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An Economic Evaluation of Interstate Quarantine Protocols for Mangoes Entering Western Australia

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Abstract

Quarantine trade restrictions enforced on agricultural commodities are both a safety measure and a form of subsidy to local producers. With appropriate strategies in place the risk posed to domestic production systems from exotic pests and diseases is reduced. This often means importers of agricultural commodities are effectively taxed, with negative effects on consumer welfare. Hence, analysis of quarantine policy decisions involves a comparison of expected production gains against social welfare loss. Given the large variety of agricultural industries and the virtually endless list of exotic pests posing a risk to domestic industries, there is a continuum of cases of this nature. In some instances the effects of quarantine policies will be felt mainly by producers, while in others it may be consumers, or a blend of the two. In the case of the mango industry in WA, both producers and consumers are affected. A quantitative assessment of the benefits and costs of Agriculture Western Australia's import clearance activities governing mango importation is provided here in which the break-even pest damage avoided through quarantine is emphasised, rather than the expected level of damage should pests enter.

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1. Introduction

In the modern climate of market globalisation and the expansion of international trade, increasing emphasis is being placed on methods of assessing the use of quarantine as an instrument of protectionism. As a major food exporter, Australia has the potential to flourish in the global market place, but it must be seen to be playing by the rules if it is to avoid retaliatory action by trading counterparts that will offset the gains to international trade. Being a signatory of the World Trade Organisation (WTO) Agreement, the federal government of Australia has a responsibility to ensure that any trade measures used in its internal markets relating to Sanitary (human and animal health) and Phytosanitary (plant health) measures are compliant with the rules and regulations governing international trade. According to these rules, any such measure must be justified by a comprehensive risk assessment, and it is here that economics can make a useful contribution by examining the likely impacts of trade restrictions on domestic producer and consumer welfare. Applying conventional Benefit Costs Analysis (BCA) methodology to quarantine measures would involve a comparison of damage avoided through pest exclusion and social welfare losses caused by restrictions to competition. However, given the substantial information requirement to do so, this analysis adopts an alternative approach. Rather than attempt to model expected pest impact(s), the minimum value of producer losses prevented by quarantine restrictions required to bring social benefits and costs in to balance is formulated.

2. Background

As a signatory of the WTO Agreement, established at Marrakesh on the 15th April 1994, the federal government of Australia has an obligation to ensure the nation's internal markets for agricultural products closely resemble those of international markets with respect to technical barriers to trade. Following the Uruguay Round of General Agreement on Tariffs and Trade (GATT) talks, concerns that the trend towards free trade may be offset by the use of alternative protection techniques began to surface. Whilst tariffs and quotas constituted the primary trade weapons of the protectionism of the late 1970s and the 1980s, the key instrument of what can perhaps best be described as ‘new protectionism' is quarantine. In response to the concerns about its use as a trade barrier an agreement on Sanitary and Phytosanitary (SPS) measures was negotiated to ensure that future SPS trade restrictions were based on scientific information (James and Anderson, 1998). In this agreement, henceforth refereed to as the SPS Agreement, is contained Commonwealth and State obligations and responsibilities relating to “…all sanitary and phytosanitary measures which may, directly or indirectly, affect international trade” (Article 1).

Annex A1 of the SPS Agreement specifically defines SPS measures as any measure applied:

(a) to protect animal or plant life or health within the territory of a Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;

(b) to protect human or animal life or health within the territory of a member from risks arising from additives, contaminants, toxins, or disease-causing organisms in foods, beverages or foodstuffs;

(c) to protect human life or health within the territory of a Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or to prevent or limit other damage within the territory of a Member from the entry, establishment or spread of pests

(d) to prevent or limit other damage within the territory of a Member from the entry, establishment or spread of pests

(GATT, 1994)

Any such measure taken against one Member by another which directly or indirectly affects international trade may be challenged through the WTO Dispute settlement process.

Since the food safety and animal and plant health regulations relating to interstate trade within Australia are often set by state and local government authorities, decisions made at all levels of government have the potential to be challenged. This is recognised in Article 13 of the SPS Agreement, which requires the central government (as the signatory) to formulate and implement positive measures and mechanisms in support of the observance of the international provisions by all tiers of government (GATT, 1994; Miller, 1999). Accordingly, a Memorandum of Understanding between the Commonwealth of Australia and all States and Territories (henceforth referred to simply as “the Memorandum”) was signed on the 21st of December 1995 in which parties agreed to act in accordance with relevant obligations under the SPS agreement (Commonwealth of Australia, 1995). Article 11 of the Memorandum stipulates:

> States and Territories shall not apply any relevant sanitary and phytosanitary measures within their jurisdictions which would not conform with the provisions of the SPS Agreement.

The “provisions” referred to are specified in Article 5 of the SPS Agreement, which begins:

> Members shall ensure that their sanitary and phytosanitary measures are based on an assessment, as appropriate to the circumstances, of the risks to human, animal or plant life or health, taking into account risk assessment techniques developed by the relevant international organisations. (GATT, 1994)

In a general sense then, any measure applied to imported products by any level of government to protect human, animal or plant health must be based on scientific principles, and not maintained without sufficient scientific evidence. The only exception is where existing evidence is insufficient to prove or disprove an unacceptable level of pest importation risk, in which case a Member may adopt provisional measures to protect itself (Miller, 1999). To help bring the collective Australian quarantine system in line with these international provisions, a review of Australia's quarantine system was initiated by the Hon. Bob Collins, Minister for Primary Industries and Energy, in December 1995. The committee appointed to carry out the review was chaired by Emeritus Professor Malcolm Nairn, which presented its findings to the Minister in November 1996 in the form of a report titled *Australian Quarantine: A Shared Responsibility*, widely referred to as the Nairn review. The report put forward 109 recommendations on how Australia's quarantine system could be improved to comply with WTO regulations, concentrating on a range of areas such as environmental awareness, community awareness, risk analysis, consultation in policy-making, surveillance and preparedness.

