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OPTIMAL POLICIES WITH STRATEGIC DISTORTIONS

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ABSTRACT

Recent work in optimal trade policy for imperfectly competitive markets usually identifies the optimal level of an instrument, and when more instruments are allowed, general interpretations have been unavailable. This paper analyzes the jointly optimal levels of a variety of instruments with oligopolistic competition. A targeting principle for identifying optimal policies is derived using the concept of a "strategic distortion." It is shown how optimal policies vary with the distortions present and the number of firms, as well as assumptions about market segmentation and regulation. The principles of targeting are illustrated using agricultural marketing boards.

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1. Introduction

Our understanding of the way in which perfectly competitive markets function, and of optimal policy for such markets when various distortions exist is quite good. Optimal policies are often explained by using the general principle of targeting developed by Bhagwati, Ramaswami and Srinivasan,[1] among others, and their non-uniqueness is explained by the Lerner symmetry theorem, Lerner (1936). In contrast to this, our understanding of optimal policy in oligopolistic markets is more limited.

In part, this is because there are so many possible models of oligopolistic behavior, both static and dynamic, that general results are hard to come by. Even limiting ourselves to static models, policies which "directly" restrict trade, such as quotas or content protection, have very different effects from those which do so "indirectly" via taxes and subsidies. The former have effects like those of a regime change while the latter do not.[2] Even the literature on indirect policies makes different assumptions about factors which affect the results. Assumptions about the strategic variables used, the number of firms, possible distortions, and the instruments considered vary among papers. Assumptions about market segmentation, or the lack of it, and regulations on firm behavior are also crucial and have not been systematically analyzed.

In this paper we develop a targeting approach which helps explain the nature of optimal policies and how they vary with differences in the above assumptions. Since the literature has focused on the first set of assumptions given above, there is some understanding of how optimal policies vary with these assumptions. Our contribution here is to identify overall optimal policies and show that they can be interpreted in a targeting framework. This provides a unified way of looking at much of the literature and shows how confining attention to one policy, as is often done, can result in the identification of overall suboptimal policies. In addition, we use this framework to analyze how regulations influence optimal policies by linking distortions and creating new ones, both of which affect the targeting of policies. We consider regulations which limit domestic monopoly power, as well as arbitrage, which we show should be thought of as a form of regulation. We analyze optimal policies for marketing boards since these provide a rich variety of types of distortions and regulations. Next, we briefly survey how our work relates to other work in strategic trade policy.

Earlier work, such as that of Auquier and Caves (1979), deals with trade policies when there is monopoly. Work on oligopoly began with that of Spencer and Brander (1983), who analyze a Cournot duopoly with one home and one foreign firm and show that an export subsidy can improve welfare.[3] Eaton and Grossman (1986) show that the strategic variable used is critical. They identify a strategic distortion using a conjectural variations model, and they show that this distortion may require a tax on exports with Bertrand competition. This strategic distortion differs from the usual terms of trade distortion.[4] Dixit (1984) and Eaton and Grossman analyze policy when there are more firms and domestic consumption.

Only a few papers in this area consider more than one policy instrument. Eaton and Grossman consider the direction of production and trade taxes separately, but they do not analyze jointly optimal policies or develop a targeting approach. For the Cournot case, Spencer and Brander (1983) consider jointly optimal R&D and export policies. Dixit (1984) examines optimal production and trade tax/subsidies in the Cournot case, and Dixit (1986) studies how optimal trade and production taxes are affected by changes in parameters using a conjectural variations model and a linear example. Dixit (1988) calculates the optimal levels of these instruments for a simulation model of the U.S. automobile industry. Cheng (1986) analyzes optimal tariffs and production subsidies for a linear example. A targeting approach is not the focus of any of this work, and most of it deals with segmented markets.[5]

Our work is also related to the literature on agricultural marketing boards. The work most closely related to ours is that of Just et al. (1979), Markusen (1984), and Thursby (1987).[6] While they consider some of the types of marketing boards we do, neither Just et al. (1979) nor Markusen (1984) focus on strategic interactions between boards. Thursby (1987) does consider strategic interactions between boards but confines her analysis to a linear Cournot example when markets are segmented.

The next section sets up the problem and discusses the institutional variations we consider. Sections 3 and 4 contain the analysis of duopoly with market segmentation. In these sections each board is the sole supplier to consumers in its home market and competes with a foreign board in a third market. Thus boards have monopoly power over domestic consumers. They may or may not exercise monopsony power over competitive suppliers depending on whether the boards are producer cartels or monopsonists. Thus, there are three distortions possible. First, there is monopsony power which causes a board to purchase too little from competitive suppliers. Next, there is monopoly power which causes it to sell too little at home. These production and consumption distortions are shown to be optimally targeted by production and consumption subsidies. In addition, there is a strategic distortion along the lines of Eaton and Grossman (1986). This arises due to the board's inability to precommit to output levels. The government's ability to precommit to taxes and subsidies allows it to correct this distortion. Trade policy optimally targets this distortion and may require a tax or subsidy on exports depending on the strategic variable, as shown in Section 3.

Section 4 considers the effect of a regulation which limits domestic monopoly power by enforcing marginal cost pricing at home. This regulation links distortions by linking domestic and export sales, and this is reflected in the optimal targeting rule. While the regulation removes the consumption distortion, it creates another distortion since it encourages boards to raise exports in order to raise marginal cost and domestic price. Optimal policy can be implemented by a single instrument, the trade tax/subsidy, and its level is determined by both the linkage of distortions and the strategic distortion.

The following section extends the analysis to many boards at home and abroad. As expected, having more domestic boards reduces market power in the domestic market which reduces both consumption and production distortions. It also creates a terms of trade distortion because the existence of many home boards removes the ability of a board to fully internalize the effects of its actions on the terms of trade. The strategic distortion remains but depends on the number of firms. In this case the targeting principle suggests that trade tax/subsidies be directed towards the terms of trade distortion as well as the strategic distortion.

In Section 6, we consider the effects of arbitrage on targeting. With arbitrage a board cannot determine the amount of home and foreign sales independently. In this case, a board which is regulated in its domestic pricing will be forced to act much like a competitive board. We show that the optimal policy in such a case is a trade policy targeted towards the terms of trade distortion, as this is the only distortion present. Without price regulation, there is room for strategic behavior on the part of the board. As was the case with market segmentation, the board's inability to precommit creates a strategic distortion which the government can offset because of its ability to precommit to tax/subsidy policies. With arbitrage, however, the inability of the board to determine home and foreign sales independently links distortions, and this affects the targeting of policy. In particular, our results suggest targeting a consumption subsidy to offset any consumption distortion, and targeting a production subsidy toward the remaining distortions including the strategic distortion. In addition, we show that the consumption distortion is linked through arbitrage to the price abroad and the strategic distortion includes a linkage effect as well. Recall that linkage effects are not present and do not affect policy with market segmentation unless domestic price is regulated.

These results suggest that a useful way to think of policy comparisons in situations with and without arbitrage is in terms of a change in regime. That is, arbitrage fundamentally changes the way the board is able to operate, and arbitrage, like a regulation, constrains the profit maximization opportunities open to the board. This in turn affects optimal policy.

