Chapter 1

The Effects of a Content Requirement on a Foreign Duopsonist

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Abstract: This chapter considers the operation of a local content requirement in a duopsony between domestic and foreign firms and demonstrates its consequences for the domestic producer of a final good. It is shown that content protection may have perverse effects on a foreign firm's profits and may be welfare-improving overall, shifting profits from the domestic firm to both the foreign firm and domestic input producers.

1. Introduction

In recent years, there has been considerable interest in the analysis of local content plans (CPs). Such schemes, which seem to be growing in popularity internationally, require that a firm use a certain “amount” of domestically-produced inputs in producing its final output. These schemes seem to be imposed solely on foreign-owned firms (either explicitly, as was lobbied for in the U.S. auto industry in the early 1980s; or de facto, either in the absence of domestic firms or by the

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definition of domestic firms). To induce a foreign firm to produce in the country at all, an incentive such as a protected final-good market is usually offered.

Most existing literature on CPs has concentrated on consequences in the input market (the protection of which is presumably the intention of a CP). As a result, there has been little attention paid to the distinction between domestic and foreign final-good firms. But there will be repercussions for domestic firms of a CP imposed on foreign firms to the extent that both purchase inputs on the same market: contraction of the domestic industry is a likely effect of content protection. The welfare effects of this contraction need not be negative, however.

In this paper, we consider the effects of a CP imposed on a foreign firm that produces some final good in the home country using both domestic and (perfectly substitutable) imported inputs. There is also a domestic firm in the same industry that has access to only domestic inputs — the distinction between domestic and foreign final-good firms is solely in this different access to international inputs. The assumption that domestic and foreign inputs are perfect substitutes clearly is not a realistic description of the world, but it does focus attention on the consequences of content protection purely through repercussions on the component market. We demonstrate that the CP may raise the foreign firm's profits in this duopsony setting by committing it to use more of the domestic input, thus pushing up its price and leading the domestic firm to contract. Nevertheless, domestic welfare may be improved because of the increased profits of domestic input producers. This result is closely related to the idea of raising rivals' costs discussed by Salop and Scheffman (1983), but is a case where this strategy is facilitated by apparently harmful regulation: the foreign firm is required to use more domestic inputs, but this may actually make it better off.

An early analytical contribution to the literature on CPs was Grossman (1981). In that paper Grossman considers a partial equilibrium model of a competitive firm that produces some final output using both an input, which may be purchased domestically or imported, and another factor. The firm is subjected to a CP

(and Grossman considers both CPs based on value-added and on physical requirements), and Grossman demonstrates the resource-allocating effects of each CP (their effects on total input use, use of imported inputs, total output and so on). He also considers how the analysis is altered in the presence of monopoly in the domestic input producing sector but throughout the analysis the final-good firm is entirely domestic, contrary to the stylized facts of markets where CPs are usually imposed.

A number of other papers have followed Grossman's, but only one addresses directly the issues targeted here. Mussa (1984) allowed domestic and imported inputs to be less than perfect substitutes, for example. Monopoly has been introduced into Grossman's framework at both the final-good level and the input level [see Mussa (1984) and Vousden (1987)] and the welfare consequences of CPs analysed under the different market structures. Krishna and Itoh (1986) examine the effects of CPs in an oligopolistic environment where a domestic firm and a foreign firm both produce the *input* good, in contrast to our model of oligopoly at the final-good stage. They demonstrate that the effect of a CP on the domestic producer's profits may be markedly different to its effect under perfect competition or monopoly, since it affects the very nature of the interactions between the two firms. More recently, Hollander (1987) has investigated the effects of various CPs imposed on foreign firms, but where there are *no* domestic suppliers — the market is a vertically integrated transnational monopolist with a continuum of production stages.

Davidson *et al.* (1987) do consider a duopoly between a domestic and a foreign firm in the final good market. They assume constant costs of inputs, the domestic component being more expensive than the imported version, and show that a content requirement then reduces sales by the foreign firm, increases sales by the domestic firm and makes the domestic firm better off. However, this ignores any repercussions on the domestic firm through the input market. We contrast their results with ours later in the paper.

