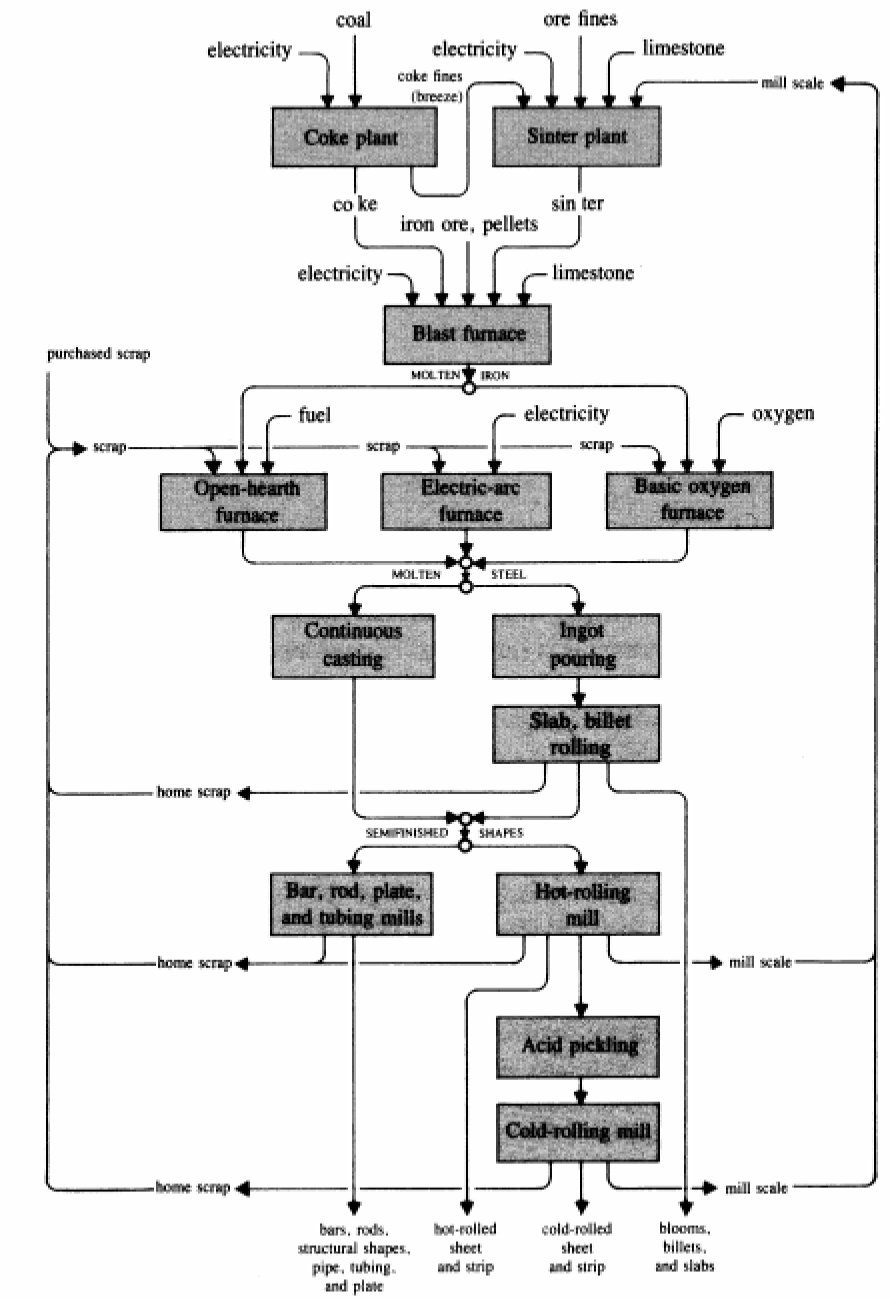
The level of stocks and capacity in the global steel industry was seen as the major cause of low prices and the reason behind moves towards protectionist policies by nations around the world (Maurer and Lynch 2002). Excess capacity and stock levels have risen in recent years with low world prices due to the economic downturn in Asian countries. The global excess capacity of the steel industry in 2001 was estimated to be 1,070 million tonnes, representing 14 percent of current global production (Maurer and Lynch 2002).

The United States represents the largest export market for Australian steel products followed by South Korea and Taiwan. In 1999, slab steel accounted for around 50 percent of total steel exports, with hot rolled sheet and coil accounting for around 17 percent of total steel exports (Ferber 2002, p. 23). Cold rolled sheet and coil accounted for close to 2 percent of the total exports in 1999 (Ferber 2002, p. 23).

3. Steel production and users

The steel industry is comprised of different enterprises that produce finished steel mill product and semi-finished slabs, blooms, and billets from iron ore, steel scrap, or both (Crandall 1981, p. 5). The output from steel producers is in the form of carbon, alloy or stainless steel. Carbon steel comprises the bulk of world steel production. The major consumers of steel goods are the construction and automotive industries (Crandall 1981, p. 5).

The steel production process is shown in Figure 1. As seen, slab steel is a primary form of steel. The input source for slab steel and other semi-finished products is iron ore. This iron ore is processed through various production methods to produce molten steel, which is used to produce slabs, blooms and billets. Hot rolled and cold rolled products are the finished steel products and use slab steel and other semi-finished products as their input source.



Source: Crandall (1981) p. 8.

Figure 1: Steel Production Process

Steel is a major input into most manufacturing industries. It is used in a range of products from defence goods to cars and therefore plays a major role in any national security plan developed by nations. This is one reason for the continuing involvement of the United States government in the steel industry aside from issues concerned with public choice.

4. Protection in the United States

The American integrated steel industry faces competition pressures from both home and aboard. High cost integrated steel manufacturers, due to a highly unionised workforce and high cost production methods are under threat from smaller domestic mini-mill producers and foreign imports which have captured a quarter of the American market (Anon 2002).

An integrated steel manufacturing plant is one, which uses iron ore in order to produce its steel via a blast furnace production method. A mini-mill is a steel manufacturing plant that users scrap steel, which is melted down to be reformed into new hot rolled and flat steel products. Mini-mills have expanded their market share since the 1970s from 5 percent in 1970 to 35 percent in 1996 (Crandall 1996). This growth was attributed to a sharp decline in scrap steel prices and relatively low production costs. Integrated steel producers have a highly unionised workforce and as part of the conditions negotiated by the unions, companies are required to pay generous benefits to retired employees (Crandall 1996).

As such mini-mill producers have a significant cost advantage over the larger integrated steel producers. This cost advantage has arisen from two sources, lower fixed costs and lower labour costs. For the industry, the United Steel Association estimates the costs to be close to $US1 billion annually, or on average, $US9 per tonne produced (Hufbauer and Goodrich 2002). Further to these payments, it is estimated that the higher capital costs incurred by integrated steel producers, mean that fixed costs per tonne of hot rolled steel produced are equivalent to $US130 for integrated producers, compared with a cost of $US30 for mini-mills (Hufbauer and Goodrich 2002). However, this cost disadvantage is partly offset by higher variable costs for mini-mills (Hufbauer and Goodrich 2002).

