An Economic Analysis of Quarantine: The Economics of Australia's Ban on New Zealand Apple Imports

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Abstract

The quarantine policy decision-making process in Australia is subject to the principles of the World Trade Organisation's SPS Agreement. It is primarily based on the risks and associated economic costs accruing to producers in the event of disease entry. The costs of a quarantine measure in terms of forgone trade benefits are not considered. The impact associated with this asymmetric approach is identified by demonstrating the gains to consumers which may arise through liberalised markets using a case study of the Australian apple industry. A partial equilibrium analysis is used to show the impacts of apple market liberalisation, which can be expected to yield gains to consumers which are greater than the economic costs to on producers.

Key words: quarantine, trade, liberalisation, apples, welfare.

1. Introduction

Quarantine measures are put in place to restrict trade in a product where there is perceived to be a risk from trade in that product resulting in the transfer of a pest or disease into a country or region free of the pest or disease (World Trade Organisation (WTO) 1995). The current process used to decide whether to put a quarantine measure in place in Australia is based on an Import Risk Analysis, which assesses the scientific risks of pest or disease entry and potential costs to any domestic industries (Binder 2001). Although some consideration is given to the economic cost of disease entry should it occur, the costs of the quarantine measure itself, in terms of forgone trade benefits as a result of a trade restriction, are not considered. In many cases, trade in these products would offer significant gains to the national economy, and on that basis warrant consideration in the quarantine policy decision-making process.

The SPS Agreement[1] was established by the WTO to restrict a member country government's ability to use technical barriers to trade, and in particular quarantine measures, as a means of restricting imports into their country for the protection of domestic producers from foreign competition. Technical trade barriers are non-tariff barriers designed to restrict or discriminate against imports (Beghin and Bureau 2001, p. 3). A quarantine measure constitutes a technical barrier by acting to restrict the importation of a product on the grounds of sanitary (human and animal) or phytosanitary (plant) pest or disease risks.

The framework set out by the SPS Agreement is asymmetric in its consideration of the 'relevant economic factors' (WTO 1995, p. 92) in the implementation of a quarantine measure. The costs faced by producers in the event of disease entry and establishment are measured, but not the forgone benefits of trade in products that would occur without the quarantine measure in place.

This paper identifies the problems inherent with the lack of comprehensive economic analysis in assessing the decision to apply a quarantine measure by:

- identifying the economic theory relevant to market intervention via quarantine measures; and
- presenting a case study analysis of the Australian apple industry, which is currently protected by a ban on imports of fresh apples from countries where fire blight is endemic.

The case study is an analysis of the impact of apple market liberalisation by allowing apple imports from New Zealand. The purpose of this case study is to empirically examine the economic impact that the quarantine measure restricting the importation of apples from New Zealand is having on social welfare in Australia, as measured by the level of economic surplus.

In all modelled situations under market liberalisation, the importation of apples is shown to provide a substantial economic benefit. Significantly, even in the event of fire blight being introduced into the Australian industry, it is expected that the net impact on the economy will be positive due to the large gains to consumers from lower apple prices.

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[1] A commonly used term for the Agreement on the Application of Sanitary and Phytosanitary Measures.

2. The Economics of Quarantine

In the general economic policy framework, consideration of the impact of a policy go beyond the effects on any one group to consider broader social interests (Sinden and Thampapillai 1995, p. 2). In the context of quarantine policy, and specifically the implementation of a quarantine measure, the rationale for government intervention is justified on the grounds of externalities, where there is a 'divergence between private and social valuations' (Mookherjee 1994, p. 42).

Externalities result when the choices of one individual exogenously affect, for better or worse, the ‘well-being’ of another individual. In the case of trade and quarantine measures, this outcome is generated when the importation of products results in domestic producers of that product bearing some of the costs of importation through pest and disease risks. The full cost of importation risk, or social cost, does not accrue to the importer or final consumer of that product.

Inversely, an embargo placed on a product negatively affects the consumers where the lobbying of quarantine policy decision-makers by producers leads to the application of quarantine measure restricting trade with no regard to the benefits of trade that can accrue to consumers. In either case, there is a divergence of the social and private benefits and costs of trade.

Consideration of the gains from trade in the decision to apply a quarantine measure would help to correct the imbalance. This could be achieved by considering the benefts and costs that accrue to consumers and producers equally, rather than automatically assigning property rights to producers. Measures designed to protect producers from quarantine risks may leave consumers worse off by raising the prices they face in the domestic market due to reduced competition from efficient world producers and restricting supply. The application of a quarantine measure to correct for the externality on producers is not always beneficial at the social level.

Improving Market Outcomes Through Intervention

Market intervention is an efficient course of action when the level of social welfare in a market can be improved; where the benefits of intervention outweigh the costs. There are two criteria used in welfare economics to measure the effect of a policy change. The first is the Pareto Improvement criterion and the second is the Kaldor and Hicks Criterion (Baumol 1965, p. 162). The latter of the two identifies a policy action as beneficial when the overall level of welfare is increased, such that the gains are greater than the losses. This is the generally accepted practical principle used to evaluate an economic policy decisions and the criterion adopted in benefit cost analysis frameworks (Sinden and Thampapillai 1995, p 20).

An import barrier in a market generally has the effect of raising the price paid for a good by restricting market supply and competition. The economic impacts on the consumers and producers from trade in a good where there is some pest and disease import risk are summarised as follows:

- the benefits of trade to consumers accrue via imports leading to greater competition, more product choice and lower prices (Anderson and James 1998, p. 430-432); and
- the costs faced by producers from trade in products potentially containing pests and diseases arise from the risk of that disease or pest becoming established in

the domestic production system, which is anticipated to result in higher production costs to monitor and control the pest or disease and cause losses in production (ie. there is a decline in technical efficiency).