Section 2 outlines the basic model we use and describes equilibrium in the absence of any CP. Section 3 then introduces a CP and derives its effects and welfare consequences. A final section concludes.

2. The model

We consider a linear model of two firms, one domestic and one foreign, each producing some homogeneous final good. The good is an importable in the small home country and may or may not be subject to a tariff. The domestic price of this good is constant at the world price plus any tariff; we set this price at unity, without loss of generality. Both firms produce this good using a single input and according to the same strictly concave production function. The input is produced in the home country under competitive conditions and the foreign firm can use either or both the domestically-produced input and/or a perfect substitute imported input. The domestic firm has access to only the domestic input.¹

Letting M_f denote the foreign firm's use of the domestically-produced input and M^* its imports of the input, the CP can be written as

$$M_f \geq j(M_f + M^*),$$

where j is the regulator's policy parameter. We assume that the domestically produced input is supplied competitively under conditions of increasing costs. To the extent that this is only tenable as a short-run characterization, the following is inherently a short-run analysis. The inverse supply curve² is thus $p[M_d + M_f]$, $p' > 0$, $p'' = 0$, where p denotes the price of the component, M_d the domestic firm's use of the component and $p'(p'')$ the first (second) derivative of p . Letting Q_i denote the output of the i th firm, $i = d, f$,

¹This assumption is not critical to our main results, as discussed in section 4, but seems more realistic a representation of industries in which CPs are prevalent than allowing equal access to imported components. In the case of the auto industry, where these schemes are particularly prevalent, the foreign producer tends to be the subsidiary of a multinational and thereby has access to foreign components not available to domestic producers. (Of course, this makes the perfect substitutes assumption between domestic and foreign components a little less plausible, but perhaps not in the context of a particular model line.) This is also why we consider only physical content plans — to avoid transfer pricing issues that arise under value-added schemes.

²Throughout this chapter, square brackets denote functions and parentheses denote products.

we have

$$\begin{aligned} Q_d &= Q_d[M_d], \quad Q'_d > 0, \quad Q''_d < 0, \quad Q_d^{-1}[0] = F > 0, \\ Q_f &= Q_f[M_f + M^*], \quad Q'_f > 0, \quad Q''_f < 0, \quad Q_f^{-1}[0] = F > 0, \\ p &= p[M_d + M_f], \quad p' > 0. \end{aligned}$$

The imported component is available to the foreign firm at a fixed price, $p^* \gg p[0]$. The domestic price of the final good is fixed at 1, the cum-tariff world price.³ This assumption enables us to concentrate on the effects of CPs on inputs without considering repercussions through the product market. So these firms have no monopoly power in the final-good market, but we assume they are both aware of their duopsony power in the market for the domestic component. In this case there are strategic interactions between the firms, and the CP affects the equilibrium of the game they play on the input market.

We assume that each firm entertains Cournot conjectures regarding its rival's behavior on the input market. The domestic firm chooses M_d to maximize profits of $\Pi_d = Q_d[M_d] - p[M_f + M_d]M_d$ and the foreign firm chooses M^* and M_f to maximize profits of $\Pi_f = Q_f[M_f + M^*] - p[M_f + M_d]M_f - p^*M^*$. (The appendix contains complete calculations for this model.) First-order necessary conditions for each firm for the optimal choice of inputs allow for the effect each firm's demand for M has on its price:

$$Q'_d[M_d] - \{p[M_d + M_f] + p'[M_d + M_f]M_d\} = 0; \quad (D)$$

$$Q'_f[M_f + M^*] - \{p[M_d + M_f] + p'[M_d + M_f]M_f\} \leq 0,$$

$$M_f > 0 \quad \text{with complementary slack; } (F_1)$$

$$Q'_f[M_f + M^*] - p^* \leq 0, \quad M^* > 0 \quad \text{with complementary slack.}$$

$$(F_2)$$

Given concave production functions and the upward-sloping supply curve of the domestic input, these conditions are also

³The analysis would be unaltered if the good was an exportable from this small country — the domestic price would then be the given world price.

sufficient for a maximum. Thus, second-order conditions are always satisfied: $Q_d'' - 2p' < 0$, $Q_f'' - 2p' < 0$, $Q_f'' - 1 < 0$ and $2p'(1 - Q_f'') - Q_f'' > 0$.