The United States became a net steel importer in 1959 and, with the emergence of Japan as a major exporter of steel products, imports gained greater penetration into the US market. From 1967 to 1968, domestic producers looked to overseas suppliers to fill their steel orders. This fall in demand for locally produced steel lead to the formation of the Voluntary Restraint Agreements with Japan and the European Union (Jones 1983, p. 8). These agreements placed voluntary restraints on steel exports to the United States.

Despite initial success, in 1979, the last year of the agreement, imports rose again sharply (Jones 1983, pp. 10-1). The reason for this rise was believed to be linked with the decline in the threat by the United States of import barriers, the lack of coverage (nations and products) and as prices rose, exporting nations responded to market forces and not the possible threat of unilateral trade protection by the United States (Jones 1983, p. 13).

Post the Voluntary Restraint Agreements a Trigger Price Mechanism was introduced in 1977 in order to offer a form of binding import restraint (as the voluntary restraint agreements where not binding but only upheld by goodwill on the part of the members). The mechanism established a system of dumping reference prices, which if import prices fell below the specified levels, then they would become subject to an investigation and possible anti-dumping duties applied. The aim of this policy was to quell the protectionist demand by steel producers and also to allow the government control over import restraints (Jones 1983, p. 50).

In 1982 the Trigger Price Mechanism was replaced, in part, by an agreement between the European Community and the United States to limit imports into the United States (Jones 1983, p. 79). After continuing problems post the minimum price scheme, the United States negotiated seven new voluntary restraint agreements with importing countries in an effort to stem fears of anti-dumping actions by United States producers. Even with these agreements the United States steel industry filed an anti-dumping action against a non-agreement importer. The United States denied anti-dumping claims by domestic producers and decided instead, to negotiate further voluntary export restraints (Howell *et al* 1988, p. 530).

This further intervention failed to solve the problems of the US steel industry as imports from non-agreement nations increased. Further to this, major steel suppliers to the United States such as Canada, Sweden, Argentina and Taiwan did not enter export restraint agreements and took advantage of the situation which limited their competitors supply (Howell *et al* 1988, p. 533). The reluctance to pursue market reforms in the face of competition and instead to look for government protection has been instilled in the US steel industry by continual government support.

Government intervention into the US steel industry can be seen as a case of policy persistence. The continued government intervention leads to a change in decision making as decision makers change their behaviour believing government support will be provided and thereby creating demand for that support should it not be given (Coate and Morris 1999). The recent safeguard actions by the United States can been seen as a further extension of a problem that first appeared in the 1960s and one which has been exacerbated by government intervention in steel trade since that time.

In the period between 1997 and 2001, 29 US steel firms filed for bankruptcy. Further to this, a total of 21 have closed since the 2000 presidential elections (Hufbauer and Goodrich 2002). These closures have lead to approximately 10,370 jobs being directly lost to the steel industry, with Bethlehem Steel and LTV causing most of the job loses. These jobs losses have placed pressure on governments to act in some way to lessen the hardship from closures of large industries. In 2001, the US International Trade Commission found that there was injury to local producers caused by imports. This gave the government the right to impose trade barriers (Maurer and Lynch 2002). The full range of trade barriers are presented in Table 1.

The national security argument has been used to defend the move by the Bush administration to safeguard the United States steel industry. Steel is an important input into the manufacturing sector of the economy, and in a period of global uncertainty after the terrorist attacks in September 2001, the United States government has been less willing to rely on imports. A Republican Senator was quoted as saying "It's important to have a vibrant domestic source of steel" (Stevenson 2001, p. C.1). This reason is used to defend the government's attempts to maintain integrated steel producers as the mini-mill sector relies on imports as well as domestic supplies of scrap steel as its major input source. However, in 1997, the United States imported 18.6 mega tonnes of iron ore, representing close to 23 percent of consumption (ABARE 1998, p. 280).

Table 1: Restrictions on Australian Steel Exports to the United States

Product	Remedy	Year 1	Year 2	Year 3
Slabs	TRQ[a]	30%	24%	18%
Hot rolled coil for re-rolling by steelscape	Exemption	250kt	250kt	250kt
Other hot-rolled sheet and coil	Tariff	30%	24%	18%
Cold-rolled sheet and coil	Tariff	30%	24%	18%
Plate	Tariff	30%	24%	18%
Coated Sheet	Tariff	30%	24%	18%
Tin Mill products	Tariff	30%	24%	18%
Hot-rolled bar, cold finished bar	Tariff	30%	24%	18%
Rebar	Tariff	15%	12%	9%
Certain welded tubular products	Tariff	15%	12%	9%
Stainless rod and bar	Tariff	15%	12%	9%
Stainless wire	Tariff	8%	7%	6%
Pipe and tube fittings and flanges	Tariff	13%	10%	7%

[a] TRQ: tariff rate quota, 30% tariff applies to tonnages in excess of country quota in year 1, 24% in year 2 and 18% in year 3, kt = thousand tonnes.
Source: USITC and Whitehouse web sites

The determinants of industry assistance may be expressed as a function of two factors, those that affect vested interest groups' incentive to demand assistance, and those that affect the governments' incentive to supply assistance (Anderson 1978). Changes in the mix of assistance are thereby caused by changes in one or both of these factors (Anderson 1978).

The United States steel industry has been declining in relative importance to the economy since the 1950s. Steel employed 1.5 percent of workers in the United States in 1950, 0.6 percent in 1980, 0.2 percent in 2000 and 0.1 percent in 2002 (Henwood 2002). As the relative importance of an industry falls, the effects of its eventually failing become more localised, and hence the loss to fewer individuals increases. This leads to a greater incentive for those individuals to become organised and lobby governments for assistance. Generally, the impact of government assistance on the rest of the economy, and the cost of that assistance is less than if the industry was still large. This reason makes it more likely for governments to be persuaded to support a certain industry, particularly if re-election hopes are affected by votes in the industries geographic heartland. However, in the case of steel, the effect on the rest of the economy is great due to its importance for the manufacturing sector.

5. The modelling of steel trade

The impact of tariffs and quotas usually sees a reduction in total welfare in the economy which implements the measures. Tariffs are imposed in order to raise the domestic price above the world price and hence allow domestic industries to compete with imports at a higher price level (Pindyck and Rubinfeld 1998, pp. 312-18). Tariffs are generally a tax on imports for goods entering into a country, either placed as a percentage of their dollar price or a fixed amount on each unit imported.

Tariffs placed by small importing nations (those which cannot influence world price) will create a fall in welfare. The tariff causes several distributional effects, there is transferred surplus from consumers to producers and a transfer from consumers to government (tariff revenue); both these effects do not represent a fall in efficiency (Tisdell 1992, p. 105). Further, there are effects that represent a fall in efficiency and as such a welfare loss, there is a transfer of consumer surplus to production cost and an area of forgone surplus as consumers have to re-allocate budgets to reflect a change in relative prices.

In the case of the safeguard tariffs used to protect the US steel industry, a series of ad valorem tariffs were used. The economic impacts and consequences of these ad valorem tariffs are basically the same as a fixed rate tariff. The ad valorem tariff is set as some percent of the international price, causing high prices to be skewed away from the world price, with low prices relatively unaffected (Houck 1986, p. 49).

