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Movie Industry: Protection and the Size of the Market

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Insper Working Paper
WPE: 036/2002

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First Version: July 30th, 2002
This Version: July 30th, 2002
JEL Classi…cation: F13; L82

Abstract

I study the e¤ects on economic welfare of an import tari¤ on foreign movies with the revenues either to subsidize output or projects of home producers. The analysis indicates that the degree of the optimum intervention reduces the greater is the market for home movies outside the country.

ÁREA: MACROECONOMIA APLICACA

Title: "Movie Industry: Protecion and the Size of the Market"

1 Introduction

The American movie industry dominates the world cinema. Although it does not make most feature movies, it is the only one that reaches every market in the world. For example, the market share of the American motion pictures in the European Union was about 70% in 1996. In Canada, 96% of all movies shown in the theaters are foreign, primarily American. Even in Japan, America accounts for more than half the …lm industry. In contrast, foreign movies represents only a tiny fraction of the American market, with a share of less than 3%.

It is no surprise that the supremacy of the American movie industry triggers movements in the rest of the world to protect their local producers. In France, there is a consumption tax on all movie tickets and the revenues are used to …nance the French movie makers. The Brazilian government provide tax exemption, up to a certain limit, to private companies that …nance cultural projects, including obviously new movies. There is pressure from many countries to exempt cultural goods from international agreements lowering trade barriers, with the justi…cation that free trade can threat national cultures.[1]

From a theoretical point of view, there is justi…cation for government intervention to protect and/or provide …nancial support for local industries characterized by increasing returns to scale, such as the movie industry.[2] The advantage of the American producers is exactly the fact that they can exploit a big market at home. They can dillute the high …xed costs in their own market and sell abroad at low marginal cost. Instead of relying or demanding protection, one can argue that producers from other countries should be more aggressive in the international market and not restrict their focus on the domestic market. However, the possibility of exploiting the global market scale is limited to these producers for one particular reason. Di¤erently from other goods traded in the international market, movies have some characteristics that are very speci…c to some markets. One obvious example is the language. American consumers do not enjoy watching movies in French, whereas this is a feature demanded by French consumers. As a result, there may exist an additional reason, beyond the traditional one, to protect an industry characterized by increasing returns to scale as the outside market is restricted. This possibility is analyzed here.

In this paper, I develop a model of a small country that produces a homogenous good and home movies, the latter characterized by scale economies

[1] For more details on this pressure, see The Economist (1998).

[2] See Helpman and Krugman (1989) for a review of the theoretical models with increasing returns to scale and the e¤ects of trade protection on welfare. Bhagwati (2002) recognizes the theoretical justi…cation for protection of selected industries characterized by imperfect competition. However, he argues that the gains may not be large enough to justify intervention. Moreover, he adds that intervention may make matters worse due to directly unproductive pro…t-seeking activities.

and product differentiation, standard features in the literature.[3] As there is monopolistic competition in the movie industry, there is room for government intervention. I consider two types of policies. First, the government imposes an import tax on foreign movies to finance the output subsidy to the home producers. Second, the government imposes the same tax to subsidize the home movie projects. Both interventions are welfare improving. The major conclusion that emerges from the analysis is that the optimal import tariff is lower, under both types of intervention, the greater is the market for home movies outside the country. In other words, the degree of the optimal intervention reduces if the home movie industry can exploit a greater market abroad. There are two papers close related to this one, Flam and Helpman (1987) and Francois and Ypersele (2002). However, neither one considers the impact of the size of the market abroad on the degree of intervention.[4]

The model is developed in section 2. Then, in section 3, I characterize the equilibrium conditions. Welfare implications are discussed in section 4 and conclusions are drawn in the last section.

2 Model

There are assumed to be a large number of potential home and foreign movies. There are two types of individuals living in the home country. Type 1 individuals get utility only from consuming home movies. Type 2 individuals care only about consumption of foreign movies. There are "fL" individuals of the former type and "$(1 - f)L$" individuals of the last type, where $0 < f < 1$ and $L > 0$.

