CENTRE of POLICY STUDIES and the IMPACT PROJECT

Eleventh Floor, Menzies Building
Monash University, Wellington Road
CLAYTON Vic 3800 AUSTRALIA

Telephone: (03) 9905 2398, (03) 9905 5112 — from overseas: 61 3 9905 2398 or 61 3 9905 5112

Fax: (03) 9905 2426 — 61 3 9905 2426

e-mail: impact@buseco.monash.edu.au

Internet home page: http//www.monash.edu.au/policy/

# Welfare effects of unilateral changes in tariffs: the case of Motor vehicles and parts in Australia

by

PETER B. DIXON
*Centre of Policy Studies*
*Monash University*

AND

MAUREEN T. RIMMER
*Centre of Policy Studies*
*Monash University*

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**Peter B. Dixon and Maureen T. Rimmer***

**Centre of Policy Studies**
**Monash University**

**September 17, 2008**

## Abstract

**We derive formulas for the optimal tariff rate in four theoretical models. We start with a model in which industries are competitive and then successively allow for: monopoly pricing by export industries; revenue-replacement costs; and cold-shower effects. The theoretical formulas accurately explain results from MONASH, a detailed CGE model. A critical parameter in determining the optimal tariff is the export-demand elasticity. Modellers are often reluctant to adopt empirically justifiable values for export-demand elasticities because such values generate embarrassingly large optimal tariff rates. A way out of this dilemma is the adoption of a non-linear cold-shower specification.**

**JEL classification:** F13, F14 and C68

**Key words:** optimal tariff, export-demand elasticities, cold-shower effect, monopoly pricing, revenue-replacement costs

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**Welfare effects of unilateral changes in tariffs: the case of Motor vehicles and parts in Australia**

**September 17, 2008**

## 1. Introduction

Starting in the 1970s, Australia has followed an ambitious program of unilateral reductions in protection. The majority of imports are now subject to tariffs of no more than 5 per cent. However tariffs of 10 per cent apply to imports of most products in the Motor vehicles and parts (MVP) sector. In 2008, the government commissioned the Bracks Inquiry into the MVP sector. This inquiry received advice from the Productivity Commission recommending continuing reductions in MVP tariffs[1].

There can be no doubt that Australia's initial movements in the 1970s towards free trade were welfare enhancing and that further gains could still be made through multi-lateral and bi-lateral trade agreements. However, it does not follow that unilateral reductions in Australia's remaining protection would enhance welfare. With tariffs at their current low levels, there is a good case for revisiting the optimal tariff argument before acting on the Productivity Commission's advice.

In this paper we set out four versions of the optimal tariff argument. We start with the simplest textbook case[2] and then consider three complications: monopoly pricing of exports; costs of replacing revenue foregone by tariff cuts; and cold-shower effects. For each version, we conduct two types of analysis. First we derive a formula for the optimal tariff in a purely theoretical framework. Second we conduct illustrative simulations with MONASH, a detailed computable general equilibrium (CGE) model.[3] The theoretical analysis leaves out details captured in the CGE model. Nevertheless, for each of the four versions, the theoretical analysis provides an accurate guide or back-of-the-envelope explanation of the CGE results.

The remainder of the paper is organized as follows. The first part of Section 2 introduces the trade-off between efficiency effects and terms-of-trade effects and derives the simplest formula for the optimal tariff rate, as a function of the elasticity of foreign demand for exports. Then we report results of MONASH simulations of the effects of changes in the tariff rates applying to Motor vehicles and parts. In common with the theoretical analysis, the MONASH simulations are conducted under the assumption that firms in Australia's export industries behave in a perfectly competitive manner, treating the price they receive for their products as their marginal revenue. In other words, in making their profit maximising decisions, exporting firms do not take into account reductions in the foreign-currency price of Australian exports associated with increases in export volumes. Section 3 reports MONASH results in which the competitive assumption is relaxed. We develop a new formula for the optimal tariff that explains these results. Section 4 builds on Section 3 by incorporating the costs of raising revenue to replace tariff collections that are lost when tariffs are cut. Again, we conduct MONASH simulations and explain the results via an enhanced formula for the optimal

[1] See Productivity Commission (2008).
[2] See, for example, Kindleberger (1963, Chapter 12) and Caves and Jones (1973, chapter 12).
[3] MONASH is described in Dixon and Rimmer (2002). It has been applied in a large number of studies for governments and businesses. The version used here has 113 industries.

tariff. Section 5 adds cold-shower effects to both the theoretical and simulation analyses of Section 4. Having identified in earlier sections the critical role of export-demand elasticities, in Section 6 we discuss the current state of knowledge concerning these parameters. Concluding remarks are in Section 7.

## 2. Efficiency effects, terms-of-trade effects and the optimal tariff under competitive assumptions

### *2.1 Theory*

The efficiency effect of a tariff cut refers to the change in Australia's ability to consume resulting from the reallocation of a fixed amount of resources (aggregate capital and labour) between different activities. At given f.o.b. prices for exports and c.i.f. prices for imports, reductions in protection allow Australia to save resources by substituting export activities for import-competing activities. The saved resources are then available to produce extra goods thereby enhancing consumption.

The terms-of-trade effect refers to changes in Australia's ability to consume arising from changes in the f.o.b. prices paid by foreigners for Australia's exports relative to the c.i.f. prices paid to foreigners by Australians for imports. With reductions in protection, Australia increases both its exports and imports. Provided that foreigners have downward-sloping demand curves for Australian products and upward-sloping supply curves for the products that they sell to Australia, unilateral cuts in protection by Australia reduce the foreign-currency price of exports and increase the foreign-currency price of imports. This negative movement in the terms-of trade reduces Australia's ability to consume.

In a leading special case in which the demand for imports is a linear function of the landed-duty-paid price, the efficiency effect of a 1 percentage point reduction in the tariff rate applying to a given import is proportional to the initial rate of the tariff. Thus, for example, reducing the tariff rate on Motor vehicles and parts from 80 per cent to 79 per cent has an efficiency effect that is 8 times larger than the efficiency effect of reducing the tariff from 10 per cent to 9 per cent. On the other hand, the terms-of-trade effect is independent of the initial tariff rate. Consequently, in applied work we find that at high tariff rates (e.g. 80 per cent), the favourable efficiency effect of reducing the tariff generally outweighs the unfavourable terms-of-trade effect. On the other hand, at low tariff rates (e.g. 10 per cent), the unfavourable terms-of-trade effect generally outweighs the favourable efficiency effect. This suggests that there is an optimal level for tariff rates at which small reductions generate efficiency gains that are exactly offset by terms-of-trade losses.

In developing the simplest theoretical formula for the optimal tariff, we assume that Australia exports one good and imports another good. The foreign demand curve for the export good is given by

$$E = \left(P_E\right)^{\varepsilon} \tag{1}$$

where

E is the volume of exports,
$\varepsilon < -1$ is the foreign elasticity of demand for exports, and
$P_E$ is the f.o.b. price. For simplicity we will assume that the exchange rate is fixed at 1 so that $P_E$ is both a domestic- and foreign-currency price.

For the import, we assume that Australia's demand is given by

$$M = \left[P_{CIF} * (1+T)\right]^{\eta} \tag{2}$$

where

M is the volume of imports,
$\eta < 0$ is Australia's elasticity of demand for imports,
$P_{CIF}$ is the c.i.f. price of imports, and
T is the tariff rate so that $P_{CIF} * (1+T)$ is the price paid by Australian consumers of imports (the landed-duty-paid price).

Next we adopt the small-country assumption for imports. That is, we treat $P_{CIF}$ as an exogenous variable, determined independently of changes in tariff rates. This seems a reasonable assumption for Australia which accounts for only a small fraction of exports from most countries. Under this assumption, the terms-of-trade effect of a tariff reduction is purely the result of a decrease in export prices associated with an increase in export volumes.[4] There is no additional effect via import prices. With $P_{CIF}$ fixed, we can assume without loss of generality that its value is one. This is convenient because it allows us to drop it from the algebra.

Finally, assume that trade is balanced, i.e.,

$$M = P_E * E \quad . \tag{3}$$

Now change the tariff rate by a small amount $\Delta T$. The change in welfare is:

$$\Delta W = \Delta M * T + \Delta P_E * E \quad . \tag{4}$$

The first term on the RHS of (4) is the efficiency effect. This can be worked out from Figure 2.1 which shows Australia's demand curve from imports as DD. When the tariff is reduced by $\Delta T$ from its initial level of T, imports increase by $\Delta M$. On the assumption that the demand curve reflects values that Australian consumers put on units of imports, the increase in the volume of imports generates a gross benefit worth area ecba. If the price of exports is constant, then Australia must generate extra exports with an f.o.b. value equal to the c.i.f. value of the extra imports, area fgba. We assume that to do this, Australia must divert resources to the production of export goods that were formerly producing consumption goods with that value. Thus, in the absence of a change in the price of exports, the net benefit to Australia of the extra imports, that is the efficiency effect, is area ecgf. In writing this as $\Delta M * T$, we ignore the small triangle cde. The assumption that the resources diverted to export production have an opportunity cost equal to the f.o.b. value of the exports they produce is justified if all industries are purely competitive, there are no externalities and indirect taxes are applied uniformly across the economy. We relax the competitiveness assumption in Section 3.

The second term on the RHS of (4) is the terms-of-trade effect. It takes account of the loss of revenue that Australia suffers through the change in the price of exports.

Using (1) - (3) and substituting into (4) we obtain an expression for $\Delta W$ in terms of $\Delta T$. In deriving the expression we start by totally differentiating (1) - (3):

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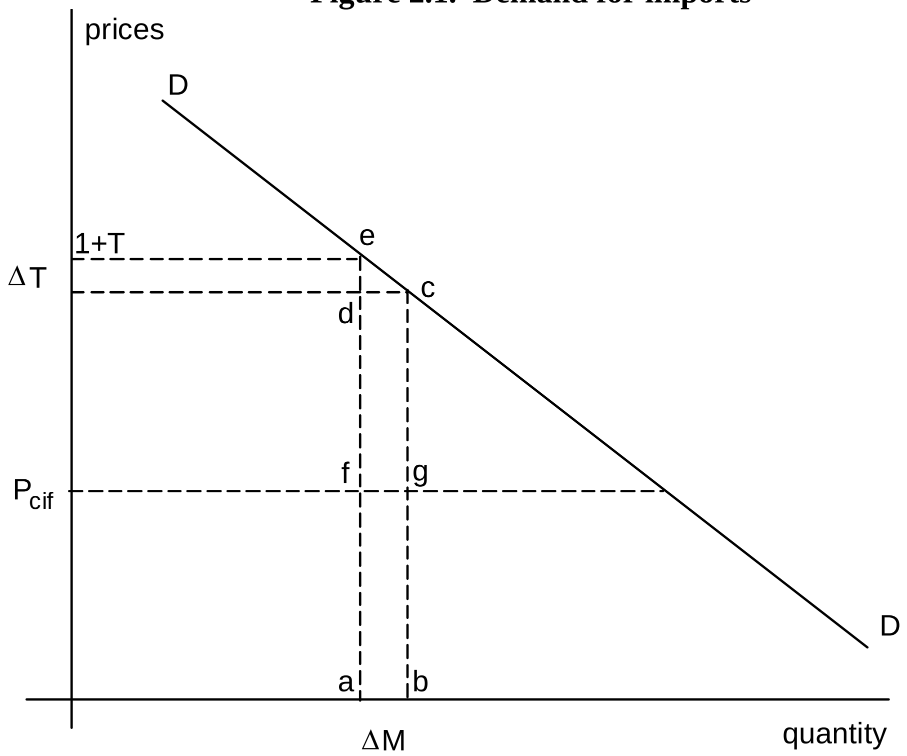
[4] There is a body of literature that emphasises the possibility that a country's tariff cuts, even those by a small country, can increase the c.i.f. prices of its imports, see for example Broda *et al.* (2006). Thus the assumption that terms-of-trade effects flow purely from the export side may be too generous to people who advocate unilateral cuts in tariffs.