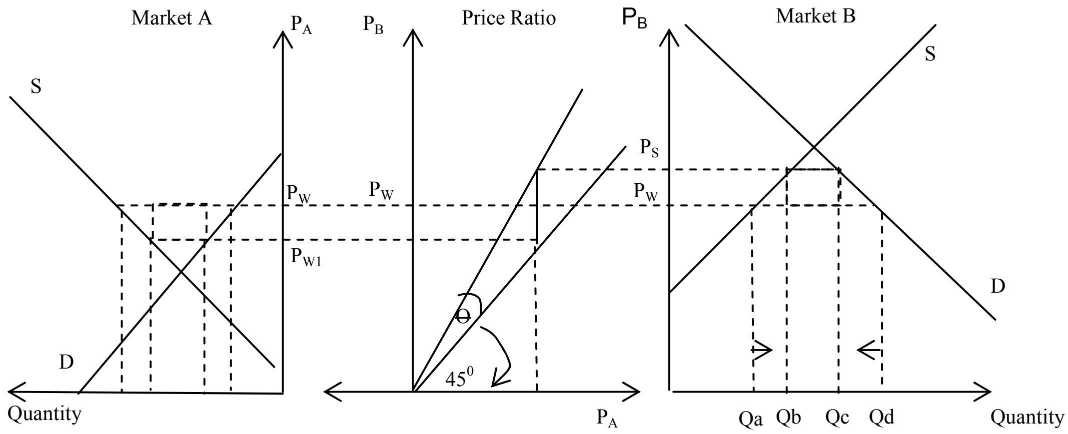


Figure 2: Effect of an ad valorem tariff
P_W is world price; P_S is support price and other variables as defined

An ad valorem tariff is depicted in Figure 2. The ad valorem tariff is applied as a percentage 'mark up' (θ) on import price (Market A's price). The non-tariff barrier transfer price between markets (given costless transfer) is given by the 45 degree line, that is, the price in Market B is the same as in Market A. The imposition of a tariff creates a wedge between the two prices, causing the price in Market B to rise, whilst creating a fall in price for Market A. The tariff revenue collected is shown by the shaded regions on Figure 2. It can be seen that revenue is collected from both markets, with the share determined by relative elasticities. The result of the tariff induced change in relative prices is an increase in domestic production at the cost of production in the exporting nation (*Qd*-*Qa* less *Qc*-*Qb*). Further, demand in the importing nation falls, whilst increases in the exporting nation.

Quotas restrict the amount of an imported product into the domestic market. After the implementation of an effective quota, domestic price increases causing domestic production to increase from the free trade level. This increase in output represents a shift in the resources used in the domestic economy away from more efficient uses, to inefficient use in the production of the protected good. This efficiency loss within the domestic economy is similar to that for a tariff.

An import quota has significant external effects on overseas producers if the importing country is large. The change in excess demand on the world market causes the world price to fall and the domestic price to rise. This fall in world price and rise in domestic price means that the imposing country is able to extract a level of quota rent from world producers. The collection of quota revenue will be similar to that seen in Figure 2 and depend on relative elasticities; however, the feed back in the fall in world price will not occur.

A tariff quota (or tariff rate quota) was imposed on Australian steel exports. A tariff quota is comprised of two parts, a 'within-quota' tariff and 'out-quota' tariff. The 'within-quota' tariff applies to the goods that are imported within the quota — in the Australian case; the within-quota tariff is equal to zero. The 'out-quota' tariff is the tariff rate applied to any goods, which are imported over the set quota

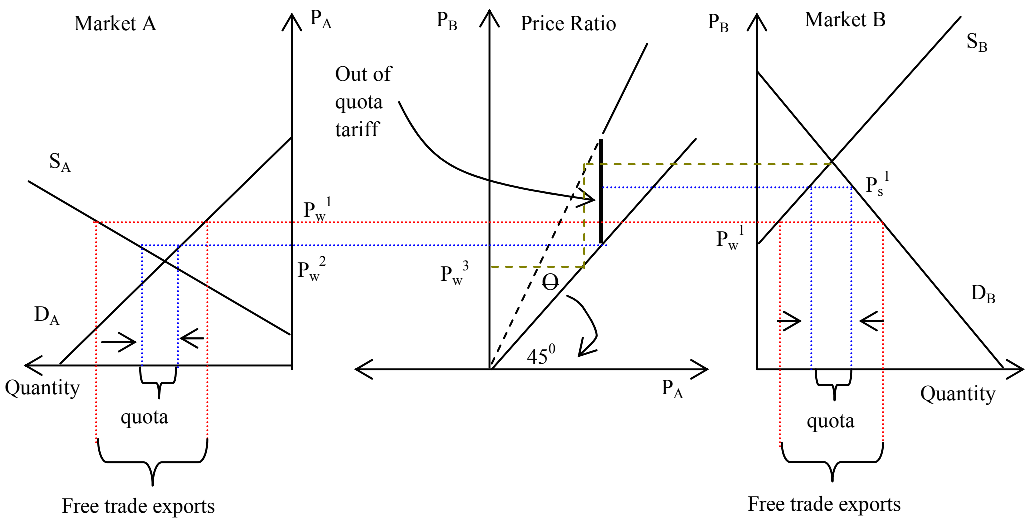


Figure 3: Tariff rate quota (within quota trade only)
D_i is demand in region i; and i = A,B, S_i is supply in region i; P_w^j is world price; and P_s is support price.

The effect of a tariff quota with a prohibitive out-quota tariff is shown in Figure 3. If a zero tariff is applied to the first 'quota' units, that is, the within-quota tariff, and an out-quota tariff equal to 'θ' (an ad valorem tariff), a stepped price ratio results (assuming no transport costs). The effect on the domestic economy is the same as with a quota, with one difference. A standard quota allows no feed back of world price to the domestic market; however, with a tariff quota there is an opportunity for a change in world price to feed back to the domestic market. If the price were to fall below P_w^3 in Figure 3, then some units would be imported with the out-quota tariff applied. The effect of this would be to lead to a lower domestic price and increased imports.

6. Spatial Equilibrium model

A spatial equilibrium model was used to evaluate the impacts of the US safeguard measures on steel trade. A spatial equilibrium model was first constructed by Enke (1951) and mathematically solved by Samuelson (1952) and Takayama and Judge (1971). Such models can be formulated with either prices or quantities as the dependant variables (Krishnaiah and Krishnamoorthy 1990). The approach uses either an welfare based objective function, or a net revenue function, which equals zero at the competitive equilibrium. The simplest from of a spatial equilibrium model is constructed under the assumption of perfect competition, where supply, demand and transfer costs are known (Batterham and MacAulay 1994). An excess demand function is derived as the horizontal difference between demand and supply in a market. Conversely, excess supply is the horizontal subtraction of the supply function from the demand function. When world price is below the autarky price, the excess demand function is positive indicating that domestic demand is greater than domestic supply. When the world price is above the autarky price, the excess supply function is positive indicating that the domestic supply is greater than demand.

Where the excess demand and supply curves intersect, the quantity and direction of trade is determined (Figure 4). The flow of goods occurs from country 1 to country 2 (denoted as x_{12}) (Figure 4). With transfer costs equal to zero, the trade equilibrium would be given by the intersection of the excess demand and excess supply curves. On Figure 4, transfer costs are given by t_{12} and represent a positive cost. The effect of this is to make the price lower in the exporting market (region 1) and higher in the importing market (region 2) than is the case with no transfer costs.