2. The Problem

Agricultural trade is often conducted through marketing boards for the product in question. Marketing boards exist for a number of commodities, including wheat, rice, jute, cocoa and coffee and are used by a number of countries including Australia and Canada.[7] These boards vary greatly across countries, in some instances they are producer cartels who maximize profits of competitive producers, while in other cases, they are monopsonists who buy from competitive producers. In many cases, boards are regulated so that they can exercise market power in the foreign market, but not in the domestic market.

Initially we consider a duopoly situation with market segmentation. There is a marketing board in each country. Each board purchases a homogeneous commodity from competitive producers in its own country and supplies its own domestic demand. However, each competes in a third market with the other marketing board. $d(y)$ is the domestic inverse demand function, while $d^*(y^*)$ is the foreign country's domestic inverse demand. y and y^* are own country sales of each board. The inverse demand in the third country is given by $D(x, x^*)$, where x and x^* are sales of each board to the third country. Notice that while a homogeneous good is provided by all domestic suppliers, domestic production may be imperfectly substitutable with foreign production.[8] With market segmentation, each board can price discriminate between its domestic market and the third market. The inverse supply function from competitive producers is given by $c(x + y)$ at home and $c^*(x^* + y^*)$ abroad, where c and c^* are marginal cost functions.

Four institutional variations are considered with market segmentation. The board maximizes either profits or producer surplus. The profit maximizing board is called a 'P' board while the surplus maximizing one is a 'S' board. In addition, the board may be regulated to supply domestic demand at its marginal cost. This is equivalent to forcing competitive supply in the home market, with the board as the sole marketing agent in international transactions. The absence of regulation is denoted by 'N' while its presence is denoted by 'R'. Thus four combinations are possible, and four kinds of marketing boards, denoted by PN, PR, SN, and SR, are analyzed.

We assume that the government has the ability to tax or subsidize exports, domestic production and consumption. s, v and r denote the level of the export subsidy, production subsidy, and consumption subsidy if they are positive and denote taxes, in the event they are negative.

The timing of moves is crucial. The government moves first and sets taxes/subsidies. Boards take these as given in making their decisions. We assume that the government sets these instruments to maximize social welfare. Social welfare is derived, as usual, on the basis of having a numeraire good which is competitively supplied and an aggregate consumer who gets all profits and government revenues. Each marketing board chooses its domestic and foreign sales to maximize its objective function, subject to any constraints imposed by regulation.

Before we begin the analysis, we would like to stress that we use a model of conjectural variations only to parameterize the nature of competition. As is well known, the appropriate choice of conjectural variations gives the special cases of Cournot and Bertrand competition.[9] Also we are considering optimal policies of the government without retaliation. That is, although the foreign government can also set tax/subsidy policies, we do not look for an equilibrium in that game.

3. Market Segmentation: Unregulated Duopoly

We will first consider the board's problem, and then analyze the optimal government policy. We will consider the behavior of a domestic board of any type, and we will assume that the foreign board is similar to the domestic one.[10] Throughout, π will denote the objective function of the domestic board. Table 1 gives profits of the PN and SN boards. These are the sum of revenues from sales at home and abroad and net subsidies from the government, less costs to the board. Notice the costs of the PN and SN boards differ. This is because the per unit cost to the PN board is the competitive supply price which rises as the amount purchased increases. Its total cost is this supply price multiplied by its purchases. However total cost to the SN board, $C(x+y)$, is just the area under the competitive supply curve.

As usual, each kind of board chooses its home and foreign sales, y and x, to maximize its objective function, given government policies and its conjectural variation parameter which is denoted by γ for the home board and γ^* for the foreign board. Both x and y are chosen according to the first order conditions for profit maximization given in Table 1.

The optimal choice of y is given by the second first order condition for profit maximization and is independent of x^*. This equation defines y for every x and $(r+v)$, denoted by $y(x, r+v)$. Substituting for $y(.)$ in the other first order condition defines the optimal level of x for every value of $(r+v)$, $(s+v)$, x^* and γ. An analogous procedure defines x^* for every value of (r^*+v^*), (s^*+v^*), x, and γ^*. These two equations in x and x^* thus implicitly define the analogues of the familiar best response functions for the home and foreign boards. We assume second order conditions and the usual stability conditions hold in our model, so that their intersection gives the equilibrium x and x* for given tax policies of the governments. The usual comparative statics exercises can also be performed by linearizing these two best response functions. Notice that changes in (r+v) or (s+v) shift the home best response function, and this traces out the foreign best response function. Therefore, the ratio of the comparative statics terms, $\frac{dx^*/da}{dx/da}$ for a = (r+v) or (s+v), gives the slope of the foreign board's best response function, g. We assume the own effects dominate cross effects so that the relative slopes of the best response functions insure stability.

Now consider the choice of r, s, and v by the government in the PN case. The government wishes to set its instruments so as to maximize social welfare. As usual, domestic demand arises from maximization of U(y) + n where n is the amount of the numeraire good. The consumer gets all profits and government revenues so that the budget constraint is given by:

$$P_c y + n = \pi + T + \pi^c$$

where T is government tax revenue which equals $-[(r+v)y + (s+v)x]$, and P_c is the price consumers pay. P_c is taken as given by the consumer. In addition, $\pi^c = c(x+y)(x+y) - {}_0\int^{x+y} c(q)dq$, the profits of competitive producers. All profits and government revenues are returned in a lump sum manner to the consumer, so that π, π^c and T are also taken as given constants in the utility maximization problem. Substituting for n from the budget constraint has the consumer choosing y to maximize $U(y) - P_c y + \pi + \pi^c + T$. Thus $U'(y) \equiv d(y) = P_c$ due to utility maximization.

This gives social welfare as given in Table 1. Since x and y depend on only (r+v) and (s+v), so does welfare.[11] Also, as $U(y) - P_c y = \phi(y)$ is consumer surplus and $\pi + T = \hat{\pi}$ is net profits of the board, welfare is just the sum of the board's net profits, consumer surplus, and the surplus of competitive producers.

Now we can turn to the optimal levels of (r+v) and (s+v). The government chooses (r+v) and (s+v) to maximize welfare. The first order conditions for this problem, after substituting in the board's first order conditions, are given in Table 1. We assume that the second order conditions hold, so that these first order conditions in turn yield the optimal policies also given in Table 1. Notice that only (r+v) and (s+v) can be defined. This arises from the observation that an export subsidy at any rate has the same effect as a consumption tax and production subsidy at the same rate. Hence there is one degree of freedom in choosing r, s, and v. Also notice that as x and y depend on (r+v) and (s+v), the solutions for these values are implicit, not explicit.