Type 1's and type 2's economic problems are, respectively, the following:

$$\max \ln\left(\sum_i c_i^{\mu}\right)^{1/\mu};$$

such that,

$$\sum_i p_i c_i = w;$$

and,

$$\max \ln\left(\sum_i c_i^{*\mu}\right)^{1/\mu};$$

[3] For examples, see Krugman (1980) and Krugman (1981).

[4] Flam and Helpman (1987) has a similar framework to the one developed here. They conclude that the welfare consequences of industrial policies depend on the details of production structure and preferences, except for a small tariff which is always welfare improving. Francois and Ypersele (2002) develops a model to explore the possibility that restrictions on trade of cultural goods either by a tariff or a quota to be welfare improving.

such that,

$$(1 + t)p^* \sum_i c_i^* = w$$

where c_i and p_i are, respectively, the consumption and price of the ith home movie, c_i^* and p^* are, respectively, the consumption and price of the ith foreign movie, t is the import tax on foreign movies, and w is the wage rate.[5] The parameter θ is the same for both groups and $0 < \theta < 1$.[6] The number of home movies actually produced, n, will be assumed to be large, although smaller than the potential range.[7]

There will be assumed to be only one factor of production, labor. Total labor is equal to the home population, L. The home country produces two types of goods, the home differentiated movies (x_i) and an homogenous good (T).

In the movie sector, I assume that every movie i is produced with the same cost structure:

$$l_i = \alpha + \beta x_i$$

where l_i is labor used in producing the ith movie, and x_i is the number of units of this movie, with $\alpha, \beta > 0$. The term α can be seen as the project cost of the motion picture, whereas β is the constant production cost per unit of output. Therefore, average cost declines at all levels of output, but at a diminishing rate. This sector is characterized by monopolistic competition, with each firm producing a different movie and having some monopoly power, but with entry of new firms driving monopoly profits to zero. Let π_i be the profits of the producer of movie i. It can bewritten as:

$$\pi_i = (1 + z)p_i x_i - (\alpha(1 - s) + \beta x_i)\, w;$$

where z is the output subsidy, and s is the project subsidy. Output and project subsidy are two alternative ways of supporting the home movie industry.

In the homogenous good sector, which is characterized by perfect competition, I assume that the cost structure is such that there is constant marginal cost and no fixed cost. Therefore, total labor used in the production of T units of the homogenous good is equal to:

$$l_T = \beta_T T, \text{ with } \beta_T > 0.$$

[5] Without loss of generality, I assume that $p_i^* = p^*$, for all i.

[6] As in Krugman (1981), I use the ln utility function because of two useful properties. First, it implies that every producer faces a demand curve with elasticity $\frac{1}{(1-\theta)}$. Second, it simplifies the welfare analysis performed below.

[7] An alternative approach would be to have all people alike, with a taste for both types of movies, home and foreign. The results would be similar. Moreover, the results would be exactly the same if total expenditures on each type of movie are fixed.

It is assumed that home individuals do not obtain utility from consuming the homogenous good. Therefore, this good is only sold in the foreign market. In order to have an equilibrium in the trade balance, total expenditures in foreign movies by type 2 individuals have to be equal to total expenditures in home movies by foreign individuals (w^*) plus the total sales of the homogenous good in the foreign market. Hence, the trade balance equilibrium condition is:

$$p_T T + w^* = p^* \sum_i x_i^*;$$

where the exchange rate is set to be equal to one (the numeraire), p_T is the foreign price of the homogenous product, and x_i^* is the number of units of the foreign movie i imported by the home country. As home individuals do not consume the homogenous good, it will be only produced in the home country as a way of obtaining resources to purchase foreign movies. I will impose some limits on the size of w^* and restrain my analysis to the case in which total expenditures on foreign movies ($p^* \sum_i x_i^*$) is always greater than total expenditures in home movies by foreign individuals (w^*). In other words, it is always necessary to produce some amount of the homogenous good in order to finance total imports, that is, $p_T T > 0$.

The home country is considered to be small. This assumption implies that it faces a given number of foreign movies, n^*, a given price of the differentiated foreign movies, p^*, a given foreign spending on differentiated home movies, w^*, and a given foreign price of the homogenous product, p_T.

