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Impacts of foreign policies on the gains from research and promotion

J.P. Voon[a,*], G.W. Edwards[b]

[a] *Department of Economics, Lingnan College, 8 Castle Peak Road, Tuen Mun, Hong Kong*
[b] *School of Agriculture, LaTrobe University, Bundoora 3083, Victoria, Australia*

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Abstract

This paper compares the direct and indirect effects of rest-of-the-world (ROW) policy on welfare in country A: the direct effect due to the change in world price caused by the policy in the absence of research/promotion-induced shifts in supply/demand, and the additional (or indirect) effect of the policy on the welfare gain to country A from its investment in research and promotion. The results showed that the reduction in aggregate economic benefits from research/promotion due to a world price-reducing policy in ROW could be in the range of 25–50% of the direct reduction in social welfare due to the ROW policy. In the case of Australian beef/veal, it is possible for the welfare impact of the ROW policy via research payoff in country A to exceed the direct welfare cost.

1. Introduction

It is well known that a country that exports a commodity experiences a reduction in welfare if the rest-of-the-world (ROW) follows policies that lower the world price of the commodity. This applies regardless of whether the price fall is caused by a distortionary policy that reduces ROW welfare, such as a subsidy on ROW exports of the commodity, or by a policy that improves welfare in ROW (e.g. removal of a distorting tax). On the other hand, an export country gains when ROW follows policies that increase world prices. Examples of these policies include: Brazil's program to divert sugarcane to ethanol production for motor vehicle fuel (Industry Commission, 1992); the removal of barriers to trade (Tyers and Anderson, 1986); and a multitude of explicit and implicit taxes in developing countries. Studies of welfare losses experienced by Australia as a result of foreign agricultural policies that reduce world prices include BAE (1985), Tyers and Anderson (1986) and Andrews et al. (1994). In the case of items that it imports, a country's welfare is increased by ROW policies that reduce world prices and reduced by ROW policies that increase world prices.

A change in world price due to policies in the ROW often has an effect on welfare in country A additional to the direct effect. This additional effect occurs as the ROW policy influences the gain to country A from its investment in research and promotion for the commodity. This paper examines how that may occur. It considers both research/promotion activities that lower the supply curve for the commodity and those that lift demand. The main focus is on analyzing the effects on economic gains to country A from its research and promotion due to ROW policies that

*E-mail: jvoon@ln.edu.hk

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change the world price of a commodity. However, the analysis is also suggestive of changes in the welfare-maximising allocation of resources between cost-reducing research and demand-lifting research/promotion in country A, and these changes are noted. The impacts of the ROW policy on the distribution of the benefits from research/promotion within country A are considered, as well as the effects on the size of those benefits.

The approach taken in this paper is to consider a number of cases. The cases are characterized by: (a) the direction of change (rise or fall) in world price due to ROW policy; (b) the type of shift (fall in supply curve or rise in demand curve) caused by country A's research or promotion; and (c) country A's trade status (exporter or importer). Cases 1 and 2 consider the effects of a fall and a rise, respectively, in world price of the commodity on the gains from supply-shifting research in an exporting country. In cases 3 and 4, the effects of a fall and a rise, respectively, in world price of the commodity on the gains from demand-lifting research or promotion are examined for an exporting economy. The analysis developed in cases 1–4 is then extended in outline form by allowing country A to be a net importer.

Both geometric and algebraic models are developed for assessing country A's gains from research/promotion. Empirical analysis is included to demonstrate the potential importance of the impacts of foreign policies on country A's gains from research and promotion. This analysis includes a comparison of the two effects – identified above – of ROW policy on welfare in country A: the direct effect due to the change in world price caused by the policy in the absence of research/promotion-induced shifts in supply/demand, and the additional (or indirect) effect of the policy on the welfare gain to country A from its investment in research and promotion. The methodology developed in this paper is applied to the Australian beef industry as a case study. The size and distribution of the social costs of research/promotion associated with a policy-induced reduction in world price are quantified using the conventional producer–consumer surplus framework.

2. The analytical approach

In the following sections, open-economy partial-equilibrium frameworks are used to illustrate the impacts of a change in world price of a commodity due to foreign policies on welfare gains in country A from its research/promotion. Changes in country A's welfare are assessed using a geometric method, following Alston et al. (1988) and Voon (1993). Algebraic models are developed for determining the conditions under which net social benefits from research/promotion with the foreign policy are lower (or higher) than those without it. These models can be used to evaluate a range of research/promotion issues.

Changes in welfare in the domestic market as a result of a change in world price induced by foreign policies are measured as changes in economic surplus. Aggregate domestic gains are the sum of changes in domestic consumers' and domestic producers' surplus. It is assumed that there are no market distortions for the commodity in country A. Supply and demand functions are assumed to take a linear specification (as in Voon and Edwards, 1992). Supply and demand shifts associated with research/promotion are assumed to be parallel and independent of the foreign agricultural policy, as in Alston et al., 1988. Research and promotion costs in order to shift the relevant supply and demand curves are assumed to be exogenous to our analytical models. This means that research/promotion costs in country A are identical in all cases. This will enable us to compare the changes in the direct and indirect social costs associated with the ROW policy in country A under alternative policy states.