The first term in the optimal level of (s+v), $\hat{\pi}_{x*}(g-\gamma)$, is the strategic distortion previously mentioned. For example, with downward sloping best responses and Cournot competition, this calls for a subsidy on exports as $\hat{\pi}_{x*} < 0$ when the domestic and foreign goods are substitutes and $g < \gamma$. This is because the domestic marketing board takes x* as given ($\gamma = 0$), but along the foreign best response function x* falls as x rises ($g < 0$). Since the government chooses policy first, it can correct this distortion by choosing $s = \hat{\pi}_{x*}(g-\gamma) > 0$ which encourages exports and increases profits as $\hat{\pi}_{x*} < 0$. The optimal export policy allows the board to credibly commit to a position of Stackelberg leadership. The second term in (s+v) arises because the board's objective function does not include the profits of competitive suppliers. This distortion arises because of the board's monopsony power. An increase in output raises π^c and so raises welfare. This calls for a subsidy on production, so $v = \pi^{c'}$. If $g = \gamma$, there is no strategic distortion, and the optimal s+v is positive to correct the distortion present due to the monopsony power of the board. In addition, the optimal level of (r+v) is such that $r = \phi' > 0$; because of its monopoly power, the board sets y too low, so that a consumption subsidy is called for. This discussion illustrates our targeting principle in oligopolistic markets. The export subsidy/tax is targeted to the strategic distortion, the production subsidy/tax is targeted to the production distortion, while the consumption distortion is targeted by a consumption subsidy/tax.[12]

Our results can also be illustrated using Figure 1. The loci XX and YY depict the PN board's first order conditions, given $r = s = v = o$, and given x^* and γ. Their relative slopes are given by our assumption that the second order conditions hold. Thus the point A represents the profit maximizing choice of x and y in the absence of policy. The point B in the figure depicts the welfare maximizing choice of x and y for any x^*. It is determined by the intersection of the xx and yy loci. The yy locus depicts the combinations of x and y such that the derivative of welfare with respect to y is zero. xx is analogously defined taking into account that x^* varies with x along the foreign best response function. Again the relative slopes are given by second order conditions. Notice that xx and yy do not shift with (r+v) and (s+v) when foreign policies are given. Optimal tax/subsidy policy is determined so that the board's profits are maximized at B rather than A. The levels of r,s, and v such that welfare is stationary in x and y at the profit maximizing point give the optimal policies of Figure 1.

Recalling that an increase in (r+v) shifts the XX locus to the right, an an increase in (s+v) does the same to the YY locus, we can determine the sign of optimal policies by evaluating the derivative of welfare with respect to x and y at A.[13] Notice that at A welfare is always increasing in y. This follows because the derivative of welfare with respect to y at A is $[\phi'(y) + \pi^{c'}]$. The derivative of welfare with respect to x at A is $[(g-\gamma)\hat{\pi}_{x*} + \pi^{c'}]$. If $(g-\gamma) < 0$, welfare is increasing in x at point A, but i $(g-\gamma) > 0$, welfare may be increasing or decreasing in x at A since $(g-\gamma)\hat{\pi}_{x*}$ and $\pi^{c'}$ have opposite effects. Hence whether B lies to the northeas of A as we have drawn it, or northwest, depends on the sign of $(g-\gamma)$.

If $(g-\gamma) < 0$, the point B lies to the northeast of A. This calls for $(r+v) > 0$ and $(s+v) > 0$ in order to shift the XX and YY loci so that they intersect at B. However, $(g-\gamma) > 0$ will imply B lies north or northwest of A Hence optimally $(r+v) > 0$, but the sign of (s+v) will depend on the relative strengths of the strategic and producer surplus distortions. If the strategi distortion outweighs the producer surplus distortion, that is, B is in Region 2 of Diagram 1, $(s+v) < 0$ and $(r+v) > 0$ is called for. If the opposit is true, B is in Region 3, so that both (s+v) and (r+v) are positive. It is easy to verify that B cannot be in Region 1 as this would require $\hat{\pi}$ to be decreasing in y at B. This is impossible since $\hat{\pi}_y$ at B, assuming B is in Region 1, is always positive.

Optimal policy with a marketing board which represents the interests of competitive producers, i.e., a SN board, is analogously derived. Again profits, welfare, and the first order conditions for profit and welfare maximization are given in Table 1, as are the optimal policies. In this case, as no production distortion exists, it is optimal to set $v = 0$. ($\hat{\pi}$ denotes net profits with a PN or SN board for notational convenience. The $\hat{\pi}$'s refer to different functions in the two cases.)

Again Figure 1 can be used to illustrate the optimal choice of $(r+v)$ and $(s+v)$. As before, the XX and YY loci depict the first order conditions for the board for a given x^* and y in the absence of policy. The xx and yy loci are defined as before so that the point B depicts the welfare maximizing choice of x and y for any x^*. As before, the value of the derivatives of welfare with respect to x and y at A indicate the position of B relative to A, and thus the direction of optimal policies. The derivative of welfare with respect to y at A is $\phi'(y)$ which is positive. The derivative of welfare with respect to x at A is simply $(g-\gamma)\hat{\pi}_{x*}$ with the SN board. Hence $(g-\gamma) < 0$ implies welfare is increasing in x at A, and this calls for $(r+v) > 0$ and $(s+v) > 0$. However, $(g-\gamma) > 0$ implies welfare is decreasing in x at A. As with the PN board, Region 1 can be ruled out, so that B is in Region 2 which calls for $(r+v) > 0$ and $(s+v) < 0$. Optimal policies again are defined by stationarity of welfare with respect to x and y at the profit maximization point.

For both the PN and SN boards, there is no terms of trade distortion motivating trade policy with market segmentation. A terms of trade distortion arises in perfectly competitive models of large countries because,[14] in the absence of government policy, marginal cost is equated with the average, rather than the marginal terms of trade from the country's point of view. No such distortion arises in these models of trade with market segmentation because, in the absence of policy, both the profit and surplus maximizing boards choose the level of exports which equates marginal cost with the marginal revenue from exports. In the next section we show that this changes when the government allows price discrimination, but does not allow the board to exercise monopoly power at home.

4. Targeting with Regulated Boards

In this section we study the effects of a particular way of regulating domestic pricing policies on optimal government intervention. The price at which consumers are willing to buy an extra unit is given by $d(y) + r$. This is called the demand price. The price at which competitive suppliers are willing to sell an extra unit is called the supply price and equals $c(x+y) - v$. The regulation considered requires that the demand price equal the supply price. This regulation prevents the exercise of monopoly power over domestic consumers.

The regulation requires that:

$$c(x+y) = d(y) + (r+v). \tag{1}$$

We focus first on a profit maximizing board. The profits of the board ar given in Table 2. However, due to the regulation, the board cannot choose the level of y. Given any $(r+v)$, and x, the level of y is determined by (1) and i denoted by $\bar{y}(x,r+v)$. It is easy to verify that $\bar{y}_x = c'(x+y)/[d'(y) - c'(x+y)]$ while $\bar{y}_{(r+v)} = \frac{-1}{[d'(y) - c'(x+y)]}$. Thus the optimal choice of x for the board is given by the first order condition for x in Table 2. An analagous condition holds for the foreign board, and the two conditions together determine the equilibrium levels of x and x* given the tax policies of governments. $\bar{y}(x,r+v)$ is determined through the regulatory constraint.