In the absence of any CP we may not observe an interior equilibrium in which the foreign firm uses both domestic inputs and imports, given Cournot behavior. For some M_d , if $p^* < p[M_d]$, then the foreign firm uses only imported inputs. Similarly, if $p^* > p[M_d + M_f] + p'[M_d + M_f]M_f$, where M_f solves (F_1) with equality, then the foreign firm uses only the domestic input.

Suppose the foreign firm does use both domestic and imported components. Then it earns profits of $\tilde{\Pi}_f = \tilde{Q}_f[\tilde{M}_f + \tilde{M}^*] - p^*\tilde{M}^* - p[\tilde{M}_f + \tilde{M}_d]M_f$, where a tilde over a variable denotes the value when (D), (F_1) and (F_2) all hold with equality. If p^* is such that the foreign firm uses only the imported component, then it must earn profits of at least $\tilde{\Pi}_f$ by revealed preference.

We wish now to construct each firm's reaction function in domestic component space. Given $p^* \gg p[0]$, the foreign firm will always use some of the domestic input if the domestic firm uses none (and may use imports too if its demand is high enough). But, as the domestic firm expands the foreign firm would use less and less domestic input, either decreasing output initially (if $M^* = 0$) or just increasing its use of the import throughout without changing output. Even if $M^* = 0$ initially, eventually, when $p[M_d + M_f] + M_f p'[\cdot] = p^*$, the foreign firm will begin to import. When $p[M_d + M_f] = p^*$, the firm will only use imports. When $M^* = 0$, (F_1) holds with equality. Differentiating with respect to M_d and M_f gives a slope of

$$0 > \left. \frac{dM_f}{dM_d} \right|_{\substack{(F_1) \\ M^* = 0}} = \frac{p'}{Q_f'' - 2p'} > -(1/2).$$

When $M^* > 0$, (F_2) implies that $dM_f = -dM^*$, so differentiating (F_1) with respect to M_f , M_d and M^* gives a slope of

$$\left. \frac{dM_f}{dM_d} \right|_{(F_1)} = -\frac{p'}{2p'} = -(1/2).$$

Fig. 1.

The foreign firm's reaction function for its M_f choice is thus downward-sloping against $\overline{M_d}$: line F in Fig. 1. The firm uses no imports along the segment $\overline{ab}$ (so output is falling from a to b) but replaces imports for the domestic input one-for-one along $\overline{bc}$.

Similarly for the domestic firm, differentiating (D) yields

$$\left. \frac{dM_f}{dM_d} \right|_{(D)} = \frac{Q_d'' - 2p'}{p'} < -2.$$

We shall assume that $M^* > 0$ in the unconstrained equilibrium, but M_f may be zero. Figure 1 illustrates the case where both M^* and M_f are positive. The unconstrained Cournot equilibrium is at point E , the foreign firm using M_f^e of the domestic component, the domestic firm M_d^e . Given the identical technologies, this equilibrium entails a greater level of output by the foreign firm than by the domestic one, but with the latter using more of the domestically-produced input than the former.

3. Content protection

Suppose we now impose a CP on the foreign firm. Suppose the CP is set at epsilon above exactly the ratio of M_f to M^* that the firm chooses when unconstrained. This may be almost zero, depending

on p^* . The foreign firm now chooses M^* and M_f to maximize profits subject to the CP above. The Lagrangian is

$$\max_{\{M^*, M_f\}} \mathcal{L} = Q_f[M_f + M^*] - p[M_f + M_d]M_f - p^*M^* + \lambda(1-j)M_f - jM^*.$$