In order to complete the basic model, I need to spell the government's problem. Its objective function is to maximize the home country's welfare function, which can be written as:

$$\max f \ln\left(\sum_i c_i^{\theta}\right)^{1/\theta} + (1 - f) \ln\left(\sum_i c_i^{*\theta}\right)^{1/\theta}$$

I mentioned above that the government can implement two types of policies. It can either provide an output or a project subsidy to the movie industry. Resources to finance either policy is obtained only through the introduction of import tax (t) on foreign movies. The government budget constraint has to be in equilibrium, which implies that:

$$tp^* \sum_i x_i^* = sn\alpha w + z \sum_i p_i x_i.$$

3 Equilibrium Conditions

I turn now to the solution to the model in order to obtain the conditions that characterize the equilibrium.

Definition 1 Given w^*, n^*, p_T, and p^*, an equilibrium is characterized by $\{c_i\}_{i=1}^{n}$, $\{c_i^*\}_{i=1}^{n^*}$, $\{p_i\}_{i=1}^{n}$, $\{x_i\}_{i=1}^{n}$, w, T, n, t, s, z, , such that: (i) given $\{p_i\}_{i=1}^{n}$, n and w, $\{c_i\}_{i=1}^{n}$ solves the type 1 individual's problem; (ii) given p^*, and w, $\{c_i^*\}_{i=1}^{n}$ solves the type 2 individual's problem; (iii) given p_T, and w, T solves the problem of the firms in the homogenous sector; (iv) given $\{p_j\}_{j\neq i}$, and w, p_i solves the problem of the firm that produces home movie i; (v) the zero profit condition holds in the movie sector, that is, $\pi_i = 0$, for all i; (vi) the labor market is in equilibrium, that is, $L = l_T + \sum_i l_i$; (vii) given $\{c_i\}_{i=1}^{n}$, $\{c_i^*\}_{i=1}^{n^*}$, and n, t, s, and z solve the government's problem; and (viii) the trade balance is in equilibrium.

In order to find the competitive equilibrium, I will proceed in the following way. First, I will obtain the demand functions for home movies from the consumer's problem. Second, the profit-maximizing behavior by firms is derived and the zero-profit condition indicates total output of each home movie. Third, the trade balance equilibrium condition indicates the amount of homogenous good to be produced. Finally, the labor market equilibrium condition indicates the equilibrium number of differentiated home movie.

The first-order condition with respect to c_i of the type 1 individual's problem is equal to:

$$c_i^{\theta-1} = \lambda_1 p_i \sum_i c_i^{\theta}$$

where λ_1 is the marginal utility of income. Since all individuals type 1 are equal, then $x_i = fLc_i$. Hence, the above equation can be rearranged in order to obtain the following demand curve facing the firm that produces home movie i:

$$p_i = \frac{\left(\frac{x_i}{fL}\right)^{\theta-1}}{\lambda_1 \sum_i \left(\frac{x_i}{fL}\right)^{\theta}}.$$

Using this demand curve in the firm's first-order condition, I obtain the familiar result that the profit-maximizing price is equal to the mark-up price[8]:

$$p_i = \theta^{-1}\beta w(1+z)^{-1}. \tag{1}$$

Using the mark-up price, the profit function becomes:

[8] For simplicity, I omitt here the foreign consumer's problem. However, it is assumed that each firm faces the same demand curve of home and foreign consumers with an elasticity of $\frac{1}{(1-\theta)}$. In this case, each firm charges the same price at home and abroad. Alternatively, it could be assumed that the demand elastiticities of foreign and home consumers were different. In this case, if price discrimination were not allowed, the same price would still be set at home and abroad and would be a combination of the different elasticities.

$$\pi_i = \theta^{-1}\beta w x_i - (\alpha(1-s) + \beta x_i) w.$$

The zero profit condition implies that:

$$x_i = \frac{(1-s)\alpha\theta}{\beta(1-\theta)}. \tag{2}$$

The implication is that the price and the quantity produced of each differentiated home movie are the same.