As before, the government need only choose (r+v) and (s+v) to maximize social welfare given in Table 2. Notice that in contrast to Section 3, the choice of y is not such that it maximizes profits given x, i.e., $\frac{\partial \pi}{\partial y} \neq 0$. Substituting for y(x,r+v) in welfare and using the profit maximization condition yields the first order conditions for welfare maximization given in Table 2. As before, g is the slope of the foreign best response function. Since $\hat{\pi}_y = -\pi^{c'} - \phi' + [d(\cdot) - c(\cdot)]$, $\hat{\pi}_y + \pi^{c'} + \phi'$ equals $d(\cdot) - c(\cdot)$. The optimal levels of (r+v) and (s+v) implied by this are given in Table 2.

As usual, r, s, and v are not uniquely defined. Our targeting principle still applies, and differences between policy here and in the absence of regulation can be explained in terms of a market linkage created by the government regulation. We illustrate this in two ways.

If the export subsidy/tax targets the strategic distortion, then $s = \hat{\pi}_{x*}(g-\gamma)$, at the optimum. The optimal production subsidy/tax is then $v = \pi^{c'}[1+\bar{y}_x] + \phi'\bar{y}_x$. This is because the presence of regulation creates a link between the distortions on the production and consumption side since an increase in x reduces y. A production subsidy raises x but lowers y. The total effect of a unit increase in x on (x+y) is $(1+\bar{y}_x)$, which is positive. This raises π^c by $\pi^{c'}[1+\bar{y}_x]$ and this effect calls for $v > 0$. However, the reduction in y also changes ϕ by $\phi'\bar{y}_x$ and this effect calls for $v < 0$. The optimal value of v is determined by both these effects. Similarly, a consumption subsidy raises y. However, regulation requires that the increase in y be induced by a reduction in x and a net reduction in (x+y). The increase in y raises welfare while the reduction in (x+y) lowers it. The optimal value of r is determined by both these effects to be $r = -\phi'\bar{y}_x - \pi^{c'}[1+\bar{y}_x]$. Notice that $r = -v$.

Alternatively, the optimal policy can be implemented with only one instrument, s, being non-zero. The regulation targets the consumption distortion. Since there is no consumer distortion when $c(x + y) = d(y)$, the regulation requires that any non-zero r and v be offsetting, and the simplest way to do this is to set both to zero. The strategic and monopsony distortions remain, but these can be offset by setting $s = \hat{\pi}_{x*}(g - \gamma) + \pi^{c'}$. But notice that the optimal level of (s+v) also includes $\bar{y}_x(\pi^{c'} + \phi')$. This term exists because the board sets foreign sales above the level at which marginal cost equals marginal revenue. It does so in order to circumvent the regulation as increasing foreign sales raises marginal cost and hence domesti price. Thus a further distortion is introduced by government regulation.

The analysis is similar when the marketing board maximizes producer surplus and is regulated. Profits here differ from the PR case only in that the latter do not include the profits of competitive suppliers. Once again y is not chosen since the board is regulated. The first order condition for maximizing the board's objective function is given in Table 2, as is social welfare, which is the sum of net profits of the board, $\hat{\pi}$, and consumer surplus, ϕ. As before (r+v) and (s+v) are the only instruments required, and the first order conditions governing their choice are given in Table 2. Since $\hat{\pi}_y = -\phi' + [d(\cdot) - c(\cdot)]$, the optimal level of (r+v) must be zero, and that of (s+v) must be $\hat{\pi}_{x*}(g-\gamma) + \phi'\bar{y}_x$. Notice again that only s need be non-zero at the optimum. Also, since the interests of competitive producers are taken into account in $\hat{\pi}$, the monopsony distortion is removed. When only one instrument is used, s targets the strategic distortion and the induced distortion in consumption. Raising x reduces y and therefore ϕ, which gives the induced consumption distortion, $\phi'\bar{y}_x$.

These results can also be illustrated using Figure 1. Where x* is given as before, point A depicts the choice of x and y which maximizes the board's objective function in the absence of either regulation or taxes. The point B depicts the welfare maximizing choice of x and y.

Under regulation, the board's choice of x and y is defined by the tangency of its highest perceived isoprofit contour with the regulatory locus, whose position is determined by (r+v). Since the objective is to have the tangency occur at B, this requires setting (r+v) = 0 so that the regulatory locus coincides with the yy curve. The tangency occurs at a point C in Figure 1 for r = v = s = 0. By altering (s+v), different points along the yy locus can be reached. In particular, the point B can be made to be the board's optimal choice. The (s+v) that performs this function is implicitly defined by the slope of a perceived isoprofit contour given γ and this (s+v) being equal to the slope of the yy locus at B.

This results in levels of (s+v) given in Table 2. The sum of the last two terms in the optimal value of (s+v) for the PR board is positive, so that (s+v) > 0 when $(g-\gamma) < 0$. In this case the point C, i.e., the tangency for (s+v) = 0, occurs to the left of B. Shifting the board's isoprofit contours appropriately can be achieved by an export subsidy which raises x, moving the tangency point towards B. When $(g-\gamma) > 0$, appropriate policy may be either an export tax or subsidy since the tangency for (s+v) = 0 may occur either to the right or left of B. With a SR board the appropriate policy may be either an export tax or subsidy depending on the sign of $\hat{\pi}_{x*}(g-\gamma) + \phi'\bar{y}_x$, i.e., the relative size of the distortions.

Notice that (r+v) is optimally zero in the regulated case since B lies along the yy locus and (r+v) = 0 along this locus. However, regulation alone does not lead to the first best optimum since tangency at B is not ensured when (s+v) = 0.

5. The Case of Many Marketing Boards

In this section we analyze optimal government policy when there are m domestic marketing boards and m* foreign marketing boards. While Sections 3 and 4 describe the cases one usually thinks of with regard to agricultural marketing boards, there are cases where different regions within a country have their own marketing boards. In addition, our analysis is intended to apply to policy targeting for any oligopolistic industry where imperfectly competitive exporters purchase a product from competitive producers to sell both at home and in world markets. Hence it is of interest to know how the number of boards in the domestic and foreign market affects optimal policy.

We shall present the analysis for boards which maximize profits in the absence of regulation. As in Section 3, domestic boards are the sole suppliers to domestic consumers, and compete with foreign boards in the third market. They are assumed to price discriminate between their domestic market and the third market. We choose this example to illustrate the effect of having more boards because of the existence of both producer and consumer surplus distortions.

Recall that optimal policy was determined by three kinds of distortions when a single domestic marketing board and a single foreign board competed in a third market. A consumption distortion called for a consumption subsidy/tax, a production distortion called for a production subsidy/tax, and a strategic distortion called for an export subsidy/tax. As the number of boards in the domestic market is increased, we would expect the consumption and production distortions to decrease because the ability of boards to exercise monopoly or monopsony power would decline. As these distortions decline we would expect the role of government policy in offsetting them to decline. Also, the results of Dixit (1984) and Eaton and Grossman (1986) show that the strategic distortion depends on the number of boards and that a terms of trade distortion is created because of the inability of a domestic board to internalize the effects of its actions on the terms of trade. This intuition is easily verified.