2.1. *Case 1: effects of a fall in world price on the gains from cost-reducing research*

2.1.1. *Geometric analysis*

The model which is used to examine the effects of a fall in world price on the benefits from supply-increasing (or cost-reducing) research is illustrated in Fig. 1. The model allows for ROW policies to impact on world price via an excess demand curve. In the absence of research and of the ROW policy reducing the world price, the domestic supply curve for country A's production is represented by S, domestic demand curve by D_d and total demand by D_t (with $D_t - D_d$ being export (excess) demand). The world price is P, the total quantity supplied by country A is Q_s, the quantity demanded domestically is Q_d, and the excess quantity demanded by ROW is $(Q_s - Q_d)$. In the presence of the ROW policy, total demand is D_t'',

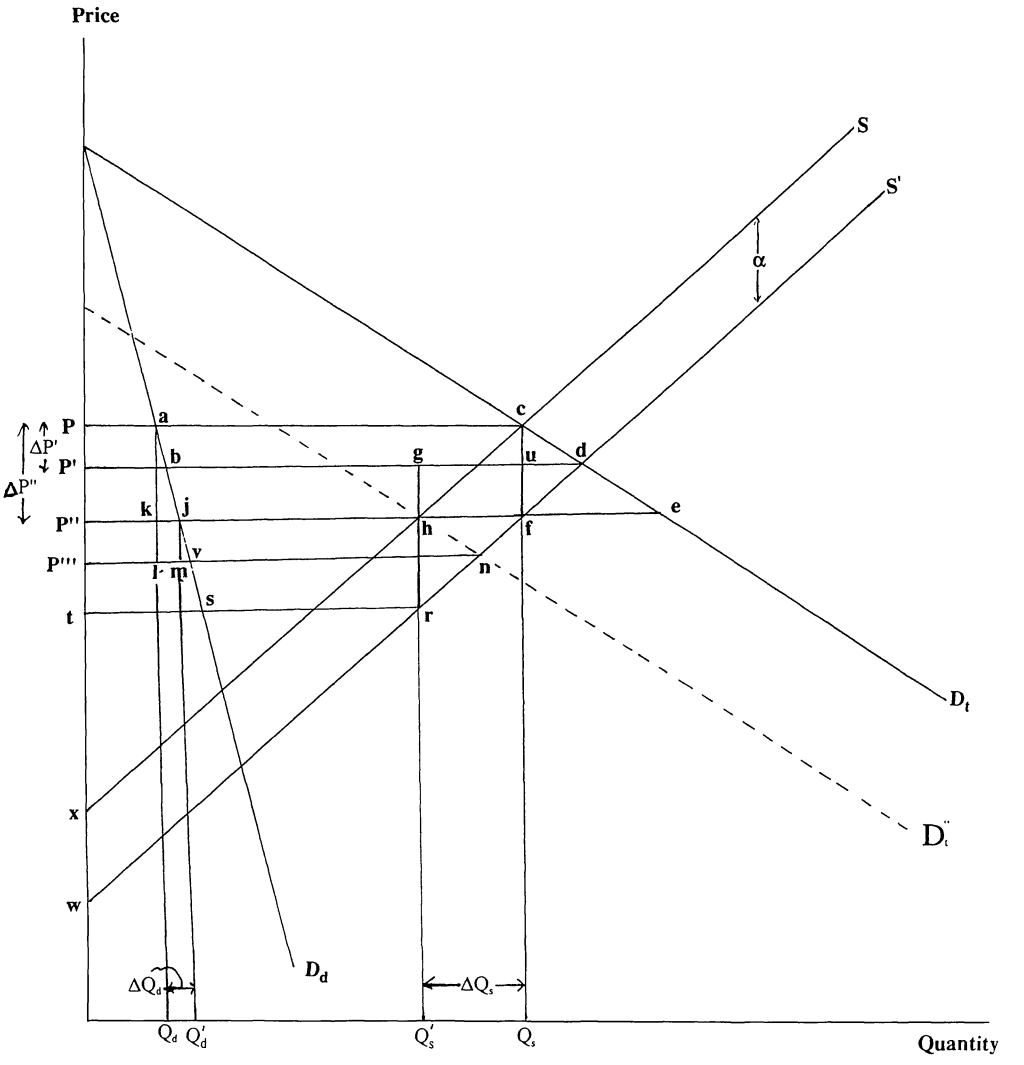

Fig. 1. Effects of a reduction in world price on the size and distribution of supply-enhancing research benefits.

the world price is P'' (the change in world price due to the foreign policy equals $\Delta P'' = P - P''$), and the quantity of exports demanded by the ROW is $(Q'_s - Q'_d)$.

The effect of cost-reducing research can be depicted by a downward shift, to S', in the domestic supply curve of the commodity. In the absence of the foreign policy that reduces the world price of the commodity, consumers in country A gain (PabP') and producers gain (P'dfP'') from the research. In the presence of the foreign policy, there will be an associated fall in world price. One can assume any arbitrary fall in world price for the purpose of empirical analysis. The conclusion of the analysis will not be changed by the extent to which world price has fallen. The greater the decrease in world price, the larger the expected reductions in the direct and indirect benefits to country A due to the foreign policy.[1]

[1]We consider the possible change in the elasticity value along the linear function as a result of a reasonably large effect of a policy change on world prices in our empirical analysis.

