

# Directing Government Procurement as an Incentive of Production

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## Abstract

*Due to the inefficacy of current government procurement policy (Baldwin [1970, 1984], Baldwin and Richardson [1971], and Miyagiwa [1991]), a new policy scheme that embodies the incentive of production is proposed in this paper. The policy, which ties positively the government purchase from each of the domestic firms to its sales to consumers, is found to have the effects of increasing domestic output and reducing imports. Moreover, the optimal policy is such that it induces the domestic firms to produce at the socially optimal level.*

## I. Introduction

It has been a popular practice for governments to give preferential treatment to domestic producers when purchasing non-military supplies. This policy directs government agencies to purchase goods from domestic suppliers, and even renders them to pay prices for domestic goods that exceed the delivered foreign price of the same goods. In the United States, the

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policy is specified as the Buy-American Act. Similar regulations can be found in the other developed and developing countries (Lowinger [1976]). Conventional wisdom suggests that such government procurement policies should tend to increase domestic production and to reduce imports.

However, this conventional view has been challenged by Baldwin [1970, 1984] and Baldwin and Richardson [1971]. They demonstrate within a perfectly competitive framework that government procurement policy neither reduces imports nor raises domestic output level. The shifting of government purchases from imports to domestic suppliers creates an equal and opposite shift in consumer demand toward imports. This result is further confirmed by Miyagiwa [1991]. In a duopoly model, he shows that if the goods are perfect substitutes, each firm's equilibrium output is determined *only* by the structure of the duopoly, *i.e.*, the demand and cost functions and the conjectures between the firms. Current government procurement policies are ineffectual with regard to promoting domestic production and reducing imports.

The primary problems in oligopolistic industries are (1) firms underproduce so that total output does not reach the socially optimal level, and (2) price is higher than marginal cost. The first of these indicates that government policies that intensify competition of firms may be beneficial from a national-social perspective. The second implies that procurement policy may be a substitute for antitrust policy if the policy can induce a reduction of price to marginal cost.

This paper provides an example in which government procurement policy can eliminate the domestic economic distortions associated with oligopoly. The policy proposed is that, if the domestic firm produces more, the government will purchase more from it. Under this policy scheme the domestic firms have the incentive to expand their production to capture more profits from sales to the government, as long as price exceeds marginal cost. As a result, price falls, so does the difference between price and marginal cost.

In section II I briefly present Miyagiwa's model to show the inefficacy of the current government procurement policy. The model is also used as a benchmark for comparing the proposed policy with the current one. In section III I construct a model of two domestic and one foreign firms when the government procurement depends on the level of the domestic firms' pro-

duction for consumers. I then derive the optimal policy. Finally, I conclude with a discussion to align the proposed policy with the GATT prospective.

## II. The Inefficacy of the Current Policy

I briefly present Miyagiwa's model in a context of three firms to demonstrate the inefficacy of the current government procurement policy.

Suppose there are two firms ( $i = 1, 2$ ) in the domestic country and only one ( $i = 0$ ) in the foreign country. Firm 0 exports its entire output to the domestic country, whereas firms 1 and 2 do not export. Demand is generated from both private and government sectors. Firm  $i$ 's sales in the private sector are denoted as  $x_i$ , and the total sales from all firms are denoted as  $X$ , *i.e.*,  $X = x_0 + x_1 + x_2$ . The private-sector inverse demand function is  $p(X)$ , and the government-sector demand is a fixed quantity  $g$ , with  $g_i$  toward firm  $i$  ( $i = 0, 1, 2$ ). Finally, all firms have the same cost function  $c(x_i + g_i)$ .

Firm  $i$ 's profit is given by

$$\pi_i = (x_i + g_i)p(X) - c(x_i + g_i). \quad (1)$$

Denoting firm  $i$ 's total output as  $y_i$ , *i.e.*,  $y_i = x_i + g_i$ , I rewrite (1) as

$$\pi_i = y_i p(y_0 + y_1 + y_2 - g) - c(y_i). \quad (1')$$

The first-order condition for firm  $i$  is:

$$d\pi_i/dy_i = p(y_0 + y_1 + y_2 - g) + y_i p'(y_0 + y_1 + y_2 - g)(1 + v_i) - c'(y_i) = 0, \quad (2)$$

where  $v_i$  is the conjectural variation that firm  $i$  makes about the output responses of its opponents to a unit change of its output. Since the government purchase from firm  $i$  is constant and exogenous to the firms,  $v_i = d(\sum_{j \neq i} y_j) / dy_i = d(\sum_{j \neq i} x_j) / dx_i$ . The value of  $v_i$  ranges from  $-1$  to  $2$ , with different values of  $v_i$  capturing different types of market structure. Assume that the second-order condition and the stability condition are satisfied.