With regard to risk analysis, the report makes it clear that the pursuit of a “zero risk” quarantine structure is nonsensical. The sheer abundance and diversity of quarantine pests makes zero risk an impossibility, so a much more realistic basis for Australia's quarantine system is “manageable risk”. At the core of this concept is *risk analysis*, which is a general term to encompass the elements of:

- Risk Assessment – the process of identifying and estimating risks associated with a policy option and evaluating the likely consequences of taking those risks.
- Risk Management – the process of identifying, documenting and implementing measures to reduce these risks and their consequences; and
- Risk Communication – the process of interactive exchange of information and views concerning risk between analysts and stakeholders (Nairn *et al.*, 1996; Nunn,

1997).

By utilising risk analysis techniques, the Nairn Review suggested, quarantine could be targeted at areas representing the greatest risks and so produce the highest social and environmental returns with available funds. The report went on to suggest several fundamental principles to be included in the analytical process, which included:

- stakeholder/industry consultation
- objectivity and robustness in scientific methodology and political independence
- transparency
- consistency and harmonisation
- subject to appeal on process, and
- subject to periodic external review.

A successful risk assessment should, in essence, exhibit each of these principles if it is to facilitate a socially-optimal allocation of scarce quarantine resources.

An official response from the federal government to the Nairn Review and its recommendations was not put forward until August 1997 (DPIE(1997)). This was to come in the form of a joint response to the Committee's report and the report of a National Task Force on Imported Fish and Fish Products presented to the government in December 1996 (DPIE (1996)[1]). While not accepting all the recommendations of the review committee, the response acknowledged the need for Australia's acceptance of the rules and guidelines of international trade to which it expects trading partners to adhere to. To bolster the national quarantine system, it indicated that additional funding of A$76 million would be delivered over the proceeding four years and be targeted towards increasing community awareness, manageable risk (science-based), protection of Australia's unique environment and recognition of the continuum of quarantine (Tanner and Nunn, 1998). The report also expressed the government's endorsement of the risk analysis process put forward by the Nairn review, with only a few minor changes[2]. To determine exactly what constitutes manageable risk, a system has now been put in place to include community and industry stakeholders in making judgements, in line with the risk assessment process.

It must be acknowledged that the appropriate role for economic analyses in this process is subject to a considerable amount of conjecture. Perhaps the most significant explanation lies with the fact that WTO-consistency and economic efficiency are not necessarily complementary concepts. In a comprehensive discussion of these issues, James (1999) asserts that Risk Assessment should lie within the realms of science, and "Risk Management…is the proper (and WTO-legal) place for economic analysis…[since] there are no limits on factors which can be considered by authorities in risk management decisions". Although such a strict partitioning of the risk analysis process is by no means accepted practice, it is envisaged that the results presented here would be of optimal use if this were the case. In view of this, the purpose of this research is to explore the role of *economic analysis* as a tool to guide quarantine policies made at the state level within Australia.

3. The Mango Industry and Interstate Quarantine

The mango (*Mangifera indica*) has been described as the "most extensively grown of all fruits" (Alexander, 1987). It is believed to have evolved in the tropical rainforests of south and South East Asia, and is now grown in every country throughout the tropical areas of the world in both hemispheres. Individual plants can live over 100 years, and reach heights of over 30 meters at maturity. There are now thousands of known mango varieties produced throughout the world, of which Watson (1984) names 277, although the real number of separate species is likely to somewhat less as several names apply to the same variety. Commercial mango growing enterprises predominate in tropical lowland areas roughly 23° 26¢ north and south of the equator. Approximately 60 per cent of the world's mango supply comes from India, which has a 6000 year history of growing the fruit (Alexander, 1987). Other major growing areas are found on the Indian subcontinent, South East Asia, and central and South America. With advances in cultivation techniques, a limited amount of production also takes place in subtropical areas such as in Israel and Spain. In 1993, world mango production was estimated to be in excess of 17.7 million tonnes (Litz, 1997), representing an increase of some 30 per cent from the early 1980's (Alexander, 1987). Despite this increase and large global production, mangoes remain insignificant in world trade when compared with other fruit varieties such as bananas, apples, and citrus fruit.

In Australia, mangoes are grown throughout the northern tropical and subtropical regions where they are picked from late September to early April (White, 1997). National production accounts for around 2 per cent of the recorded world output of mangoes, producing just over 27,000 tonnes in 1995/96 (ABS, 1998[3]; Litz, 1997). With a history of broad acre agriculture, it is perhaps not surprising the Australian mango industry has never reached a large size by world standards, but it continues to grow in size and stature. In the early 1970's, national production (of 1-2,000 tonnes at that stage) was marketed mainly from Sydney and Brisbane, but by the mid-1980's mangoes were available from all major Australian markets (Alexander, 1987). The major producing states are Queensland, New South Wales, and of course Western Australia.

In WA, the mango industry has been expanding significantly over the past ten years. In 1995/96 it accounted for around 5 per cent of national output, producing a total of 1,258 tonnes (ABS, 1998). This made it the third largest producer behind Queensland (85 per cent) and the Northern Territory (NT) (9 per cent) (White, 1997). Production is centred around two main regions, Carnarvon (890 tonnes, 1995/96) and Kununurra (550 tonnes). The former's production peaks from late December to February, while the latter is one of the earliest producers in Australia, peeking during October and November. Other growing centres include Broome (52 tonnes), Gingin (22 tonnes) and Derby (2.2 tonnes) (ABS, 1998). This dispersion of producers across the state causes a lengthy picking time, and a continuous supply to the Perth Market from October through to April (White, 1997).

Generally, WA is free from serious mango pests and diseases, although isolated occurrences of Bacterial Black Spot (*Xanthomonas campestris* pv. *Mangiferaeindicae*) and Anthracnose (*Colletotrichum gloeosporioides* Penz. Var. *minor*) are detected from time to time, as are several common fungal diseases. The only insect pest of significance to mangoes which is endemic in the state is Mediterranean Fruit Fly (*Ceratitis capitara*), and a pilot eradication programme is currently underway in the Broome region to provide information for future feasibility studies of more extensive campaigns.