A binding constraint means $\lambda > 0$ and $j > 0$ means $M_f > 0$. Also, when the constraint is just binding, we know $M^* > 0$ by our assumption that $M^* > 0$ in the unconstrained equilibrium. Hence, all first-order conditions hold with equality and equilibrium is described by

$$Q'_d[M_d] - \{p[M_d + M_f] + p'[M_d + M_f]M_d\} = 0; \quad (D)$$

$$Q'_f[M_f + M^*] - j\{p[M_d + M_f] + p'[M_d + M_f]M_f\} - (1-j)p^* = 0; \quad (F)$$

$$(1-j)M_f - jM^* = 0. \quad (CP)$$

Differentiating these conditions and evaluating at the initial level of j it is simple to show (see the appendix) that a small tightening of the CP will raise the foreign firm's use of the domestic input and decrease its use of the import, decrease the domestic firm's output, increase overall demand for the domestic input and either decrease the foreign firm's output or, if it only uses imports in the initial equilibrium, leave its total output unaffected.

All of this may *raise* the foreign firm's profits, depending on the magnitude of the CP requirement. Take the case of an interior equilibrium initially and consider a CP that exactly binds. For all M_f greater than the initial level, the CP has no effect — these satisfy the requirement so the foreign reaction function is unchanged above point E . But at any M_f below M_f^e the CP is violated, given the level of M^* . Now (CP) describes the change in M^* consequent on any change in M_f satisfying the CP, so differentiating (F) with respect to M^* , M_f and M_d solves for the slope of the foreign firm's reaction to a change in M_d when constrained by the CP and allowing for changes in imports

$$0 > \left. \frac{dM_f}{dM_d} \right|_{(F)(CP)} = \frac{2j^2p'}{Q''_f - 2j^2p'} > -1,$$

which is uniformly flatter than in the absence of the CP (as $j < 1$). Thus, the foreign reaction function swivels out around the initial equilibrium point. (It is easily shown that this is true even if

Fig. 2.

equilibrium was initially on the section $\overline{ab}$ in Fig. 1.) Tightening the constraint a little then flattens the reaction function more and shifts it up: more M_f is used at each level of M_d . Figure 2 illustrates this case — the new foreign reaction function is F' yielding a new equilibrium of E' .

A small CP in this setting will make the domestic final-good firm worse off, the foreign firm better off, and the domestic input firm better off. If $M^* = 0$ initially, then the only difference is that foreign profits may be reduced by the CP. It may also raise domestic welfare overall. This all contrasts with the results of Davidson *et al.* (1987) where a CP imposed on foreign firms reduces their final sales, thus increasing those of their Cournot domestic-firm competitor, raising the latter's profits. This, however, may reduce domestic welfare as total sales fall and consumer surplus is decreased (as imports are prohibited in their model).

The intuition of our results is that, in the absence of any scheme, the Nash equilibrium in M quantities entails too much use of M from the firms' collective viewpoint, as each ignores the impact its use of M has on the other (through the price). From society's point of view, however, M is underused, as the firms equate their marginal revenue product with the marginal cost of M , not the price. A small

CP is then equivalent to a credible commitment by the foreign firm to use more of the domestically-produced input, and it induces a contraction in demand by the domestic firm. In this respect the CP moves the foreign firm towards the Stackelberg leader position in the game on the input market. From society's viewpoint the CP yields a gain in that it induces greater total use of M , but this is at least partially offset by the transfer of rents from the domestic final-good firm to the foreign one. It is more likely that there will be a net gain if (1) the input supply curve is flat, as then a given increase in M_f has less of an impact on p ; and (2) the domestic production function is highly concave, as then a given increase in p has less of an impact on Q_d .

It may seem counterintuitive that the foreign firm's profits rise even though its output (and revenue) falls and it uses more domestic inputs. The intuition is that, for a small, just-binding CP, the adjustments in input use have approximately no effect on the firm's profits, by the envelope theorem, leaving the decreased use of the domestic input by the domestic firm as the sole effect on foreign profits. This latter effect is positive. A large CP requirement, on the other hand, could reduce foreign firm profits as the input adjustments become more costly.

It should be pointed out that this effect is not unique to a CP. In fact, a small tariff on the imported input would have similar effects, except that one can show that it will unambiguously raise domestic welfare because of its revenue effects. It should also be clear that allowing the price of the output to vary would not affect the basic intuition, but would complicate the analysis somewhat, as the firms' rents would stem from monopoly power in both the input *and* output markets.