In Fig. 1, the fall in world price from P to P'' is assumed to be equal to α: this is done in such a way as to make the algebraic analysis less formidable. With total demand being given by D_t'', the gain to consumers from the research is (P''jvP''') and the gain to producers from the research is (P'''nrt). Producers' gain from research with the foreign policy is lower than that without by area (gufh). (Note that $(P - P') = (P'' - P''')$). Consumers' gain from research with the foreign policy, on the other hand, is larger than that without by area (kjml). Therefore, if (gufh) > (kjml), aggregate social benefits to country A from cost-reducing research in the presence of the foreign policy are lower than that they are without the policy.

2.1.2. Algebraic analysis

Algebraic equations are formulated to determine the direction of change in net social benefits from the research caused by the foreign policy which reduces world price of the commodity. This can be accomplished by equating the net change in domestic producers' surplus with the net change in domestic consumers' surplus. Consider first, the net change in the economic benefits (kjml) accruing to consumers. Using Fig. 1, we observe that

$$\text{Area(kjml)} = \Delta P' \Delta Q_d \tag{1}$$

where $\Delta P' (\Delta P' = P - P' = P'' - P''')$ is the research-caused change in world price and ΔQ_d is the change in domestic quantity demanded due to the change in world price induced by the foreign policy. Using the domestic demand price elasticity (η_d) formula (refer to triangle ajk)

$$\Delta Q_d = \frac{\eta_d Q_d \Delta P''}{P} \tag{2}$$

where $\Delta P''$ is change in world price induced by the foreign policy measured at point 'a' (corresponding to P and Q_d) on the domestic demand curve and η_d is taken to be positive.Substitute Eq. (2) into Eq. (1):

$$\text{Area(kjml)} = \frac{\eta_d Q_d \Delta P' \Delta P''}{P} \tag{3}$$

Consider now the net change in benefits accruing to domestic producers (gufh) due to the foreign policy. Again referring to Fig. 1

$$\text{Area(gufh)} = (\Delta P'' - \Delta P')\Delta Q_s \tag{4}$$

where ΔQ_s is change in aggregate quantity supplied due to the policy-induced change in world price. Using the domestic supply price elasticity formula applied at point 'c' (corresponding to P and Q_s) on the aggregate supply curve (S)

$$\Delta Q_s = \frac{\varepsilon Q_s \Delta P''}{P} \tag{5}$$

where ε denotes domestic supply price elasticity. Substitute Eq. (5) into Eq. (4)

$$\text{Area(gufh)} = \frac{\varepsilon Q_s \Delta P''(\Delta P'' - \Delta P')}{P} \tag{6}$$

The aggregate social benefits from supply-increasing research with the foreign policy are equal to that without if (gufh) = (kjml), i.e. if

$$\frac{\varepsilon Q_s \Delta P''(\Delta P'' - \Delta P')}{P} = \frac{\eta_d Q_d \Delta P' \Delta P''}{P} \tag{7}$$

or

$$\varepsilon Q_s(\Delta P'' - \Delta P') = \eta_d Q_d \Delta P' \tag{8}$$

Substituting $\Delta P'' = \overline{cf} = \alpha$ (as in Fig. 1), we obtain

$$\varepsilon Q_s(\alpha - \Delta P') = \eta_d Q_d \Delta P' \tag{9}$$

In the case of a research-induced downward parallel shift in supply

$$\Delta P' = \frac{\alpha\varepsilon}{\varepsilon + \eta_t} \tag{10}$$

where α is the absolute per unit cost reduction and η_t is aggregate demand price elasticity.Substitute Eq. (10) into Eq. (9) and simplify[2]

$$\frac{\varepsilon}{(\varepsilon + \eta_t)(1 + \eta_d/\varepsilon Q_d/Q_s)} = 1 \tag{11}$$

The aggregate social benefits from cost-reducing research with the foreign policy are lower than social benefits without it if

$$\frac{\varepsilon}{(\varepsilon + \eta_t)(1 + (\eta_d/\varepsilon)(Q_d/Q_s))} < 1 \tag{12}$$

[2]By expanding the relation $\varepsilon Q_s(\alpha - \Delta P') = \eta_d Q_d \Delta P'$, we obtain $\alpha\varepsilon Q_s - \varepsilon Q_s \Delta P' = \eta_d Q_d \Delta P'$ or $\alpha\varepsilon Q_s = \Delta P'(\varepsilon Q_s + \eta_d Q_d)$. Substituting $\Delta P'$ with $\alpha\varepsilon/(\varepsilon + \eta_t)$, we get $\alpha\varepsilon Q_s = \alpha\varepsilon/(\varepsilon + \eta_t)$ $(\varepsilon Q_s + \eta_d Q_d)$ or by simplification $1 = 1/(\varepsilon + \eta_t)(\varepsilon Q_s + \eta_d Q_d)$. By arranging the term on the right hand side, $1 = \varepsilon/(\varepsilon + \eta_t)$ $(1 + (\eta_d Q_d/\varepsilon Q_s))$.

This condition is likely to be fulfilled if $|\eta_d|$, ε and (Q_d/Q_s) are low and $|\eta_t|$ is high (e.g. under small-country conditions).