3.1 Quarantine Protocols for Mangoes Imported from Interstate

Because of WA's freedom from many major pests, quarantine plays a vital role for the domestic industry (Strickland, 1992). Pests exotic to WA but endemic in other states and territories of Australia include invertebrates such as Queensland Fruit Fly (*Bactrocera tryoni*), Northern Teritory Fruit Fly (*B. aquilonis*), Mango Seed Weevil (*Sternochaetus mangiferae*), Mango Pulp Weevil (*S. frigidus*), European Red Mite (*Panonynchus ulmi*), Melon Thrips (*Thrips palmi*), Spiraling Whitefly (*Aleurodicus dispersus*), Mango Leaf Hopper (*Idioscopes niveosparsus* and *I. clypealis*), and diseases such as Mango Scab (*Elsinoe mangiferae*). These pests have the potential to severely hamper mango production in WA if outbreaks (if and when they occur) are not detected and treated early, and/or to add significantly to production costs if they were to become endemic in WA.

Up to the early 1990s, importation from the largest eastern States rivals were prohibited (Hawkins, 1994). The presence of exotic pests like Mango Seed Weevil (MSW) and Northern Territory Fruit Fly in the Northern Territory, and Queensland Fruit Fly (Q-fly) in Queensland meant that the risk of importing such pests was deemed too high. However, in 1994 a new set of protocols was introduced to permit imports from the former under certain circumstances. The quarantine requirements for imported product currently in place are strict, with specific preventative measures undertaken to reduce the risk of entry of all the pests mentioned above. Queensland imports remain prohibited. All costs are born by interstate growers seeking to export mangoes into WA, the most significant of which are made up of post harvest sprays for fruit fly, and sampling costs for MSW.

Protocols to prevent the introduction of fruit flies to the state are very specific. In the case of Q-fly, they require product from all states and Territories to be certified as having been immersed in a dip containing 400mg/L of dimethoate or fenthion for 1 minute; or having been flooded as part of a single layer of produce with 400mg/L of dimethoate or fenthion at ambient temperature in a high volume application of at least 16L/m2 per minute for at least 10 seconds and as having remained wet for at least 1 minute before drying; or having been fumigated with methyl bromide at rates between 24 g/m3 (at 26° - 31.9° C) and 48 g/m3 (at 10° - 14.9°C) for 2 hours at one of the following rates (WAQIS, 1999). Dipping or flood spraying must be the last treatment before packing (Scott, 1998).

Detection of MSW requires the fruit to be dissected and inspected for evidence of larvae in the seed, as the name would suggest, rendering it unfit for sale. An eastern States property wishing to export to WA must undergo sampling for two years prior to the first consignment being permitted to cross the border to demonstrate *property freedom*.

This involves up to 4,000 fruit being inspected at the commencement of each season. If approval is given by the Western Australian Quarantine and Inspection Service (WAQIS) and export takes place, a market sample of 600 fruit will be taken either prior to or immediately upon arrival. Maintenance of property freedom is accepted on the basis of there being no MSW infestation within 50km of the property, and no detection in annual fruit sampling or consignment sampling (WAQIS, 1999; Manbulloo Mangoes Australia, pers comm, 26/8/99).

4. Static Analytical Framework

In the following discussion, let the term "social welfare" refer to *gains from trade*. Simply stated, this is the extra consumption benefits achieved through interstate trade less production costs brought about by competition. By trading goods interstate, WA consumers enjoy a wider range of products obtainable at a cheaper price than would otherwise be the case, translating into a rise in consumer welfare. At the same time, domestic producers are subjected to higher degrees of competition from rival growers elsewhere in the country if state borders are open to trade. In terms of an appropriate modelling framework, this results in the scope for an accurate economic analysis having to be broad. Not only is there a need to account for benefits to agricultural industries from preventing costly exotic pest incursions, but also the costs to consumers resulting from import restrictions[4].

Consider an exotic pest to WA, such as MSW, which is endemic in the eastern states of Australia. The probability of the organism entering WA from the eastern states in sufficient quantities to reproduce can be lessened by ensuring imported fruit are subjected to the treatments detailed in section 3.1 before they are permitted to cross the border. But, the reduced risk comes at the cost of a welfare loss for consumers, and so the net result is conceptually ambiguous. It is this *net welfare change* an analytical model must encapsulate.

4.1 The Static, Partial Equilibrium Model

To maintain a level of simplicity conducive to the effective communication of results to multidisciplinary decision-making bodies, it is useful to employ several assumptions concerning the nature of the mango market in WA, and the pests which are of quarantine significance to it. These assumptions allow the use of a basic comparative-static, partial equilibrium model of interstate trade to examine the welfare implications of mango quarantine protocols. While more complex methodologies can be used to examine the expected damage from pest incursions, using techniques such as Markov chains to model the dynamics of pest spread and impact[5], constraints on input data and extension limit the effectiveness of these in practice. The emphasis here is on (potentially) pest-affected markets, rather than the nature and dynamics of pest impact. Assuming the following, Figure 1 depicts the WA mango industry:

1. The domestic market for mangoes is perfectly competitive.
2. Variations in the domestic market conditions for mangoes has virtually no effect on world trade in mangoes.
3. Mangoes are a homogenous product. Demand and supply curves can be aggregated across the extensively grown Kensington Pride (including Kimberley Research Station (KRS) selection), and late maturing varieties such as Keitt and R2E2.
4. Society has a neutral attitude to risk [6];.
5. Potentially imported agricultural pests attack one host exclusively (i.e. mangoes), with no polyphagous tendencies which might affect other industries.
6. Under quarantine restricted trade, the onus is on importing centres to abide by certified protocols, bearing any necessary costs in order to do so.