Samuelson (1952) provided a means to solve more complex spatial models by using the concepts of consumer and producer surplus and a mathematical programming formulation. Samuelson described the 'net social pay-off' from trade as the benefit to producers from the exporting countries and the benefit to consumers in the importing countries less the transfer costs (the shaded area on Figure 4). This is given by the area between the excess demand and supply curves in Figure 4 less the total transfer costs. The equilibrium is then defined as the point where the net social payoff is maximised.

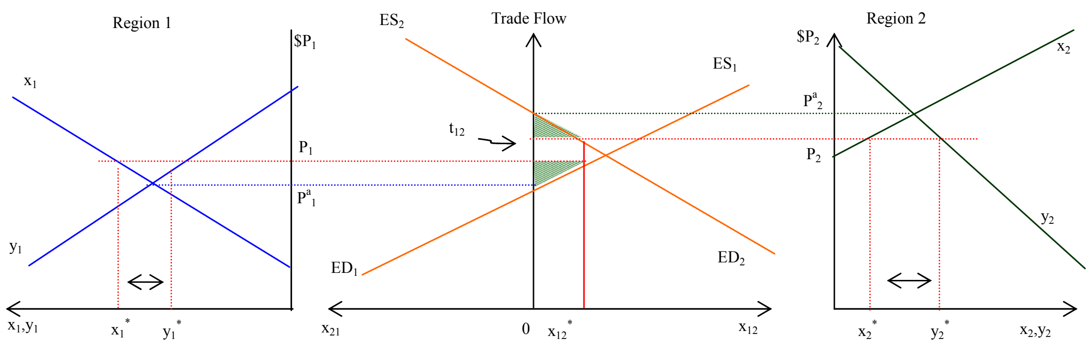


Figure 4: Trade between two regions
Where x_i is supply in region i; y_i is domestic demand in region i; where i = 1,2 ES_i is excess supply from region i; ED_i is excess demand from region i; t_{12} is transfer cost from region 1 to region 2; x_{ij} is exports from region i to region j. and j is 1,2. P_i is price in region t; P^a_i is autarky price for region i,

The excess supply and demand functions can be used to show the welfare effects from trade. Trade causes welfare changes as prices rise for the exporting region (country 1) and fall for the importing region (country 2). As such there are associated changes in producer and consumer surplus. As prices rise for the exporter, producer surplus increases and consumer surplus falls (the opposite case is true for the importing nation). The area between the excess supply and excess demand functions less transfer costs represents the net welfare gain from trade (shown by the shaded area in Figure 4), and it is changes in these that will be examined to determine the welfare impacts of the safeguard measures.

The approach used in this study is one based on the quadratic programming model developed by Takayama and Judge (1971) and that used by Batterham and MacAulay (1994). Takayama and Judge (1971) showed that the Samuelson model, based on a social welfare function could be solved using what was termed 'net social monetary gain' as the objective function (referred to as the 'net revenue' function in Batterham and MacAulay (1994)).

The net social revenue solution is depicted in Figure 5. Under perfect competition, a transfer services demand function can be implicitly derived from the vertical difference between the excess supply and excess demand functions. The difference between the excess supply and excess demand functions is the difference in the autarky prices between the regions, and hence, as long as transfer costs do not exceed the difference between the curves, trade will take place. In other words, the vertical distance between the curves is the 'willingness to pay' for transfer services and is effectively the demand for transfer services. Total revenue from transfer services is equal to the total traded volume multiplied by transfer costs. Under perfect competition, the set of price transfer cost relationships are required to hold so that the net social revenue is zero. As such, the models objective function is maximised to a zero value.

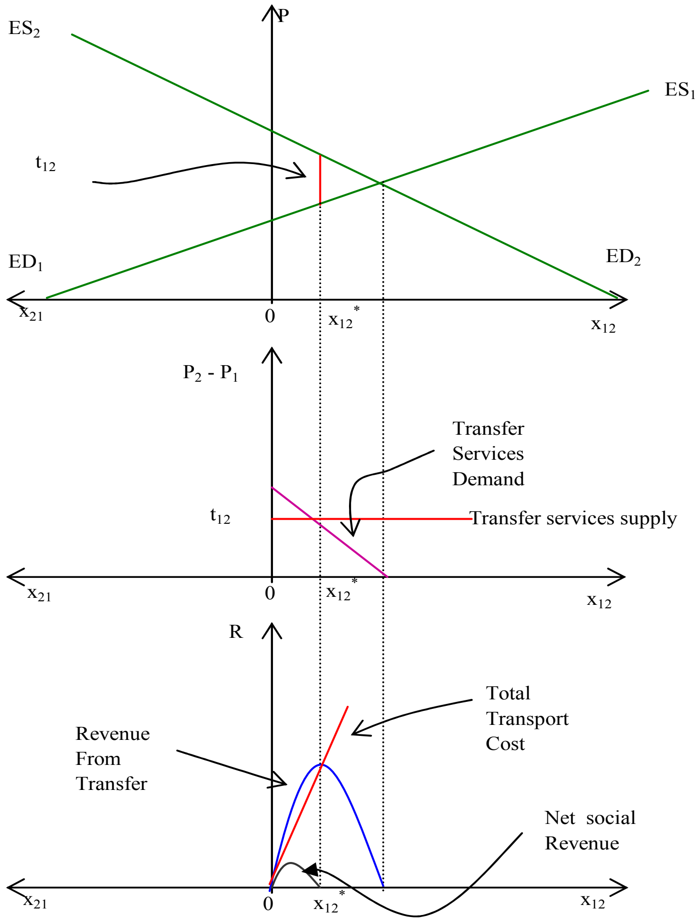


Figure 5: Representation of a net social revenue solution

There are three sets of equilibrium conditions that are essential to the spatial equilibrium model. First, the difference in prices between markets must be less than or equal to the transfer costs between each of the markets (Samuelson 1952). This condition is known as an arbitrage condition and can be seen as an extension of the *law of one price*. It is based on the assumption that the products from each region are perfect substitutes and that no firm has market power to influence price (that is perfect competition). Second, supply can be separated into trade flows. If the quantity produced in one-region (x_1) remains in that region, then the trade flow x_{11} is such that $y_1 = x_1 = x_{11}$. In other words, in autarky, the demand in region 1 (y_1) is equal to the supply in region 1 (x_1). With trade, demand in any region, y_j, is local production, x_j, plus imports $\Sigma_j x_{ij}$. Conversely, the supply, x_i, is equal to exports, $\Sigma_i x_{ij}$, plus demand, y_i. The spatial model allows for no excess demand to exist, but does allow excess supply if a slack variable is included in the model (MacAulay 1976, p. 159).

A price-orientated spatial equilibrium differs from a quantity-oriented spatial model as outlined by Martin (1981), in its decision variables. In both models the returns from trade for the participating nations are maximised, that is, the area between the excess supply and excess demand functions less the transfer costs (net social revenue) are maximised (Batterham and MacAulay 1994). Price-orientated spatial equilibrium models reach equilibrium in the simulated market through solution for price levels which give rise to quantities produced and traded as the Lagrangian multipliers on the dual variables. In the quantity formulation the solution is for quantities that subsequently lead to equilibrium prices as the dual variables.