Wage is determined from the first-order condition of the firms operating in the homogenous good sector:

$$w = \frac{p_T}{\beta_T}. \tag{3}$$

From the trade balance condition and assuming without loss of generality that $p^* = p_T$, one can get the total output of good T:

$$T = \sum_i x_i^* - \frac{w^*}{p_T}.$$

From type 2 individual's problem, one can show that he consumes the same amount of each of the n^* foreign movies available. As a result, the representative type 2 agent buys $c^* = \frac{w}{n^* p^* (1+t)}$ units of each foreign movie. Since there are $(1-f)L$ type 2 individuals, total units of foreign movies imported are equal to $n^* x^* = n^*(1-f)Lc^* = \frac{(1-f)Lw}{(1+t)p^*}$. Using this result and equation (3), the trade balance condition becomes:

$$T = \frac{(1-f)L}{(1+t)\beta_T} - \frac{w^*}{p_T}. \tag{4}$$

In order to find the number of home movies produced, I turn now to the labor market equilibrium condition:

$$L = l_T + \sum_i l_i = \beta_T T + \sum_i (\alpha + \beta x_i).$$

Using equation (2) and (4) in the above equation, the number of different local movies produced is equal to:

$$n = \frac{(1-\theta)}{\alpha(1-\theta s)} \left[L - \frac{(1-f)L}{(1+t)} + \frac{\beta_T w^*}{p_T} \right]. \tag{5}$$

As a result of the steps followed in this section, I obtain all variables of the model as a function of the policy variables under the control of the government (t, z, and s). Hence, it is now possible to analyze the impact of the different government policies on the economic welfare. Before turning to this analysis in the following section, it is convenient to rewrite the government's budget constraint, using the expressions obtained in this section for n^*x^*, p and x. Then, it becomes equal to:

$$\frac{t(1-f)L}{(1+t)} = n\alpha\left[s + \frac{z(1-s)}{(1-\theta)(1+z)}\right]. \tag{6}$$

4 Welfare Analysis

I consider two types of policies and analyze their effects on the economic welfare. First, the government imposes an import tax on foreign movies to finance the output subsidy to the home producers. Second, the government imposes the same tax to subsidize the home movie projects.

In order to proceed with the analysis, it is necessary to follow two steps. First, I find the expressions for n, c, and c^* as a function of t, the import tax, which is the choice variable for the government. Second, using these expressions in the welfare function, I obtain the optimal import tax. Next subsections analyze each one of these policies.

4.1 Import Tax and Output Subsidy

Under the scheme in which the government provides output subsidy financed through import tax, s is set equal to zero. Then, the government budget constraint (equation (6))becomes:

$$z = \frac{t(1-f)L(1-\theta)}{n(1+t)\alpha - t(1-f)L(1-\theta)}. \tag{7}$$

Using (3) and the assumption that $p_T = p^*$ in individual type 2's budget constraint, I obtain c^* as a function of t:

$$c^*(t) = \frac{1}{n^*(1+t)\beta_T}. \tag{8}$$

Total imports of foreign movies decline with the import tax, as it should be. Government intervention does not affect individual's wages[9] and p^* is fixed and exogenously given. With greater tax rate, home individuals who cares only about foreign movies consume less goods. Obviously, they are made worst off with the import tax.

Using (7) in (5), I obtain the number of differentiated home movies (n) as a function of t:

[9] See equation (3).

$$n(t) = \frac{(1-\theta)}{\alpha}\left[L - \frac{(1-f)L}{(1+t)} + \frac{\beta_T w^*}{p_T}\right]. \tag{9}$$

Output subsidy financed through import taxes allows each firm that produces home movies to charge a lower price and still have positive profits. As a consequence, more firms are attracted to this market and it increases the number of differentiated home movies (n) available in the new equilibrium.

From equation (9), one can see that the greater is the import tax, the greater is the number of differentiated home movies produced. As less goods are imported, it is necessary a lower production of the homogenous good T in order to be reached a trade balance. Therefore, more resources can be devoted to the production of home movies, which increases n.

Using (3), (1), (7), and (9) in individual type 1's budget constraint, one can obtain the expression of c as a function of t:

$$c(t) = \frac{\alpha\theta p_T}{(1-\theta)\beta\left[f p_T L + \beta_T w^*\right]}. \tag{10}$$

Under this policy, note that c does not depend on t. The intuition behind this result runs as follows. On the one hand, with the reduction in the price of home movies, each consumer would be willing to consume more units of each home movie. On the other hand, as a greater number of home movies is available, each consumer would be inclined to reduce the consumption of the old home movies in order to consume positive units of the new home movies. The net effect, with the log utility function, is to maintain unaltered the number of units consumed of each home movie (c).[10]

Note that the individuals who care only about the consumption of home movies are better off with the imposition of import tax: c does not change but n increases.