Eq. (12) can be applied in another way. For example, for a given scenario, which could be determined at the outset of the research, i.e. for given values of $|\eta_d|$, ε, and (Q_d/Q_s), how low must $|\eta_t|$ be if the aggregate social benefits from cost-reducing research with the foreign policy are higher than without it. Therefore, if it is known that $|\eta_d| = \varepsilon = 1$ and $(Q_d/Q_s) = 0.5$, then $|\eta_t| = \varepsilon = 1$ according to Eq. (12), must not exceed 0.5. For exporters with $|\eta_t|$ in the range 4–20, (for example, Australian wheat, Canadian beef, Brazilian coffee), social gains from cost-reducing research would be lower with the foreign policy than without it.

2.2. *Case 2: effects of a rise in world price on the gains from cost-reducing research*

Where the foreign policy induces a rise in world price, consumers' surplus from cost-reducing research is lower, and producers' surplus higher with the foreign policy than without. The aggregate social benefits from cost-reducing research with price-increasing foreign policy are found to be lower than those without if

$$\frac{\varepsilon}{(\varepsilon + \eta_t)(1 + (\eta_d/\varepsilon)(Q_d/Q_s))} > 1 \qquad (13)$$

This condition is likely to be fulfilled if $|\eta_d|$, ε and (Q_d/Q_s) are high and $|\eta_t|$ is low (e.g. under a big-country condition).

2.3. *Case 3: effects of a fall in world price on the gains from demand-lifting research or promotion*

2.3.1. *Geometric analysis*

Now consider the effects of a foreign policy on country A's welfare gain from its demand-lifting research or promotion. Demand-lifting research or promotion for tradable commodities raises both the domestic and the rest-of-the-world demand curves (refer to Fig. 2). Initially, the vertical shifts in domestic and aggregate demand functions are assumed to be identical. In the 'without research' situation, the domestic and total demand functions for country A's production are assumed to have a common intercept, m, on the price axis.

Country A's demand-lifting research or promotion causes its domestic demand curve to shift up from D_d to D'_d, and its total demand curve from D_t to D'_t. In the absence of the world price-decreasing foreign policy, the domestic quantity demanded is Q_d and the total quantity supplied is Q_s. With the initial price P and with research shifting D_t to D'_t and D_d to D'_d, producers gain ($P'baP$) and consumers gain (edfP') from the research. Suppose now that producers do the research with the foreign policy in place such that there is an arbitrary fall in world price. Again, as in the case of cost-reducing research, the conclusion of the analysis will not be changed by the magnitude of price reduction. However, the greater the fall in world price, the larger the expected reductions in direct and indirect benefits to country A due to the foreign policy. In Fig. 2, the fall in world price from P to P'' is assumed to be equal to β or γ in order to make the algebraic analysis more tractable than the case with any arbitrary fall in world price. With the initial price P'' and with research shifting D''_t to D_t (and fixing $\overline{PP} = \overline{P''P}$), producers in this case gain ($PagP''$) and consumers gain (wvh$P$)[3]. Producers' surplus is reduced by (xzay), and consumers' surplus is increased by (rfuc) ((rfuc)=(chjk)) by the foreign policy. The aggregate social benefits from the research with the policy are lower than those without if (xzay) > (rfuc).

2.3.2. *Algebraic analysis*

Using the domestic demand price elasticity formula applied at point 'c' on the supply curve (corresponding to triangle cde in Fig. 2($\overline{cd} = \beta$)

$$\Delta Q_d = \frac{\eta_d Q_d \beta}{P} \qquad (14)$$

where β is the absolute vertical displacement in the domestic demand curve. Area (rfuc) ($\Delta P' \Delta Q_d$) can be written as

$$\text{Area(rfuc)} = \frac{\eta_d Q_d \beta \Delta P'}{P} \qquad (15)$$

Using the supply price elasticity formula applied at point 'a' (corresponding to P and Q_s) on the supply curve

[3]Area (edfP') is derived as follows. The change in consumer surplus is first represented by area (nfP'−mc$P$), which is equal to (mnft−P'tc$P$) or (mnhc−P'fh$P$). However, (mnhc) = (mndc+dhc) = (edc$P$+dhc) = (edh$P$). Therefore, (mnhc-P'fh$P$) = (edh$P$−P'fh$P$) = (edfP').