Importantly, 'absolute levels of health and safety (ie a risk free approach) are prohibitively expensive', indicating that a positive level of trade risk is regarded as more efficient and acceptable (Roberts 2001, p. 12).

Therefore, key issues to consider in light of the current approach to quarantine policy decision making are whether:

- the current framework for determining the application of quarantine measures is acceptable in terms of the inclusion of social welfare implications, or whether opportunities exist for a process that can improve the level of net social welfare; and
- potential changes to the framework which incorporate more economic analysis in quarantine policy decision-making are compatible with the World Trade Organisation's current SPS Agreement framework at the domestic level.

The second of these issues is not dealt with in this paper.

Other Impacts of Barriers to Trade

Beyond the impacts on consumers and producers in the market for a particular good, other market and non-market benefits and costs may include:

- the effect on the environment;
- improved trade relationships, which constitute the main non-market benefits;
- an important measurable effect associated with more open trade includes the benefits or costs that may accrue to other productive industries;
- reduced trade dispute settlement and policy compliance costs provide an example of the measurable costs of keeping markets closed; and
- impact on Australia’s reputation as a ‘clean and green’ producer of agricultural and food goods, being relatively free of pests, disease and the need for associated treatments.

Important considerations of any trade policy measures are the potential for a trade dispute case and the effect on Australia's trade relationships. A number of cases, including the Australian salmon import ban, European Union hormone ban and Japan's varietal testing requirements for United States apple imports, are demonstrative of the high cost and disruptive nature of contentious quarantine measures and the dispute resolution process. The costs of dispute resolution and the benefits of improved trade relationships are also important values to consider when making decisions regarding the application of quarantine measures.

The Lack of Economics Underlying Quarantine Policy Decisions

The core problem with the current quarantine policy framework is the asymmetric consideration of welfare for the above mentioned groups when applying a quarantine measure. Consideration of economic welfare in the SPS Agreement and subsequently in domestic quarantine policy processes primarily quantifies the impact on producers. Consequently, the removal of SPS measures from markets can generate significant economic gains to the broader economy.

By maximising domestic welfare and minimising the impacts on trade, economic gains can be achieved. Situations may arise where a quarantine measure is shown to be 'bad' on sanitary or phytosanitary risk grounds but 'good' on an economic basis. The point made here is that neither form of analysis should be discounted, but some combination of both economic and scientific approaches should be utilised.

Incorporating Economics

The goal of incorporating comprehensive economic analyses into quarantine policy decisions is to quantify the effects of technical trade barriers (quarantine measures) on market equilibrium, trade, economic efficiency and net social welfare. In considering the economic impact of a quarantine measure as both costs and benefits, there is potential to evaluate trade-offs when governments choose between alternative regulatory and non-regulatory actions. Roberts, Josling and Orden (1999) proposed the existence of three effects of a technical barrier to trade, including the supply shift effect, the demand shift effect and the regulatory protection effect of providing rents for the domestic industry via higher prices. Beghin and Bureau (2001) and Maskus, Wilson and Otsuki (undated) suggest modelling the impact of these three effects in a comparative static partial equilibrium framework should be the primary focus of any analysis demonstrating the economy-wide welfare effect of a quarantine measure.

Undertaking an assessment of technical barriers utilises net social benefit evaluation techniques to the assessment of quarantine policies, as is the use of a risk analysis framework. In a number of cases (eg. Anderson and James, 1998) a simple linear supply and demand system is used to evaluate the producer and consumer surplus and hence the net social impact on the market.

A case study of the Australian apple market is provided here to demonstrate the impacts of quarantine measures on welfare.

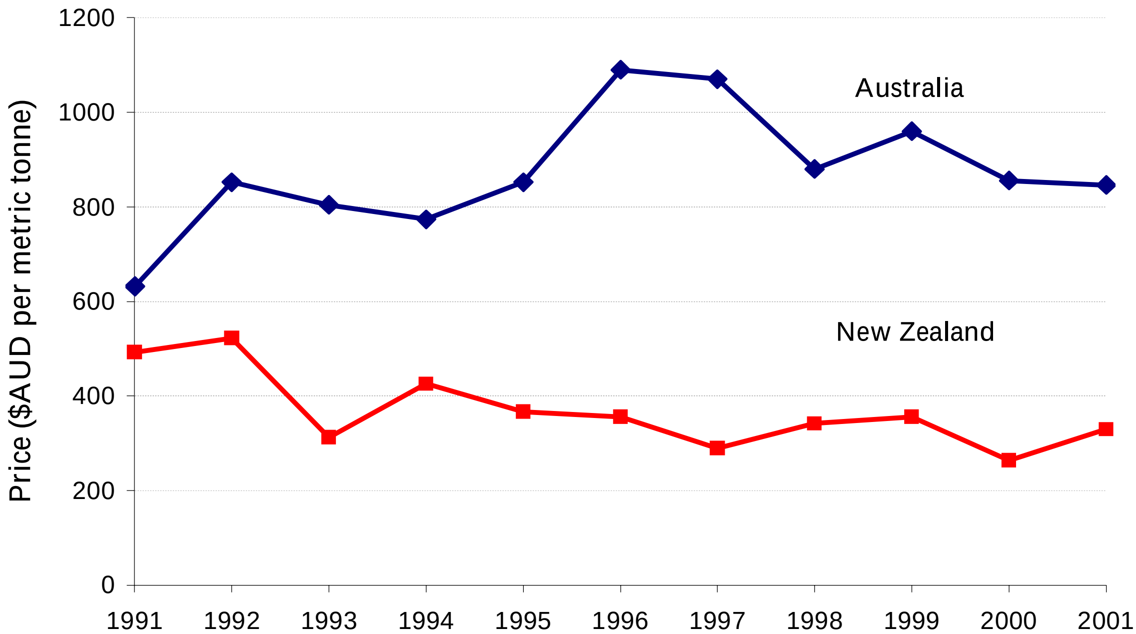
3. A Case Study of the Australian Apple Industry