From (2) the equilibrium outputs ( $y_0^c, y_1^c, y_2^c$ ) are defined, which are not related to  $g_i$ . Then, I obtain Miyagiwa's result that in an oligopoly shifting government purchases toward domestic firms changes neither firm's total output. The model demonstrates that the current government procurement

policy fails to increase domestic output and reduce imports. I set  $g_0 = 0$  and  $g_i = g/2$  ( $i = 1, 2$ ), and denote the corresponding sales in the private sector as  $(x_0^C, x_1^C, x_2^C)$  for uses below.

### III. The Incentive Policy

The government and both domestic firms are the main players in the model. The government designs a reward system to motivate the domestic firms to increase production through its purchases. An important assumption is that the government possesses full information of the industry structure and is able to devise its procurement policy in advance of the quantity decision of the firms. The procurement policy that embodies the incentive of production is as follows. The government purchase from each domestic firm,  $g_i$  ( $i = 1, 2$ ), is positively related to the firm's sales in the private sector, *i.e.*,

$$g_i = a + bx_i, \quad i = 1, 2, \quad (3)$$

where  $a$  is a negative number and  $b$  is the incentive coefficient.<sup>1</sup> The addition of  $a$  in (3) is to free the government from its binding physical budget constraint:  $g_1 + g_2 = g$ . The smaller  $a$  is the larger the incentive coefficient  $b$  can be. Since  $b$  is the marginal gain of government purchases, the larger  $b$  is the higher the incentive is for the domestic firms to increase their private-sector sales. The government purchase  $g_i$  will not be zero, negative, or more than what it needs because of the existence of the civilian market and the assumption of the timing of the game and information structure.<sup>2</sup> The magnitudes of  $a$  and  $b$  are characterized by first, solving the firms' quantity decision problems under the incentive policy, and second, based on this information the government selecting  $a$  and  $b$  to maximize the social welfare. Under this scheme the government will not buy from the foreign firm, *i.e.*,  $g_0 = 0$ .

The profit of each domestic firm under the incentive policy is given by

$$\pi_i = (x_i + a + bx_i)p(X) - c_i(x_i + a + bx_i), \quad i = 1, 2. \quad (4)$$

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1. The idea to add a negative number  $a$  in the equation was provided by Professors Acharya and Balvers, to whom I am thankful.
  2. For the analysis of no private-sector demand cases, see a paper by McAfee and McMillan [1989].

The first-order condition for the domestic firms becomes:

$$\begin{aligned} d\pi_i/dx_i &= (1+b)p(X) + (x_i + a + bx_i)p'(X)(1+v_i) \\ &\quad - (1+b)c'(x_i + a + bx_i) = 0, \quad i = 1, 2. \end{aligned} \quad (5)$$

The first-order condition for the foreign firm under the incentive policy is the same as in (2), except  $g_0$  is set to zero. Equation (2) for the foreign firm and equation (5) define the equilibrium  $(x_0^I, x_1^I, x_2^I)$  under the incentive policy. Denote  $x_d$  as the total private-sector sales from the domestic firms, *i.e.*,  $x_d = x_1 + x_2$ . Note that the domestic firms are symmetric, *i.e.*,  $x_i = x_d/2$  and  $v_i = v_d$ , ( $i = 1, 2$ ). Denote the perceived marginal profit of each domestic firm as  $\mu_d$  and the perceived marginal profit of the foreign firm as  $\mu_0$ , *i.e.*,

$$\begin{aligned} \mu_d &= (1+b)p(X) + [a + (1+b)(x_d/2)]p'(X)(1+v_d) \\ &\quad - (1+b)c'[a + (1+b)(x_d/2)] = 0, \text{ and} \end{aligned} \quad (6)$$