7. Empirical model

7.1 Elasticities and data used in the model

A spatial equilibrium model requires data on consumption, productions and exports. These data points are used in conjunction with elasticities to estimate the supply and demand functions for the regions in the model. The data were collected from International Iron and Steel Institute (2002), American Iron and Steel Institute (2002) Ferber (2002), and International Trade Commission (2002). The data obtained was used to develop a global balance sheet for steel production for 1999 as this was the most current year in which a full data set was available. As such, the results obtained are based on changes from the 1999 levels, however, export levels to the United States remained stable over the period from 1999 to 2002 (U.S. Census Bureau 2001).

The demand for slab steel can be seen as a derived demand. If this is the case, the elasticity for the derived product is a function of the final product and the marketing margin involved. The marketing margin is the difference in the price from the derived level and the final level, or in this case, the semi-finished steel price and the finished steel price. The finished steel price is greater than the semi-finished price due to the extra production costs (marketing margins) involved in transforming the good from its semi-finished to finished state.

The elasticity at the derived level is less than the elasticity at the retail level because the derived price is lower than the retail price (Tomek and Robinson 1990, p. 42). As such, demand for slab steel is assumed to be fairly inelastic — more inelastic than final products such as coated sheet and hot rolled sheet.

The steel industry uses many inputs which are industry specific (even labour can be seen as fairly immobile due to the specialised nature of the skills required). It is assumed that factors are as mobile down the production process as up the production process — that is from coated products to hot rolled to slab. Although there is a large capital expenditure required to move into finished products, and there is a large capacity of many integrated steel producers responsible for producing much of the semi-finished products (Crandall 1981, p. 12), the substitution elasticities are assumed to be the same due to the fact that it would take time to move from one process to the other and the static nature of the spatial equilibrium analysis.

Information on supply elasticities was unavailable, and as such, the elasticities of supply were estimated. Supply for steel products is assumed to be relatively elastic for all steel products. Slab steel is assumed to have a more elastic supply due to it being a primary product, whilst the elasticity of the further processed steel is assumed to be more inelastic. Again, elasticities for the Rest of World region are assumed to be more elastic than for the other nations. Due to the uncertainty about the elasticities being estimated for use in this study, a range of elasticities will be used to examine the sensitivity of the model. A similar technique will be used for the cross-price elasticities.

Inventory (stocks) data were unavailable and so a just in time production process has been assumed. This assumption will be weak in some respects as producers of hot rolled and coated sheet products would hold inventories of slab steel and other semi-finished steel products in order to be more responsive to shifts in demand. However, exporters if holding stocks would still face the tariffs applied and hence be subject to the same conditions. Crandall (1981, p. 124) estimated total stocks of slab steel in the United States to be close to six million tonnes, which would mean their response to a price rise (in terms of quantity produced) would be greater than otherwise. Inventory levels for steel products in the United States were estimated to be equal to 1.82 months of production (Jondrow *et al* 1982). This level corresponded to an average level of 103 tonnes per producer, with estimates of imported steel inventory levels being equal to zero (Jondrow *et al* 1982) —that is, a just in time supply was used

7.2 The model structure

The products chosen were slab steel, hot-rolled steel and coated sheet steel due to their significance to the Australian industry. Slab steel is Australia's major steel export to the United States, followed by hot rolled products (Ferber 2002, p. 7). The tariffs applied excluded some slab steel exports within a global quota, with hot rolled products later subject to a quota exclusion as well. To assess the impact, coated sheet steel was chosen as it also attracted the full tariffs. The countries included in the study were Australia, the United States of America, Japan, Rest of World importing nations and Rest of World exporting nations.

As production and consumption of steel can change between products, particularly due to the application of trade distorting measures that favour one product over another, substitution coefficients were estimated. Substitution coefficients were calculated for each steel product in order to measure whether producers would respond to the tariffs by sending alternate products into the United States. The substitution of each steel product for the other, that is slab steel for hot rolled, slab steel for coated sheet and hot rolled for coated sheet for both supply and demand functions were estimated and inserted into the model (the cross coefficients were included in the Ω and H matrices, see MacAulay (2002)). The calculation of the coefficients for each region was as follows:

$$\text{Demand: } \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} P_1 \\ P_2 \\ P_3 \end{bmatrix} \tag{1}$$

where y_i is demand for good i, α_i is the intercept for demand i, and β_{ij} is the cross coefficient of demand for good i given the price of good j these coefficients are required for the spatial equilibrium model. It was assumed that the cross-price elasticity for good 1 given the price of good 2 was equal to the cross-price elasticity for good 2 given the price of good 1 (symmetry). The definition of the relationship between β_{ij} and the cross-price elasticities is shown below:

$$\begin{bmatrix} \mathrm{E}_{11} & \mathrm{E}_{12} & \mathrm{E}_{13} \\ \mathrm{E}_{21} & \mathrm{E}_{22} & \mathrm{E}_{23} \\ \mathrm{E}_{31} & \mathrm{E}_{32} & \mathrm{E}_{33} \end{bmatrix} = \begin{bmatrix} 1/y_1 & & \\ & 1/y_2 & \\ & & 1/y_3 \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} P_1 & & \\ & P_2 & \\ & & P_3 \end{bmatrix} \tag{2}$$

The solution to equation (1), in terms of α_i using equation (2) is:

$$\begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} = \left[(1 - \mathrm{E}_{11} - \mathrm{E}_{12} - \mathrm{E}_{13}) \quad (1 - \mathrm{E}_{21} - \mathrm{E}_{22} - \mathrm{E}_{23}) \quad (1 - \mathrm{E}_{32} - \mathrm{E}_{32} - \mathrm{E}_{33}) \right] \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} \tag{3}$$

and β_{ij} :

$$\begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} = \begin{bmatrix} 1/P_1 & & \\ & 1/P_2 & \\ & & 1/P_3 \end{bmatrix} \begin{bmatrix} y_1 & & \\ & y_2 & \\ & & y_3 \end{bmatrix} \begin{bmatrix} \mathrm{E}_{11} & \mathrm{E}_{12} & \mathrm{E}_{13} \\ \mathrm{E}_{21} & \mathrm{E}_{22} & \mathrm{E}_{23} \\ \mathrm{E}_{31} & \mathrm{E}_{32} & \mathrm{E}_{33} \end{bmatrix} \tag{4}$$

The advantage of incorporating cross-price terms into the spatial model is that it will allow the three demand equations to act in a dependent way (as with supply). This modification to the model will mean the spatial model can be used to model any range of substitute and complementary goods by allowing price changes from a policy shock to be determined for the full range of goods, even if a certain policy issue only affects one of the goods examined.

Tariffs are incorporated into the spatial equilibrium model through the arbitrage conditions (MacAulay 1992; Takayama and Judge 1971 and Koo and Larson 1985). The application of an ad valorem tariff is analogues to the incorporation of an exchange rate. Essentially, the ad valorem tariff increases the costs of transfer from one region to the other, and hence can be linked to the transportation cost (MacAulay 1992, p. 305).