Australia ranks just twelfth in the world for apple production efficiency and eleventh in its overall level of competitiveness (Hassall & Associates 2001), as recorded by the production statistics below. Compared to the production efficiency of the New Zealand industry, ranked second in the world, Australian producers are comparatively inefficient. In the southern hemisphere, where Australia competes with other world market producing nations, Australia is ranked sixth by competitiveness, behind New Zealand, Chile, South Africa, Brazil and Argentina (Hassall & Associates 2001, p. 11).

New Zealand is the second most efficient apple producer in the world based on production efficiency, and is the world leader in cost competitiveness based on production costs per tonne of apples (Hassall & Associates 2001, p. 11). Apple producers in New Zealand had, on average, higher costs per hectare ($US8,500/ha) than those in Australia ($US5,900/ha), reflecting the intensive cultivation methods used by New Zealand producers. However, on a per tonne basis, New Zealand production costs are much lower at $US185/tonne relative to $US380/tonne for Australia. The cost of producing each tonne of apples in New Zealand is less than half that of Australia, reflecting the large price differential between the two domestic markets (Hassall & Associates 2001, p. 12).

Average wholesale apple prices for the New Zealand and Australian markets in 2001 are provided in Figure 1. The cost effectiveness of New Zealand producers is due firstly to the higher yields from the superior varieties grown, intensive cultivation techniques and as a result of better growing conditions (Hassall & Associates 2001, p. 12).

Figure 1 Australian and New Zealand Wholesale Apple Prices



Source: Food and Agriculture Organisation of the United Nations, FAOstat database (2004).

The increased apple supply and competitive effects that imported apples from New Zealand are likely to have on prices in Australian apple markets are important. It is also expected that entry, should it occur, and spread of the fire blight disease in Australia would increase production costs and therefore reduce competitiveness with New Zealand apple producers. This would directly reduce the economic surplus available to producers.

Estimates of the potential effect of fire blight on the Australian apple industry range between a 3 to 20 percent reduction in fresh apple fruit production at the industry level (Hinchy and Low 1991, p.12). Estimates assume the spread of disease to all production areas and the impact of the disease on the apple trees to be relatively high. Fire blight is expected to increase on-farm apple production costs by between 2 and 6 percent, depending on the severity of infection (Hinchy and Low 1991, p. 12).

An important consideration for the domestic industry and exporters of fresh apples is the spatial variation of Australian production. In 2000, 74 percent of apple exports (though only a relatively small proportion of production) came from Tasmania and Western Australia, two states with very isolated production areas. In the event that fire blight entered the eastern mainland production zone, these isolated production areas could potentially be quarantined, preventing further spread of the disease and losses to exporting producers (Hassall & Associates 2001, p. 13).

Domestic Market Impacts

The benefits of liberalisation are contingent on the nature of imports in terms of competitive pricing effects and the benefits of greater product variety (ABARE 1997, p. 5). These benefits have to be quantified to determine whether there are gains to consumers from the importation of apples, and ultimately, positive net gains to society as a whole. If apples imported from New Zealand are perceived to be substitutable with Australian apples, then market competition is expected to lead to lower prices, greater consumer demand and a greater overall level of consumer surplus (Anderson and James 1998, p. 435).

A further issue of interest is the likelihood of substitution between New Zealand product and Australia apples. As noted by ABARE (1997, p. 5) some apple varieties produced in New Zealand differ from those produced in Australia and there is likely to be a certain degree of product differentiation. Whether consumers would view the new varieties as wholly substitutable with Australian varieties is unknown, however, given the drive in the marketplace for new varieties to maintain consumer interest, it is likely that consumers will not be averse to a wider selection of apple varieties. There is also likely to be some investment in varieties known to be sought in the Australian market if New Zealand producers were granted access to the Australian market.

4. Analytical Framework

The apple market case study incorporates both quantitative economic and scientific risk analysis in the estimation of producer and consumer surplus. By measuring the economic welfare of the apple market under different assumptions with respect to the level of protection and the possibility of disease entry and spread, the loss or gain to net social welfare of removing the quarantine ban on apple imports from New Zealand can be calculated.