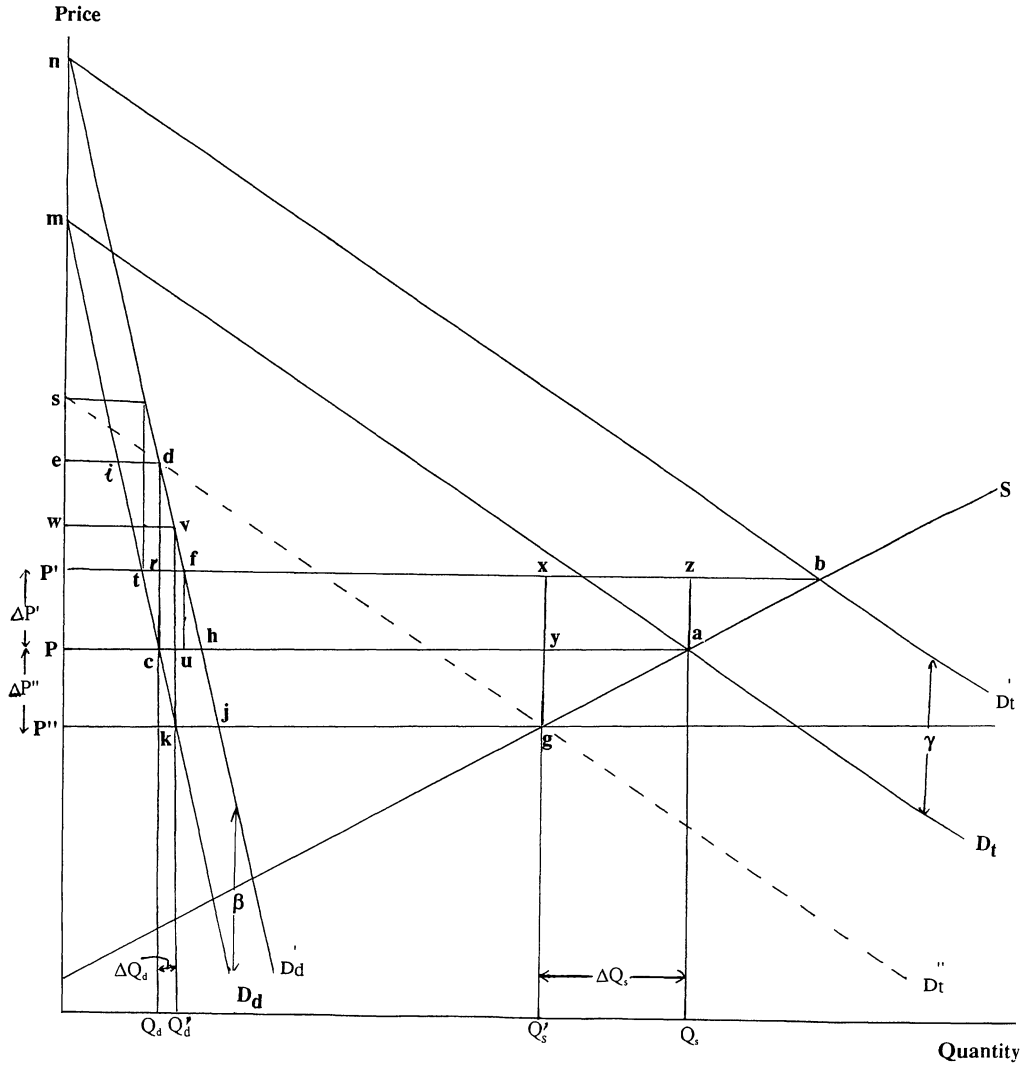

Fig. 2. Effects of a reduction in world price on the size and distribution of demand-enhancing research benefits.

$$\Delta Q_s = \frac{\varepsilon Q_s \Delta P'}{P} \tag{16}$$

and therefore,

$$\text{Area(xzay)} = \frac{\varepsilon Q_s \Delta P' \Delta P''}{P} \tag{17}$$

The aggregate social benefits from demand-lifting research or promotion with the foreign policy are equal to that without if (rfuc) = (xzay), i.e.

$$\beta \eta_d Q_d = \varepsilon Q_s \Delta P'' \tag{18}$$

In the case of an upward parallel shift in demand

$$\Delta P' = \Delta P'' = \frac{\gamma \eta_t}{\varepsilon + \eta_t} \tag{19}$$

where $\gamma (\gamma = \beta)$ is the absolute vertical displacement in the aggregate demand curve (the derivation is available from the authors). Substitute Eq. (19) into Eq. (18) and simplify

$$\frac{\eta_t}{(\varepsilon + \eta_t)[1 + (\varepsilon/\eta_d)(Q_s/Q_d)]} = 1 \tag{20}$$

The aggregate social benefits from the demand-lifting research or promotion with the policy are lower than without the policy if

$$\frac{\eta_t}{(\varepsilon+\eta_t)[1+(\varepsilon/\eta_d)(Q_s/Q_d)]} > 1 \qquad (21)$$

If it is known that $|\eta_d| = \varepsilon = 1$, and $(Q_d/Q_s) = 0.5$ (adopting the same conditions as applied in case 1), then social gains to country A from the demand-shifting research will be lower with the ROW policy than without it if $|\eta_t| > 0.5$. This conclusion is dependent upon research shifting domestic and excess demand in an identical manner.

Where the research raises only the domestic demand curve for the commodity, domestic consumers' surplus and aggregate social benefits from the research/promotion are always higher (by area (chjk)) with the policy than those without. Where research raises only the ROW excess demand curve for the commodity, domestic producers', domestic consumers' and aggregate benefits from the research/promotion are always lower with the policy than those without. The analysis suggests that in the presence of a foreign policy which reduces the world price of the commodity, research which lifts the domestic demand is preferred by country A consumers and producers to that which lifts the excess demand, all else constant.

2.4. *Case 4: effects of a rise in world price on the gains from demand-lifting research or promotion*

Where foreign policy induces a rise in world price, the results corresponding to case 3 are reversed. For research that raises the domestic and aggregate demand curves identically, the increase in consumers' surplus is lower, but the increase in producers' surplus higher, with the foreign policy than without. The aggregate social benefits from demand-lifting research/promotion with the policy are found to be lower than those without if

$$\frac{\eta_t}{(\varepsilon+\eta_t)[1+(\varepsilon/\eta_d)(Q_s/Q_d)]} < 1 \qquad (22)$$

where all terms are explained as in case 3.