**Figure 2.1. Demand for imports**




$$\Delta E = \varepsilon * P_E^{\varepsilon-1} * \Delta P_E \quad , \tag{5}$$

$$\Delta M = \eta * (1+T)^{\eta-1} * \Delta T \quad , \tag{6}$$

$$\Delta M = \Delta P_E * E + P_E * \Delta E \quad . \tag{7}$$

Multiplying (5) by $P_E$ and using (1) gives

$$\Delta E * P_E = \varepsilon * P_E^{\varepsilon} * \Delta P_E = \varepsilon * \Delta P_E * E \quad . \tag{8}$$

Combining (7) and (8) gives

$$\Delta M = \Delta P_E * E * (1+\varepsilon) \quad . \tag{9}$$

Substituting into (4) we obtain[5]

$$\Delta W = \Delta M * T + \Delta M * \left( \frac{1}{1+\varepsilon} \right) \quad . \tag{10}$$

Finally, we combine (6) and (10) to give our desired expression for $\Delta W$:

$$\Delta W = \eta * (1+T)^{\eta-1} * \left( T + \frac{1}{1+\varepsilon} \right) * \Delta T \quad , \tag{11}$$

or equivalently

---

[5] In the special case in which M is a linear function of T (so that $\partial M / \partial T$ is a constant), equation (10) supports the earlier assertion that the efficiency effect (first term on the RHS) of a given small reduction in the tariff is proportional to its initial rate whereas the terms-of-trade effect (second term on the RHS) is independent of the initial rate. Although we do not assume that M is a linear function of T [instead we adopt (2)] the assertion is still a suggestive approximation.

$$\frac{\partial W}{\partial T} = \eta * (1+T)^{\eta-1} * \left( T + \frac{1}{1+\varepsilon} \right) \quad . \tag{12}$$

Because $\eta * (1+T)^{\eta-1}$ must be negative, we can conclude from (12) that increases in the tariff rate from a low level [less than -1/(1+ε)] increase economic welfare but that increases in the tariff rate from a high level [greater than -1/(1+ε)] reduce economic welfare. Thus, the optimal tariff rate is given by

$$T_1^{opt} = -\frac{1}{1+\varepsilon} \tag{13}$$

Figure 2.2 is a sketch of the relationship between W and T given by (12) for the case in which ε = -4 and η = -0.6 and the initial tariff rate is 8 per cent.[6] These values closely mirror standard values in MONASH in which the average over all commodities of the export-demand elasticities is -4, the import demand elasticity for MVP is about -0.6 and the average tariff rate applying to imports of MVP is 8 per cent.

***2.2. MONASH simulations***

We conduct four series of MONASH simulations of the long-run effects of changes in the tariff applying to MVP. As shown in Table 2.1, the series differ with respect to assumptions concerning: (a) the substitution elasticity between domestically produced and imported MVP products; and (b) the average across all products of the value of the foreign-demand elasticity for Australian exports. The series-1 elasticity values are the standard values used in MONASH simulations for the Productivity Commission[7] and other users of the model. In the other series of experiments we investigate the effects of much larger elasticities.

Figure 2.3 shows results from the four series for the effects of MVP tariff changes on private and public consumption (which are assumed to move together). The model is set up in a simple way with aggregate employment, aggregate capital, aggregate investment, industry technologies and the balance of trade held fixed. Under these assumptions, the movement in consumption is a legitimate measure of the overall welfare effect of the tariff changes. It reflects the efficiency effect and the terms-of-trade effect.

The figure shows the effects of moving MVP tariffs away from their present levels which average 8, see Table 2.2. Our modelling recognizes that this average reflects different rates applying to different countries of supply. Consistent with Table 2.2, we allowed for three sources of supply: one which supplies at zero tariff; one which supplies at 5 per cent tariff; and one which supplies at 10 per cent tariff. In the movements away from this initial situation, we assume that MVP tariffs are equalized, at zero per cent, at 8 per cent, at 16 per cent, at 20 per cent etc.

The theoretical argument in Subsection 2.1 suggests that economic welfare is maximized when tariff rates are set according to (13). This formula gives an optimal tariff rate of 33 per cent if ε = -4 and 14 per cent if ε = -8. As can be seen from Figure 2.3, our results are highly consistent with this elementary theory.

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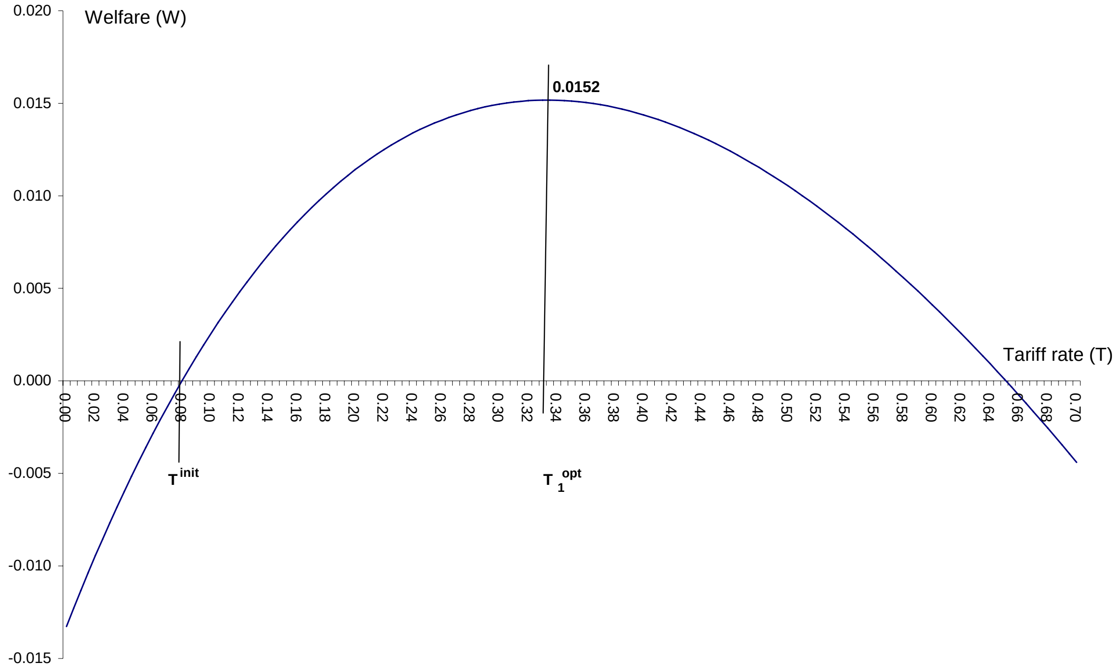
[6] An explicit formula for W as a function of T can be obtained by integrating (12) by parts.

[7] See for example Industry Commission (1996, 1997) and Centre of Policy Studies (2003).

**Figure 2.2. Welfare effect of moving the tariff on imports away from 8 per cent in the theoretical model with ε = -4 and η= -0.6**




In interpreting the numbers on the vertical axis, it is useful to recognise that the c.i.f. value of imports in the simple model is initially 0.955 (= $1.08^{-0.6}$). The gain from moving from the initial tariff of 0.08 to the optimal tariff of 0.333 is 0.0152, that is 1.59 per cent of the initial c.i.f. value of imports (= 100*0.0152/0.955). In MONASH, imports of MVP are worth 2.1 per cent of GDP. Therefore we would expect the welfare gain in MONASH from moving to the optimal tariff for MVP to be about 1.59 per cent of 2.1 per cent of GDP, that is 0.0334 per cent of GDP. Public and private consumption is about 80 per cent of GDP. Thus we would expect the consumption gain to be about 0.042 per cent (= 0.0334/0.8). This is close to the MONASH result for series 1 in Figure 2.3.

**Table 2.1. MONASH simulations: elasticity assumptions**

| | Domestic/import MVP substitution elasticity* | Average export-demand elasticity over all products |
|---|---|---|
| Series 1 | 5.2 | -4 |
| Series 2 | 10.4 | -4 |
| Series 3 | 5.2 | -8 |
| Series 4 | 10.4 | -8 |

* The import demand elasticity (η) is approximately proportional to the substitution elasticity. With the substitution elasticity at 5.2, MONASH behaves as if the import demand elasticity is about -0.64 and with the substitution elasticity at 10.4, MONASH behaves as if the import demand elasticity is about -1.28. These may seem surprisingly low (close to zero) price elasticities. However, a large part of Australia's MVP imports are used without much domestic competition as inputs to the MVP industry.

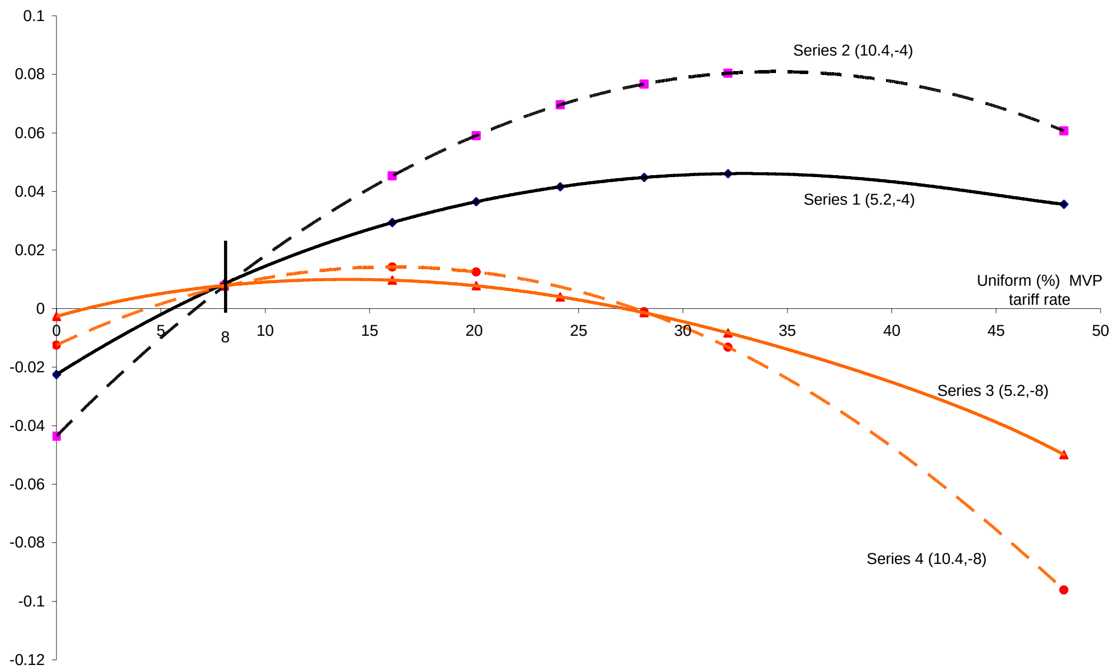
**Table 2.2. Tariff rates for MVP imports, 2005+**

| | Tariff rate (%) | Per cent of MVP c.i.f. imports |
|---|---|---|
| | 0 | 3.7* |
| | 5 | 31.7 |
| | 10 | 64.5 |
| Average | 8 | |

\+ Derived from data extracted by the Productivity Commission from World Integrated Trade Solutions.

* Includes a very small amount of imports with tariff rate of 2.5 per cent.

**Figure 2.3. MONASH simulations: percentage effects on consumption of moving MVP tariff rates away from their present levels (averaging 8)**




Other prominent features of the results are:

(a) that there are consumption gains at the tariff rate of 8. These arise from equalizing the tariff rates, thereby eliminating distortions in Australia's choice between foreign suppliers.

(b) that the substitution elasticity plays an accentuating role. With a larger substitution elasticity (10.4 instead of 5.2) tariff movements cause larger changes in MVP imports and thus (via the balance of trade assumption) larger changes in exports. This accentuates both the terms-of-trade and the efficiency effects of tariff movements.

(c) that with a higher export-demand elasticity (-8 rather than -4), the gains from moving even to the optimal tariff are small and the losses from moving to high tariffs can be significant. This is because at any given tariff rate a higher export-demand elasticity reduces the positive terms-of-trade effect without affecting the negative efficiency effect.