4. Conclusion

One of the most common types of performance requirement imposed on foreign firms by host governments is a requirement that some minimum 'amount' of domestic inputs be used by the firm. Most analyses of such content requirements have concentrated on their

consequences for input producers, ignoring the effects on domestic final-good producers who also use these protected inputs. This paper has attempted to remedy this omission.

As mentioned in Section 1, Davidson *et al.* (1987) also consider the case of two final-good producers, but playing against each other in the output market. They assume that production costs of the final good are constant (and the foreign firm has to be forced to use any domestic inputs at all, as they are more costly than inputs in the foreign country). They also have a prohibitive tariff on the final good. It is clear that this will be necessary for the model to work at all: otherwise the foreign firm would continue to export the finished good to the domestic country and would produce nothing domestically. If there was any foreign production domestically *and* imports of the final good, then the final-good price would be fixed and the duopoly would be impotent: it would consist of two firms with no market power. Accordingly, it seems perhaps more reasonable for final-good firms to extract their duopoly power on the input market rather than the output market. The effects of content protection are then markedly different, as shown above.

Our results are not sensitive to the assumption that we start with an interior equilibrium, as explained in the text. Nor is it critical, for the qualitative results, that the domestic firm not have access to the imported component. An increase in the use of the domestic component by the foreign firm will still induce a reduction in use by the domestic firm, which benefits the foreign firm in exactly the same way as above. Also, the assumption that the product price is fixed is not critical: relaxing it gives additional monopoly power to these duopsonists and the CP will have repercussions in the product market. This adds greatly to the algebra without illuminating our basic argument. Finally, it should also be apparent that the results do not depend on there being only two firms here — the same effects will be present in any model with Nash behavior on input markets, regardless of the number of firms. In a competitive framework, our results regarding profitability would be similar (but represented by an increase in the number of foreign firms and a decrease in the number of domestic firms as free entry and exit occurs in response

to profits and losses) so long as the domestic supply curve of the input is upward-sloping. However, a CP would always have negative consequences for domestic welfare (aside from any second-best effects on final-good tariff revenue) as there would be no rents to shift on the input market.

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Appendix

In the absence of a CP, the domestic firm chooses M_d to maximize

$$\prod_d = Q_d[M_d] - p[M_f + M_d]M_d.$$

The first-order condition for this problem is listed as (D) in the text. For the foreign firm, the problem is to choose M_f and M^* to maximize

$$\prod_f = Q_f[M_f + M^*] - p[M_f + M_d]M_f - p^*M^*.$$

The first-order conditions for this problem are listed as (F₁) and (F₂) in the text.

When a CP is imposed, the domestic firm's problem is unchanged. But the foreign firm now must choose M_f and M^* to maximize the following Lagrangian:

$$\mathcal{L} - Q_f[M_f + M^*] - p[M_f + M_d]M_f - p^*M^* + \lambda((1 - j)M_f - jM^*).$$

First-order conditions for this problem are rewritten as (CP) and (F) in the text.

Differentiating (D), (F) and (CP), we can write

$$\begin{bmatrix} Q_d'' - 2p' & -p' & 0 \\ -jp' & Q_f'' - 2jp' & Q_f'' \\ 0 & 1 - j & -j \end{bmatrix} \begin{bmatrix} dM_d \\ dM_f \\ dM^* \end{bmatrix} = \begin{bmatrix} 0 \\ (p + M_f p' - p^*) \\ M_f + M^* \end{bmatrix} dj.$$

Defining the determinant of the coefficient matrix as σ , one can show that

$$\sigma = j^2 p'(2Q_d'' - 3p') - Q_f''(Q_d'' - 2p') < 0$$

(by second-order conditions).