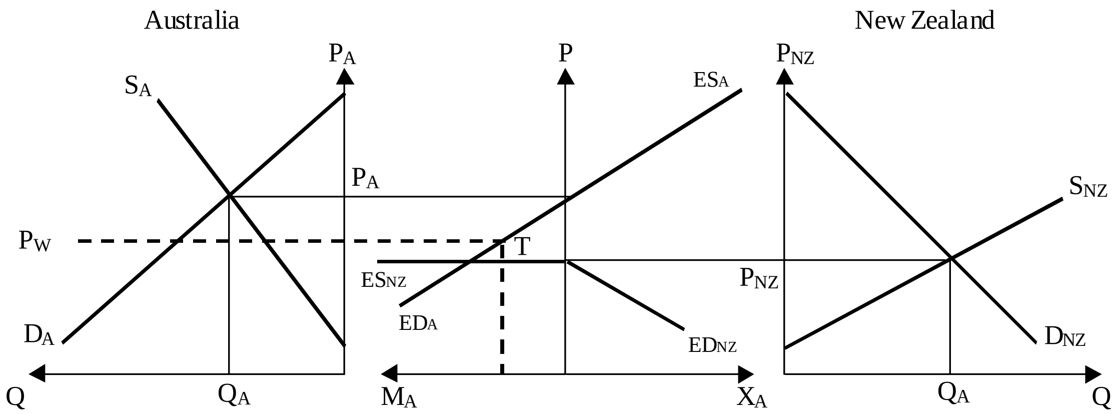
A Markov Chain analysis is also used to assess the dynamic 'policy effect' of the quarantine measure on social welfare to include the realistic implications for the disease risk over time, rather than relying only on the static measurement of the quantitative effects of a quarantine measure.

Measuring the welfare effect of policy changes in a comparative static framework assumes the effect of changes in technical barriers can be reasonably measured at some point in the medium term, when the market has re-established at a new equilibrium. Comparison of the economy-wide welfare at the different equilibria is made by showing the same market under different assumptions with respect to quarantine measures and product importation.

A spatial market framework (see Figure 2, p.7) is used as the basis for the estimation. An initial estimation of Australian producer and consumer surplus under the prevailing market (autarky) structure is compared to several other market situations, including market liberalisation in various assumptions regarding the impact of fire blight entry and spread in Australia.

Given the comparison of the competitiveness and difference in price levels between the two apple markets, it is reasonable to assume trade will flow from New Zealand to Australia. The characteristics of the two markets that lead to this determination were discussed in Section 3. The current equilibrium market price of fresh apples in New Zealand (P_{NZ}) is significantly lower than that of Australia (P_A). Permitting trade between the two nations would result in the importation of apples at a 'world price', or New Zealand apple export price inclusive of transport and transaction costs, below the Australian market autarky equilibrium price, shown as P_W in Figure 2. This world price is given by the intersection of the New Zealand excess supply curve (ES_{NZ}) and the Australian excess demand curve (ED_A), taking into account transport and transaction costs (T), which act as a wedge between the two curves. The domestic price under autarky is determined by the intersection of the domestic supply and demand curves, labelled S_A and D_A respectively. The supply of apples from New Zealand is expected to be relatively elastic, since producers in New Zealand are export orientated and export quantities similar to current total Australian domestic consumption.

Figure 2 Spatial Model of the Australian and New Zealand Apple Industries



Source: Houck 1986, p. 36.

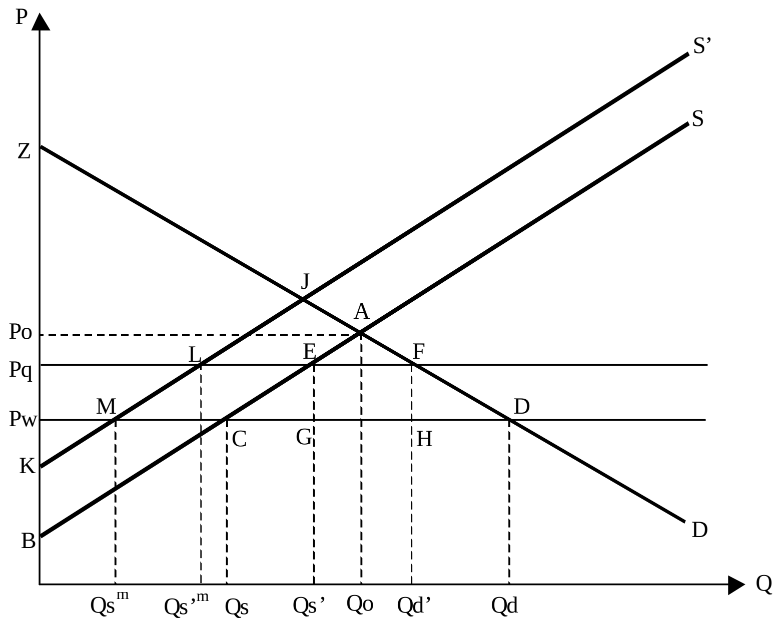
It will be assumed that New Zealand is more cost competitive relative to Australia, can price its product lower and will export apples to Australia if it can gain market access.

Welfare Analysis with Quarantine Risk and Trade

The Australian apple market is shown in Figure 3. With a domestic market restricted an import ban on fresh apples, the market is an autarky. The autarky equilibrium occurs at point A, the intersection of the domestic supply and demand functions. The resulting prices and quantities in the market are given as P_o and Q_o, which represent the current domestic market equilibrium price and quantity respectively. In this market situation, the consumer surplus is given by triangle AZP_o and producer surplus given as triangle and ABP_o (Anderson and James 1998, p. 430). By removing the ban on apple imports and allowing free trade between Australia and New Zealand, a fall in the domestic market price to the 'world price' level would occur, as represented by Pw, the New Zealand apple import price. This 'world supply curve' exists as an infinitely elastic function, and results in domestic demand increasing from Q_o to Q_d, and the domestic supply declining from Q_o to Q_s due to the lower market price. The result is a higher level of consumer surplus as given by DZP_w, and a reduced level of producer surplus to BCP_w (Anderson and James 1998, pp. 430-431). The net change in the total welfare is the change in producer surplus (negative) plus the change in consumer surplus (positive), given by triangle ACD, noted by Anderson and James (1998, p. 430) as the 'standard gains from-trade triangle'.