(d) that the welfare effects of reducing tariffs are moderate. All four series show negative effects from equalizing the MVP tariffs at zero but the largest of these negative effect is only -0.04 per cent or about \$320m, occurring in series 2.

## 3. The implications of non-competitive export behaviour

### *3.1. Theory*

When we cut MVP tariffs, the extra imports must be paid for via extra exports of minerals, agricultural products, etc. A fundamental assumption of the theoretical analysis in Subsection 2.1 is that the resources used to produce extra exports have an opportunity cost equal to the f.o.b. value of the extra exports. However, this may not be a satisfactory simplification. Consider, for example, the situation in which exports are taxed by the exporting country. In this case, the f.o.b. value of the extra exports will be greater than the opportunity cost of the resources used to produce them, and our analysis is Section 2 will underestimate the net benefit to Australia of extra imports.

In the Australian case, export taxes are not a major consideration. However, export taxes are not the only possible reason for supposing that the opportunity cost of resources used in additional exporting might be less than the f.o.b. value of the exports. Corden (1997, pp. 89-90) draws attention to the potential role of non-competitive behaviour by exporters. For example, assume that Australian exporters of a given commodity are able to organize themselves so as to maximise industry profits. With the foreign elasticity of demand for their product being $\varepsilon$, they will set their export price ($P_E$) according to the formula:[8]

$$\frac{P_E}{MC} = \frac{\varepsilon}{1+\varepsilon} \quad , \tag{14}$$

where MC is their marginal cost of production. For long-run analysis it is reasonable to suppose that marginal costs are equal to average costs, leading to:

$$AC = \frac{1+\varepsilon}{\varepsilon} * P_E \quad . \tag{15}$$

With AC representing the opportunity cost of a long-run unit expansion of exports, equation (15) implies that the value of consumption that must be given up to divert resources to production of extra exports is the fraction $(1+\varepsilon)/\varepsilon$ of the f.o.b. value of the extra exports. Thus, for example, if $\varepsilon = -4$, then extra exports with an f.o.b. value of \$1 will absorb resources with a value of only \$0.75 in alternative uses. Put another way, if (15) is applicable, then the fundamental assumption of Subsection 2.1 (that resources used to produce extra exports have an opportunity cost equal to the f.o.b. value of the extra exports) generates an over-estimation of the welfare cost of extra exports worth $1/(-\varepsilon)$ times their f.o.b. value.

We doubt that monopolistic profit-maximizing behaviour of the type leading to (15) is a realistic description of pricing in Australia's agricultural, manufacturing and service industries. For mining though, it may be more applicable. In any case, where S

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[8] The industry will set its price and quantity so that marginal revenue (MR) equals marginal cost (MC). Under (1), the industry's revenue, $P_E$*E, is equal to $E^{(1+1/\varepsilon)}$. From here we find that

$$MR = (1+1/\varepsilon)*E^{1/\varepsilon} = \frac{1+\varepsilon}{\varepsilon}*P_E$$ , quickly leading to (14).

is the share of Australian exports in which monopoly pricing applies, we can take account of this behaviour in our theoretical analysis by adding a term to equation (4):

$$\Delta W = \underset{\textit{efficiency effect}}{\Delta M * T} \quad + \quad \underset{\textit{terms-of-trade effect}}{\Delta P_E * E} \quad + \quad \underset{\textit{monopoly correction}}{\Delta E * P_E * \left(\frac{S}{-\varepsilon}\right)}. \tag{16}$$

The additional term in (16) corrects for over-estimation in (4) of the opportunity cost of resources used to generate extra exports.

Using (5) - (7) and (1) we can derive from (16) a new expression for $\partial W/\partial T$:

$$\frac{\partial W}{\partial T} = \eta * (1+T)^{\eta-1} * \left(T + \frac{1-S}{1+\varepsilon}\right) , \tag{17}$$

implying that the optimal tariff rate in the monopoly-pricing model, $T_2^{opt}$, is

$$T_2^{opt} = -\left(\frac{1-S}{1+\varepsilon}\right) . \tag{18}$$

Equation (18) implies that monopoly export pricing (S > 0) reduces the optimal tariff. It is also clear from (17) that at any value of T the recognition of monopoly pricing reduces $\partial W/\partial T$. Thus we would expect the introduction of monopoly pricing to cause the W-T curve to peak at a lower value for W.

In Figure 3.1 we have sketched the relationships between W and T given by (12) and (17) for the case in which ε = -4 and η = -0.6. As in Figure 2.2, we have assumed that the starting tariff rate is 8 per cent. For relationship (17) we have assumed that S = 0.267. This is the share of Australia's exports accounted for by mining in the database for the MONASH model. As can be seen from Figure 3.1, the introduction of monopoly pricing causes the W-T curve to shrink to the south west.

### *3.2. MONASH simulations with monopoly pricing for mining*

We conduct two series (5 and 6, Table 3.1) of MONASH simulations of the long-run effects of changes in MVP tariffs with monopoly pricing applying to Australia's mining industries. In both series, export-demand elasticities average -4 over all commodities and are exactly -4 for the commodities in which monopoly export pricing applies. We do not report monopoly series for ε = -8: at this value monopoly power has little impact on the welfare effects of tariff changes.

Results from series 5 and 6 are given in Figures 3.2 and 3.3. To assist comparison, these figures also show earlier results from series 1 and 2. As expected on the basis of our theoretical analysis, the introduction of monopoly pricing for mining exports causes the W-T curves to shrink towards the south west. In both series 5 and 6 the optimal tariff is quite close to the value implied by the theoretical formula (18), 24.4 per cent.

## 4. The implications of dead-weight losses in revenue collection

### *4.1. Theory*

Cuts in tariffs cost the government revenue. In Sections 2 and 3 we have implicitly assumed that this revenue is replaced in a way that causes no further *net* welfare-affecting distortions beyond those concerned with the allocation of resources between export and import-competing activities. We have ignored distorting effects of both

**Figure 3.1. Welfare effect of moving the tariff away from 8 per cent in two versions of the theoretical model with ε = -4 and η= -0.6**

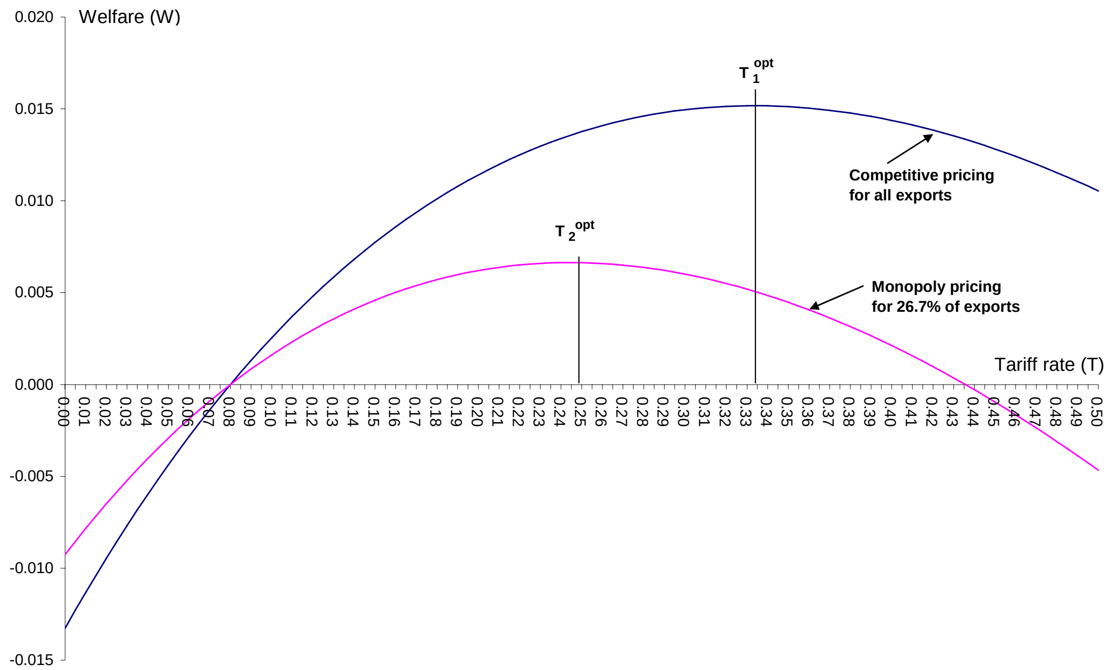



**Table 3.1. MONASH simulations: elasticity and competitiveness assumptions**

| | Competitiveness of Australian exporters | Domestic/import MVP substitution elasticity | Average export-demand elasticity over all products |
|---|---|---|---|
| Series 5 | Mining industries monopolistic, others competitive | 5.2 | -4 |
| Series 6 | Mining industries monopolistic, others competitive | 10.4 | -4 |

tariffs and replacement taxes on incentives to work (labour-leisure choice) and on resource-consuming avoidance and evasion activities. Ignoring these effects would be justified if we were confident that the distortion-reducing effect of raising \$x less revenue from tariffs is balanced by the distortion-increasing effect of raising \$x more revenue via the replacement tax. However, we cannot be confident about this.

In the MONASH simulations reported earlier we assumed that replacement of lost tariff revenue is achieved by an across-the-board increase in income-tax rates. Research by Freebairn (1995), Campbell and Bond (1997) and others suggests that income taxes may, at the margin, impose deadweight losses worth 20 to 30 per cent of revenue raised.[9] That is, if we raise \$1 of extra revenue via an across-the-board increase in income tax rates, then the welfare of households is reduced by an amount that is equivalent to what would happen with the imposition of a poll tax (distortion free) of between \$1.20 and \$1.30.

[9] Numbers such as these are also mentioned in popular discussions, see for example Kerin (2008).

**Figure 3.2. MONASH simulations under different assumptions for export pricing, series 1 and 5: percentage effects on consumption of moving MVP tariff rates from their present levels**