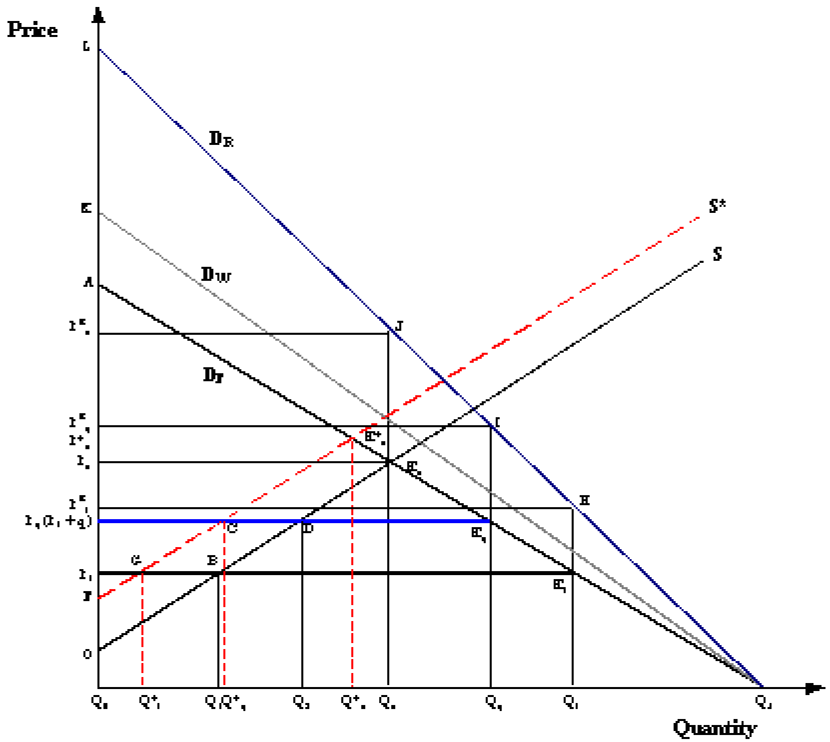
(James and Anderson, 1998).

Consider firstly a closed WA economy where no trade in mangoes takes place with the eastern states of Australia (or international centres). In Figure 1, local suppliers face a downward sloping demand curve (DF) for their product in the domestic market, and an upward sloping supply curve (S). The intersection of these two curves (at Ec) determines the domestic, or closed economy producer price (Pc) and quantity supplied at this price (Qc), and is termed the *closed economy* equilibrium.

Before moving on, it is necessary to incorporate marketing margins into the model. Most WA fruit and vegetable growers sell their wares on the Perth market through a market agent[7], who in turn sells them to retail outlets, from which they are purchased by consumers. The size of marketing margins applied at each stage and the manner in which they are applied are difficult to verify. Sources close to the market indicate wholesale margins to be in the order of 10-15 per cent (Mercer Mooney; Quality Produce International; Central Fruit Sales; Etherington & Sons, pers comm, 23/11/99), and retail margins around 33 per cent (Woolworths – Fresh Produce, pers comm, 22/11/99; Quality Produce International, pers comm, 23/11/99). Further details of the idiosyncratic nature of fruit marketing are difficult to extract, and hence marketing margins are assumed constant in percentage terms. Consequently, the model infers that (generally) the price paid for mangoes "at the farm gate" is around 12.5 per cent below the wholesale price of fruit and vegetables, which is in turn is approximately 33 per cent below the retail price.

Figure 1 shows the domestic demand curves for mangoes at the wholesale and retail as DW and DR respectively. For the most part the DW curve can be ignored since demand at the retail level is of primary concern. Looking once more at the closed economy equilibrium, when the producer price is Pc and the quantity supplied is Qc, the corresponding retail price is PRc. Therefore, although PS remains constant, CS with marketing margins in place becomes PRcJL. If the market is now opened up for unrestricted trade with other states, WA suppliers will be thrown into direct competition with imported product. Instead of dictating terms in the market, WA producers will become price-takers assuming the prevailing state producer price (Pc) exceeds the national producer price (Pf) (CIE, 1988). At Pf domestic suppliers are willing to supply Q1, while demand is Qf. Hence, Qf-Q1 is made up by imported fruit. As it has been drawn in the diagram, CS increases by the area PRcJHPRf (i.e. from PRcJL to PRfHL) as the economy is opened up to free trade, and PS decreases by the area PfBEcPc (i.e. from OEcPc to OBPf). With this information it is possible to calculate the net welfare change by subtracting the loss in PS from the gain in CS. In the case of the economy moving from a state of autarchy to one of free-trade, net welfare change is equivalent to PRcJHPRf – PfBEcPc.

Figure 1: Interstate Import Clearance and Social Welfare Loss



With no restrictions on trade in place the probability of exotic pest incursions is maximised, there being Qf-Q1 imports entering the state free of screening mechanisms. Suppose now that a quarantine restriction on imported mangoes is introduced in an effort to decrease the likelihood of pest entry. The cost to external (i.e. to WA) producers of complying with the specified protocols, *q*, is passed on to consumers as higher prices. Hence, with the quarantine restriction in place the market faces the producer price Pq and retail price PRq. At this price, consumers remain better off than under the closed economy scenario, but worse off than under a free trade regime. Their CS is now PRqIL, an increase of PRcJIPRq relative to autarchy. The opposite is true of producers, being worse off than under autarchy and better off than under free trade. The PS is now ODPq, a decrease of PqDEcPc relative to the no trade situation. Therefore, the net welfare change resulting from quarantine restricted trade as opposed to a closed economy is represented by PRcJIPRq - PqDEcPc.

Using the partial equilibrium framework, the impact of quarantine restrictions on CS and PS are clearly seen. Consider what happens when there is an incursion of an exotic pest which is highly host-specific. Once it has entered and been detected, certain measures will be taken to manage the spread of the pest according to its biological characteristics, the existence of nationally co-ordinated management strategies, the size and structure of the affected market, and so forth. For now, assume the impact of these management strategies is to raise the domestic cost of mango production. In the absence of any demand shocks domestic supply will contract from S to S* in Figure 1, while the volume of mangoes imported increases[8]. Under the quarantine restricted price Pq domestic supply will be Q*q, and imports Qq-Q*q. Domestic CS will remain constant at PRqIL, and PS will contract to FCPq. Therefore, the net loss to the WA economy of importing the pest becomes the area ODCF.