In order to focus on the effect of market size on distortions, we present the case of many marketing boards with Cournot competition. We look at identical boards at home and, similarly, at identical boards abroad, and consider the symmetric equilibrium.

Profits of the ith domestic board are given in Table 3. Capital Y and X denote total sales of all domestic boards at home and in the third market, and X* denotes total sales of foreign exporting boards in the third market. Profits of the jth foreign board are given by an analogous equation. Each board chooses x^i and y^i to maximize π^i, given r, s, v and its conjecture that both domestic and foreign rival boards maintain given sales at home and abroad. The first order conditions for each board are as given in Table 3. Given Cournot competition, the sum of all of the m boards' first order conditions at home can be written as:

(2) $d'(Y)Y + md(Y) - c'(X+Y)(X+Y) - mc(X+Y) + m(r+v) = 0$

(3) $D'(X+X^*)X + mD(X+X^*) - c'(X+Y)(X+Y) - mc(X+Y) + m(s+v) = 0$

Similar equations arise from summing the m* foreign boards' first order conditions. It is easily verified from these four equations that $\frac{dX^*/d(s+v)}{dX/d(s+v)} = \frac{dX^*/d(r+v)}{dX/d(r+v)}$ which we will denote by g. The usual second order and stability conditions are assumed.

The government chooses (s+v) and (r+v) to maximize welfare. Table 3 gives social welfare and the first order conditions for welfare maximization, where use is made of (2) and (3) and the definition of g given above. These first order conditions define the optimal policies in Table 3. As before, v can be targeted toward the production distortion, and equals $\pi^{c'}/m$. r then targets the consumption distortion, given by ϕ'/m. The strategic and terms of trade distortions are targeted by s, which is now given by $D'Xg + D'X[m-1]/m$. The first term represents the familiar strategic distortion in the Cournot case. With downward sloping best response functions this calls for a subsidy. However, with more boards, competition among boards in the third market is excessive since firms do not fully internalize the effects of their output decisions on price faced by domestic boards. This is captured by the second term and calls for a tax for $m \geq 1$. Since the strategic and terms of trade distortions have opposing effects, the sign of s is ambiguous and depends on the relative magnitudes of g and [m-1]/m. The slope of the foreign best response function, g, depends on the number of foreign boards as well as demand and cost parameters, so that whether an export tax or subsidy is called for depends on the relative number of boards at home and abroad.

As before, the optimal policies are implicit as X and Y depend on (r+v) and (s+v). Explicit solutions for the optimal policies in a linear example are available from the authors. With linear demand and marginal cost, the optimal value of (r+v) approaches zero as the number of home boards approaches infinity. This results from the diminished ability of home boards to exercise monopoly and monopsony power at home as m becomes large. The optimal (s+v) becomes a tax as m approaches infinity. This is because the terms of trade distortion outweighs the strategic distortion, and the production distortion vanishes.

6. Incorporating Arbitrage

6.1 The Effect of Arbitrage

In our analysis so far we have assumed that no arbitrage is possible between markets. This is what allowed the neat targeting results of the earlier sections. In this section we show that the effect of arbitrage on the nature of optimal policies is substantial. Arbitrage links markets and distortions, creating multimarket effects of policies and so links the optimal levels at which the instruments are set. While arbitrage prevents firms from setting domestic and foreign sales separately, the government can help separate markets by setting trade taxes/subsidies to do so.

We show that with arbitrage, a regulated board loses the ability to behave strategically. This is because regulation with arbitrage regulates the world market and essentially reduces the board to follow marginal cost pricing and behave competitively. This removes any production, consumption, and strategic distortions. However, it creates the usual terms of trade distortion since the government can change the terms of trade by its trade tax/subsidy policies. Thus, the optimal policy here is shown to be one that targets the terms of trade distortion and consists of only an export tax or import tariff depending on whether the country is a net exporter or importer. This is true whether we consider a PR or SR board.

The optimal policies without regulation are more complex. We analyze a SN board, leaving the analysis of a PN board to the reader. In this case, the consumption subsidy/tax can be set so as to equate marginal utility of consumption at home with marginal cost of production and this calls for a consumption subsidy. Since boards have market power, the production tax/subsidy then is set to target the strategic and other distortions.

Arbitrage requires that the price boards receive at home equal the price they receive abroad so that for the home board:

$$(4) \qquad d(y) + r + v = D(x + x^*) + s + v.$$

Notice we are assuming that both boards produce a homogeneous good in this section for simplicity.[15] This equation shows how arbitrage links x and y for any given x^* and (s-r). Let $y(x+x^*, s-r)$ be implicitly defined by the solution to (4). $y(\cdot)$ rises with $(x+x^*)$ and falls with (s-r). This is because an increase in $(x+x^*)$ reduces the world price, and by arbitrage reduces the domestic price, raising domestic consumption. An increase in (s-r) raises domestic price, reducing consumption at home. The board can therefore only set x independently. The analogy to regulation is apparent. However, in this case y and x are positively related, while with regulation they are negatively related. In addition, the arbitrage locus is not as closely related to the welfare maximizing locus, yy, as the regulation condition is.

We will consider the case with arbitrage and regulation first since it i more transparent.

6.2 Arbitrage and Regulation

Regulation requires that the board equate the demand and supply price at home. With arbitrage this means that it must be set so that

$$d(y(x+x^{*}, s-r)) + r = c(x + y(x+x^{*}, s-r)) - v. \tag{5}$$

Thus, for a given x^*, the board has no choice in setting x. Thus (5) is the analogue of the home board's best response function in earlier sections. The analogous equation defined for the foreign board gives another relationship between x and x^*, and is

$$d^{*}(y^{*}(x+x^{*}, s^{*}-r^{*})) + r^{*} = c^{*}(x^{*} + y^{*}(x+x^{*}, s^{*}-r^{*})) - v^{*}. \tag{6}$$

Together these equations solve for the equilibrium levels of x and x^* fo any given levels of taxes. Notice that (5) and (6) hold irrespective of whether we have a PR board or a SR board. Also, since home taxes/subsidies only affect the location of (5), g, the change in x^* as x changes along (6) the ratio, $\frac{dx^*/da}{dx/da}$ for a = (r+v) and (s-r). As usual, we assume that the relative slopes of best response functions are such that the equilibrium is stable.

Now we are ready to define optimal policy. As before, welfare equals th sum of consumer surplus and total net profits. With a SR board these are ju the board's profits. With a PR board, these equal the sum of the board's profits and those of competitive producers. In either case:

$$(7)\qquad W = \phi(y(\cdot)) + [d(y(\cdot))y(\cdot) + D(x+x^*)x - C(x+y(\cdot))]$$

$$= \phi(y(\cdot)) + \hat{\pi}(x,x^*,y(\cdot))$$

where $C(\cdot)$ is total cost. Since the equilibrium level of x depends on (s-r), (r+v), (s*-r*), and (r*+v*) from (5) and (6), so does y. Therefore welfare can be affected only by changing (s-r) and (r+v). The former is the difference between the price consumers face at home, d(y), and the price that consumers face abroad, D(x+x*) as seen from the arbitrage condition (4). The latter is the difference between marginal costs and the price consumers face at home by (5).