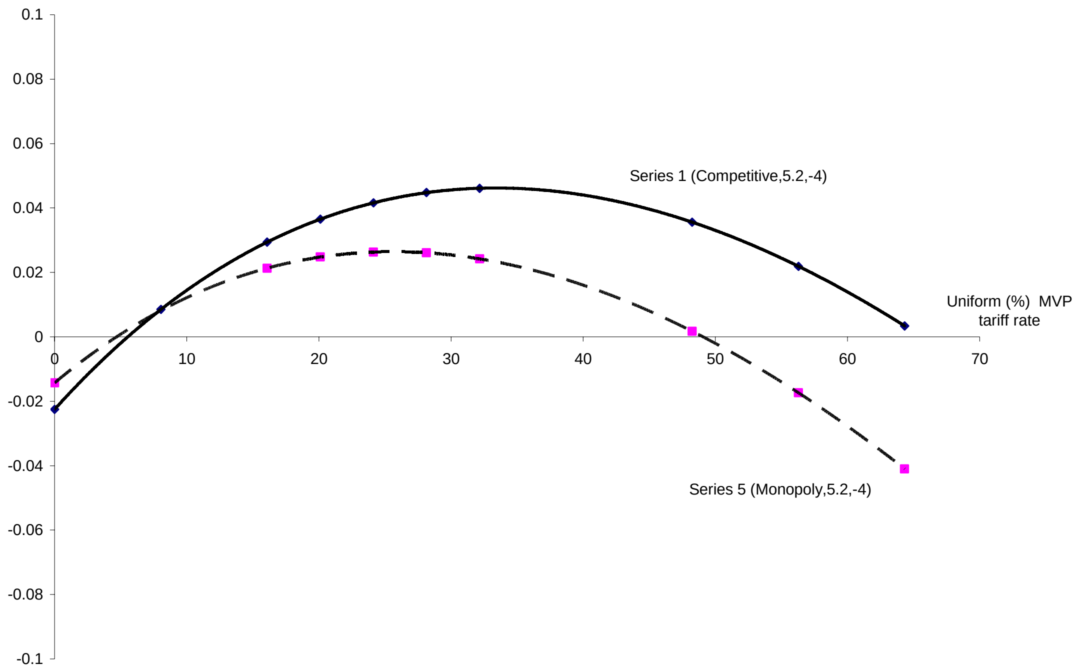
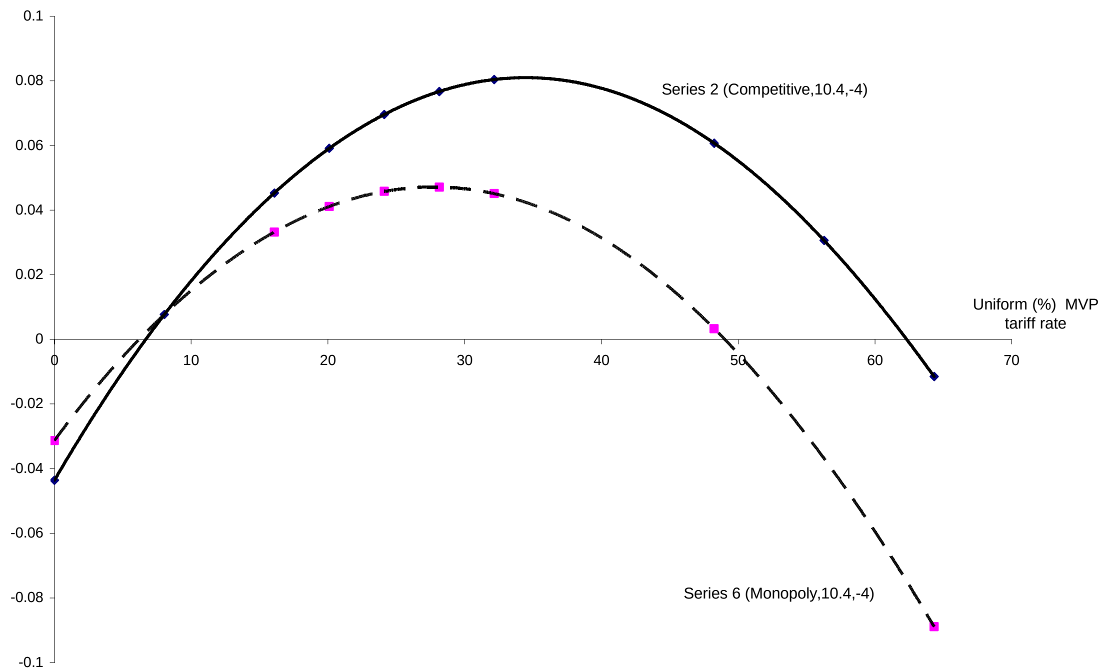



**Figure 3.3. MONASH simulations under different assumptions for export pricing, series 2 and 6: percentage effects on consumption of moving MVP tariff rates from their present levels**



We know of no Australian estimates of the marginal deadweight losses (beyond trade-distorting effects) of tariff revenue. Sources of deadweight loss that come to mind are that increased tariff rates could induce resource-using smuggling efforts or efforts to avoid/evade tariffs by redirecting imports through countries having an FTA with Australia. However, for low tariffs such as the current MVP tariffs, we suspect that non-trade-related distorting effects are low.

To help us speculate about the potential importance of revenue replacement, we extend the algebra of Subsection 3.1 by assuming that the difference between the marginal deadweight loss of revenue raised via an across the board increase in income-tax rates and the marginal deadweight loss (beyond trade-distorting effects) of revenue raised via tariffs is D.[10] Then (16) becomes

$$\Delta W = \underbrace{\Delta M * T}_{\textit{efficiency effect}} + \underbrace{\Delta P_E * E}_{\textit{terms-of-trade effect}} + \underbrace{\Delta E * P_E * \left(\frac{S}{-\varepsilon}\right)}_{\textit{monopoly correction}} + \underbrace{D * \Delta(T * M)}_{\textit{revenue-replacement cost}} \tag{19}$$

The additional term recognises that replacement of the lost tariff revenue imposes a deadweight loss of D times the lost revenue. With (19) replacing (16), we can quickly rework the algebra of Subsections 2.1 and 3.1 to obtain

$$\frac{\partial W}{\partial T} = \eta * (1+T)^{\eta-1} * \left( T * \left[1 + D * (1+\eta)/\eta\right] + \frac{1-S}{1+\varepsilon} + \frac{D}{\eta} \right) \ . \tag{20}$$

In interpreting (20), it is reasonable to restrict attention to situations in which

$$\eta < \frac{-D}{1+D} \ . \tag{21}$$

This condition is comfortably met if D is between 0 and 1 and $\eta$ = -0.64 or -1.28 as assumed for MVP imports in the MONASH simulations. Under (21), $\left[1 + D * (1+\eta)/\eta\right] > 0$. Recalling that $\eta * (1+T)^{\eta-1}$ is negative, we can conclude from (20) that the optimal tariff rate in the theoretical model with both monopoly export pricing and revenue-replacement costs, $T_3^{opt}$, is

$$T_3^{opt} = \left[ -\left(\frac{1-S}{1+\varepsilon}\right) - \frac{D}{\eta} \right] \Big/ \left[1 + D * (1+\eta)/\eta\right] \tag{22}$$

Assuming that D > 0 (that is, apart from trade distortions tariffs are a relatively benign tax) then (20) implies that the recognition of the cost of replacement taxes in our analysis raises the value of $\partial W / \partial T$ at all values of T, raises the optimal tariff, and moves the W-T relationship in a north-easterly direction.[11] In Figure 4.1 we have sketched the relationships between W and T given by (12), (17) and (20) for the case in which $\varepsilon$ = -4, $\eta$ = -0.6, S = 0.267, the starting tariff is 8 per cent and D is set at a

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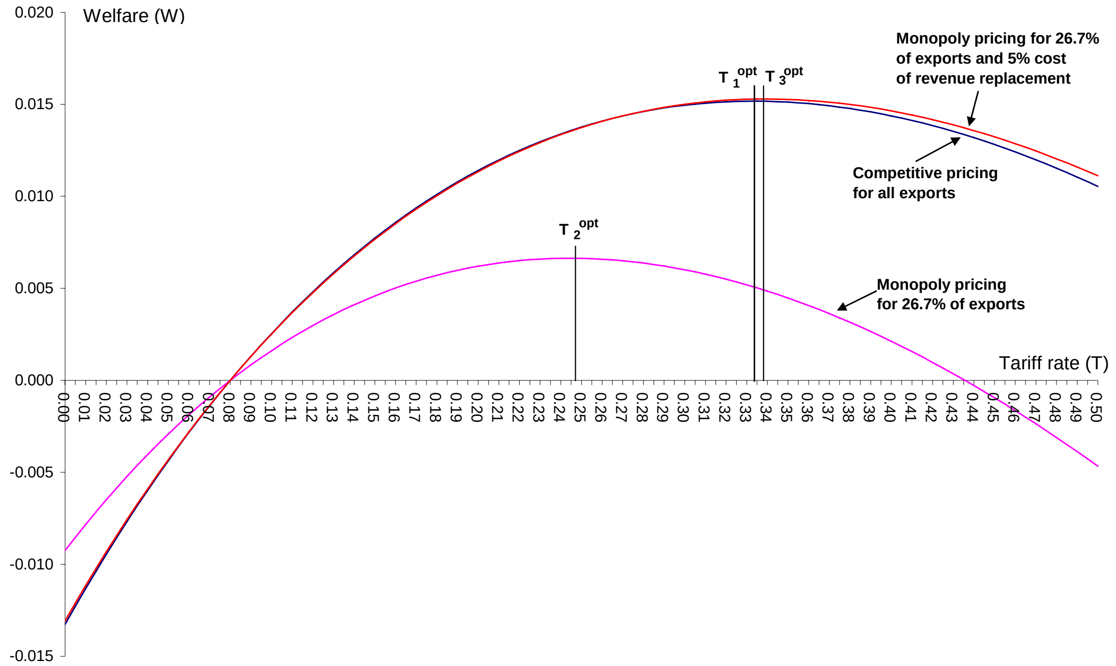
[10] We treat D as a parameter. Ideally, we should allow D to fall as the tariff rate rises and the rate of the replacement tax falls. We have omitted this complication because: (a) we focus on what seems to be a very low value of D (0.05); and (b) we are concerned mainly with the effects of tariff changes around their present value.

[11] From (20), $\partial^2 W / \partial D \partial T = (1+T)^{\eta-1} * [T*(1+\eta)+1]$. For relevant values of T and $\eta$, (say T<0.5 and $\eta$>-3) $\partial^2 W / \partial D \partial T > 0$. Thus, introducing a positive value for D increases $\partial W / \partial T$ at all relevant values of T.

**Figure 4.1. Welfare effect of moving the tariff away from 8 per cent in three versions of the theoretical model with ε = -4 and η= -0.6**




seemingly moderate value of 0.05. With this setting for D, we are assuming that the marginal deadweight loss of collecting \$1 from income taxes is only 5 cents higher than marginal deadweight loss (apart from trade distortions) of collecting \$1 from tariffs.

A final noteworthy implication of assuming that D > 0 is that the optimal tariff can be significantly above zero even if the export-demand elasticity is very large in absolute size (the small country case). For example, if $\varepsilon = -\infty$, η = -0.6 and D = 0.05, then for any value of S, (22) gives the optimal tariff as 8.6 per cent.

### *4.2. MONASH simulations with monopoly pricing and costs of revenue replacement*

To illustrate the potential effects of deadweight losses associated with replacement of lost tariff revenue, we modified the MONASH model by adding an equation specifying a reduction in economy-wide total-factor productivity of 5 per cent of the change in tariff revenue. In terms of the algebra in Subsection 4.1, we set D at 0.05. As mentioned earlier, we think this is a conservative assumption when replacement is done by an across-the-board change in income-tax rates.

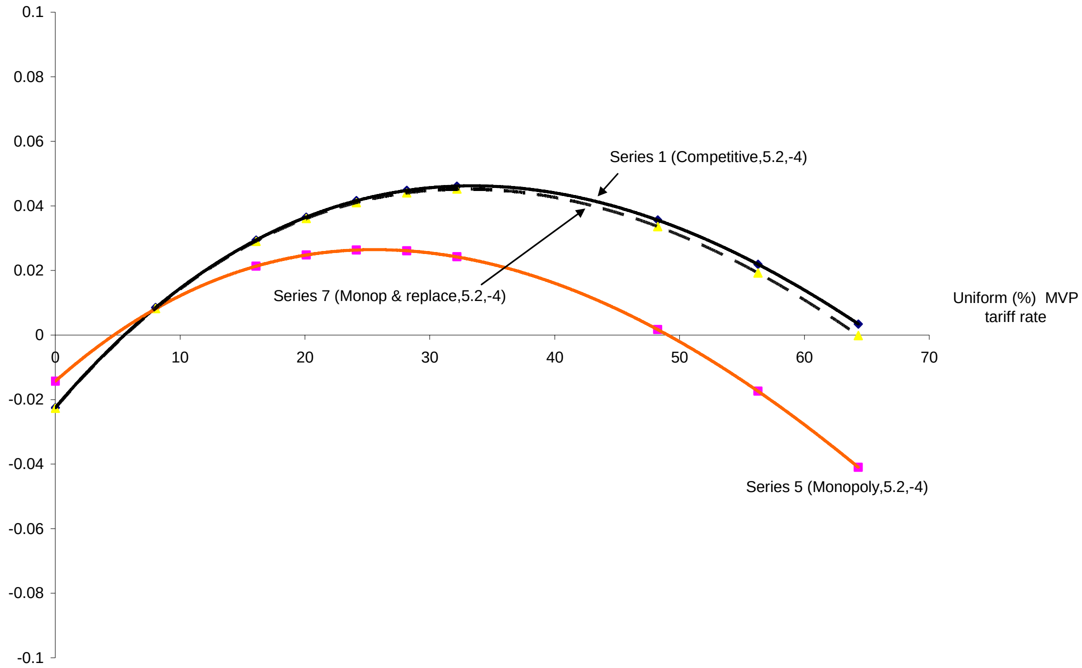
With this modification in place, we ran two additional series of MONASH simulations, see Table 4.1. Results from these additional simulations together with those from earlier simulations are shown in Figures 4.2 and 4.3.