An estimate of the potential economic benefits and costs of adopting any one strategy (either a free trade policy or quarantine restricted trade) can now be calculated by comparing the net gains from trade with the potential loss of domestic PS should a pest enter. The potential net benefits to a free trade policy (PBft) relative to a closed economy situation, for instance, are given by:

(1)
PBft = (PRcJHPRf – PfBEcPc) – (*p* x OBGF)

where;

$$p = \text{probability of pest entry under free trade}$$
$$P^R{}_f \, HJP^R{}_c - P_f BE_c P_c = \text{net gains from trade under a free trade regime}$$
$$OBGF = \text{potential loss of PS under free trade}$$

With unrestricted trade, *p* is expected to be relatively high when compared to a restricted environment assuming quarantine only affects the probability of a disease outbreak, and has no impact on the severity. The potential net benefits to a quarantine restricted trade policy (PBqt) with respect to a closed economy situation is calculated as:

(2)
PBqt = (PRcJIPRq - PqDEcPc) – (*p** x ODCF)

where;

$$p^* = \text{probability of pest entry under quarantine restriced trade (i.e. } p^* < p)$$
$$P^R{}_c JIP^R{}_q - P_q DE_c P_c = \text{net gains from trade under a quarantine policy}$$
$$ODCF = \text{potential losses to PS brought about by a pest incursion.}$$

If expected losses under a free trade regime are sufficiently low when compared to those expected under a quarantine policy, then it is very difficult to justify this protection. On the other hand, if the pests which could potentially enter WA through imported mangoes are capable of inflicting severe damage, it may be that free trade is not worth the risk. By subtracting (2) from (1), an expression is derived indicating the potential net welfare change resulting from quarantine policies relative to that under free trade (PBqt/ft):

(3)
PBqt/ft = [(PRcJIPRq - PqDEcPc) - (*p* x* ODCF)] – [(PRcJHPRf – PfBEcPc) - (*p* x OBGF)]

Estimating (*p* x* ODCF) and (*p x* OBGF), the expected losses to PS from pest incursions under quarantine and free trade respectively, involves a high degree of subjectivity. An alternative is to calculate (PRcJIPRq - PqDEcPc) - (PRcJHPRf – PfBEcPc), the total net welfare loss to society resulting from choosing quarantine restrictions over free trade, and assume the policy will break even (i.e. total net gain = total expected PS lost to pest incursions, so PBqt/ft = 0):

(4)
(PRcJIPRq - PqDEcPc) - (PRcJHPRf – PfBEcPc) = (*p* x* ODCF) - (*p* x OBGF)

(5)
or (PfBDPq - PRqIHPRf) = (*p* x* ODCF) - (*p* x OBGF)

In doing so, it is possible to estimate the minimum value of the right hand side of (4) necessary for the policy to be justified on economic grounds. Comparing the figure on the right to an estimate of total PS in WA post-quarantine restriction allows the expected damage to the domestic mango industry avoided through trade restrictions to be placed in perspective.

5. Data Specification

Post-Quarantine Quantity Supplied (Qq) - using ABS time series data supplemented by White (1997), an estimated proportion of total supply was formed based on a three year average from 1997-1994. Prior to 1994, interstate importation of mangoes was prohibited (Hawkins, 1994) due to the risks associated with exotic pests like MSW, Northern Territory Fruit Fly and Queensland Fruit Fly. However, in 1994 a new set of protocols was introduced to permit imports from the Northern Territory under strict conditions while Queensland imports remain prohibited. So, using post-1994 supply data and relative contributions to production from the Central and Kimberley statistical divisions, the former comprises of some 56 per cent (790 tonnes) of total production, and the latter around 43 per cent (610 tonnes) (ABS, 1998; White, 1997).

Post-quarantine Price (Pq) - was calculated (in real terms) as a five year average from the period following 1994 when imports from the eastern states were no longer prohibited using PMA and FAO data. On this basis the best bet value for Pq is $1,800/tonne (PMA, 2000b; FAO, 2000). Closed Economy Price (Pc) - taken as a five year average from the period following 1994 using PMA and FAO data. This gives the best bet value for Pc as $1,950/tonne (PMA, 2000b; FAO, 2000).

Free Trade, or National Price (Pf) - is specified to approximate the marginal cost of mango production for eastern states rival growers. If there were no restrictions to trade, these producers would be inclined to take advantage of the WA market and increase supply to the point where all profits are diminished, and price equals AVC in the long run. White (1997) calculated the marginal cost of production and transport to local markets for producers in Carnarvon, Kununurra, Katherine in the Northern Territory, and Mareeba in Queensland. By substituting transport costs to Perth for local transport costs (i.e. Brisbane-Perth = $410/tonne; Sydney-Perth = $380/tonne (Harris Transport, pers comm, 4/10/99)) for eastern states producers, the lowest marginal cost was found to be in Queensland at around $1,750/tonne.

Wholesale and Retail Marketing Margins - These are of most importance to the aggregate model. The size of the marketing margins applied at the wholesale and retail levels are difficult to verify, as is the manner in which they're applied. Sources close to the market indicate wholesale margins to be around 10-15 per cent (Mercer Mooney; Quality Produce International; Central Fruit Sales; Etherington & Sons, pers comm, 23/11/99), and retail margins around 33 per cent (Woolworths – Fresh Produce, pers comm, 22/11/99; Quality Produce International, pers comm, 23/11/99). Since further details of the idiosyncrasies of fruit marketing are difficult to extract, marketing margins are assumed constant in percentage terms. Consequently, the model infers that (generally) the price paid for mangoes “at the farm gate” is around 12.5 per cent below the wholesale price of fruit, which is in turn is approximately 33 per cent below the retail price.