$$\mu_0 = p(X) + x_0p'(X)(1+v_0) - c'(x_0) = 0. \quad (7)$$

Let

$$\begin{aligned} \alpha_d &= \partial\mu_d/\partial x_d = (1+b)[(3+v_d)/2]p' + [a + (1+b)(x_d/2)](1+v_d)p'' \\ &\quad - [(1+b)^2/2]c'', \end{aligned} \quad (8)$$

$$\beta_d = \partial\mu_d/\partial x_0 = (1+b)p' + [a + (1+b)(x_d/2)](1+v_d)p'', \quad (9)$$

$$\alpha_0 = \partial\mu_0/\partial x_0 = (2+v_0)p' + x_0(1+v_0)p'' - c'', \text{ and} \quad (10)$$

$$\beta_0 = \partial\mu_0/\partial x_d = p' + x_0(1+v_0)p''. \quad (11)$$

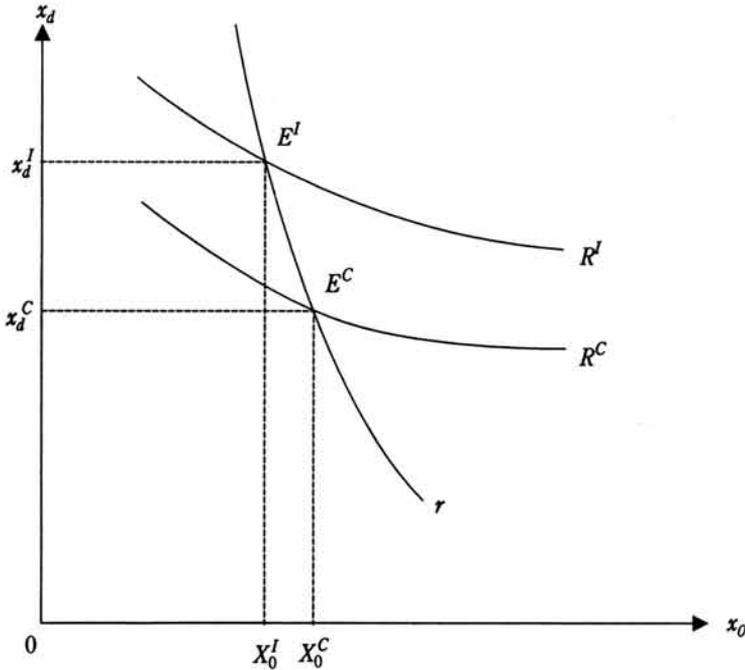
The market is stable if  $\alpha_0 < 0$ ,  $\alpha_d < 0$  and  $\alpha_0\alpha_d - \beta_0\beta_d > 0$ .<sup>3</sup> I assume that these conditions and the second-order condition are satisfied.

In order to compare the equilibrium of the incentive policy with the current one, first, I set  $g_0 = 0$  and  $g_i = a + bx_i$  ( $i = 1, 2$ ) in (2), and second, by substituting (2) for the domestic firms into it, I evaluate (5) at the equilibrium  $(x_0^C, x_1^C, x_2^C)$ :

$$d\pi_i/dx_i = b(p - c') > 0, \quad i = 1, 2. \quad (12)$$

3. See, for example, Dixit [1986] for the derivation of the stability condition.

Figure 1



Because equilibrium price is always higher than firms' marginal cost in an oligopoly, the domestic firms' marginal profits become positive. They have the incentive to expand their production if they produce at the equilibrium output level of the current policy. The foreign firm does not have any incentive to change its production plan, since its marginal profit is zero.