If the condition stated in Eq. (22) is met, the optimal level of investment in demand-shifting research and promotion in country A will be lower in the presence of the foreign policy which raises the world price. With $|\eta_d| = \varepsilon = 1$, and $(Q_d/Q_s) = 0.5$ (adopting the same conditions as applied in cases 1 and 3 again), the relationship in Eq. (22) will hold if $|\eta_t| < 0.5$.

3. Significance of the models

The effects of a world price-reducing ROW policy on aggregate welfare in country A depends on parameter specifications in Eqs. (12) and (21). Table 1 shows the impact of the ROW policy on country A's aggregate welfare benefits from its supply-shifting and demand-shifting research/promotion using a range of combinations of the relevant parameters.

The aggregate social benefits from research with the policy are significantly lower than those without it ($W_s < 1$) where Q_d/Q_s is low coupled with high $|\eta_t|$. On the demand side, the aggregate social benefits from / research/promotion with the policy are significantly lower than those without it ($W_d > 1$) if Q_d/Q_s is high

Table 1
Effects of a decrease in world price on country A's gains from research and promotion

$\varepsilon/\lvert\eta_d\rvert$	Q_d/Q_s	$\lvert\eta_t\rvert$	Fall in supply	Rise in demand[a]
			W_s^b	W_d^b
		0.5	0.800	0.500
0.5	0.1	4	0.240	0.208
		20	0.057	0.175
		0.5	0.733	0.273
1	0.1	4	0.220	0.114
		20	0.052	0.100
		0.5	0.840	0.738
2	0.1	4	0.350	0.071
		20	0.095	0.052
		0.5	1.867	1.929
0.5	0.9	4	0.560	0.804
		20	0.133	0.675
		0.5	1.267	1.421
1	0.9	4	0.380	0.592
		20	0.090	0.497
		0.5	1.160	1.552
2	0.9	4	0.483	0.466
		20	0.132	0.341

[a] Identical vertical shifts in domestic and excess demand.
[b] $W_s = \varepsilon/(\varepsilon+\eta_t)(1+\eta_d/\varepsilon Q_d/Q_s)$ and $W_d = \eta_t/(\varepsilon+\eta_t)[1+(\varepsilon/\varepsilon/\eta_d)(Q_s/Q_d)]$. If $W_s < 1$ or $W_d > 1$, the aggregate social benefits from research/promotion with the foreign policy are lower than those without it.

and $|\eta_t|$ is relatively low. The extra benefits accruing to country A consumers from research and promotion because of the price-reducing ROW policy are more than offset by the smaller research benefits to country A producers. Put differently, the reduction in world price due to the ROW policy reduces output of the commodity in country A, reducing its welfare gain from a given downward shift in supply or upward shift in demand. This result is relevant to most rural commodities facing high values for $|\eta_t|$ and also for commodities for which $|\eta_t|$ is relatively low. Under 'large country' conditions (e.g. $|\eta_t| < 0.5$) W_s is bigger than unity, implying that the aggregate social benefits from research are larger with the world price-reducing ROW policy than without. The ROW policy in these conditions increases the gains to country A producers. There are few, if any, rural commodities for which low elasticity of export demand is combined with a small share of production exported (Cronin, 1979; Throsby and Rutledge, 1977).

The impact of a ROW policy on the welfare gains to country A from its research and promotion is an indirect effect. The direct effect is the change in welfare caused by the ROW policy in country A in the presence of its 'without research' supply and demand curves. Country A's welfare loss due to ROW's price-reducing policy is equal to area (acej) in Fig. 1, while its welfare gain from the ROW's price-reducing policy in Fig. 2 is equal to area (tbac). It is of interest to consider how large are the indirect welfare effects of the ROW policy on country A compared with the direct effects.

The direct change in welfare benefits accruing to country A can be measured using the following equation:

$$Y = \alpha\left[(Q_s - Q_d) - \frac{0.5\alpha}{P(\varepsilon Q_s + \eta_d Q_d)}\right] \qquad (23)$$

where all terms are explained earlier. Eq. (23) is negative with a fall in world price and is positive with a rise in world price. The indirect effects on country A's welfare in the case of cost-reducing (supply-raising) research can be quantified using the equation

$$X_s = \alpha^2\varepsilon/P(\varepsilon + \eta_t)[Q_s\eta_t - \eta_d Q_d] \qquad (24)$$

Eq. (24) is derived by subtracting Eq. (3) from Eq. (6) and then by making the necessary simplification.

The indirect effects (X_s) are compared with the direct effects (Y) by setting $P = Q_s = 100$ and $\alpha = 0.1P$ and by allowing other parameter values (ε, $|\eta_d|$, $|\eta_t|$, Q_s and Q_d) to vary within a plausible range. Note that a 10% fall in world price, for instance, aligns approximately with some estimates of the impact of removing agricultural protection in major countries (Tyers and Anderson, 1986). The results arising from the analysis are tabulated in Table 2.

Table 2 shows that the Y value decreases with increases in Q_d/Q_s, implying that the direct welfare changes in country A from ROW's policy are small if the fraction of the domestic production exported is small. In contrast to the direct effects, the indirect effects (X_s) are not very responsive to specifications of Q_d/Q_s. X_s is observed to be more sensitive than Y to specifications of domestic demand and supply price elasticities.