6. Results and Sensitivities

The information outlined above was placed into a simple spreadsheet model which calculates the net gains from trade in both a free trade and post quarantine setting, in line with the methodology outlined earlier. To clarify, the objective is to estimate the value of total notional PS loss saved by the quarantine protocol for mangoes (as a result of preventing pest incursions) required to exactly offset the total net welfare loss resulting from inflating prices above a free trade level. In the absence of information on the aggregated probability of pest incursions under quarantine versus free trade regimes, these notional PS losses have been grouped together. Although this is regrettable in many ways, the results will still provide a good indication of the necessary cost effectiveness of interstate quarantine protocols if they are to be justified on economic grounds.

Results of a “best bet” approximation are detailed in Table 1 with references to Figure 1 in brackets, below which are listed the key assumptions used in the estimation. Here, the post-quarantine price (Pq) was calculated (in real terms) as a three year average in the period following 1994 when imports from the eastern states were no longer prohibited due to the threat of MSW using PMA data. The closed economy domestic equilibrium price (Pd), quantity demanded (Qd) and post-quarantine quantity demanded (Qq) were derived in a similar manner using pre-1994 data.

Table 1: Key Assumptions

	Free Trade	**Post Quarantine**

Where;

Demand Elasticity = -2.30

Supply Elasticity = 0.60

Closed Economy Equilibrium Price (Pd) = $1.95/kg

Closed Economy Equilibrium Quantity (Qd) = 630,000/kg

Price Under Free Trade (Pn) = $1.75/kg

Post Quarantine Price (Pq) = $1.80/kg

The free-trade equilibrium price (Pn) was assumed to approximate the marginal cost of mango production for eastern states rival growers. If there were no restrictions to trade, these producers would be inclined to take advantage of the WA market and increase supply to the point where all profits are diminished, and price equals marginal cost. White (1997) calculated the marginal cost of production and transport to local markets for producers in Carnarvon, Kununurra, Katherine in the Northern Territory, and Mareeba in Queensland. By substituting transport costs to Perth for local transport costs (i.e. Brisbane-Perth = $410/tonne; Sydney-Perth = $380/tonne (Harris Transport, pers comm, 4/10/99)) for eastern states producers, the lowest marginal cost was found to be in Queensland at around $1.75/kg. Therefore, using this information as input into the model, results indicate that the potential loss to PS avoided by maintaining quarantine protocols must be in the order of $22,250 for the policy to break even. As the curves are defined here, domestic PS in a quarantine restricted trade situation (i.e. post-1994) is approximately $757,600.

Therefore, in order for the policy to break even, the expected value of PS saved by excluding mango pests must constitute around 2.9% of the current total value of the industry. To put this another way, the probability of the industry being completely destroyed by imported pests must be in the order of 2.9% per year. This is surprisingly high, particularly when the geographic constraints to pest spread in WA are taken into account. In light of the subjective nature of many assumptions used to derive this result, it is prudent to run an extensive sensitivity analysis to indicate the areas most likely to cause bias. Each of the key input variables was tested, and a summary of the results appears in Table 2. Various aspects of this table warrant a brief comment.

Table 2: Sensitivity Analysis

Variable (Best Bet Value)	Value	Relative Change in Value from “Best Bet” Scenario	Net Gain Under Free Trade	Net Gain Under Quarantine Restricted Trade	Net Welfare Loss Due to Quarantine	Relative Change in Net Welfare Loss from “Best Bet” Scenario ($22,250)
		%	$	$	$	%
Elasticity of Demand	-1.00	-56.52	72,300	51,850	20,455	-8.08
(-2.30)	-3.04	32.17	78,640	55,365	23,280	4.61

Elasticity of Supply	0.30	-50.00	72,610	52,020	20,595	-7.45
(0.60)	1.00	66.67	81,315	56,845	24,470	9.96
Closed Economy Price ($/kg)	$1.90	-2.56	56,015	35,395	20,620	-7.34
(Farm: $1.95)	$2.00	2.56	101,880	77,805	24,075	8.18
Free-Trade Price ($/kg)	$1.70	-2.86	100,500	54,090	46,410	108.55
(Farm: $1.75)	$1.79	2.29	58,385	54,090	4,300	-80.68
Post-Quarantine Price ($/kg)	$1.76	-2.22	76,340	71,740	4,600	-79.33
(Farm: $1.80)	$1.85	2.78	76,340	33,735	42,605	91.45
Wholesale Marketing Margin	10.00%	-20.00	96,605	73,800	22,805	2.48
(12.50%)	15.00%	20.00	55,134	33,670	21,465	-3.55
Retail Marketing Margin	25.00%	-25.00	63,425	44,720	18,705	-15.95
(33.33%)	50.00%	50.00	102,170	72,820	29,355	31.91

Firstly, the net welfare loss does not appear to be overly sensitive to changes in the elasticity of demand. The relationship is positive, as might be expected, but the sensitivity is lowsince changes in Pd lead to less than proportional changes in net welfare loss of the same sign.

As previously stated, the sensitivity of net welfare loss to the elasticity of supply is not expected to be high, so it is not surprising that this is exactly what the table shows. Very large changes in the supply elasticity produce only minor changes in the same direction. This partly justifies the lack of a formal derivation of this value in the analysis.

The situation is somewhat different for the price under autarky, Pd. Changes in this value lead to slightly more than proportional changes in net welfare loss of the same sign, so the results could be said to be relatively sensitive to Pd. However, the areas of highest sensitivity are associated with the free trade price, Pn, and post-quarantine price, Pq. The former displays a negative relationship with the net welfare loss, and the latter a positive relationship. Relatively small changes in these values have a large impact on the net welfare loss, which is easily explained by returning once more to Figure 1.

The sensitivities alter the distance between Pn and Pq, thus affecting the size of the areas PRqIHPRn (the opportunity cost of maintaining quarantine protocols) and PnBDPq (the gain in PS). It follows that raising the value of Pn diminishes the loss in CS and gain in PS, whilst the opposite effect is had by increasing Pq. So, the extreme sensitivities are to be expected in terms of Figure 1.