Denoting the ratio of M_f to $(M_f + M^*)$ when unconstrained as j^* , note that at j^* we have $p + p'M_f - p^* = 0$. We can now invert the system above to derive the following results discussed in the text:

$$\left. \frac{dM_d}{dj} \right|_{j^*} = -\frac{1}{\sigma}(M_f + M^*)Q_f''p' < 0;$$

$$\left. \frac{dM_f}{dj} \right|_{j^*} = -\frac{1}{\sigma}(M_f + M^*)Q_f''(Q_d'' - 2p') > 0;$$

$$\left. \frac{dM^*}{dj} \right|_{j^*} = -\frac{1}{\sigma}(M_f + M^*)\{(Q_f'' - 2jp') \times (Q_d'' - 2p') - j(p')^2\} < 0;$$

$$\left. \frac{d(M_d + M_f)}{dj} \right|_{j^*} = -\frac{1}{\sigma}(M_f + M^*)Q_f''(Q_d'' - p') > 0;$$

$$\left. \frac{d(M^* + M_f)}{dj} \right|_{j^*} = -jp' \frac{1}{\sigma}(M_f + M^*)\{2Q_d'' - 3p'\} < 0.$$

Note that even if M_f is zero initially, so that $j^* = 0$, all the qualitative results above are unchanged. To see the consequences for the foreign firm's profits, Π_f , note that

$$\begin{aligned} \left. \frac{d\Pi_f}{dj} \right|_{j^*} &= \frac{\partial \Pi_f}{\partial M_f} \frac{dM_f}{dj} + \frac{\partial \Pi_f}{\partial M^*} \frac{dM^*}{dj} + \frac{\partial \Pi_f}{\partial M_d} \frac{dM_d}{dj} \\ &= \frac{\partial \Pi_f}{\partial M_d} \frac{dM_d}{dj} \text{ by first-order conditions at } j^* \\ &= -M_f p' \frac{dM_d}{dj} > 0. \end{aligned}$$

Similarly,

$$\left. \frac{d\Pi_d}{dj} \right|_{j^*} = -M_d p' \frac{dM_f}{dj} < 0.$$

We can define domestic welfare as the sum of consumer surplus, the domestic final-good firm's profits, the domestic input-producing firm's profits and, in the case where the final good is an importable, any tariff revenues. (In the case where the good is an exportable, the following is correct with t set to zero.) Thus, where CS denotes consumer surplus, $\bar{p}$ the world price of the final good, t the specific tariff on imports, Π_m the profits of the domestic component industry, I imports and W welfare

$$\begin{aligned} W &= CS + \prod_d + \prod_m + tI \\ &= CS + (\bar{p} + t)Q_d + p[M_f + M_d]M_f - C[M_f + M_d] + tI \end{aligned}$$

after cancellations, where $C[\cdot]$ is the total cost of producing the input. Because the domestic price of the final good is unchanged from unity

($= \bar{p} + t$) as j varies, so total demand and CS are unchanged as the CP is varied. Furthermore, the change in imports is just the negative of any change in output by domestic and foreign firms, and competitive supply of the domestic input implies $C' = p$, so

$$\begin{aligned} dW &= (Q'_d + M_f p' - C') dM_d + (p + M_f p' - C') dM_f \\ &\quad - t \{ Q'_d dM_d + Q'_f (dM_f + dM^*) \} \\ &= (Q'_d - p + M_f p') dM_d + M_f p' dM_f \\ &\quad - t \{ Q'_d dM_d + Q'_f (dM_f + dM^*) \} \\ &= p' (M_d dM_d + M_f (dM_f + dM_d)) \\ &\quad - t \{ Q'_d dM_d + Q'_f (dM_f + dM^*) \} \end{aligned}$$

by the first-order condition (D). Substituting in for the expressions calculated above and rearranging gives

$$\begin{aligned} \left. \frac{dW}{dj} \right|_{j^*} &= A \{ Q''_f (M_d + M_f) p' + (p' M_f Q''_f Q''_d) \\ &\quad - t [Q'_d Q''_f + j Q'_f (2Q''_d - 3p')] \}, \end{aligned}$$

where $A = -p' (M_f + M^*) / \sigma > 0$. If the two firms' technologies are identical, then the first-order conditions evaluated at j^* imply $M_d > M_f$ and $Q'_d > Q'_f$. Thus the first term in the curly brackets above is negative, the second is positive and the third is negative. Thus $dW/dj|_{j^*}$ is indeterminate in sign, but more likely to be positive the smaller is p' and the greater is $|Q''_d|$, as discussed in the text.