The gains from trade are based on a fully liberalised Australian apple market with respect to trade with New Zealand, assuming trade has no other effects on the market or the broader economy. The effect of market liberalisation should also be considered for at least two other important case: firstly, under limited access arrangements granted to New Zealand exporters; and secondly, with the risk of disease entry and spread into the Australian apple market. These cases are considered next.

Figure 3 Market for Domestic Autarky with Liberalisation Possibilities



Source: Anderson and James 1998, p. 430.

The Affect of Quarantine Measures

The case of a conditionally liberalised domestic market is the most likely case, based on the conservative 'appropriate level of protection' in Australia and the specifications of the New Zealand apple Import Risk Analysis. The Import Risk Analysis (AQIS 1998) requires apples to be sourced from certified fire blight free orchards, treated by chlorine dipping and be held for a minimum period in cold storage. These costs are incorporated into an assumed per unit cost of q, which represents the compliance costs of the quarantine measures imposed by the Australian government. When apples are imported with administrative requirements, the cost of the imported goods will rise to P_q, which is simply the world price P_w plus the cost of the technical barrier, such that $P_q = P_w (1 + q)$. This has the effect of raising the price of imports (world price) and hence the price in the domestic market, represented by the horizontal price line P_q in Figure 3. The higher world price in the domestic market will reduce demand from the free market level of Q_d to Q_d', and the domestic supply will rise from Q_s to Q_s'. The gains from trade are reduced due to the higher prices and reduced import levels, shown as the smaller 'gains from trade triangle' AEF (Anderson and James 1998, p. 431). The effect of the quarantine measures on consumers is a reduction in the gains from trade because the price in the domestic market is higher relative to the case where trade is completely liberalised trade case.

The Impact of Disease on the Domestic Industry

Suppose a disease (ie fire blight) enters the domestic production system via imports from New Zealand and that this results in increased costs of production and declines in yield to Australian producers. It is assumed that extra costs will be incurred through crop monitoring and treatment. However, because there are no completely effective treatment methods for fire blight, the disease will cause losses in production and therefore reduced output levels regardless of the preventative steps taken (AQIS 1998). The overall effect is a rise in the marginal costs of production, represented in Figure 3 as an upward shift in the domestic supply curve from S to S' (Anderson and James 1998, p. 431). Note that the rise in marginal costs is equivalent to a shifting of the supply curve, because the supply curve represents the long run marginal cost curve for all product prices greater than minimum average cost. The rise in marginal costs occurs for two reasons: as yields decline the output per unit of input declines, and additional expenditure is made to reduce the impact of disease on production. A critical part of the equilibrium analysis is the determination this shift in the industry supply curve (Anderson and James 1998, pp. 430-431). There are two effects that need to be accounted for in the analysis: the impact of lower yields from losses due to disease, which can be treated as a 'negative technology shock' or decline in technical efficiency; and the direct impact that rising costs will have on farm level production (Hinchy and Fisher 1991, pp. 27-28).

The effect on producers and consumers should also be considered. The higher marginal costs of production shift the supply curve up, which means the intersection of the supply curve with the free market world price is now at point M, and the domestic supply quantity falls to Q_{sm}. Domestic demand remains unaffected at the free market world price of Q_d, and therefore imports will increase from $Q_d - Q_s$ to $Q_d - Q_{sm}$ to meet the fall in domestic production. In terms of welfare, producer surplus is reduced to KMP_w from BCP_w, whilst consumer surplus remains unchanged at DZP_w. Therefore examining the economy-wide effects of liberalisation with disease incursion requires a consideration of the net 'gains from trade' to consumers and producers. It is reasonable to expect that without disease entry, liberalisation would unambiguously increase economic surplus. However, if disease entry does occur the rise in economic surplus is more uncertain (Anderson and James 1998, pp. 430-431). The general rule given by Anderson and James (1998, p. 432) for determining whether liberalisation under disease risk is beneficial is based on the Kaldor-Hicks welfare criterion. If there is expected to be a net gain in total economic surplus from market liberalisation, measured by an excess of consumer surplus gain over and above producer surplus loss, the market should be liberalised (Anderson and James 1998, p. 440).

Modelling Assumptions

A number of standard simplifying assumptions are made in standard comparative static analysis of trade liberalisation, highlighted by Anderson and James (1998, p. 429) as:

- the world price is lower than the domestic market price, and relates to a single homogeneous product;
- small-country and small-industry assumptions - the changes in this industry as a result of the change in import barriers will have no impact on the price of imported product, exchange rates or other domestic product markets;
- the domestic industry is considered to be perfectly competitive;
- the domestic society is assumed to have no kind of risk preference and is thus risk neutral (they are neither risk averse or risk preferring);
- the disease affects only the producers in the industry under analysis and will only impact on their marginal costs;
- the impact of the disease is a constant per unit rise in the costs of producers, or a constant rise in marginal costs;
- technology levels are assumed to remain constant; and
- any costs incurred in the processing of imported products are charged to the importer as a proportion of the product price.

For a small industry, as is the case with Australian apples, these assumptions provide a realistic basis for analysis. However, the second assumption as an example, could be relaxed to account for the potential impact of trade in apples on other industries. Another example is the study by Hinchy and Low (1991) also evaluating the economic impact of apple importation. Hinchy and Low (1991) relaxed the first assumption, so that imported and domestically produced apples were treated as differentiated products.