With various areas in need of further research, it is difficult to pass judgement on the current interstate quarantine protocols for mangoes based on these results. Perhaps the most obvious requirement is an investigation of the probabilities of pest entry and spread under the different trade environments, and quantifying the added production costs which would be incurred should a pest or pests of mangoes enter WA as a result of imports from the eastern states. However, an appropriate methodology has been demonstrated, and with further refinement will enable a more concise evaluation to be performed.

Nevertheless, for the moment assume (hypothetically) that the probability of pest entry and establishment is 100 per cent under free trade (p = 1.0) and 0 per cent under quarantine restricted trade (i.e. p^* = 0.0). If it is decided to abort the quarantine protocols and permit trade in interstate mangoes, using the data presented in this analysis the PS which would be lost would be in the order of $757,600 while the net welfare gain to society through trade would be around $22,250. Obviously this is an impossible scenario. However, given the geographic obstacles limiting potential pest spread vectors p will be significantly lower than 100 per cent, say 2 per cent for the sake of argument. If this were the case, expected PS losses under free trade would be around $15,150. So, a rational, risk neutral society may be prepared to wager this loss against a more significant increase in CS if this information is accurate.

Again, it must be reiterated that the extreme volatility of prices over time and the high sensitivity of results to changes in post quarantine and free trade prices make it difficult to pass a final judgement on the mango quarantine issue.

7. Limitations of the Model

Although this methodology is capable of providing valuable insights into real world market situations, it is important to recognise its shortcomings. Firstly, PS losses are calculated on the assumption of zero tangible opportunity cost. Once profits are lost, they are lost permanently since no assumptions are made concerning alternative, or “next best” land uses. This implies all land, labour and capital resources displaced from the industry concerned through pressure from imported goods could not be employed profitably elsewhere in the economy. This dynamic sense, since it ignores any form of adaptive behaviour. As a result, producer losses may be overstated (Sinner,1999). There may well be considerable socio economic factors to consider in any resource re-allocation, which would be difficult to “sell” politically since they tend to be more visible than the indivisible loss of welfare to consumers in general.

A second problem is that the analysis is industry specific, and does not allow for cross-industry impact analysis. While some pests attack one host exclusively, others are highly polyphagous, attacking a variety different hosts in different ways, depending on the idiosyncrasies of the attacker.

Finally, concise information on marketing margins, particularly at the retail level, is hard to come by. There is therefore a level of uncertainty surrounding the position of the retail demand curve (DR), which may have implications for the model's obtainable level of accuracy.

8. Conclusion

The economics of quarantine policy is indeed an involved area of applied research. This study has attempted to apply the model developed by James and Anderson (1998), designed to evaluate trade restrictions enforced on agricultural commodities as a means of agricultural pest protection, to an interstate trade issue. WA places significant requirements on mangoes imported from the eastern states of Australia, principally the Northern Territory, but to date there have been no economic assessments made of their impact on consumer welfare. The estimates derived here have been calculated by estimating the net welfare loss associated with restricting interstate competition. That is, the difference between the loss in CS resulting from quarantine restricted trade (relative to free trade) and the gain in PS. For the policy to have a zero welfare impact, the results indicate that the potential losses to domestic producer surplus avoided through quarantine protocols must be in the order of $22,250. Considering the presumably low probability of pest entry and establishment and the estimated $757,600 domestic PS, it is difficult to speculate just how "close to the mark" present protocols are. This is not aided by the variability of quantity and price information. Nevertheless, the application of the model to interstate problems provides an insight into the key variables determining policy outcomes, which when combined with pest risk analyses could provide a comprehensive framework for decision-makers.

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9. Bibliography

ABS (1997) Agstats, Australian Bureau of Statistics, Canberra.

Alexander, D. (1987) *The Mango in Australia*, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Melbourne.

Australian Quarantine and Inspection Service (1995) *Import Risk Analysis - Disease Risks Associated with the Importation of Uncooked, Wild, Ocean-Caught Pacific Salmon Product from the USA and Canada*, Draft Report, Department of Primary Industries and Energy, Canberra.

Bigsby, H. (1999) *Quantifying Phytosanitary Barriers to Trade*, Paper Presented at 43rd Annual AARES Conference Pre-Conference Workshop, Christchurch, New Zealand, 19th January 1999.

CIE (1988) *Australian Quarantine: Some Economic Aspects*, Report prepared for the Quarantine Review Committee, Centre for International Economics, Canberra.

DPIE (1996) *Report of the National Task Force on Imported Fish and Fish Products: A Report into the Implications Arising from Aquatic Animal Imports*, Department of Primary Industries and Energy, Canberra.

DPIE (1997) *Australian Quarantine: A Shared Responsibility: The Government Response*, Department of Primary Industries and Energy, Canberra.

FAO (2000) *FAOSTAT Database*, Food and Agriculture Organization of the United Nations, Rome.

Fraser, R.W. (2000) "An Economic Risk Assessment of the Impact on Producers of Removing Quarantine Restrictions", Paper Presented to the 44th Annual Conference of the Australian Agricultural and Resource Economics Society, University of Sydney, Sydney, 23rd-25th January.

GATT (1994) "Agreement on the Application of Sanitary and Phytosanitary Measures", in: *The Results of the Uruguay Round of Multilateral Trade Negotiations: The Legal Texts*, General Agreement on Tariffs and Trade Secretariat, Geneva, pp. 69-84.

Hawkins, A. F. (1994) *A Hedgerow Mango Plantation in Carnarvon*, Information Sheet No. 10/94, Agriculture Western Australia, Carnarvon.

Hinchy, M. D. and Fisher, B. S. (1991) *A Cost-Benefit Analysis of Quarantine*, Australian Bureau of Agricultural and Resource Economics Technical Paper 91.3, Australian Government Publishing Service, Canberra.