The inclusion of revenue-replacement costs in the MONASH simulations has the effects that could be anticipated on the basis of the theory in Subsection 4.1. In each case, revenue-replacement costs move the W-T curve to the north east. In Figure 4.2, revenue-replacement costs happen to approximately offset the effects of monopoly pricing in mining, so that the W-T curve for series 7 is close to that for series 1 (the simplest simulation, without monopoly or revenue-replacement costs). In Figure 4.3, the inclusion of revenue-replacement costs has a less pronounced effect on the W-T curve

**Table 4.1. MONASH simulations: elasticity, competitiveness and revenue-replacement assumptions**

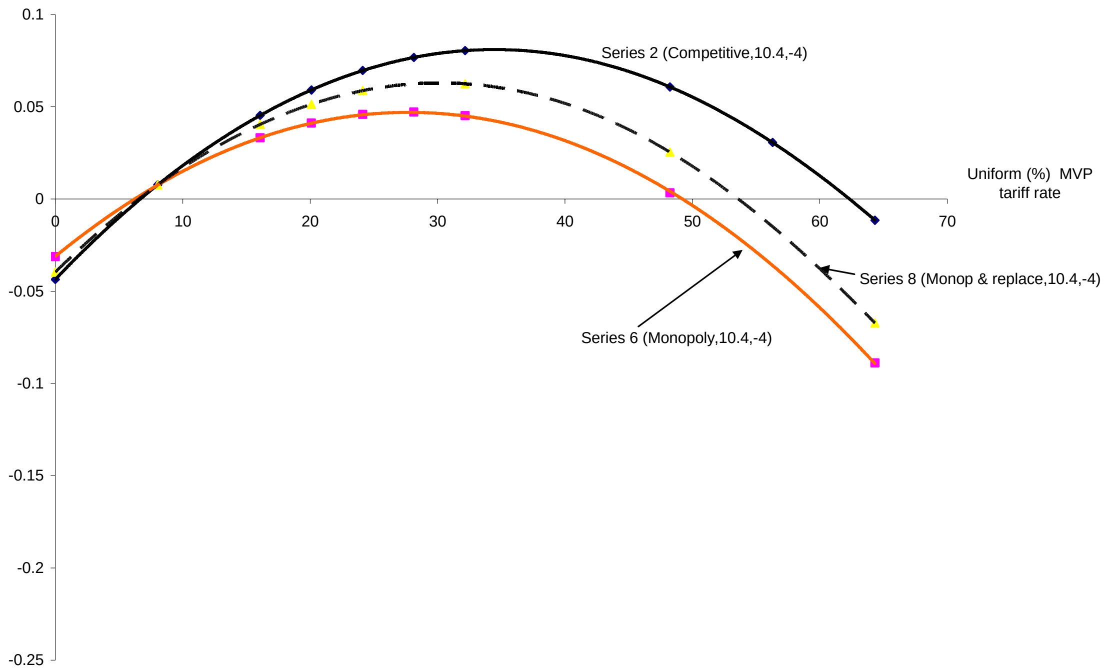
| | Revenue replacement cost (D) | Competitiveness of exporters | Dom/imp MVP substitution elasticity | Ave. export-demand elasticity |
|---|---|---|---|---|
| Series 7 | 0.05 | Mining monopolistic | 5.2 | -4 |
| Series 8 | 0.05 | Mining monopolistic | 10.4 | -4 |

**Figure 4.2. MONASH simulations under different assumptions for export pricing and revenue-replacement costs, series 1, 5 and 7: percentage effects on consumption of moving MVP tariff rates from their present levels**




than it had in Figure 4.2. With a higher demand elasticity for MVP imports, increases in tariff rates generate smaller increases in tariff revenue. Consequently as we move from series 7 in Figure 4.2 to series 8 in Figure 4.3, increases in tariffs have less advantage in terms of providing revenue with low avoidance and incentive costs.

**Figure 4.3. MONASH simulations under different assumptions for export pricing and revenue-replacement costs, series 2, 6 and 8: percentage effects on consumption of moving MVP tariff rates from their present levels**




## 5. Adding the cold-shower effect

### *5.1. Theory*

The cold-shower hypothesis is that inputs to import-competing industries are used more productively if tariffs are low than if they are high. It is difficult to set out a formal behavioural model that supports this hypothesis.[12] Nevertheless, it seems plausible that exposure to import competition could induce an industry to improve its management practices, to produce products more in line with customer preferences, to modernize its production processes, and to become generally more amenable to innovative ideas. While the underlying theory remains a little vague, the hypothesis has considerable empirical support, see for example Chand *et al.* (1998), Chand (1999), Bloch and McDonald (2002), Palangkaraya and Yong (2007).

We think the hypothesis makes most sense in a non-linear form. In this section we investigate the implication of the following specification:

$$CS = \alpha * T^2 \tag{23}$$

where

T is the tariff rate expressed as a fraction;

$\alpha$ is a positive parameter; and

---

[12] A notable success along these lines is Melitz (2003). He produces a theoretical model in which an import-competing industry is specified as monopolistically competitive. Each firm has a productivity level that is randomly selected at the beginning of its life. Firms with different productivities are able to survive because they produce differentiated products. However, reductions in tariffs drive out the low-productivity firms whose products are replaced largely by imports. In this way, tariff cuts increase productivity in the industry.

CS, the cold-shower effect, is the tariff-related wastage of resources in an import-competing industry expressed as a fraction of the resources used. Thus, for example, if $\alpha$ = 0.24 and the industry is protected by a tariff of 60 per cent, then (23) means that adoption of best practice by the industry (practice that is adopted if the tariff is zero) would allow the industry to increase the output from the resources it is using by 8.6 per cent (= $100*0.24*0.6^2$). On the other hand, if the industry is protected by a tariff of 30 per cent, then its resource wastage is only 2.2 per cent [ = $100*0.24*0.3^2$].

Underlying our choice of a non-linear specification such as (23) is the idea that there are diminishing returns to import penetration in imposing competitive discipline on an import-competing industry. We think it is reasonable to suppose that when imports take their first 20 per cent of the domestic market, then this encroachment will cause much greater reforms among domestic producers than when imports take the next 20 per cent. The first 20 per cent will eliminate the most easily removed slack practices by domestic producers, making further reforms to meet import competition successively more difficult.

Under (23), we can expand the definition given in (19) for the change in welfare caused by a change in the tariff rate to include the cold-shower effect:

$$\Delta W = \underbrace{\Delta M * T}_{efficiency} + \underbrace{\Delta P_E * E}_{terms\text{-}of\text{-}trade} + \underbrace{\Delta E * P_E * \left(\frac{S}{-\varepsilon}\right)}_{monopoly\ correction} + \underbrace{D * \Delta(T * M)}_{revenue\text{-}replacement} - \underbrace{\Delta(\alpha * T^2 * V)}_{cold\text{-}shower} \qquad (24)$$

where V is the quantity of resources devoted to the import-competing activity.

Before we can use (24) we need to deal with two issues: the determination of a value for $\alpha$ and the specification of the behaviour of V.

In determining $\alpha$, we draw on the work of Chand *et al.* (1998). Their econometrics covers the period 1968/9 to 1994/5. In a panel study, they found that a one percentage point reduction in a typical manufacturing industry's tariff rate caused a 0.15 per cent increase in the industry's productivity.[13] During the period tariff rates for individual industries varied over the range from 1 per cent (for chemicals in 1994/5) to 62 per cent (for TCF in 1985/6).[14] We interpret this as meaning that

$$\frac{CS(0.62) - CS(0.01)}{62 - 01} = 0.0015 \ , \qquad (25)$$

that is, as the tariff rate falls by 61 percentage points (from 62 per cent to 1 per cent), productivity improves per percentage point of tariff reduction by the fraction 0.0015. Substituting from (23) into (25) gives

$$\frac{\alpha * \left(0.62^2 - 0.01^2\right)}{62 - 1} = 0.0015, \qquad (26)$$

generating $\alpha$ =0.24.

---

[13] Chand *et al.* (1998) also give results for individual sectors. However, we prefer to use their overall result for manufacturing. We see no reason to suppose that MVP productivity is related to the MVP tariff by a different function than that for other manufacturing industries.

[14] See Industry Commission (1995) and Productivity Commission (1998). These sources show separate tariff rates for Textiles and for Clothing & footwear. Chand *et al.* (1998) dealt with the aggregate sector TCF. In calculating TCF tariff rates we have taken an output weighted average of the rates applying to Textiles and to Clothing & footwear.

In specifying V, we assume that

$$V = R - M \ , \tag{27}$$

where M is the quantity of imports and R is the economy's requirement for the importable commodity. This requirement can be satisfied by domestic production or imports. For simplicity we will assume that R is fixed and that reductions in imports caused by tariff increases translate directly into increases in resources devoted to import-competing activities. In our numerical calculations we assume that the value for R is twice the initial value ( $\bar{M}$ ) for M, that is

$$R = 2 * \bar{M} \ , \tag{28}$$

implying that imports initially satisfy half the demand for the importable product. This is approximately the case for Australia's imports of MVP. From (2) we can evaluate R as

$$R = 2 * (1 + \bar{T})^{\eta} \ , \tag{29}$$

where $\bar{T}$ is the initial tariff rate.

Using (27) we can rewrite (24) as

$$\begin{aligned} \Delta W = \ & \Delta M * T \ + \ \Delta P_E * E \ + \ \Delta E * P_E * \left( \frac{S}{-\varepsilon} \right) \ + \ D * \Delta(T * M) \\ & - \alpha * 2 * T * (R - M) * \Delta T + \alpha * T^2 * \Delta M \end{aligned} \tag{30}$$

From here we can follow steps similar to those used in deriving (12), (17) and (20) to obtain

$$\frac{\partial W}{\partial T} = \left(1 + T\right)^{\eta - 1} * \left(a * T^2 + b * T + c\right) - 2\alpha R * T \tag{31}$$

where

$$a = \alpha\left(\eta + 2\right) \ , \tag{32}$$

$$b = \eta * \left( 1 + D + \frac{D}{\eta} + \frac{2\alpha}{\eta} \right) \ \text{, and} \tag{33}$$

$$c = \eta * \left( \frac{1 - S}{1 + \varepsilon} + \frac{D}{\eta} \right) \ . \tag{34}$$

The optimal tariff, $T_4^{opt}$, can be computed by equating (31) to zero and solving for T.

In Figure 5.1 we use (31) to trace out the effects on welfare of moving the tariff away from 8 per cent in the model incorporating the cold-shower effect.[15] The elasticity of demand for imports ($\eta$) is set at -0.6, the elasticity of demand for exports ($\varepsilon$) is set at -4 and R is set according to (29). To aid comparison, the figure includes results from the three previous versions of the theoretical model. The optimal tariff rates for all versions with various values of export and import-demand elasticities are recorded in Table 5.1.[16]

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[15] W can be expressed as an explicit function of T by applying integration by parts twice. Details are available from the authors.

[16] To aid comparability between cells in Table 5.1, we fix R at $2*1.08^{-0.6}$ even when we change $\eta$ from -0.6 to -1.2.