Thus, the optimal levels of (s-r) and (r+v) are implicitly defined by the following:[16]

$$(8)\qquad \frac{dW}{d(r+v)} = \left[\hat{\pi}_x + \hat{\pi}_{x^*}g + [\hat{\pi}_y + \phi'(y)]y_{x+x^*}(1+g)\right]\frac{dx}{d(r+v)} = 0$$

and

$$(9)\qquad \frac{dW}{d(s-r)} = \left[\hat{\pi}_x + \hat{\pi}_{x^*}g\right]\frac{dx}{d(s-r)} + \left[\hat{\pi}_y + \phi'(y)\right]\left[y_{x+x^*}(1+g)\frac{dx}{d(s-r)} + y_{(s-r)}\right] = 0.$$

This requires that:

$$(10)\qquad \hat{\pi}_y + \phi'(y) = d(y) - c(y) = 0$$

and

$$(11)\qquad \hat{\pi}_x + \hat{\pi}_{x^*}g = D'(x+x^*)x(1+g) + D(x+x^*) - c(x+y)$$

$$= D'(x+x^*)x(1+g) - (s+v) = 0$$

where the second equality in (11) comes from the arbitrage and regulation conditions. Thus, from (10) and regulation we know $(r+v) = 0$ optimally, while from (11) we know that $(s+v) = D'(x+x^*)x(1+g)$. Therefore, $r = v = 0$, and $s < 0$ if $x > 0$, i.e., an export tax, and $s > 0$ if $x < 0$. As usual, we interpret the latter as an import tariff. In this we are assuming that $(1+g) > 0$ as it is with symmetry and stability.

The optimal policies can be understood using Figure 2, which is drawn for x^* equal to its equilibrium value with r, s, v, set optimally. yy and xx have the same interpretation as before. The RR line gives the locus of points satisfying the regulation equation (5). RR is drawn for $(r+v) > 0$. It lies above yy which is also the regulatory if $(r+v) = 0$. xx and yy intersect at B. The curve $\alpha\alpha$ is the arbitrage equation (4) for $s = r = 0$. The intersection of RR and $\alpha\alpha$ at A gives the equilibrium levels of x and y for $s = r = 0$, $v > 0$. The government's problem is to move A to B. This is done by setting $r = v = 0$ which moves RR to yy. This moves the intersection to C. In addition, the $\alpha\alpha$ curve has to be moved to go through B. This is done by changing s. Figure 2 is drawn for the case where an export tax is optimal. A tax on exports is optimal if the equilibrium level of x, when policies are set optimally, is positive. In this case the $\alpha\alpha$ curve with $s = 0$ lies below B as shown. A decrease in s shifts $\alpha\alpha$ up to $\alpha'\alpha'$ so that the intersection point of the arbitrage and regulation equations goes through B.

6.3 Arbitrage without Regulation

In the absence of regulation, arbitrage merely limits the ability of the board to set both x and y independently. It does not remove the choice of output itself as occurs when regulation is also imposed. We will consider the SN board here, leaving the analysis of the PN board to the reader. $\hat{\pi}$ denotes net profits of the board.

Maximization of profits, after substituting in for y(x+x*, s-r) determined by (4), gives:

$$(12) \qquad \hat{\pi}_x + \hat{\pi}_{x*}\gamma + (s+v) + [\hat{\pi}_y + (r+v)]y_{x+x*}(1+\gamma) = 0$$

where γ is the conjectured variation on x* by the home board. A similar equation exists for the foreign board, and the equilibrium values of x and x* are implicitly defined by these two equations. Once again changes in r, s, and v shift (12), and trace out the foreign best response function so that g has the usual meaning.

The welfare maximizing choices of (s+v) and (s-r) are defined by the government's first order conditions. These imply that the optimal (s+v) and (s-r) are those defined by (13) and (14) below:

$$(13) \qquad \hat{\pi}_x + \hat{\pi}_{x*}g = 0$$

$$(14) \qquad \hat{\pi}_y + \phi'(y) = d(y) - c(x+y)$$

$$= D(x+x^*) - c(x+y) + (s-r) = 0$$

where the second equality arises from using the arbitrage condition. The optimal level of (s-r) is thus:

$$(15) \qquad s-r = -[D(x+x^*) - c(x+y)]$$

Therefore, if the world price exceeds marginal cost of production, the price to consumers at home should be below the price to consumers in the third market, i.e., this calls for a consumption subsidy. Substituting for the board's first order condition in (13) and for (s-r) yields:

(16) $$\hat{\pi}_{x*}(g-\gamma) - (s+v)\left[1+y_{x+x*}(1+\gamma)\right] - (\hat{\pi}_y + D-c)y_{x+x*}(1+\gamma) = 0$$

This gives the optimal level of (s+v) as:

(17) $$(s+v) = \frac{\hat{\pi}_{x*}(g-\gamma)}{1+y_{x+x*}(1+\gamma)} - \left[\hat{\pi}_y + (D-c)\right] \frac{y_{x+x*}(1+\gamma)}{1+y_{x+x*}(1+\gamma)}$$

Let s = 0 so that (15) gives r and (17) gives v.

To interpret these policies first recall that there is no production distortion with the SN board. The board exercises monopoly power at home in the absence of regulation, and our analysis shows a consumption subsidy should be targeted toward this distortion. Notice that the consumption subsidy is set so that $d(y) = c(x+y)$, but arbitrage links $d(y)$ to the world price.

Also notice that, because of the multimarket linkages caused by arbitrage, the strategic distortion does not enter in the setting of (s-r), so that a production subsidy can be targeted toward the strategic distortion. Again, arbitrage crucially affects the targeting principle as the optimal level of v is determined by linkage effects in addition to the strategic distortion. Hence, the strategic term in (17) is $\frac{\hat{\pi}_{x*}(g-\gamma)}{1+y_{x+x*}(1+\gamma)}$. Also notice that the optimal v includes both this strategic effect and an additional term because of arbitrage.

7. Conclusion

In this paper we have attempted to illustrate how the concept of a strategic distortion can be used to identify optimal policy in imperfectly competitive markets, and to derive an analogue of the targeting principle for competitive markets. As we have shown, this is much easier, when price discrimination is allowed between markets, as arbitrage links markets together creating multimarket effects of a policy. However, even in the presence of arbitrage and in the absence of regulation, the strategic distortion influences only (s+v), the wedge between the producer price and the consumer price in the third market, i.e., the world price. It does not affect (s-r), the wedge between the consumer price at home, d(y), and the world price, D(·). Regulation eliminates any strategic distortion and a role for policy exists to the extent that exports exist and the terms of trade can be affected by policy.

There are a number of issues which are not addressed in our analysis. Marketing boards are often direct extensions of the government, and have the same objective function as the government. In this case, the government can have no effect on welfare unless it has some advantage, informational or otherwise over the board. However, in general, any objective function on the part of the board and of government can be handled and the results will, of course, be sensitive to the formulation employed.