The number of different foreign movies produced does not change with the local government intervention. As the home country is small, this number is fixed and equal to n^*.

Government's problem is to choose the import tax that maximizes the welfare function W. On the one hand, import tax benefits individuals who consume home movies. On the other hand, it hurts individuals who cares only about foreign movies. Its problem is the following:

$$\max_t W = f \ln[n(t)c(t)^{\theta}]^{1/\theta} + (1-f)\ln[n^* c^*(t)^{\theta}]^{1/\theta};$$

subject to equations (7), (8), (9), and (10).

The solution to the government's problem leads to the following results.

[10] Krugman (1980) discuss this issue and notes that in order to get an increase in scale, it must be assumed that the demand facing each individual firm becomes more elastic as the number of firms increases. As in Krugman (1980), I use the constant elasticity case for simplicity.

Proposition 2 Under a policy regime with import tax and output subsidy, the optimum tax is equal to $t^{opt} = \frac{(\theta^{-1} - 1)p_T f L - \beta_T w^*}{p_T L + \beta_T w^*}$. Hence: (i) if $w^* = 0$, then $t^{opt} = \left(\frac{1-\theta}{\theta}\right) f$, (ii) if $w^* > \frac{(1-\theta)}{\theta} f L w$, then $t^{opt} < 0$; (iii) if $w^* < \frac{(1-\theta)}{\theta} f L w$, then $t^{opt} > 0$.

Proposition 3 Under a policy regime with import tax and output subsidy, $\frac{dt^{opt}}{dw^*} < 0$.

The main point is what justifies the potential gain in welfare due to the introduction of the combination of import tariff and output subsidy. Consider first the simplest case in which w^* is equal to zero. With this assumption, the optimal import tariff is positive. With a positive import tax, total imports is lower. As a consequence, the production of the homogenous good T, which is characterized by constant returns to scale, becomes less important. It occurs because homogenous good is only used to finance the purchase of foreign movies, the only imported good in this model. At the same time, it becomes more lucrative to produce home movies, a sector characterized by increasing returns to scale, with the boost received by the output subsidy provided by the government. As a result of the government intervention, the gains to consumers of home movies (type 1 consumers) surpass the losses of consumers of foreigns movies (type 2 consumers), increasing the economic welfare. The difference in the nature of the production process in the home movies sector vis-à-vis the homogenous good sector explains this result.

Proposition 2 indicates that the optimal import tariff is negatively related with the size of the market for home movies abroad, that is, with w^*. A greater w^* works exactly in the same way as the introduction of the import tax mentioned above. When it increases, there is a change in the production mix in favor of the sector characterized by increasing returns to scale. In other words, there is a shift in the home production from the homogenous good to the home movies. As exports increase, it is less necessary to produce the homogenous good to exchange for foreign movies. As a result, the optimal import tariff is lower.

Moreover, proposition 1 indicates that the optimal import tariff is negative as w^* becomes greater than a critical value. The intuition behind this result is the following. As discussed above, w^* plays the same role as t. As w^* increases, the additional benefits to type 1 consumers diminish and they do not compensate the losses incurred by type 2 consumers of a greater import tax, due to the concavity of the utility function. It reaches a point, when w^* is beyond the critical value, that an increase in the welfare function can only be obtained by subsidizing the consumption (import of foreign movies) of type 2 consumers, that is, $t < 0$.

4.2 Import Tax and Project Subsidy

Under the scheme in which the government provides project subsidy financed through import tax, z is set equal to zero. Equation (6), which represents government's budget constraint, becomes:

$$s = \frac{t(1 - f)L}{n(1 + t)\alpha}: \qquad (11)$$

As in the previous subsection, using (3) and the assumption that $p_T = p^*$ in individual type 2's budget constraint, I obtain c^* as a function of t:

$$c^*(t) = \frac{1}{n^*(1 + t)\beta_T}: \qquad (12)$$

As under the another type of government intervention discussed in the previous subsection, those individuals who consume only foreign movies are made worst off with this new policy too. The explanation is the same.