**Figure 5.1. Welfare effect of moving the tariff away from 8 per cent in four versions of the theoretical model with ε = -4 and η= -0.6**

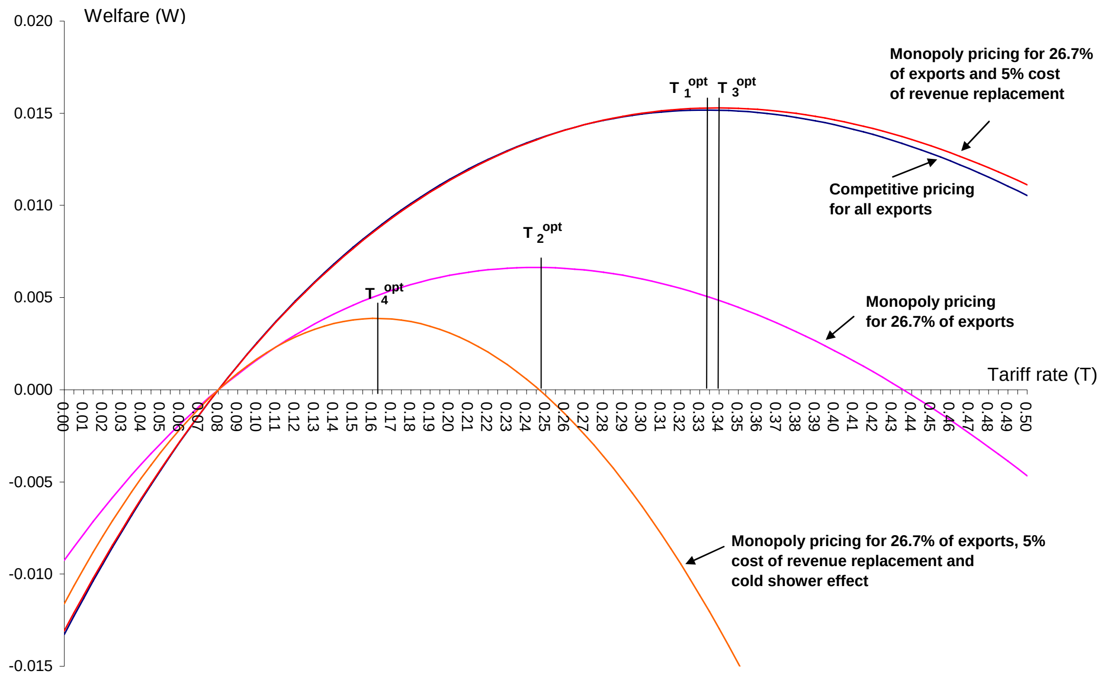


**Table 5.1. Optimal tariff rates (per cent) in theoretical models**

| | | | | |
|---|---|---|---|---|
| Import demand elasticity (η) | -0.6 | -0.6 | -1.2 | -1.2 |
| Export demand elasticity (ε) | -4 | -8 | -4 | -8 |
| ***Model:*** | | | | |
| 1. Competitive *(Subsection 2.1)* | 33.3 | 14.3 | 33.3 | 14.3 |
| 2. Monopoly for 26.7% of exports *(Subsection 3.1)* | 24.4 | 10.5 | 24.4 | 10.5 |
| 3. Monopoly for 26.7% of exports and 5% revenue-replacement costs *(Subsection 4.1)* | 33.9 | 19.5 | 28.4 | 14.5 |
| 4. Monopoly for 26.7% of exports, 5% replacement costs and cold shower *(Subsection 5.1)* | 16.2 | 9.8 | 17.1 | 9.5 |

Figure 5.1 and Table 5.1 show that the cold-shower effect strongly influences the optimal tariff rate. With our non-linear specification, the cold-shower effect is significant at high tariff rates. Thus its inclusion sharply reduces optimal tariff rates (compare results for models 3 and 4 in Table 5.1). As in earlier versions, the optimal tariff rate in the model with the cold-shower effect is *sensitive* to the export-demand elasticity (compare the first column of results in Table 5.1 with the second column, and

the third with the fourth). Also, as in earlier versions, the optimal tariff rate in the cold-shower version is relatively *insensitive* to the import-demand elasticity (compare the first column with the third column, and the second with the fourth).

### *5.2. MONASH simulations with monopoly pricing, costs of revenue replacement and cold-shower effect*

We conduct four series of MONASH simulations (series 9 to 12, Table 5.2) which include a cold-shower effect introduced for the MVP industry by an equation of the form (23) with $\alpha$ set at 0.24. Results are in Figures 5.2 and 5.3.

Consistent with our theoretical model, Figures 5.2 and 5.3 show:

(a) optimal tariff rates for the cold-shower simulations close to those in the last row of Table 5.1: about 17 per cent when the export-demand elasticity is -4 (series 9 and 10); and about 10 per cent when the export-demand elasticity is -8 (series 11 and 12).

(b) optimal tariff rates are relatively insensitive to the value of the import-demand elasticity.

(c) the optimal tariff rate is sharply reduced by the introduction of the cold-shower effect (compare series 9 with series 7 in Figure 5.3).

## 6. What do we know about export-demand elasticities for Australia?

The analysis in Sections 2 to 5 shows that export-demand elasticities are key parameters in the determination of the welfare effects of unilateral cuts in tariffs. This section reviews some of the evidence and opinions concerning these elasticities.

It is easy to write down a definition of the export-demand elasticity for a commodity: it is the percentage change in foreign demand caused by a one per cent increase in the foreign-currency f.o.b. price. Table 6.1 helps us to interpret what this really means. Consider for a moment the currently booming price of Australia's iron ore exports, reflecting strong foreign demand and infrastructure-constrained supply. According to Table 6.1, an export-demand elasticity of -16 means that if Australia could relax supply constraints sufficiently to double its exports, then this extra supply would reduce the price by only 4.2 per cent. On the other hand, if the export-demand elasticity is -4, then a doubling of supply would reduce the price of the Australian product by 15.9 per cent. Where on Table 6.1 should we locate Australian products?

In describing the setting of export-demand elasticities for the ORANI model, Dixon *et al.* (1982, p. 195) wrote that

> *"Substantial differences of opinion exist among Australian economists as to the extent to which Australia can exert market power for individual export commodities. Little convincing econometric evidence is available to assist in resolving these differences."*

In similar vein, in commenting on estimates of export-demand elasticities, Corden (1997, p. 96) wrote

> *"There are great statistical problems, and it is apparent that not too much reliance can be placed on any of the figures that have been calculated; curves shift, circumstances change, and other things are, regrettably, never equal."*

Despite the uncertainties, for quantitative modelling we cannot avoid making judgements about export-demand elasticities. The builders of the ORANI model

**Table 5.2. MONASH simulations: elasticity, competitiveness, revenue-replacement and cold-shower assumptions**

| | Revenue replacement cost (D) | Competitiveness of exporters | Cold shower ($\alpha$) | Dom/imp MVP substitution elasticity | Ave. export-demand elasticity |
|---|---|---|---|---|---|
| Series 9 | 0.05 | Mining monopolistic | 0.24 | 5.2 | -4 |
| Series 10 | 0.05 | Mining monopolistic | 0.24 | 10.4 | -4 |
| Series 11 | 0.05 | Mining monopolistic | 0.24 | 5.2 | -8 |
| Series 12 | 0.05 | Mining monopolistic | 0.24 | 10.4 | -8 |

**Figure 5.2. MONASH simulations with monopoly export pricing, revenue-replacement costs and cold-shower effects, series 9 to 12: percentage effects on consumption of moving MVP tariff rates from their present levels**

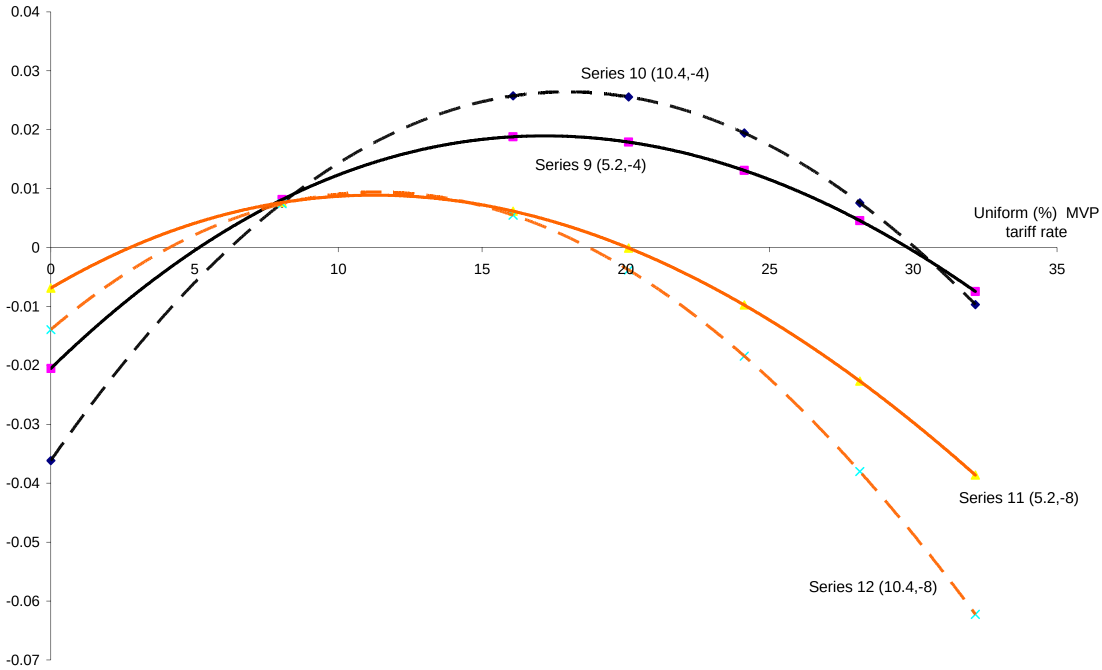

**Figure 5.3. MONASH simulations under different assumptions for export pricing, revenue-replacement costs and cold-shower effects, series 1, 5, 7 and 9: percentage effects on consumption of moving MVP tariff rates from their present levels**

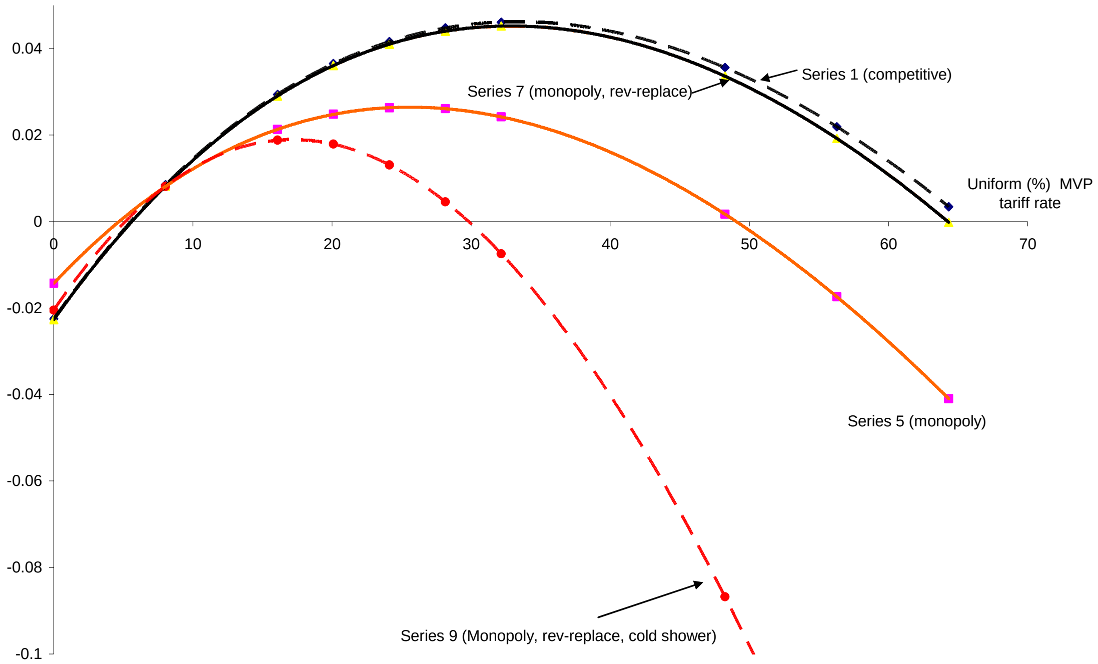


**Table 6.1. Interpreting export-demand elasticities***

| Export demand elastities (ε) | Percentage reduction in f.o.b. price to allow a doubling of demand |
|---|---|
| -1 | -50.0 |
| -2 | -29.3 |
| -3 | -20.6 |
| -4 | -15.9 |
| -5 | -12.9 |
| -6 | -10.9 |
| -7 | -9.4 |
| -8 | -8.3 |
| -9 | -7.4 |
| -10 | -6.7 |
| -11 | -6.1 |
| -12 | -5.6 |
| -13 | -5.2 |
| -14 | -4.8 |
| -15 | -4.5 |
| -16 | -4.2 |
| -17 | -4.0 |
| -18 | -3.8 |
| -19 | -3.6 |
| -20 | -3.4 |

* Numbers in the second column are computed as 100*(P-1) where P = $2^{(1/\varepsilon)}$.

generally came down on the side of high elasticities. They were guided by Freebairn (1978) who calculated export-demand elasticities via formulas in which Australia was viewed as exporting commodities that are indistinguishable from those of foreign competitors. Under this assumption, export-demand elasticities must be high for all commodities in which Australia has only a small share of the world market. Consequently in the ORANI model export-demand elasticities were set at numbers between -10 and -20 for all commodities except wool and prepared fibres (a derivative of wool). The use of high export-demand elasticities in ORANI was criticized vigorously by Cronin (1979).