Elasticities sourced from previous studies and are shown in Table 1. The demand elasticity of -0.2 was estimated by ABARE (1989) from Brisbane market data. The demand elasticity estimate of -0.4 is based on a series of studies conducted by Allison and Ricks (1986), Bale (1986) Destorel (1986) and Kajikawai (1987) which reported estimates over the -0.1 to -0.4 range. Hinchy and Low (1991, p. 9) have therefore selected -0.4 as the upper bound of the price elasticity of demand, in absolute terms.

It is suspected that demand for apples may be more elastic than indicated by the elasticity estimates sourced form past studies.

It is reasonable to expect a lag in the short to medium term supply response to changes in the prices of horticultural tree crops such as apples, since it takes up to five years for a newly established orchard to become commercially viable. This effect must be included in the supply elasticity used, and therefore the short to medium term supply elasticity adopted is 0.3, as recommended by Hinchy and Low (1991, p. 8). The analysis was also repeated with a doubled supply elasticity of 0.6 to again observe sensitivity to changes in the chosen elasticity estimate.

The 'observed' equilibrium used in the estimation of the demand and supply curves is based on the prices and marketing margins shown in Table 2.

Table 1 Apple Prices and Imputed Marketing Margins

Point in marketing chain	Price ($/tonne)	Marketing margin (%)
New Zealand import price	420	
Farm gate	627	
Wholesale	841	34
Retail	1,143	36

Source: ABARE 1997 and AQIS 1998.

Table 1 shows the price per metric tonne of apples at each of the farmgate, wholesale and retail levels, and for New Zealand apple imports. The New Zealand apple import price is the assumed 'world price', and includes transport, transaction and post entry inspection costs. The marketing margin of 34 percent between the farm gate and wholesale levels incorporates the costs of transporting the product to the market and the cost of using an agent to sell the fruit (Productivity Commission 1993). The marketing margin between the wholesale and retail level of 36 percent is based on average prices reported by ABARE (1997), over a 5 year period from the 1991-92 production year to the 1995-96 production year. The margins are assumed here to be a constant proportion of the price.

Markov Chain Analysis

A Markov Chain analysis utilises a set of 'transition probabilities' for disease entry, establishment and spread events occurring. In this study, the probabilities have been sourced from the New Zealand apple Import Risk Analysis (AQIS 1998) and the fire blight biological risk assessment paper of Roberts (1990). The transition probabilities are specified in the form of a transition matrix that defines the probabilities of certain states of nature or events occurring (disease status in this case) in the next time period. In a dynamic system, the probabilities of the given states of nature occurring in one period are related to the probabilities of the states of nature that occurred in previous periods.

In a Markov Chain Analysis there can only be a finite number of potential outcomes that can occur in any given year. The probabilities of all the possible outcomes, conditional on a previous state, sum to 1 and may be applied over a given number of future periods. Two states of nature are specified for the case studies: the disease enters the domestic industry or the disease does not enter the domestic industry.

Two policy actions, equivalent to those analysed using the static analysis, are specified: a ban on imports of apples from New Zealand, and a liberalised market where trade is permitted.

Since there are two policy actions, and two states of nature, the four following cases are specified:

- with quarantine measure in place and no disease entry occurs;
- with quarantine measure in place and disease entry does occur;
- without quarantine policy in place and no disease entry occurs; and
- without quarantine measure in place and disease entry does occur.

These states of nature can be expanded into further market cases by varying assumptions regarding the impact of fire blight on production and geographic spread.

Multiplying the total economic surplus level in each of the four cases listed above by the probability of those four events occurring yields a weighted average economic surplus value. In the dynamic analysis, instead of the benefits and costs of disease entry and quarantine policy being evaluated based on a single period of time and one set of state of nature probabilities assumed to prevail for each year beyond, the Markov Analysis allows the probabilities of disease being present in each of the four states to alter over time and thus generate weighted average calculations of the economic surplus based on the dynamic probabilities of disease entry. Once the annual expected economic surplus is calculated for each year, they are discounted to a net present value representing the welfare effect of the quarantine measure. The net present value is the net gain or loss in economic welfare resulting from the removal of the quarantine measure as opposed to having the restriction on imports in place.

5. Analysis Results

The results of the analysis are discussed in this section of the paper in relation to six potential Case Study scenarios which have been modelled. These are:

- Case 1: Open trade, no disease entry;
- Case 2: Worst case scenario of fire blight entry in all production areas;
- Case 3: Mild fire blight losses from disease in all areas;
- Case 4: Light losses from fire blight;
- Case 5: Disease in NSW production areas only; and
- Case 6: Disease entry into mainland production areas except Western Australia.

The impact of fire blight on the industry supply curve is to shift the supply curve up by a percentage change in the intercept coefficient, dependent on the assumed impact of the disease on the marginal costs of producers. The slope of the supply curve remains constant. Two of the demand curves estimated are shown in Table 2: an inelastic demand curve based on an elasticity of -0.4, and an elastic demand curve based on an elasticity of -1.5.

Estimated economic surplus levels under autarky are indicated in Table 2. With both levels of demand elasticity, the level of consumer surplus exceeds the level of producer surplus. The level of consumer and total economic surplus are also greater at the higher level of elasticity of demand, by an average of approximately 45 percent.

Table 2 Current Domestic Market (autarky)

Market parameter	$\mathbf{E_d^* = -0.4}$
Farm gate price ($AUD/tonne)	627
Wholesale price ($AUD/tonne)	840
Retail price ($AUD/tonne)	1,143
Consumption per capita (kg)	16.51
Consumer surplus ($m)	458
Producer Surplus ($m)	171
Total economic surplus ($m)	**629**

Note: denotes the price elasticity of demand.