The indirect social welfare effects are expressed as a percentage of the direct effects ($Z = X_s/Y(100)$). Table 2 shows that Z increases substantially with

Table 2
Effects of world price reduction originating in ROW on social welfare in country A: indirect social welfare (X_s) as a percentage of the direct effect (Y)

$\varepsilon/\lvert\eta_d\rvert$	Q_d/Q_s	$\lvert\eta_t\rvert$	Y^a	X_s^b	Z^c
		4	845.0	78.0	9.23
	0.1				
		20	845.0	94.8	11.21
		4	425.0	70.0	16.47
1	0.5				
		20	425.0	92.9	21.85
		4	110.0	76.0	69.09
	0.8				
		20	110.0	94.3	85.7
		4	795.0	130.0	16.35
	0.1				
		20	795.0	180.9	22.76
		4	375.0	116.7	31.12
2	0.5				
		20	375.0	177.3	47.27
		4	60.0	106.7	177.8
	0.8				
		20	60.0	174.5	290.9

[a] $Y = \alpha[(Q_s - Q_d) - 0.5\alpha/P(\varepsilon Q_s + \eta_d Q_d)]$ (The direct effect).
[b] $X_s = \alpha^2\varepsilon/P(\varepsilon + \eta_t)(Q_s\eta_t - \eta_d Q_d)$ (The indirect effect).
[c] $Z = X_s/Y(100)$ (The indirect effect as a percentage of the direct effect).
Note: In calculating Z and X_s, we set $P = Q_s = 100$ and $\alpha = 0.1$P.

increase in Q_d/Q_s but moderately with increase in $\varepsilon/|\eta_d|$ and $|\eta_t|$. The indirect effects associated with research-caused shifts in supply are likely to be large in value in the case of a small-country producer exporting a small proportion of its domestic production. This may not be a case of substantial interest in country A's rural sector. However, especially in the presence of high $\varepsilon/|\eta_d|$, the reduction in country A's research benefits due to the ROW price-reducing policy may amount to around 30–50% of the direct welfare reduction when $Q_d/Q_s = 0.5$.

4. An application to the Australian beef industry

In this section, we apply the framework developed earlier to evaluate both the direct and the indirect effects of a ROW price-reducing policy on the welfare of producers and consumers in the Australian beef industry. Andrews et al. (1994) estimated a rise of 6% in beef prices for Australia as a result of the Uruguay Round outcome. This implies a world price for Australian beef about 5.65% lower due to those policy distortions that are being removed in the Uruguay Round.

The total 1996 production of beef in Australia was 1736 kt, of which 728 kt was consumed domestically and the remaining quantity (1028 kt) was exported. The saleyard price of beef was A1.553 per kg in 1996 (ABARE, 1997a).

The long-run supply price elasticity of Australian beef was estimated to be 2.99 (ABARE, 1997). The domestic demand price elasticity for Australian beef was reported to be 0.94 (see Murray, 1984; ABARE, 1997). The export demand for beef is likely to be extremely price elastic ($|\eta_t| > 30$) given the small proportion of the world beef being produced in Australia.[4] In this paper, a range of demand and supply elasticity values higher and lower than the reported recent estimates are used for our sensitivity analysis. The results arising from the analysis are tabulated in Table 3.

Using the most recent demand and supply price elasticity estimates reported by ABARE (1997b), the price-reducing policy originating in ROW in the absence of the cost-reducing research results in a direct social loss of A$ 73.88 million in 1996 (not shown in Table 3). With the research shifting down the beef supply curve by 5.65% of the commodity price – equal to the price fall due to the ROW policy[5] – the indirect social loss from the ROW policy in the form of a reduction in Australia's gain from research is A$ 23.96 million per year. In this case, the indirect welfare cost is equivalent to 32.43% of the direct welfare cost.

5. An extension to country A as an importer

Cases 1–4 correspond to the analysis which specifies country A as a net exporter of the commodity. The analysis can be applied to the case where country A is a net importer. The analytical results arising from the geometric analysis which allows country A to be a net importer are summarized in Table 4.

Table 3 shows that producers of a commodity in country A gain less from their country's cost-reducing and demand-lifting research as a result of ROW policies that reduce the world price of the commodity. Country A's consumers gain more from their country's research due to the ROW policy. The direction of country A's social gains from research/promotion in the presence of foreign policy depends on the parameters which apply to country A.

[4]The price elasticity of world demand for Australian beef may be expressed as: $\eta_t = 1/f(\eta_w - \varepsilon_r) + \varepsilon_r$ where η_w is the world price elasticity of demand for beef from all sources, ε_r is the price elasticity of supply of beef in the rest of the world, and f is the fraction of world beef being produced in Australia. With f equals to 0.034 and the inverse of f thus 29.4 (derived from statistics in ABARE, 1997a), η_w is about -0.6 and e_r is about unity, η_t is estimated to be 46.0.

[5]Our supply price value elasticity value corresponds to the initial equilibrium price-quantity coordinate point c in Fig. 1. With quite a large impact of a policy intervention on the world price, it is of interest to assess how the supply price elasticity at point h (the new equilibrium price and quantity coordinate after the price change) deviates from the initial-equilibrium elasticity value (see Fig. 1), given the use of linear supply and demand curves. The supply price elasticity at point h can be derived using the relation where s denotes the supply price slope and $\Delta P''$ is the change in world price induced by the foreign policy. Using the data for the Australian beef industry, we show that $\varepsilon_h = 1.025\varepsilon_c$. That is, the new-equilibrium supply price elasticity value deviates little from the initial value with the 6% change in the price of Australian beef. This implies that the linear elasticity (constant slope) approximation model is appropriate to be used for our study.