Since the construction of the ORANI model in the 1970s no definitive econometric evidence has been found to resolve the issue of export-demand elasticities. However, the market place has changed and economic theory has moved on. Branding, including country of origin identification, has become ever more important in the market place and product differentiation now plays a dominant role in modern trade theory. Products in which differentiation is clearly important, such as tourism, education, wine and seafood, have become major components of Australia's exports. Even for traditional mineral and agricultural exports, we now recognize that Australian varieties are distinguishable from those produced in the rest of the world. For example, Australian black coal has distinguishing properties of environmental relevance.

In view of these developments, the builders of the MONASH model in the 1990s set the export-demand elasticities using a formula that recognises the role of product differentiation.[17] As a starting point for their formula they imagined that agents in foreign countries determine their imports of Australian product i by solving a cost-minimising problem of the form:

chose $X_a(i)$ and $X_o(i)$

$$\text{to minimize } P_a(i) * X_a(i) + P_o(i) * X_o(i) \tag{35}$$

$$\text{subject to } R(i) = CES\left(\frac{X_a(i)}{B_a(i)}, \frac{X_o(i)}{B_o(i)}\right) \tag{36}$$

where

$P_a(i)$ and $P_o(i)$ are the purchasers' prices in foreign countries of good i from Australia and good i from alternative sources;

$X_a(i)$ and $X_o(i)$ are foreign demands for good i from Australia and good i from alternative sources;

$B_a(i)$ and $B_o(i)$ are variables allowing for changes in foreign preferences for good i from Australia and good i from alternative sources;

R(i) is foreign requirements for good i; and

CES(...) denotes constant-elasticity-of-substitution function.

Next, they specified the purchasers' price to foreigners of good i from Australia as a combination of the f.o.b. price [PE(i), the price at the port of exit from Australia] and of costs [Q(i)] that are incurred between the port of exit and the final destination. These separating costs include transport and insurance between Australia and foreign ports,

[17] The Productivity Commission (2002, p. 305) misrepresents the MONASH approach to setting export-demand elasticities. They imply incorrectly that these elasticities were estimated by a statistical technique debunked by Orcutt (1950).

foreign tariffs, foreign sales taxes and transport and insurance costs incurred between foreign ports and foreign users of Australian products. The specification they used was:

$$P_a(i) = PE(i)^{S_{fob}(i)} * Q(i)^{1-S_{fob}(i)} \quad . \tag{37}$$

where

$S_{fob}(i)$ is the share of the purchasers' price in foreign countries of Australian export i accounted for by the f.o.b. price.

The final step in the theory underlying the MONASH formula for export-demand elasticities is the specification of world demand for commodity i according to:

$$R(i) = G_i\left(PW(i), \text{other factors}\right) \tag{38}$$

and

$$PW(i) = P_a(i)^{S_a(i)} * P_o(i)^{1-S_a(i)} \tag{39}$$

where

$PW(i)$ is the average purchasers' price of good i in foreign countries; and

$S_a(i)$ is the share of foreign expenditures on good i devoted to the Australian variety.

On the basis of (35) to (39) the builders of MONASH derived an equation for the foreign demand curve for Australian exports of i of the form:[18]

$$x_a(i) = \varepsilon(i) * pe(i) + f(i) \quad . \tag{40}$$

where

$x_a(i)$ and $pe(i)$ are percentage changes in $X_a(i)$ and PE(i);

f(i) is a variable that shifts the position of the foreign demand curve in response to movements in:

the prices of i from alternative sources [ $P_o(i)$ ];

preferences [ $B_a(i)$ and $B_o(i)$ ];

separating costs [Q(i)]; and

factors apart from prices that drive world requirements for i [R(i)] ;and

$\varepsilon(i)$ is the foreign elasticity of demand for Australian exports of i determined according to the formula

$$\varepsilon(i) = \left[\delta(i) * S_a(i) - \phi(i) * (1 - S_a(i))\right] * S_{fob}(i) \quad . \tag{41}$$

In this formula,

$\delta(i)$ < 0 is the foreign elasticity of demand for commodity i, that is the response in (38) to movements in PW(i), and

$\phi(i)$ > 0 is the elasticity of substitution in foreign countries between the Australian variety of i and other varieties, that is the substitution parameter in the CES function specified by (36).

Formula (41) is the MONASH formula for setting export-demand elasticities. The part of the formula in square brackets recognises that an increase in the purchasers' price to foreigners of the Australian variety of good i has two effects on demand for Australian

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[18] For details of the derivation see Dixon and Rimmer (2002, pp. 222-225).

exports of i. The first effect comes from the increase in the overall price of good i. If the purchasers' price of the Australian variety increases by one per cent, then the overall price of i to foreigners increases by $S_a(i)$ per cent. This translates into a percentage change in foreign demand for good i, including the Australian variety, of $\delta(i) * S_a(i)$. The second effect comes from the increase in the price of the Australian variety relative to the price of other varieties. Holding the price of other varieties constant, a one per cent increase in the purchasers' price of the Australian variety induces a substitution effect that reduces foreign demand for the Australian variety by $\phi(i) * (1 - S_a(i))$ per cent.[19] The final term on the RHS of (41), $S_{fob}(i)$, recognises that $\varepsilon(i)$ is the foreign elasticity of demand with respect to the *f.o.b. price* of the Australian variety. A one per cent increase in the f.o.b. price causes less than a one per cent increase in the purchasers' price. Assuming, reasonably, that separating costs are determined independently of f.o.b. prices, a one per cent increase in the f.o.b. price of Australian product i causes an increase in its purchasers' price in foreign countries of $S_{fob}(i)$ per cent.

In most foreign markets, Australian commodities account for only a small share of sales [$S_a(i)$ is close to zero]. Consequently, the first term in the square brackets on the RHS of (41) has little effect. The builders of MONASH accepted that most Australian products face considerable competition from substitutes produced in other countries. They attempted to reflect this by choosing values for $\phi(i)$ (known as the Armington elasticity[20]) at the upper end of the range supported by empirical research. Typically they set $\phi(i)$ at 6. They thought that a realistic value for $S_{fob}(i)$ is 0.7, so that with $S_a(i)$ close to zero they obtained a typical value for $\varepsilon(i)$ of -4.

For a few commodities (most notably wool), the Australian variety is both distinctive [$\phi(i)$ is low] and occupies a major share of foreign markets [$S_a(i)$ is comparatively large]. For such commodities, values for $\varepsilon(i)$ smaller in absolute size than 4 are appropriate. For example, if $\phi(i) = 3.2$, $S_a(i) = 0.5$, $S_{fob}(i) = 0.7$ and $\delta(i) = -0.5$, then $\varepsilon(i) = -1.3$. This is the value currently in MONASH for the export-demand elasticity for wool.

In their 2002 and 2003 reviews of automotive and TCF assistance, the Productivity Commission were clearly unhappy with the standard MONASH export-demand elasticities. For example, in their automotive report (Productivity Commission, 2002, pages 304 and 305), they comment that

> "*the low value of 4 … , which is the standard value adopted in the MONASH model for non-traditional[21] exports, may be appropriate in a short run forecasting context, but is likely to significantly overstate the extent to which Australian producers can differentiate their products in overseas markets in the longer term. The intermediate value of 10 is close to the average adopted in the MM 600+ model. The high value of 20 is close to the average now*

[19] A one per cent increase in the purchasers' price of the Australian variety relative to those of other varieties reduces the ratio of purchases from Australia to purchases from elsewhere by $\phi(i)$ per cent. This is made up of a reduction in demand for the Australian variety of $\phi(i) * (1 - S_a(i))$ per cent and an increase in demand for other varieties of $\phi(i) * S_a(i)$ per cent.

[20] See Armington (1969 and 1970).

[21] In fact values like -4 are used in the MONASH model for nearly all exports.

*preferred in the GTAP multi-country model … . High values are preferred there because:*

- *they imply a degree of product differentiation consistent with observed engineering measures of economies of scale; and*
- *they better enable multi-country models to reproduce observed historical changes in global trade patterns.*"

Surprisingly, the Commission cites no evidence to support any of this comment.

It is clear from Murphy (2002, p. 10) that his use of high elasticities in MM600+ is a judgement, not supported by empirical evidence. We also note that in Murphy's econometrically estimated macro model the standard value for the export-demand elasticity is -3.4 (see Powell and Murphy, 1997, page 205).

We do not know the basis of the Commission's comment about values of 20 being the preferred GTAP export-demand elasticities.[22] The GTAP website describing the data for the GTAP 5 model lists values for inter-source or Armington elasticities [$\phi(i)$ in (41)] for 57 products, see chapter 20 of Dimaranan and McDougall (2002). A simple average of these 57 values is 5.0. For GTAP 6, Hertel *et al.* (2007) have provided a new set of $\phi(i)$ values, most of which are econometrically estimated. A simple average of these new values is 6.3. Via (41), we see that these GTAP estimates certainly do not support the use of numbers like -20 for Australian export-demand elasticities. In fact they support standard MONASH-style numbers.

We guess that in making their comment about "the degree of product differentiation" and "observed engineering measures of economies of scale" the Commission had in mind a model of monopolistic competition in which each firm in an export-oriented industry earns zero pure profits (price equal to average costs) and sets its price at $\varepsilon/(1+\varepsilon)$ times marginal cost, where $\varepsilon$ is the elasticity of demand for its product.[23] If $\varepsilon = -4$, then in this view of the world, export-oriented firms operate with their average cost 33 per cent higher than their marginal cost. To us, this doesn't obviously imply an unrealistic level of scale economies. More importantly, a value of -4 for the foreign export-demand elasticity for an Australian product does not necessarily imply that each Australian exporter of the product faces an elasticity of demand of -4. The Australian industry could be purely competitive with each Australian firm behaving as if the elasticity of demand for its product is extremely high, so that its average-cost/marginal-cost ratio is close to one. Collectively, however, the industry can face an export-demand elasticity of -4.

Again we can only guess what the Commission had in mind with their comment about high elasticities and reproduction of observed changes in trade patterns. Perhaps they were referring to a well-known paper by Gehlhar (1997). He used the GTAP model to explain changes in Pacific rim trade patterns between 1982 and 1992. In his conclusions he comments that

> *"There is also some indication of a small improvement in the correlation results [between simulated and observed movements in trade flows – not in the original] by increasing the trade elasticities in the GTAP model."*

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[22] Models such as GTAP do not include export-demand elasticities. Exports from any country are specified via imports of partner countries. Thus we assume that the Commission is referring to inter-source or Armington elasticities in GTAP. As can be seen from (41), these provide an upper bound on the negative of export-demand elasticities.

[23] See equations (14) and (15).

The improvements were indeed small and the increase in the trade elasticities was 20 per cent, certainly taking them nowhere near values that would justify the use of export-demand elasticities for Australia of -20.