Estimated changes in surplus as a result are market liberalisation are reported in Table 3. The reported figures are the changes in the consumer, producer and total economic surplus from the base case market autarky levels to a market with trade. The largest gain in net economic surplus is obtained with open trade and no disease (Case 1): $108 million. With open trade and fire blight entry (Case 2), which assumes the worst possible disease impact, there is a net gain in total economic surplus of $90 million. The gains in total economic surplus increased when the elasticity of supply was doubled from 0.3 to 0.6.

Importantly, the impact of market liberalisation is positive irrespective of the severity of the entry of disease or the severity of the impact.

Table 3 Market Liberalisation Welfare Changes
Demand elasticity of -0.4, supply elasticity of 0.3

Parameter	**Change in surplus from the base case (autarky)**					
	Case 1 (best case)	Case 2 (worst case)	Case 3	Case 4	Case 5	Case 6
Consumer surplus	201	201	201	201	201	201
Producer surplus	-93	-111	-102	-96	-97	-106
Total economic surplus	**108**	**90**	**100**	**106**	**105**	**96**

A more elastic demand curve results in a more favourable gain in total economic surplus when the apple market is liberalised, because greater gains to consumers occur at the lower market prices, but the impact on producers remains unchanged.

Interpretation of the Analysis Outcomes

The net gain is the net increase in total economic surplus, in this case, for a rise in consumer surplus and a fall in producer surplus.

In all cases the change in total economic surplus is positive when moving from the current market autarky to open trade in apples between Australian and New Zealand. In the worst case scenario where fire blight is established in all Australia's apple production areas, and causes the maximum expected production decline of 20 percent, and raises costs by 6 percent, there is still an anticipated net gain in economic surplus of $90 million.

Relative Gains and Losses

The impacts of apple market liberalisation can be considered in relative terms for producers, consumers and in aggregate. That is, one can assess the percentage change in these surpluses, relative to the surplus levels prior to liberalisation, reported in Table 2. Consider the results in Table 3. For a market liberalisation case where fire blight is not introduced to Australia (case 1), and assuming supply and demand elasticities of 0.3 and -0.4 respectively, there is a $201 million dollar increase in consumer surplus and $93 million decrease in producer surplus. There is a 44 percent rise in consumer surplus and a 54 percent fall in producer surplus respectively. Total economic welfare rises by 17 percent, which is a significant gain. Now consider a worst case scenario (Case 2) with the same elasticities. Again consumer surplus rises by $201 million or 44 percent, but producer surplus is reduced by a greater level of $111 million or 65 percent. Total economic surplus increases by $90 million, or 15 percent. In this case, consumer surplus still increases by a significant amount, whilst producer surplus more than halved. In the worst case scenario, the gains to consumers are still large relative to the losses to producers. The losses to apple producers need to be considered in light of the concentration of this loss in relatively fewer individuals and therefore the political sensitivity of these results.

Dynamic Welfare Analysis Results

The Markov Chain analysis indicates that net present value of the gain in total economic surplus from removal of the quarantine measure, by calculating the net gains in economic surplus in future years and discounting them back to time zero. Discount rates of 5, 7 and 10 percent have been arbitrarily selected to test the sensitivity of the results to changes in the discount rate. A time horizon of 50 years was selected but the analysis could easily be extended to include a longer time frame.

The weighted average impact of market liberalisation on economic welfare is estimated at $125 million initially, at time zero, using the probabilities prescribed by AQIS (1998, p. 25). Taken over a 50 period (50 year) time horizon, the increase in economic surplus from removing the quarantine measure restricting imports is estimated at $1,876 million using a 7 percent discount rate.

Table 4 Net Present Value of Benefits from Liberalisation Dynamic analysis ($ millions)

Time horizon	AQIS 5%	AQIS 7%	AQIS 10%
0	125	125	125
5	674	645	606
10	1,105	1,016	905
20	1,706	1,469	1,205
30	2,075	1,699	1,321
40	2,302	1,816	1,366
50	2,441	1,876	1,383

Note: Based on supply elasticity of 0.3 and demand elasticity of 0.4 and 5, 7 and 10 percent discount rates.

The results showed no net sensitivity to the elasticities used or the discount rate adopted. Varying the elasticity of demand did vary the net increase in welfare and therefore the overall outcome.

6. Conclusions

When the gains from trade to consumers are expected to outweigh the potential losses to producers, the market should be liberalised when using a broad social welfare criterion to assess the effect of a trade restrictive quarantine measure. The case study of the Australian apple market shows that over a wide range of assumptions the liberalisation of the apple market could generate an increase in total economic surplus in the Australian economy in excess of $100 million. This is achieved by considering the effects of removing the trade restrictive quarantine measure on both producers and consumers in the apple market. However the process currently adopted by the WTO under the SPS Agreement, and consequently by domestic quarantine policy makers, does not provide scope for the consideration of the benefits of trade. The apple market case study provides empirical evidence that ignoring the gains from trade to consumers in the decision to apply a quarantine measure over estimates the benefits provided by that measure.