Table 3
Direct and indirect social losses incurred by the Australian beef industry due to the world price reducing policy

η_t	30.0				60.0			
ε	2.5	2.5	3.5	3.5	2.5	2.5	3.5	3.5
η_d	0.7	1.0	0.7	1.0	0.7	1.0	0.7	1.0
Y	76.43	75.88	72.12	71.58	76.43	75.88	72.12	71.58
X_s	19.67	19.58	26.71	26.60	20.55	20.51	28.32	28.26
X_s/Y (%)	25.73	25.81	37.04	37.16	26.89	27.03	39.27	39.48

Note: Y and X_s denotes direct and indirect losses, respectively.

Table 4
Summary of the effects of changes in world prices due to foreign policies on country A's gains from research/promotion

Direction of change in world price (P_w)	Type of shift in supply[b] or in demand[c]	Country A's trade status	Size and distribution of gains from research/promotion[a]		
			Producer	Consumer	Aggregate
	Fall in Supply	Exporter	−	+	?
		Importer	−	+	?
Fall in P_w					
	Rise in demand	Exporter	−	+	?
		Importer	−	+	?
	Fall in Supply	Exporter	+	−	?
		Importer	+	−	?
Rise in P_w					
	Rise in demand	Exporter	+	−	?
		Importer	+	−	?

[a] A positive entry (+) indicates that benefits from research to that sector are greater with the foreign policy than without, a negative (−) entry indicates lower benefits, and (?) indicates ambiguous effect (refer to Eqs. (11),(12) and (21) for the conditions under which a correct sign is anticipated).
[b] Vertical shift in supply in country A.
[c] Identical vertical shift in demand in country A and ROW.

6. Summary and Implications

This paper has addressed the relationship between developments in the ROW which change the world price of a commodity and the economic benefits accruing to country A from its research and promotion activities for the commodity. The focus has been on commodities which are exported by country A, though extension of the analysis to the import case was considered briefly.

The effect of a policy change in ROW on country A's economic gains from research and promotion was found to be potentially significant from two different perspectives. First, country A's gain in economic surplus from its cost-reducing research could be reduced substantially under small country conditions with production overwhelmingly for export by a ROW policy which depressed the world price. In contrast, country A's aggregate economic payoff from its demand-lifting research could be increased by the ROW price-reducing policy, especially when domestic consumption was small relative to production.

The second perspective on the significance of ROW policies for country A's welfare gains from its research is provided by comparing that impact on research benefits with the direct effect on country A's welfare of the policy-induced change in world price, that is the effect in the absence of shifts in supply and demand curves due to country A's research. The result of this comparison is heavily dependent on the relevant elasticities and the ratio of domestic consumption to production. However, for conditions corresponding to many rural industries, the reduction in aggregate economic benefits from research due to a world price-

reducing policy in ROW could be in the range of 25–50% of the direct reduction in social welfare. With a high ratio of domestic consumption to production, as in Australian beef/veal, it is possible for the welfare impact of the ROW policy via research payoff in country A to exceed the direct welfare cost.

The analysis suggests that the reduction in social benefits to country A from its research/promotion due to world price-reducing ROW policy could be larger, or the increase in its social benefits smaller, for cost-reducing research than for demand-lifting research which lifts domestic and total demand curves identically, all else constant. With government allocating the research/promotion budget with the objective of maximizing the aggregate welfare of producers plus consumers in country A, country A may benefit if the government responds to the ROW's price-reducing policy by increasing the amount spent on lifting demand relative to that spent on lowering the supply curve. On the other hand, increases in world commodity prices, such as those expected to result from the Uruguay Round of multilateral trade negotiations (Andrews et al., 1994), mean that country A's welfare-maximizing mix of supply-shifting and demand-shifting research and promotion shifts towards the former.

Whatever the policy change in ROW that reduces the world price, the incentive to country A's producers to invest in research/promotion for the commodity would be weakened – assuming that research funds are available from a producer-funded common revenue and that producers allocate resources in order to maximize their quasi rents. In contrast, the incentive to country A's consumers to support investment in research/promotion would be strengthened given that consumers are assumed to maximize consumer surplus. The incentive facing the government of country A supposing it to be motivated by the public interest – to allocate public research/promotion resources to the industry is likely to be diminished by the ROW policy under 'small country' conditions.

The distribution of the economic benefits from research/promotion in country A may be judged worse with the ROW policy lowering the world price than without if producers are in a poorer welfare group than consumers are. The rationale is that producers gain less and consumers gain more from research/promotion in the presence of the price-decreasing ROW policy. This applies whether country A is an exporter or an importer. Governments of developing as well as developed countries commonly pursue the objective of reducing national income inequality (Todaro, 1990). This being so, the existence of ROW policies that reduce world price could on equity grounds decrease governments' incentive to invest in research for the industry impacted by the policy. This equity effect on publicly-funded research would reinforce the efficiency effect in indicating a lower optimal investment in the presence of ROW policies that reduce world price.

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