When incorporated into the model, a converter matrix R_τ can be constructed to incorporate the tariffs (MacAulay 1992, p. 306). With different tariff rates for different trade flows, the arbitrage condition matrix (see MacAulay (2002) for a general formulation) becomes:

$$\begin{bmatrix} R_\tau & G'_y & G'_x \end{bmatrix} \begin{bmatrix} \rho_y \\ \rho_x \end{bmatrix} \leq T \qquad (5)$$

where R_τ is in a (n^2 x n^2) matrix. For example, if φ_{ij} is $1/(1+\tau_{ij})$ and the tariff rate τ_{ij} is applied on the trade flow from region i to j then R_τ is a square n^2 x n^2 matrix for n regions and has φ_{ij} terms on the main diagonal for those trade flows with tariffs (see MacAulay 1992)

For use in the model, the ad valorem tariffs were applied to the steel demand price in the United States. With a tariff level equal to τ_{12} levied on the price of steel products exported from country 1 to country 2, the arbitrage condition thus becomes:

$$(1-\tau_{12})\rho_1 - \rho^2 \leq t_{12} \qquad (6)$$

Thus, a tariff of 30 percent would mean the value of $(1-\tau_{12})$, would be 0.7 in the arbitrage condition matrix.

Australia successfully negotiated an exemption for 250 kilo-tonnes of hot rolled sheet imports. In order to incorporate this exemption into the model, an 'within-quota' tariff (the tariff applied to the first N units imported into a nation, where N is equal to the quota volume) of zero percent will be applied to the first 250 kilo-tonnes of hot rolled sheet exported to the United States, and an 'above-quota' tariff (the tariff applied to the importation of any units above the quota level N) of 30 percent will be applied to the remaining steel exports to the United States. The incorporation of a quota has been done by separating the trade flows into the United States into an within-quota trade flow with no tariff and a quota imposed, and an out-quota trade flow with the full tariff rate applied. Slab steel was subject to a global quota of 54 million tonnes which has been implemented in the model in a similar way to the Australian specific quota on hot rolled steel.

Transfer costs for the model were estimated by using unit value differentials between regions. The differential chosen was calculated as the United States domestic price less the export unit value. The reason for this choice was due to the difficulties in obtaining transfer costs. Transfer costs were unavailable for the specific products examined with country specific prices also unavailable. Prices were available for the major countries or trading areas but not the smaller areas such as Australia. However, the price differences between export unit values and the United States domestic price did correspond with the trade flows, so that the net exporting regions — Australia and Japan — had lower export unit values than the United States domestic price.

The difference in export unit values and the US domestic price includes the transfer costs from the exporting nation to the United States, but it may also include other factors. If exports are concentrated towards a higher or lower value sub-product, then the export unit value will be skewed towards the higher or lower price range. This may exaggerate or under estimate the transfer cost. Notwithstanding this discrepancy, as well as other factors influencing the US domestic price, the transfer costs obtained are the best available given the data set.

8. Results

The results obtained from the spatial equilibrium model are presented in this section. The results are discussed in terms of changes in prices, quantities and economic surplus. In order to calculate the changes in producer and consumer surplus, a line integral was required. This was because the demand and supply equations were specified as a function of not only own price, but also of the price of the other goods in the model. In terms of the partial equilibrium, this relation to three variables means the demand and supply functions are a plane in a three dimensional space. The calculation used to determine the consumer and producer surplus for industry 1 is shown in equation (7) which is:

$$\begin{aligned} CS_1 &= \left(\frac{\alpha_1}{\beta_{11}} \overline{P}_2 \overline{P}_3 + \frac{\beta_{12}}{2\beta_{11}} \overline{P}_2^2 \overline{P}_3 + \frac{\beta_{13}}{2\beta_{11}} \overline{P}_2 \overline{P}_3^2 \right) \\ PS_1 &= \left(\frac{\alpha_1}{\beta_{11}} \overline{P}_2 \overline{P}_3 + \frac{\beta_{12}}{2\beta_{11}} \overline{P}_2^2 \overline{P}_3 + \frac{\beta_{13}}{2\beta_{11}} \overline{P}_2 \overline{P}_3^2 \right) \end{aligned} \qquad (7)$$

where β_{ji} = cross-price coefficients of good j for price of good i; β_{ii} = Own price coefficient for good i; αi = demand intercept of good i; and $\overline{P}_i$ = the equilibrium price of good i.

This calculation is an adaptation of the calculation used in MacAulay (1976, p. 158) with the use of a line integral set out in Spiegel (1968, p. 121) and Stewart (1995, p. 896). The problem with using line integrals to determine consumer and producer surplus is that they are path dependant (see MacAulay 1976, p. 158). However, for the purpose of this study, the change in consumer and producer surplus is relevant, and so the above formula was used for all calculations with the changes in surplus used to examine the impact, and not the actual surplus.

8.1 Prices

Using the model, the world price for the three steel products examined fell as a result of the safeguard measures. The price changes are shown in Table 2. The largest fall in price occurred for coated sheet steel, in which all countries with the exception of the United States experienced a fall of $US12.78. Despite the uniform drop in absolute price across nations other that the United States, the relative changes differed within nations. The relative differences in prices allowed producers in the model to substitute between different production activities, changing the direction and composition of exports. For the United States, the price levels for all products increased. The smallest increase was seen for slab steel as the barriers placed on this product were the least restrictive.

The quota restriction gave rise to a quasi quota rent for both slab and hot rolled steel products. The quasi-quota rent estimated for Australian exports of slab and hot rolled steel was equal to $US18.88 and $US42.28 per tonne respectively. The global slab steel quota had an associated rent of $US18.88 per tonne. No nation continued to export with the full 30 percent tariff rate.

Table 2: Changes in prices paid/received ($US/tonne)

Country	Product	Pre	Post	Change	Percentage Change
Australia	Slab	209	207.53	-1.47	-0.701
United States		230	247.42	17.42	7.572
Japan		217	215.53	-1.47	-0.675
Rest of World[a]		230	228.53	-1.47	-0.637
Rest of World[bc]		228	226.53	-1.47	-0.643
Australia	Hot rolled	290	286.20	-3.80	-1.310
United States		352	390.49	38.49	10.934
Japan		280	276.20	-3.80	-1.357
Rest of World[a]		352	348.20	-3.80	-1.079
Rest of World[bc]		306	302.20	-3.80	-1.241
Australia	Coated sheet	653	640.11	-12.78	-1.957
United States		677	760.55	83.55	12.341
Japan		650	637.22	-12.78	-1.965
Rest of World[a]		677	664.22	-12.78	-1.887
Rest of World[bc]		675	662.22	-12.78	-1.893

[a]. Rest of World importing nation, [b]. Rest of World exporting nation, [c]. supply price.

8.2 Production

Total trade in steel products fell from a pre safeguard level of 38.6 million tonnes of steel to a post level of 30.9 million tonnes. This represents a fall of close to 20 percent in world trade for the three products examined. The quota for slab steel was binding for both the Australian and global imports. Total exports to the United States, post safeguard actions, represented 5.75 million tonnes (the summed quota levels), a fall from 7.1 million tonnes. Changes in production and consumption are shown in Table 3.