Under the current provisions of the SPS Agreement, members of the WTO are not required to undertake a comprehensive economic analysis of the impact of a quarantine measure on social welfare. Rather, the current process is one that is based on the domestic policy makers position of putting in place quarantine measures that are 'legally defensible' (Orden et al. 2001, p. 212). In cases where the risks and costs of infestation are high relative to consumer gains, an economic analysis of quarantine will indicate the same result as a scientific risk analysis that does not incorporate any consumer benefits; trade should not occur. However, in cases where the pest or disease risks and economic costs from infestation are low, the gains are more likely to outweigh the losses (Orden et al. 2001, pp. 200-201), as has been shown in the case of the Australian apple market. It is in these cases that policy makers should consider the forgone trade benefits of quarantine measures, and the costs of defending that measure should it be challenged by another member of the WTO.

Appealing to the Theory

The 'political sensitivity factor' is important because of the unequal distribution of the changes in economic surplus between consumer and producer groups. The apple industry in Australia is relatively small, and losses may occur through liberalisation of apple trade with New Zealand, accruing to relatively few individuals, namely 1,500 apple producers. However the benefits of open trade accrue over the entire apple consumer group, made up of millions of individuals. This will not be a case where simple application of a normative welfare economics principle, such as the Kaldor-Hicks welfare criterion, will be sufficient to generate a practical, socially acceptable outcome. Indicating that potential gains from trade may accrue to one group in society is unlikely to provide the political grounds for market liberalisation. Evidence from the apple market case study, and others such as Anderson and James (1998) and Orden et al. (2001), suggests that significant gains from trade may be forgone when using trade restrictive quarantine measures. There should at least be a consideration of those gains.

The Kaldor-Hicks welfare criterion was founded on the problem of economic changes that result in 'winners' and 'losers'. It is suggested that if the overall change in economic welfare was positive, the change should take place; the losers could potentially be compensated for bearing a loss. Whether such compensation is paid is irrelevant, but due to political sensitivity of quarantine measures, the idea of compensation in the event of disease entry could be considered, as noted by Anderson and James (1998, p. 440). An important issue is how the effects of quarantine measures and sanitary phytosanitary risks should be weighted on different groups in society (Roberts 2001, p. 25). This is an issue that will have to be resolved as the costs and benefits of trade in an environment of pest and disease risks are not equally distributed.

Domestic Quarantine Policy

The current Import Risk Analysis approach adopted by Australian quarantine policy decision-makers does not include the economic benefits derived from trade when deciding whether to implement a trade restrictive quarantine measure. The case study presented in this paper and the studies of others demonstrate that total economic surplus, or the economic welfare of society could be increased by applying more economics in the consideration of quarantine measures. Therefore the current approach to quarantine-based trade restrictions is not an acceptable means by which to pursue the best interests of society as a whole.

Aside from the direct gains from trade obtained from importing cheaper products than can be produced domestically, several indirect benefits can be identified that further the argument for a greater use of economic analysis in the implementation of quarantine measures. Stanton (2001, p. 73) cites the high costs of continually defending measures set in place under a quarantine policy that accepts a low level of sanitary phytosanitary risk, stating that 'governments face important financial and resource costs when they are bringing a challenge, or defending their requirements' to the WTO. This idea also reflected in work by Anderson and James (1998). If it can be shown from the outset that the 'maximum possible loss to producers and others from importation of that good' are notably less than the gains to consumers from market liberalisation with the presence of pest or disease risks, there is no economic grounds to even undertake an Import Risk Analysis (Anderson and James 1998, p. 440). It is intuitively perverse for government agencies to spend taxpayer funds defending the protection of an industry that would offer gains from trade to taxpayers if the protection was removed. The benefits identified here are two fold: a reduction in the costs of undertaking Import Risk Analyses and defending quarantine measures are achieved; and obtaining increases in economic welfare associated with trade in goods between countries that have cheaper production costs and thus offer goods to consumers at lower prices.

Adopting a less protectionist stance on quarantine issues would also allow Australia to more offensively pursue trade liberalisation cases against other nations with markets in we have a comparative advantage and which are highly protected. The current Import Risk Analysis process may benefit from a reassessment of the level of risk-return trade off that is made between disease risks and the benefits associated with more open trade. In cases where an economic analysis indicates irrefutable gains from trade, it may be acceptable allow trade in a good even when the risk of pest or disease entry rises (Orden et al. 2001, p. 212). This would be equivalent to an adjustment in Australia's current Appropriate Level of Protection, which could also be considered by domestic quarantine decision-makers.

The Influence of the WTO and the SPS Agreement

The incorporation of a more comprehensive economic analysis in the decision to apply a quarantine measure is unlikely to be disputed by other members of the WTO. Economic analysis could lead to greater levels of market access for other WTO members, who may also be encouraged to use economic analysis in examining their quarantine measures in the long run. The aggregation of scientific and economic analysis techniques into quarantine policy decision-making is also likely to result in more measures that were 'least trade restrictive' (WTO 1995, p. 60) and therefore offer more favourable outcomes for the WTO, which would have few grounds to object to such an outcome (Orden et al. 2001, p. 212).

Importantly, an economic approach to the application of quarantine measures would not necessarily impede any WTO member countries' ability to provide evidence of the need for quarantine protection where the risks and costs of disease justify border protection. In cases where results of analysis show that it is economically undesirable to import a product in the presence of risk (the net change in total economic surplus is negative), it would not alter the ability of a WTO member to refuse entry to those imports based on their rights under the SPS agreement. The large costs (which exceed the benefits of trade) are still a reflection of the 'relevant economic factors' (WTO 1995, p. 62) required by the WTO as justification for quarantine measures in the SPS Agreement. If the analysis shows gains from trade are in excess of potential costs to producers, then it demonstrates to policy makers that serious contemplation should be given to the liberalisation of the market.

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