Hooker, N. H. and Caswell, J. A. (1999) "A Framework for Evaluating Non-Tariff Barriers to Trade Related to Sanitary and Phytosanitary Regulation", *Journal of Agricultural Economics*, Vol. 50, No. 2, pp. 234-246.

Horticultural Policy Council (1991) *The Impact of Fruit Flies on Australian Horticulture*, Industry Report No. 3, Primary Industries and Energy, Canberra.

Humphrey, J.D. (1995) *Quarantine Policies and Practices for Aquatic Animals and Their Products: A Review for the Australian Quarantine and Inspection Service*, Bureau of Resource Sciences, Canberra.

James, S. (1999) *An Economic Analysis of Quarantine and Food Safety Issues Following the SPS Agreement*, Unpublished Thesis, Adelaide University, Adelaide.

James, S. and Anderson, K. (1998) "On the Need for More Economic Assessment of Quarantine Policies", *Australian Journal of Agricultural and Resource Economics*, Vol. 42, No. 4, pp. 425-444.

Kane, J. (1989) "*Mango Mythunderstandings": An Alternative Strategic Mission for Reaching the Demand Potential of Mangoes on the Australian Domestic Market*, Queensland Department of Primary Industries, Brisbane.

Litz, R. E. (ed.) (1997) *The Mango: Botany, Production and Uses*, Centre for Agriculture and Biosciences (CAB) International, Cambridge.

Mather, D. (ed.) (1992) *Proceedings of a Mango Seminar*, Agriculture Western Australia, South Perth.

Milham, N. and Davenport, S. (1999) *Plant and Animal Health Regulation: Some Competition Policy Issues*, Paper Presented at 43rd Annual AARES Conference Pre-Conference Workshop, Christchurch, New Zealand, 20th-22nd January 1999.

Miller, D. (1999) *WTO: Commonwealth Obligations for State and Territory Quarantine – Measures Affecting International Trade*, Issues Paper, Department of Foreign Affairs and Trade, Canberra.

Nairn, M. E., Allen, P. G., Inglis, A. R. and Tanner, C. (1997) *Australian Quarantine - A Shared Responsibility*, Department of Primary Industries and Energy, Canberra.

Nunn, M. (1997) "Quarantine Risk Analysis", *Australian Journal of Agricultural and Resource Economics*, Vol. 41, No. 4, pp. 559-578.

PMA (1998a) *Fruit Throughput Statistics for 1984/85-1997/98*, Perth Marketing Authority, Canningvale.

PMA (1998b) *Monthly Price Summaries for 1984/85-1997/98*, Perth Marketing Authority, Canningvale.

QDPI (1991) *Mango Pests and Disorders*, Queensland Department of Primary Industries, Brisbane.

Scott, N. (1998) "Market Access Requirements for Queensland Tomatoes", *DPI Note*, Department of Primary Industries, Brisbane.

Sinner, J. (1999) *Cost-Benefit Analysis and the SPS Agreement*, Paper Presented at Workshop on Border Securuty and Risk Analysis, Lincoln, New Zealand, 19th January Standing Committee on Uniform Legislation and Intergovernmental Agreements (1996) *Competition Policy - Consideration of the Implementation of a National Competition Policy*, State Law Publisher, Perth.

Strickland, G. (1992) "Mango Pest Management", In: *Proceedings of a Mango Seminar*, ed. D.

Mather, Agriculture Western Australia, South Perth., pp. 108-115. Tanner, C. (1997) "Principles of Australian Quarantine", *Australian Journal of Agricultural and Resource Economics*, Vol. 41, No. 4, pp. 541-558.

Mather, Agriculture Western Australia, South Perth., pp. 2-18. Varian, H. R. (1992) *Microeconomic Analysis*, 3rd Edition, W. W. Norton and Company, New York.

Tanner, C. and Nunn, M. (1998) "Australian Quarantine Post the Nairn Review", *Australian Journal of Agricultural and Resource Economics*, Vol. 42, No. 4, pp. 545-558.

Toohill, B. (1992) “Update on the Australian and Kimberley Industries”, In: *Proceedings of a Mango Seminar*, ed. D.

WAQIS (1999) *Interstate Quarantine WA: Operations Manual*, Western Australian Quarantine and Inspection Service ‘Control Copy', Agriculture Western Australia, South Perth.

Watson, B. J. (1984) “The Australian Mango Gene Pool Accession Identification”, In: Proceedings of the First Australian Mango Workshop, Cairns, 26th-30th November 1984.

White, K. (1997) *The Mango Industry in Western Australia: A Situation Analysis*, Agriculture Western Australia, South Perth.

Footnotes

[1] The National Task Force on Imported Fish and Fish Products was established in June 1995 to examine issues related to imports of aquatic animals and their products. Particular emphasis was placed on quarantine issues raised in a significant scientific review of aquatic animals health and quarantine (Humphrey (1995)) and the recommendations of a national working party that examined this review (Nunn (1995)) (Tanner and Nunn, 1998).

[2] These included a decision not to establish the Australian Quarantine and Inspection Service (AQIS) as a statutory authority, and another not to establish a centre for quarantine-related risk analyses. In regard to the latter, the government's response indicated that AQIS and the Bureau of Resource Sciences (BRS) would continue to provide risk analysis services (DPIE, 1997; Tanner and Nunn, 1998).

[3] Subsequent ABS surveys of agricultural enterprises are to be conducted at intervals of five years.

[4] Environmental welfare should also be included in the assessment when necessary, if not in a quantitative capacity, qualitatively.

[5] See Hinchy and Fisher (1991).

[6] While this approach may seem simplistic, Fraser (2000) asserts that the impact of risk in determining the net effect of quarantine policies on an industry is relatively minor.

[7] There are around 23 Perth market agents in WA (PMA, pers comm, 23/11/99).

[8] It is conceivable that consumers will switch to rival goods if the pest has a negative impact on “product image”. However, the model ignores this possibility, recalling assumption (3) above.

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