Table 3: Production and consumption (million tonnes)

		Production			Consumption		
Product	Region	Pre	Post	Change	Pre	Post	Change
Slab	Total	5874.67	5875.28	0.61	587.47	587.53	0.06
Hot rolled		3761.88	3761.03	-0.85	376.19	376.10	-0.09
Coated sheet		778.98	777.20	-1.79	77.90	77.72	-0.18
Slab	Australia	8.054	8.07	0.01	6.51	6.51	0.00
Hot rolled		3.81	3.81	-0.01	3.29	3.30	0.01
Coated sheet		0.646	0.64	0.00	0.11	0.11	0.00
Slab	United States	93.425	93.29	-0.13	100.52	99.05	-1.47
Hot rolled		62.58	63.91	1.33	67.54	64.16	-3.38
Coated sheet		18.813	19.45	0.64	20.92	19.45	-1.47
Slab	Japan	91.547	91.81	0.27	89.29	89.23	-0.06
Hot rolled		51.31	51.20	-0.11	33.919	34.08	0.16
Coated sheet		11.298	11.21	-0.09	7.74	7.82	0.08
Slab	Rest of World	388.11	388.02	-0.09	391.15	392.73	1.58
Hot rolled		253.97	252.70	-1.27	271.44	274.56	3.12
Coated sheet		45.21	44.50	-0.70	49.12	50.33	1.21

Total production actually increased by just over 61 thousand tonnes as a result of the measures, an increase of 0.01 The reason for this change is linked to the trade diversion effects caused by the measures, for instance much of the slab steel originally exported to the United States was redirected to the Rest of World importing nation. Producers shifted production away from the hot rolled and coated sheet products and into slab steel production, as slab steel price was the least affected by the move (as it was subject to the least restrictive measures). As such, total production for hot rolled and coated sheet products fell globally in response to the safeguard measures, with production of slab steel increasing.

For the United States, the price of hot rolled and coated sheet products rose by a greater percent than seen for slab steel. This change in relative prices created a shift in production away from slabs as hot rolled and coated sheet products had a greater return. Interestingly, mini-mill producers who produce such products will benefit from this increase in price. The higher price received for the transformed products could create a situation where mini-mills increase their market share to the disadvantage of integrated producers. Thus response would undermine the purpose of the safeguard policy.

Exports to the United States fell significantly in the three products examined as a result of the safeguard measures. Total imports fell by an average of 71 percent for all steel products examined in the study. This fall in imports should allow domestic producers in the United States the opportunity to restructure their industry without a fear of increases in foreign competition and loss of market share as a result. The reduction in imports equated to a fall in market share from 7.5 percent to 3.3 percent for the products examined. Changes in imports are presented in Table 4

Table 4: Imports to the United States (million tonnes)

	Australia			Japan			ROW[a]		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Slab	0.44	0.35	-0.09	0.32	0.15	-0.17	6.33	5.25	-1.07
Hot rolled	0.24	0.25	0.01	0.21	0.00	-0.21	4.51	0.00	-4.51
Coated sheet	0.01	0.00	-0.01	0.17	0.00	-0.17	1.94	0.00	-1.94

[a] Rest of World importing nation

8.3 Economic surplus

The effects of the safeguard measures on consumer and producer surplus are shown in Table 5. For all nations except the United States, producer surplus fell and consumer surplus increased. The net effect in the Rest of World region was the smallest, as it had the largest change in exports and imports. Consumers benefited from the redirected cheaper imports, whilst producers lost export markets and local sales.

The results for Australia and Japan are similar and show that total surplus actually increased. The cause of this increase in total surplus was due to the redirection of exports away from the United States to the Rest of World importing nation and a shift in the composition of production away from highly protected products. An assumption of the spatial equilibrium model is that producers can costless (ignoring the differences in relative transfer costs), shift exports from one region to the other, as such the most viable option from producers in Australia and Japan was to seek alternate markets. Further, as the elasticity of demand in the Rest of World importing nation was relatively more elastic, the lower price led to greater demand, meaning this nation was able to absorb the shift in exports.

For the United States, the implementation of the safeguard measures led to a net loss in surplus. The measures did increase domestic production, and as such, increased producer surplus. Despite this, the impact on US consumers was great, meaning that the surplus gained for producers was outweighed by the lost incurred by consumers.

Table 5: Changes in economic surplus ($US millions)

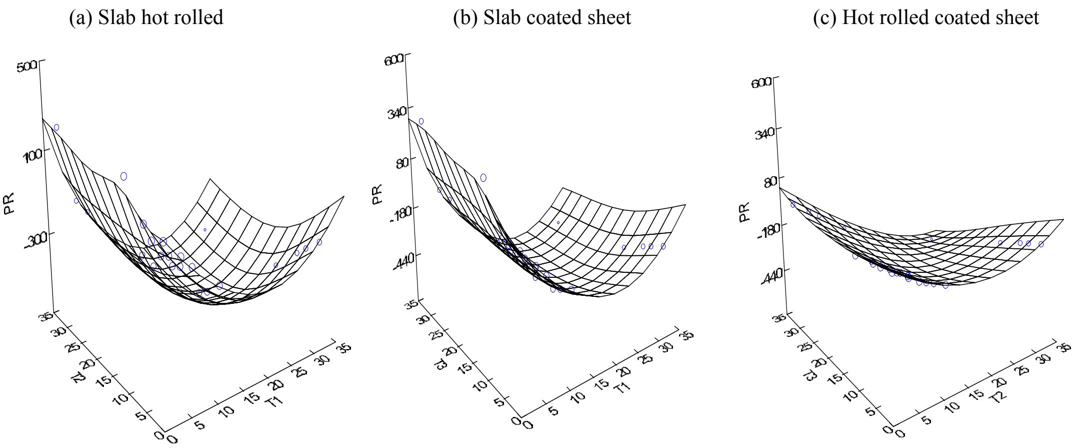
Industry	Region	Change in Producer Surplus	Change in Consumer Surplus
Slab	Total	15.17	-34.74
Hot rolled		15.18	-22.61
Coated sheet		15.30	-21.23
Totals		**45.65**	**-78.58**
Total Change in surplus			-32.92
Slab	Australia	-1.24	3.72
Hot rolled		-1.97	2.72
Coated sheet		-1.49	2.13
Totals		**-4.70**	**8.57**
Total Change in surplus			3.87
Slab	United States	20.64	-45.85
Hot rolled		21.87	-31.28
Coated sheet		20.26	-26.96
Totals		**62.78**	**-104.08**
Total Change in surplus			-41.31
Slab	Japan	-1.74	4.39
Hot rolled		-1.95	2.71
Coated sheet		-1.50	2.02
Totals		**-5.20**	**9.12**
Total Change in surplus			3.92
Slab	Rest of World	-2.49	3.01
Hot rolled		-2.77	3.24
Coated sheet		-1.97	1.57
Totals		**-7.23**	**7.82**
Total Change in surplus			0.59

9. Policy responses

Policy response surfaces were formulated in order to examine alternative responses of Australian steel producers. In order to map the policy response surfaces, a set of varying tariff levels were used. Because there were three products examined, three different policy response surfaces were estimated, namely, slab-hot rolled, slab-coated sheet and hot rolled-coated sheet. The policy response surfaces map differing levels of producer revenue collected by Australian producers for a range of tariff levels between zero and 30 percent. The tariffs that will be used to map changes in producer revenue will be all combinations of 30, 10, 5, 3 and 0 percent for each product (with no concessions).