It may be argued that the direction of the strategic distortion is hard to identify in practice; however, recent work suggests that computable partial equilibrium models, such as Dixit (1988), can be used to estimate the strategic distortion, making practical applications feasible. On the other hand, precommitment to a policy may be hard and possible retaliation by other countries could undo any beneficial effects of such policies. Also optimal policy becomes much more complex when one allows for endogenous distortions, as in Rodrik (1987). Simple targeting principles are no longer applicable in such scenarios. Finally, the reader may be perturbed by the nonuniqueness of r, s, and v. Such nonuniquesness is generic in these models, and in this paper we assign instruments to distortions following economic intuition. A way of pinning this down would be to include a cost of such policies but this would obfuscate the targeting principles derived here.

We believe that our work is important for at least two reasons. First, it shows that use of trade policy should be examined, in terms of optimality, by considering all existing distortions and available instruments. This is because trade policy may be unable to target all the distortions and thus be far from first best when considered in isolation. Our targeting principle allows us to interpret when trade policy is first best.

Second, while computable partial equilibrium models promise to help formulate optimal policy, our results show that optimal policy is sensitive to assumptions about market structure, arbitrage, and regulation. The use of such models is warranted only when sensitivity analysis indicates the results are not dramatically affected by changes in model structure. Our work would help in developing model variations for sensitivity analysis and in interpreting the results of such exercises. In future work we hope to provide further applications of targeting as well as address some of the issues raised above.

Footnotes

1. See Bhagwati (1971).

2. See for example Krishna (1984) and Krishna and Itoh (1988).

3. A related paper is Brander and Spencer (1985). We will not discuss the literature in detail, but refer the interested reader to the excellent survey by Dixit (1987).

4. The terms of trade distortion exists because of a coordination problem. The individual firms take the world price as given, when it, in fact, depends on total domestic output. In the case of one home firm, no such problem arises.

5. Eaton and Grossman (1986) allow arbitrage when domestic consumption is included and point out that the effect of policy on the price faced by domestic consumers is vital.

6. Just *et al*. (1979) derive optimal policy for each of the institutional variations in marketing boards we consider in Sections 3 and 4. However, their analysis is of a marketing board which is a monopolist in the world market, so that strategic effects are absent. Their analysis is also a partial equilibrium one like ours.

Markusen (1984) examines a board which maximizes producer surplus, with and without regulation. His analysis is a general equilibrium one, but his focus is not on strategic interactions between boards.

7. See Hoos (1979) and World Development Report (1986) for some examples of real life marketing boards and how such boards operate in different countries.

. Greater product differentiation can be allowed, but as it adds little to he interpretations offered and does complicate the derivations. In later ections when we allow arbitrage, we assume the same homogeneous good is roduced by both domestic and foreign firms as product differentiation greatly omplicates the analysis.

. The standard objection to conjectural variations models is the absence of well defined extensive form. However, we feel that its usefulness in arameterizing the nature of competition and the strategic distortion warrants ts use as an expository tool in this paper.

0. Changing this assumption will only have quantitative, not qualitative, ffects.

1. It is worth noticing that in the absence of arbitrage between home and oreign markets, the government can create a wedge between the price producers et at home, P_p^h and the price consumers pay at home P_c^h and the price producers et abroad P_p^f and the price consumers pay abroad, P_c^f. Since $_p^h = d(y) + (r+v)$, $P_c^h = d(y)$, $P_p^f = D(x,x^*) + (s+v)$, and $P_c^f = D(x,x^*)$, the ormer wedge is given by the size of (r+v), and the latter by (s+v). This is he reason why only (r+v) and (s+v) enter the problem.

2. Expressing these policies in terms of elasticities provides additional ntuition. $s/D = -(g-\gamma)\theta/E$ where θ is the share of the home board in the hird market and E is the elasticity of demand in the third market. Thus the xport subsidy as a percentage of the world price is greater the larger is /E. Also $r/d = 1/\epsilon$ where ϵ is the home market's elasticity of demand. Thus he consumption subsidy is high in percentage terms when the market elasticity s low. Finally, $v/c = \eta$ where η is the elasticity of marginal cost. Thus v

as a percentage of marginal cost is large when marginal cost is elastic in output, i.e. when marginal cost rises relatively fast.

13. Of course, we are assuming that both welfare and the board's objective functions are well behaved. That is, they are quasiconcave and have a unique maximum.

14. See Jones (1987) for a discussion of the optimum tariff and market segmentation with a private monopolist.

15. This allows us to keep the framework as close to the no arbitrage case as possible. Allowing product differentiation with arbitrage would significantly complicate the analysis of arbitrage without adding much to the results.

16. Note that although y(x+x*, s-r), we are using $\hat{\pi}_x$ to denote the derivative of $\hat{\pi}$ with respect to x for a given y, while $\hat{\pi}_y$ denotes the derivative of $\hat{\pi}$ with respect to y given x.

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Table 1

Unregulated Duopoly

Type of Board	PN	SN
Profits	$\pi = d(y)y + D(x,x^*)x - c(x+y)(x+y)$	$\pi = d(y)y + D(x,x^*)x - {}_0\int^{x+y} c(q)dq$
	$+ (s+v)x + (r+v)y$	$+ (s+v)x + (r+v)y$
	$= \hat{\pi}(x,x^*,y) + (s+v)x + (r+v)y$	$= \hat{\pi}(x,x^*,y) + (r+v)y + (s+v)x.$
Profit Maximization	$FOC_x: \ \hat{\pi}_x + \hat{\pi}_{x^*}\gamma + (s+v) = 0$	$FOC_x: \ \hat{\pi}_x + \hat{\pi}_{x^*}\gamma + (s+v) = 0$
	$FOC_y: \ \hat{\pi}_y + (r+v) = 0$	$FOC_y: \ \hat{\pi}_y + (r+v) = 0$
Welfare	$W = U(y) - P_c y + \hat{\pi}(x,x^*,y) + \pi^c(x+y)$	$W = D(x,x^*)x + d(y)y - {}_0\int^{x+y} c(q)dq + U(y) - yd(y)$
Welfare Maximization	$\frac{dW}{d(s+v)} = \left[\hat{\pi}_{x^*}(g-\gamma) - (s+v) + \pi^{c'}\right] \frac{dx}{d(s+v)}$	$\frac{dW}{d(s+v)} = \left[\hat{\pi}_{x^*}(g-\gamma) - (s+v)\right] \frac{dx}{d(s+v)}$
	$+ \left[\pi^{c'} - (r+v) + \phi'\right] y_x \frac{dx}{d(s+v)} = 0$	$+ \left[\phi'(y) - (r+v)\right]\left[y_x \frac{dx}{d(s+v)}\right] = 0$
	$\frac{dW}{d(r+v)} = \left[\hat{\pi}_{x^*}(g-\gamma) - (s+v) + \pi^{c'}\right] \frac{dx}{d(r+v)}$	$\frac{dW}{d(r+v)} = \left[\hat{\pi}_{x^*}(g-\gamma) - (s+v)\right] \frac{dx}{d(r+v)}$
	$+ \left[\pi^{c'} - (r+v) + \phi'\right]\left[y_x \frac{dx}{d(r+v)} + y_{(r+v)}\right] = 0$	$+ \left[\phi'(y) - (r+v)\right]\left[y_x \frac{dx}{d(r+v)} + y_{(r+v)}\right] = 0$
Optimal Policies	$(r+v) = \phi' + \pi^{c'}$	$r + v = \phi'$
	$s+v = \hat{\pi}_{x^*}(g-\gamma) + \pi^{c'}$	$s + v = \hat{\pi}_{x^*}(g-\gamma)$