The first-order condition (6) also defines the 'aggregate reaction' function of the domestic firms under the incentive policy,  $x_d = R^I(x_0)$ , which is depicted in Fig. 1 as curve  $R^I$ . The reaction function of the foreign firm either under the current policy with  $g_0 = 0$  or under the incentive policy,  $x_0 = r(x_d)$ , is defined by its first-order condition (7) and depicted as curve  $r$ . Applying the implicit-function theorem to (7) yields the slope of the foreign reaction function:

$$dx_d/dx_0 = -\alpha_0/\beta_0 = -[(2+v_0)p'+x_0(1+v_0)p''-c']/[p'+x_0(1+v_0)p'']. \quad (13)$$

The slope of the 'aggregate reaction' function of the domestic firms can be derived by the same approach. I assume that both  $\beta_0$  and  $\beta_d$  are negative so

that the slopes of all reaction functions are negative. The intersection between curves  $R^I$  and  $r, E^I$ , determines the equilibrium  $(x_0^I, x_d^I)$  under the incentive policy. Curve  $R^C$  depicts the domestic reaction curve under the current policy when  $g_0 = 0$  and  $g_i = g/2$ , ( $i = 1, 2$ ), satisfying (2) for the domestic firms. Curve  $R^I$  lies above  $R^C$ , since from (12),  $R^I(x_0^C) > x_d^C$ . This implies that given the amount of sales from the foreign firm in the private sector, the incentive policy always results in a higher amount of sales from the domestic firms in that sector. The intersection between curves  $R^C$  and  $r, E^C$ , determines the equilibrium  $(x_0^C, x_d^C)$ . Because the total government purchases in both policy regimes are the same, the differences in the private-sector sales also reflect the differences in the firms' total output. To obtain the effects of the incentive policy on the total private-sector sales from all firms and on price, I rearrange (13) to get

$$d(x_0+x_d)/dx_0 = (\beta_0 - \alpha_0)/\beta_0 = [c'' - (1+v_0)p']/[p' + x_0(1+v_0)p''] < 0, \quad (13')$$

since its numerator is positive.<sup>4</sup> The contraction of imports means the expansion of the total private-sector sales. Therefore, I obtain Proposition 1.

**Proposition 1:** *In an oligopoly with two domestic firms and one foreign firm, if the government purchases from the domestic firms are positively related to the firms' sales in the private sector, the resulting total domestic output is greater than that if the government simply buys from them, and the corresponding imports and price are lower.*

Proposition 1 can be intuitively explained as follows. The monopoly power of imperfectly competitive firms results in underproduction from the perspective of social welfare, and thus creates a margin between marginal cost and price. Sales to the government earn the domestic firms extra profits whenever price exceeds their marginal costs. When the government ties its purchases from the domestic firms to the amounts they deliver to consumers, the domestic firms have the incentive to increase their sales in the private sector to capture the extra profits. This results in expansion of

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4. The stability condition,  $\alpha_0 < 0$ ,  $\alpha_d < 0$  and  $\alpha_0\alpha_d - \beta_0\beta_d > 0$ , includes the case in which the government purchases zero amount of the goods, *i.e.*,  $g = 0$ . Then  $\alpha_0 = \alpha_d$  and  $\beta_0 = \beta_d$ . The condition becomes  $\alpha_0 < 0$  and  $\alpha_0^2 - \beta_0^2 > 0$ , or  $\beta_0 - \alpha_0 > 0$ .

domestic production. Because the foreign firm de facto reacts negatively to the domestic output, imports decrease. But the increase of the domestic production outweighs the decrease in imports, and price falls.

Assume demand is derived from a utility function,  $U = u(X) + N$ , where  $N$  represents consumption of a numeraire competitive good, the social welfare under the incentive policy can be represented by standard surplus measures. That is, it is the sum of consumer surplus, profits of the domestic firms, and government net benefits:

$$W = [u(X) - Xp(X)] + \{[2a + (1+b)x_d]p(X) - 2c[a + (1+b)(x_d/2)]\} + [G - gp(X)], \quad (14)$$

where  $G$  is the government benefits from the consumption of  $g$ .

The optimal incentive government procurement policy can be derived from maximizing  $W$  with respect to  $a$  and  $b$ , subject to the government's physical budget constraint:

$$\begin{aligned} \text{Max}_{(a, b)} \quad & u(X) - Xp(X) + [2a + (1+b)x_d]p(X) - 2c[a + (1+b)(x_d/2)] + G - gp(X) \\ \text{Subject to} \quad & 2a + bx_d = g. \end{aligned} \quad (15)$$

Substituting the constraint into the objective function, (15) can be reduced to

$$\text{Max}_b \quad u(X) + G - x_0p(X) - 2c[(x_d + g)/2]. \quad (15')$$

The welfare effect of a small change in the incentive coefficient  $b$  is:

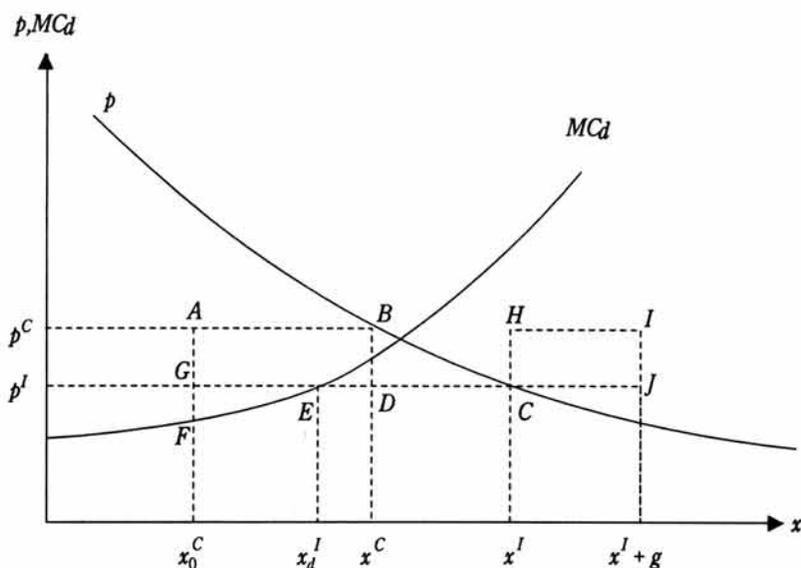
$$dW/db = (p - c')(dx_d/db) - x_0(dX/db)p'. \quad (16)$$

As shown in (13) and (13'), an expansion of the domestic firms' sales in the private sector,  $x_d$ , increases the total sales in that sector,  $X$ . As long as  $p > c'$ , the domestic firms always respond to the incentive policy by expanding production, and both  $dx_d/db$  and  $dX/db$  are positive. But the increase of the total sales in the private sector reduces the margin between price,  $p$ , and the domestic firms' marginal cost,  $c'$ .<sup>5</sup> Eventually,  $p$  equals  $c'$ . The profits from selling to the government disappear. The domestic firms will no longer

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5. See footnote 3.

Figure 2



respond to the incentive policy, and both  $dx_d/db$  and  $dX/db$  are zero. Therefore, I obtain Proposition 2:

**Proposition 2:** *The optimal incentive government procurement policy is to select the incentive coefficient  $b$  which results in  $p(X) = c'[(x_d + g)/2]$ .*

This proposition implies that the incentive government procurement policy can be devised to shrink the wedge between marginal cost and price, and to be a substitute for antitrust policy.

The welfare effects of the optimal incentive policy are illustrated in Fig. 2.  $MC_d$  is the horizontal summation of the domestic firms' marginal cost curves. The total sales in the private sector under the current policy is  $X^C$ , and the corresponding price is  $p^C$ . The total sales under the optimal incentive policy is  $X^I$ , and the price is  $p^I$ . Area  $ABDEG$  is the transfer of the foreign profits into the domestic consumer surplus; area  $BCD$  is the recovery of the consumer dead-weight losses; area  $HIJC$  is the net government benefits due to the reduction of price; area  $EFG$  is the recovery of the producer dead-weight losses because of the expansion of domestic production. Together these areas represent the welfare gain of the optimal incentive policy.

#### IV. Concluding Remarks

A scheme of government procurement policy which embodies the incentive of production is proposed and analyzed. This policy relates government purchases to the domestic firms' production for consumers. The policy is shown to promote domestic production and reduce imports. Moreover, it can be devised to induce the imperfectly competitive firms to produce at the socially optimal level.

However, this proposed policy falls into the category of the existing policies, such as the Buy-American Act, in the sense of favoring domestic producers. As this type of policies is against the goal of GATT to ensure equal treatments of domestic and foreign suppliers in the procedures of government procurement, the proposed policy can be easily modified to meet this goal. The incentive government procurement policy can be devised to include the foreign firm in its production-purchase-reward system, and imports will be higher than under the existing policy. Also, the modified incentive policy will work for the case of one domestic firm.

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