Using (11) in (5), the expression for n as a function of t is the following:

$$n(t) = \left[L + \left(\frac{\theta t(1 - f)L - (1 - \theta)(1 - f)L}{(1 + t)(1 - \theta)} \right) + \frac{\beta_T w^*}{p_T} \right] \frac{(1 - \theta)}{\alpha}: \qquad (13)$$

Project subsidy gives an incentive for firms to invest in new projects. It can be shown that the number of home movies (n) increases with the import tax, that is, the derivative of n with respect to t is positive. Hence, when an import tax is imposed to finance the project subsidy, it increases the number of home movies.

Using (1) in individual type 1's budget constraint, I obtain the expression for c as a function of t:

$$c(t) = \frac{\theta}{n(t)\beta}: \qquad (14)$$

Note that the number of units of each home movie consumed reduces with the import tax, as n increases. The explanation behind this result is the following. As the price charged by each firm does not change with the introduction of project subsidy[11], and there is a greater variety of home movies, the consumption of each home movie available is necessarily lower.

Note that, with the government intervention through import tax plus project subsidy, the individuals who care only about the consumption of home movies choose to consume less units of each movie but they take advantage of a greater variety of those movies. In other words, c decreases and n increases. They are necessarily better off with this change as they could have opted to keep the same pattern of consumption without the government intervention but they choose not to do that.

The number of different foreign movies produced does not change with this new type of home government intervention. This number is fixed and given exogenously by n^*.

[11] See equation (1).

Government's problem is to choose the import tax that maximizes the welfare function W. Its problem is the following:

$$\max_t W = f \ln[n(t)c(t)^{\theta})^{1/\theta} + (1 - f)\ln[n^*c^*(t)^{\theta}]^{1/\theta};$$

subject to equations (11), (12), (13), and (14).

The solution to the government's problem leads to the following results.

Proposition 4 Under a policy regime with import tax and project subsidy, the optimum import tax is equal to $t^{opt} = \frac{(1-\theta)[(1-\theta)fLp_T - \theta\beta_T w^*]}{\theta[(1-\theta f)Lp_T + (1-\theta)\beta_T w^*]}$. Hence: (i) if $w^* = 0$, then $t^{opt} = \frac{f(1-\theta)^2}{\theta(1-\theta f)}$ (ii) if $w^* > \frac{(1-\theta)}{\theta} fLw$, then $t^{opt} < 0$; (iii) if $w^* < \frac{(1-\theta)}{\theta} fLw$, then $t^{opt} > 0$.

Proposition 5 Under a policy regime with import tax and project subsidy, $\frac{dt^{opt}}{dw^*} < 0$.

The results obtained above are similar to the ones found in the previous subsection with the same explanations. Hence, both types of government intervention have exactly the same impact in terms of economic welfare.

5 Conclusion

It is well known in the economic literature that there is room for government to intervene in industries characterized by increasing returns to scale. However, when one deals with the movie industry, there is one additional complication. The possibility of exploiting the global market scale is limited to producers from a small country. Differently from other goods traded in the international market, movies have some characteristics that are very specific to some markets. One obvious example is the language.

The analysis above indicates that the size of external markets to home movie producers affects the degree of the optimal government intervention to correct the inefficiencies of a market characterized by increasing returns to scale or monopolistic competition. The optimal import tariff, with the revenues used either to subsidize production or projects, is lower the greater is the external market to the home movies produced. A greater external market induces a shift in the home production from the homogenous good, characterized by constant returns to scale, to the home movies.

The difference in the nature of the production process in the home movies vis-à-vis the homogenous good sector explains the above result. As in Flam and Helpman (1987), the existence of other non-competitive industries that produce with economies of scale may reduce or eliminate the welfare effect of the tariff. However, if one takes two industries with the same production structure (with economies of scale), home preferences toward their products and etc, a protection of the industry with less access to the foreign market would be welfare improving. This result also would hold for other cultural activities other than the film industry produced under increasing returns to scale such as radio and television programming, literature or print media.