Table 2

Regulated Duopoly

Type of Board	PR	SR
Profits	$\pi = d(y)y + D(x,x^*)x - c(x+y)(x+y)$ $+ (s+v)x + (r+v)y$ $= \hat{\pi}(x,x^*,y) + (s+v)x + (r+v)y$	$\pi = d(y)y + D(x,x^*)x - {}_0\int^{x+y} c(q)dq$ $+ (s+v)x + (r+v)y$ $= \hat{\pi}(x,x^*,y) + (s+v)x + (r+v)y.$
Profit Maximization	$FOC_x: \quad \hat{\pi}_x + \gamma\hat{\pi}_{x*} + \hat{\pi}_y\bar{y}_x$ $+ (r+v)\bar{y}_x + (s+v) = 0$	$FOC_x: \quad \hat{\pi}_x + \gamma\hat{\pi}_{x*} + \hat{\pi}_y\bar{y}_x$ $+ (r+v)\bar{y}_x + (s+v) = 0$
Welfare	$W = U(y) - P_c y + \hat{\pi}(x,x^*,y) + \pi^c(x+y)$	$W = D(x,x^*)x + d(y)y - {}_0\int^{x+y} c(q)dq + U(y) - yd(y)$
Welfare Maximization	$\frac{dW}{d(s+v)} = \Big[\hat{\pi}_{x*}(g-\gamma) - (r+v)\bar{y}_x - (s+v)$ $+ \pi^{c'}[1+\bar{y}_x] + \phi'\bar{y}_x\Big] \frac{dx}{d(s+v)} = 0$	$\frac{dW}{d(s+v)} = \Big[\hat{\pi}_{x*}(g-\gamma) - (s+v) - (r+v)\bar{y}_x$ $+ \phi'\bar{y}_x\Big] \frac{dx}{d(s+v)} = 0$
	$\frac{dW}{d(r+v)} = \Big[\hat{\pi}_{x*}(g-\gamma) - (r+v)\bar{y}_x - (s+v) + \pi^{c'}[1+\bar{y}_x]$ $+ \phi'\bar{y}_x\Big] \frac{dx}{d(r+v)} + \Big[\hat{\pi}_y + \pi^{c'} + \phi'\Big] \bar{y}_{(r+v)} = 0$	$\frac{dW}{d(r+v)} = \Big[\hat{\pi}_{x*}(g-\gamma) - (s+v) - (r+v)\bar{y}_x$ $+ \phi'\bar{y}_x\Big] \frac{dx}{d(r+v)} + \Big[\hat{\pi}_y + \phi'\Big] \bar{y}_{(r+v)} = 0$
Optimal Policies	$(r+v) = 0$ $(s+v) = \hat{\pi}_{x*}(g-\gamma) + \pi^{c'}(1+\bar{y}_x) + \phi'\bar{y}_x$ $= \hat{\pi}_{x*}(g-\gamma) + \pi^{c'} + \bar{y}_x(\pi^{c'} + \phi')$	$(r+v) = 0$ $(s+v) = \hat{\pi}_{x*}(g-\gamma) + \phi'\bar{y}_x$

Table 3

The Case of Many Marketing Boards

Type of Board	PN
Profits of the ith Board	$\pi^i = d(Y)y^i + D(X+X^*)x^i - c(X+Y)(y^i+x^i) + (s+v)x^i + (r+v)y^i$ $= \hat{\pi}^i + (s+v)x^i + (r+v)y^i$
Profit Maximization	$FOC_x i: \hat{\pi}^i_{x^i} + (s+v) = 0$ $FOC_y i: \hat{\pi}^i_{y^i} + (r+v) = 0$
Welfare	$W = \sum_{i=1}^{m} \hat{\pi}^i + \pi^c(X+Y) + \phi(Y)$
Welfare Maximization	$\frac{dW}{da} = \left[\{d(Y) - c(X+Y)\}(1-m) + \pi^{c'} + \phi' - m(r+v)\right] \frac{dY}{da}$ $+ \left[\{D(X+X^*) - c(X+Y)\}(1-m) + D'Xg + \pi^{c'} - m(s+v)\right] \frac{dX}{da} = 0$ for $a = (r+v)$ and $(s+v)$.
Optimal Policies	$(r+v) = \frac{\pi^{c'} + \phi'}{m}$ $(s+v) = \frac{\pi^{c'}}{m} + D'Xg + D'X \frac{(m-1)}{m}$

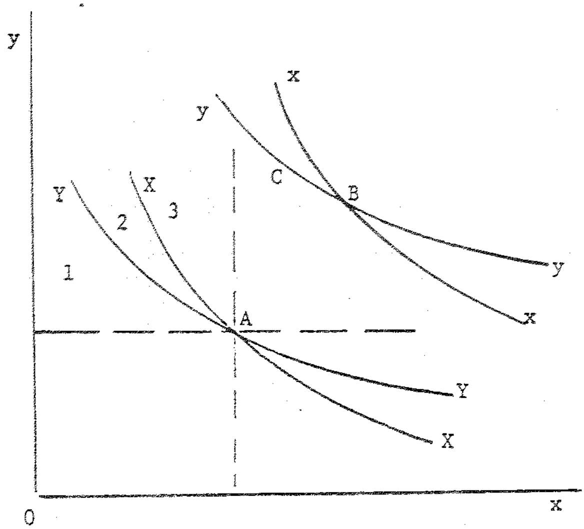

Figure 1

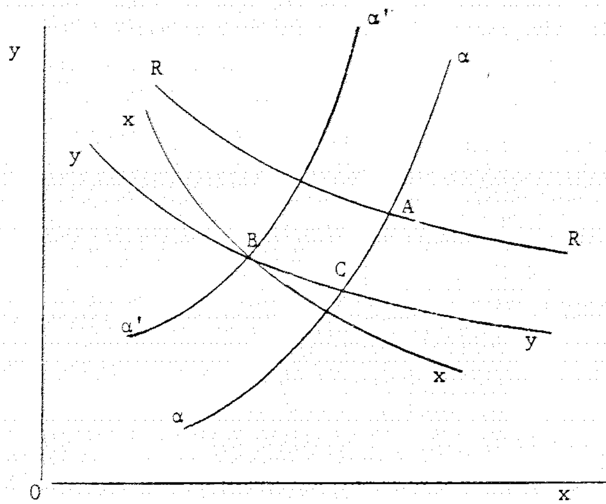

Figure 2