The returns to producers varied with differing levels of slab and hot rolled tariff combinations. The producer revenue surface is shown on Figure 6(a) where producer revenue is graphed as change in revenue from the no tariff situation. From Figure 6(a), it can be seen that any relaxation in the slab tariff level (*T1*) would yield the greatest benefit for Australian producers. Even with a zero tariff level on hot rolled steel the gain to Australian producers is marginal (given a 30 percent tariff on slab steel). The reason for this is that slab steel is Australia's most competitive steel product, and hence the greatest benefits would occur if Australian producers were allowed to further specialise in the production of this product. Australian producers would capture any extra returns from an increase in the price of slab steel that occurs with the increase in the price of the other two products (prices of substitute goods tend to move in the same direction).

Figure 6: Policy response surfaces



Where PR = producer revenue change in $US100,000, T1 = slab tariff level, and T2 = hot rolled tariff level.

With tariff free imports of slab or hot rolled steel into the United States, Australian producers would benefit through the ability to take advantage of the higher domestic price. Although, tariff free access (for Australia) would increase Australian production and exports significantly, the extra quantities would not place enough pressure on US prices to force them down to pre safeguard levels. Combinations of tariffs for slab steel 10 percent and above yielded a negative result for Australian producers independent of the hot rolled steel tariff.

The policy surface estimated for slab-coated sheet products in terms of producer revenue is shown in Figure 6(b). The results are similar to those seen for the slab-hot rolled policy response functions as tariff free access for slab steel yields the greatest benefits for producers. In the case of hot rolled-coated sheet tariff free access for either coated sheet or hot rolled steel would still mean that the Australian steel industry would be worse off than with the zero tariff position. With zero tariff access for hot rolled steel and full tariff rate on coated sheet, Australian producers are only marginally better off (Figure 6(c)). This indicates that if no slab steel concession was given, Australian steel producers should lobby for a total reduction instead of any concession on hot rolled or slab steel products.

An implication from the above analysis is that the best outcome for Australian producers is to have some form of preferential access to the US market (assuming the concession was given on slab steel). This policy only arises from the producer point of view, and if consumer surplus (or as a proxy consumer expenditure change) were modelled, the best position for Australia would be at the lowest points on Figures 6(a), (b) and (c). These points would show points of lowest cost to Australian consumers.

This conclusion appears obvious, but the implications of the cross elasticities signalling that the products were in some way substitutes for the purpose of the study, mean that only one product would need to have tariff free access into the US market for benefits to flow from the other products in the study. The increase in price that would be created through tariff free access into a protected market would not only increase the price of that good, but place upward pressure on the prices of the other goods. The concept of total elasticity is a useful way to envisage the overall effect (Tomek and Robinson 1990). The increased price, for slab steel, would lead to decreased domestic demand for that good, but increased demand for both hot rolled and coated sheet products. This increase in demand reduces the downward pressure that is placed on prices as a result of the tariffs placed on the importation of those products into the United States.

10. Concluding comments

The impacts of the safeguard measures on the world steel industry can be viewed through examining changes in producer and consumer surplus. It was seen from the results, that the initial position was more efficient for the global steel market because of the negative change in total surplus that has occurred with the safeguard tariffs. It can be said, that free trade provides greater *overall* benefits, whilst trade protection leads to short term benefits for protected steel producers.

Total surplus for the global steel market is seen to fall by $US32.92 million due to the imposition of the safeguard actions. Benefits for steel producers in the United States (measured in the form of producer surplus) increased by $US62.78 million, with losses in consumer surplus equal to $US104.08 million. Due to this overall loss, a more efficient policy to enable the US steel industry to restructure would be one aimed at market reforms, and not trade protection.

A figure excluded from the change in producer and consumer surplus is the transfer that occurs with the impositions of tariffs and quotas. The United States government may receive an income stream from these protection measures depending on the structure of the quota. Governments traditionally face a lower treasury cost — with the economy facing efficiency costs due to trade protection than under microeconomic polices which involve budget outlays. The United States is a large importer, and as such, can benefit from the imposition of trade barriers. The effect of the trade distorting measures used — tariffs and quotas — led to a fall in world price. This fall allows for the US government to capture some surplus from the world steel market. With the inclusion of the surplus from quota revenue, the US economy would actually gain (quasi-quota rent can be viewed as a surplus transfer) equal to $US77.69 million.

Due to the size of the US economy, the imposition of the safeguard trade barriers has the possibility of benefiting its economy. However, the benefits to the steel market would only increase if the quota revenue were transferred to this market (which may be the case). As this quasi-rent may be placed into treasury depending on the structure of the quota, the revenue collected may go to other causes, leading to a net loss in the market. This rent also ignores administration costs, which are usually high with quotas if the revenue is to be collect by governments due to difficulties in collection. With appropriate permit controls, it is possible that the quota rent may not be collected by the United States, and in fact be collected by world exporters, or importing firms depending on degrees of market power or levels of regulation.

The trade protection measures used by the United States were supposed to provide an environment in which domestic steel producers can expand output, increase revenues and hence provide the means to allow for structural reform. The higher price levels encourage increases in production. This increase in production requires a shift in resources away from other sectors of the US economy, in which these resources would have been better used given world prices. However, it has been shown that trade protection by a large nation has several external and internal effects. If it was viewed by the US government that this policy was best — either the costs to the market are worth paying, or that government revenue is favoured over outlays — the response by the steel industry may not be what the government is after. It has been seen throughout history that the US government has intervened in the steel market whenever steel producers were adversely affected by imports. This continual intervention has meant that steel producers have relied on the government if the economic situation turned against them. This policy has caused unproductive practices and large excess capacity to remain in the industry. The question becomes, would this be any different this time?

The results obtained from the analysis of the safeguard actions show an increase in the price of all steel products within the United States. These price movements, however, were not uniform and were skewed towards the higher valued products such as coated sheet and hot rolled steel. Both integrated steel producers and mini-mills produce these two products. The safeguard policy was primarily aimed at the larger integrated producers due to their political significance and the fact that it was these producers that were most under threat from the surge in imports. With the higher prices favouring the products that mini-mills produce, the safeguard barriers may not help the integrated producers, but allow mini-mills to capture more of the US market at the expense of the integrated producers.

Finally, some avenues for further work could be suggested here. The model chosen to was a spatial equilibrium model. As with any model, the accuracy of the results obtained depends largely on the quality of the data used. As such, a study conducted on supply and demand elasticities would have complemented the analysis.

Data on supply, exports, imports and consumption for the products studied were particularly difficult to obtain. This difficulty meant that some of the categories originally chosen had to be aggregated in order to obtain the necessary data points. With aggregation of products, the problem of non-homogeneity arises. It was necessary for the spatial equilibrium model to assume homogeneity between products produced by different nations. This assumption may hold (or may not, see Armington (1979)), but with a higher level of aggregation, representative prices become difficult to obtain — particularly if export unit values are used (export unit values represent the value of exports, and hence if these exports are oriented toward a higher value sub-product, export unit values will be higher without necessarily representing a higher cost production process). Non-homogeneity may appear in the form of two-way trade flows in the same product in the observed data.

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