The Commission (2002, page 305 and 306) quotes Head and Reis (2001) who summarize results from several studies of estimates of Armington elasticities and related parameters. Some of these studies suggest higher values for $\phi(i)$ than the 6 used in (41) in setting the MONASH export-demand elasticities, but others suggest lower values. Certainly none of the quoted studies seems to support export-demand elasticities for Australia with absolute values as high as 10, let alone 20. Another paper containing a review of Armington elasticities is McDaniel and Balistreri (2003). Again, there is nothing in this review which supports the use of high export-demand elasticities for Australia.

Following the motor vehicle and TCF inquiries of 2002 and 2003, the Commission has undertaken considerable theoretical research on Armington models.[24] Researchers at the Commission appear to be searching for a new theoretical approach that will support the Commission's apparent view that cutting tariffs is always a good idea: that negative terms-of-trade effects of tariff cuts are outweighed by positive efficiency effects. Zhang (2008), for example, includes in his overview of the Armington approach the following:

> *"What are the drawbacks?*
>
> *There are two well-known features of Armington models:*
>
> *1. larger than expected changes in inter-country relative prices, which result in excessive terms of trade effects, especially for small countries*
>
> *2. smaller-than-expected changes in inter-industry relative prices and, therefore, in national outputs, leading to an underestimate of possible reallocation efficiency gains from trade liberalization …"*

Apart from producing the "wrong result", no indication is given of the standard by which terms-of-trade results from Armington models are being judged as excessive or efficiency gains are being judged as underestimated. In any case, it is not the Armington approach, as such, that determines the simulated trade-off between terms-of-trade and efficiency effects. As we have demonstrated in Sections 2 to 5, this trade-off is determined by the values used for key parameters.

As well as theoretical work, the Commission has conducted empirical work on Armington elasticities. This is reported in Zhang and Verikios (2003) and Shomos (2005). Nothing in this work suggests that export-demand elasticities of -10 and -20 are appropriate for modelling the effects on the Australian economy of tariff cuts. If we have interpreted Zhang and Verikios's Tables 4 and 5 correctly, their estimates under one method give an average substitution elasticity between Australian and foreign products in Australia's export markets of 3.5. Under another method this average works out at 8. Translated via (41), the Zhang and Verikios numbers suggest average export-demand elasticities for Australian products of about -2.45 or -5.6.

## 7. Concluding remarks

This paper suggests that under empirically justifiable assumptions concerning export-demand elasticities, aggregate welfare in Australia would be reduced by a unilateral cut in MVP tariffs. In reaching this conclusion, we have undertaken three

[24] See, for example, Lloyd and Zhang (2006) and Zhang (2006 and 2008).

types of analysis: theoretical; MONASH model simulation; and review of literature on export-demand elasticities.

### *7.1. Theoretical analysis*

We derived a series of formulas for the derivative of welfare with respect to the rate of tariff, $\partial W / \partial T$. We started with a model in which all export industries are competitive. Next we modified the formula for $\partial W / \partial T$ to allow for the possibility that firms in some export industries behave monopolistically. Then, we elaborated the formula further to allow for the costs of raising revenue to replace lost tariff revenue. Finally, we incorporated cold-shower effects.

Table 7.1 sets out some implications of these formulas. If we are making marginal cuts in tariffs from 8 per cent (the average rate applying to MVP), then under competitive assumptions welfare is increased only if export-demand elasticities are greater in absolute magnitude than 13.5. Equivalently, welfare is increased only if export demand for the average Australian product is sufficiently elastic that a doubling of export sales could be achieved with a reduction in f.o.b. price of less than 5.0 per cent (see Table 6.1).

The introduction of monopoly pricing for some exports makes a welfare improvement from a tariff cut more likely. If monopoly applies to 26.7 per cent of exports (the mining share), then our formula with monopoly pricing indicates that marginal cuts in tariffs from 8 per cent will increase welfare only if export-demand elasticities are greater in absolute magnitude than 10.2. Equivalently, welfare is increased only if export demand is sufficiently elastic that a doubling of export sales could be achieved with a reduction in f.o.b. price of less than 6.6 per cent.

Our third theoretical formula, with allowance for revenue-replacement costs, indicates that there may be no value of export-demand elasticities at which a marginal cut in tariffs from 8 per cent would increase welfare. As indicated in Table 7.1, this applies even when revenue replacement costs are as low as 5 per cent. A value this low seems quite conservative when replacement of lost tariff revenue is via an across-the-board increase in income-tax rates.

Under the final theoretical formula, introducing cold-shower effects, marginal cuts in tariffs from 8 per cent would increase welfare only if export demand elasticities are larger in absolute size than 12.3. Equivalently, welfare would be increased only if export demand were sufficiently elastic that a doubling of export sales could be achieved with a reduction in f.o.b. price of less than 5.5 per cent.

### *7.2. MONASH simulations*

Our second type of analysis was simulations with the MONASH model. These simulations add empirical detail to the theoretical analysis. For example, they recognize that MVP imports enter Australia under several tariff rates (averaging 8 per cent) and that there are welfare effects from equalizing these rates. However, none of the empirical detail included in the MONASH simulations upsets the qualitative conclusions derived from the theoretical analysis.

**Table 7.1. Conditions under which a marginal cut in tariffs from 8 per cent improves welfare**

| Model | Absolute value of Export-demand elasticities (-ε) | Reduction in price from doubling supply (%)[e] |
|---|---|---|
| Competitive[a] | > 13.5 | < 5.0 |
| Monopoly for 26.7% of exports[b] | > 10.2 | < 6.6 |
| Monopoly for 26.7% of exports and 5% replacement costs[c] | No values | n.a. |
| Monopoly for 26.7% of exports, 5% replacement costs' and cold-shower effect[d] | > 12.3 | < 5.5 |

[a] Calculated via (13). [b] Calculated via (18). [c] Calculated via (22) with $\eta = -0.6$.
[d] Calculated via (29) and (31) to (34) with $\eta = -0.6$. [e] See Table 6.1.

The main contribution of the MONASH simulations is to provide a quantitative dimension that is lacking in the purely theoretical analysis.[25] The simulations show that MVP tariffs are not an important determinant of Australia's economic welfare. For example, the most comprehensive simulations, those incorporating monopoly, revenue-replacement and cold-shower effects, show losses in Australia's welfare from reducing MVP tariff rates to zero ranging from 0.007 per cent (about $56m) to 0.036 per cent (about $290m). While these amounts are small, they should not be simply sacrificed by implementation of faulty policy.

### *7.3. Export-demand elasticities*

Our third type of analysis was a critical review of literature relevant to understanding the likely magnitudes of export-demand elasticities for Australian products. On our interpretation, this literature implies that the standard MONASH values of -4 are reasonable. We found no empirical support for values that would be large enough in absolute size to challenge the conclusion that efficiency gains from further unilateral cuts in Australia's tariffs would be dominated by terms-of-trade losses, let alone losses associated with replacement of foregone tariff revenue.

Given the present state of knowledge concerning export-demand elasticities, we are confident that the use of numbers such as -4 in policy simulations for Australia is appropriate. However, the present state of knowledge is unimpressive. In the 1970s, the Industries Assistance Commission, through the IMPACT Project, supported a major econometric study of import-domestic substitution elasticities.[26] The study absorbed

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[25] Models such as MONASH can provide quantification across a wide range of variables including employment by industry, occupation and region. For broad-ranging MONASH analyses of the effects of tariff cuts, see for example Dixon and Rimmer (2002, chapter 2), Centre of Policy Studies (2003) and Dixon *et al*. (1997). These broad-ranging studies have been useful in demonstrating that Australia can undertake tariff reductions without significant adjustment costs. For this paper, we have taken that as given and concentrated solely on overall welfare effects.

[26] The main papers from the study are Alaouze (1976, 1977a and 1977b) and Alaouze *et al.* (1977). For an overview, see Dixon *et al.* (1982, subsection 29.1). Estimates from the study were picked up and used by modellers throughout the world. Rather disgracefully, for want of a better alternative, the estimates are still being used in Australia and elsewhere.

several person-years of work. It required assistance from data experts in both the Industries Assistance Commission and the Australian Bureau of Statistics and involved painstaking mobilization of detailed data on quantities and prices of imported and domestic goods in the Australian market place. The payoff was a statistically supported set of import-demand elasticities that helped to inform policy makers about the likely adjustment implications of reducing tariffs from the high levels that then applied. An updating and broadening of that study to include export-demand elasticities is long overdue.

In the absence of a detailed, up-to-date, authoritative, peer-reviewed study of export-demand and related trade elasticities, the Australian policy debate will continue to be plagued by self-serving assertions. Organizations supporting unfettered free trade will continue to cling to the notion that Australia has insignificant scope to influence the prices of its exports. On the other hand, supporters of export promotion schemes such as the Export Market Development Grant Scheme[27] will maintain that Australia faces limited export markets (implying low or moderate export-demand elasticities). The subsidization provided in these schemes of promotion expenses incurred by firms at international trade fairs, in export advertising and in implementing other export marketing strategies would be pointless in a world in which Australia could sell any quantity at the going price.

It is not only in the formation of trade policy that Australia would benefit from a high-quality set of estimates of export-demand elasticities.[28] Consider, for example, the GST debate. The modellers[29] found that implementation of the government's GST plans would have quite serious negative implications for Australia's tourist industry. This was because unlike Australia's other exports, it was planned that tourism exports (sales in Australia to foreign visitors), would be subject to the GST. The modellers' estimates of damage were based on judgments that the foreign elasticity of demand for tourism services from Australia was between -2 and -3. The government was quick to produce an expert witness[30] willing to assert that

> *"elasticities of 2 or 3 applying to all tourists overstates and gives a misleading impression of the impact of the ANTS package on tourism."*

This was backed up by research, not subject to rigorous peer review, undertaken by the Department of Tourism, Transport and Business Development that purported to show that the absolute value of the relevant elasticity is less than 1. Subsequently, that research was shown to be potentially seriously misleading (see Dixon and Rimmer 1999, pages 194-6).

In the context of the tariff debate, many modellers are reluctant to use export-demand elasticities with values that seem reasonable in light of the available evidence. Possibly the main reason is that with such elasticities their models imply embarrassingly high optimal tariff rates. In this paper, we have found that the cold-shower effect provides a way out of this dilemma.

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[27] For a description and analysis of this scheme, see Centre for International Economics (2005).

[28] This point is developed in detail by Dixon and Rimmer (2005). What it means is that even if we agree with Krugman (2008) that trade policy is unimportant relative to economic policies in other areas, we may still think that an expensive study of trade elasticities would generate major benefits.

[29] See Dixon and Rimmer (1999) and Econtech (1999).

[30] See the evidence given by Geoff Carmody to the Senate Employment, Workplace Relations, Small Business and Education References Committee (1999, page 121).

The Productivity Commission drew on the "cold shower" effect in their Review of Australia's General Tariff Arrangements (Productivity Commission, 2000) to produce modelling results showing welfare gains from reducing tariffs from levels as low as 5 per cent. In specifying the relationship between tariff cuts and productivity gains, the Commission relied on a linear extrapolation of econometric relationships between these variables for a period stretching from the 1960s to the 1990s. In particular, they assumed the same percentage improvement in MVP productivity per percentage point reduction in MVP tariff rates would apply to future tariff reductions as appeared to apply to past tariff reductions. While it seems plausible that a MVP industry that was isolated from the world by high levels of protection in 1960s could have experienced significant productivity improvements from exposure to international competition, it is doubtful that the same linear relationship is relevant today. The MVP industry is now exposed to intense competition with about half the Australian market accounted for by imports. With a linear specification of the cold-shower effect, the Commission came up with an unconvincing justification of unilateral adoption of very low tariffs.

We think the cold-shower hypothesis should be applied in a non-linear form. In this form, it does not provide a justification for cutting low tariffs but it does provide reassurance to economists who believe that Australia would suffer if tariffs were 20 or 30 per cent. With a non-linear cold shower it is possible to reconcile empirically supportable values for export-demand elasticities with optimal tariff rates of moderate size. Thus, a non-linear cold shower may take some of the heat out of the debate on export-demand elasticities.

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