It is important to add that, in spite of the above results, one should be cautious in adopting policies to protect cultural industries. First, the introduction of import tariff may lead to retaliation from other countries. Second, the gains associated with the economies of scale may not be large enough from an empirical point of view to justify intervention. Third, it is not an easy task to define the producers who should receive the subsidies. It is not difficult to find stories of public money being directed to producers who do not need it or would have developed their projects anyway without any aid. Finally, the misuse of public money is always a possibility.

6 Appendix

Proposition 2: Under a policy regime with import tax and output subsidy, the optimum tax is equal to $t^{opt} = \frac{(\theta^{-1} - 1)p_T f L - \beta_T w^*}{p_T L + \beta_T w^*}$. Hence: (i) if $w^* = 0$, then $t^{opt} = \left(\frac{1-\theta}{\theta}\right) f$, (ii) if $w^* > \frac{(1-\theta)}{\theta} f L w$, then $t^{opt} < 0$; (iii) if $w^* < \frac{(1-\theta)}{\theta} f L w$, then $t^{opt} > 0$.

Proof. Using equations (9), and (8), I obtain, respectively, the following expressions:

$$\ln(n) = \ln\left(\frac{(1-\theta)}{\alpha p_T}\right) + \ln\left[(1+t)p_T L - p_T(1-f)L + (1+t)\beta_T w^f\right] - \ln(1+t);$$

and

$$\ln(c^*) = \ln(1) - \ln(n^* \beta_T) - \ln(1+t).$$

Using the above expressions in the welfare function, taking the derivative with respect to t, and making some arrangements, the following result is obtained:

$$t^{opt} = \frac{(\theta^{-1} - 1)p_T f L - \beta_T w^*}{p_T L + \beta_T w^*}$$

■

Proposition 3: Under a policy regime with import tax and output subsidy, $\frac{dt^{opt}}{dw^*} < 0$.

Proof. From the expression for the optimal import tax obtained in the previous proposition, it is straightforward to show that $\frac{dt^{opt}}{dw^*} < 0$. ■

Proposition 4: Under a policy regime with import tax and project subsidy, the optimum import tax is equal to $t^{opt} = \frac{(1-\theta)[(1-\theta) f L p_T - \theta \beta_T w^*]}{\theta[(1-\theta f) L p_T + (1-\theta)\beta_T w^*]}$. Hence: (i) if $w^* = 0$, then $t^{opt} = \frac{f(1-\theta)^2}{\theta(1-\theta f)}$ (ii) if $w^* > \frac{(1-\theta)}{\theta} f L w$, then $t^{opt} < 0$; (iii) if $w^* < \frac{(1-\theta)}{\theta} f L w$, then $t^{opt} > 0$.

Proof. Using equations (13), (14), and (12), I obtain, respectively, the following expressions:

$$\ln(n) = \ln\left[(1+t)(1-\theta)p_T L - (1-f)L(1-\theta)p_T + \beta_T w^f(1+t)(1-\theta) + \theta t(1-f)Lp_T\right] - \ln(1+t) - \ln(p_T\alpha);$$

$$\ln(c) = -\ln\left[(1+t)(1-\theta)p_T L - (1-f)L(1-\theta)p_T + \beta_T w^f(1+t)(1-\theta) + \theta t(1-f)Lp_T\right] + \ln(1+t) + \ln\left(\frac{p_T\alpha\theta}{\beta}\right);$$

and

$$\ln(c^*) = \ln(1) - \ln(n^*\beta_T) - \ln(1+t).$$

Using the above expressions in the welfare function, taking the derivative with respect to t, and making some arrangements, the following result is obtained:

$$t^{opt} = \frac{(1-\theta)\left[(1-\theta)fLp_T - \theta\beta_T w^f\right]}{\theta[(1-\theta f)Lp_T + (1-\theta)\beta_T w^f]}.$$

■

Proposition 5: Under a policy regime with import tax and project subsidy, $\frac{dt^{opt}}{dw^*} < 0$.

Proof. From the expression for the optimal import tax obtained in the previous proposition, it is straightforward to show that $\frac{dt^{opt}}{dw^*} < 0$. ■

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