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# Tariff-Rebate on Intermediate Inputs for Exportables in a Two-period Model with Learning-from-Exporting

By

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## Abstract

This paper develops a two period, perfectly competitive model of international trade of a small open economy with the following features. The country is a net importer of an intermediate input, and there is an import tariff on this good in period 1. The exporting firms that use this intermediate input receive a rebate on its imports in period 1. There are transaction costs of exports in both periods. However, the transaction costs in period 2 is a decreasing function of the amount of exports made in period 1, implying some degree of learning-from-doing in exports. Net tax revenue is used to provide a public good.

In this framework, we determine and characterize, *inter alia*, the optimal level of rebate given to the exporting sector on tariffs paid on imported intermediate inputs.

**JEL Classifications:** F1, O2, O5.

**Keywords:** VAT, tariffs, government revenue, tariff-rebate, export promotion.

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# 1 Introduction

International trade as a proportion of total trade is over 50% and growing.<sup>1</sup> This is true for most countries in the world. In particular, it is also true for the United States of America whose total imports is more than \$2.5 trillion, and 90% of it are imports of intermediate inputs.<sup>2</sup> Imports of intermediate inputs have been shown to be an important contributor to economic growth in many countries. For example, Cavallo and Landry (2018) estimated that imported intermediate inputs are responsible for 14% of growth in the United States of America.

However, the issue of intermediate inputs did not receive adequate attention in the theoretical literature on international trade until the works of Baldwin (1966) and by Ronald Jones and his co-authors (Sanyal and Jones, 1982; Jones, 2000; Findlay and Jones, 2001).<sup>3</sup>

In recent years, the importance of intermediate inputs for international trade for many countries, has been receiving quite a lot of attention (see, for example, Halpern et al., 2015; Acharya and Keller, 2009; Kasahara and Rodrigue, 2008; Amiti and Konings, 2007; Eaton and Kortum, 2001 and 2002; Lee, 1995; Bas and Strauss-Kahn, 2014; Feng et al., 2016; Hummels et al., 2001.)

Turning to the specific cases of India and Pakistan, using firm-level data, Goldberg et al. (2010) analyzed the role of imported intermediate input in promoting the introduction of new products in India. They found that access to new imported intermediate inputs played a significant role in the growth of new products. Lahiri et al. (2000) developed a trade-theoretic model for Pakistan with intermediate inputs and revenue constraints and estimated optimal policies towards imports of steel and found the actual tariffs to be much higher than the optimal ones. Therefore, there is room for significant reductions in those

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<sup>1</sup>[https://www.wto.org/english/news\\_e/news23\\_e/stat\\_01feb23\\_e.htm](https://www.wto.org/english/news_e/news23_e/stat_01feb23_e.htm) (last accessed 30 October 2023).

<sup>2</sup>U.S. Census, <https://www.thebalance.com/u-s-import-export-components-and-statistics-3306270>.

<sup>3</sup>More recently, the framework developed by Eaton and Kortum (2001, 2002) have been receiving a lot of attention in the theoretical and empirical literature.

tariffs.

To complement the findings by Goldberg et al. (2010) and Lahiri et al. (2000), we shall first consider two examples from India to suggest that without imports of intermediate inputs, it is difficult to export.

The first example is the case of the computer software industry in India. Until 1970, India imported almost all computer hardware it needed. In 1972, India introduced high tariffs on imports of computers as a part of its import-substituting industrialization strategy. Its aim was to become self-reliant in computer production. Electronic Corporation of India Limited (ECIL) was handed monopoly power to produce and supply computers in India. Software production remained stagnant as software engineers needed high-quality computers to write high-quality software. In 1991, computer tariffs were reduced, and software production and exports skyrocketed.

The second example is the case of the pharmaceutical industry. India is a very significant producer of generic medicines in the world. It enjoys a 20% share of the world market for generic medicines. It also supplies 60% of the world's vaccine demand. Allowing cheap imports (mainly from China) of chemical intermediate inputs has been a key factor behind India's success in the field of pharmaceutical products. India imported \$12 billion worth of organic chemical products from China in 2021.

However, in recent years India has introduced trade restrictions on imports of chemicals, among others, in order to substitute imports of chemical products with domestic production. In the absence of other mitigating policies, this might affect adversely India's standing in the world pharmaceutical products market.

Turning to India's neighbour Pakistan, like India, it also followed an import substituting strategy for industrialization. As a result, its export performance had been weak. This weak export performance contributed to its current-account deficits, and despite the large inflow of workers' remittances that began in the late seventies, deficits persisted. In

the mid 1980s policy makers started to realize that trade policy reforms were necessary and started relaxing quantitative trade restrictions. The next step was tariff reductions, and by 2003 maximum tariffs was only 25%.<sup>4</sup>

Tariffs on intermediate inputs such as chemical products and steel act like a tax on exports, as these tariffs result in a higher cost of production of exportable goods and thus place these goods at a disadvantage against competing exports from other countries. One of the ways in which this problem is addressed in both India and in Pakistan is by providing refunds to exporters on duties that had been paid on their imported inputs.<sup>5</sup> Over the years there has been an improvement in the processes and systems of duty drawbacks or rebates provided to exporters.<sup>6</sup> In this paper, this rebate takes centre stage in our analysis.

Before trade policy reforms in India and Pakistan, import tariffs assumed a big share in tax revenues. Given the dependence on tax revenues for the provision of public goods, the success of tariff reform was contingent upon developing alternative sources of revenue and improving the quality of tax administration. Pakistan tried to depend more and more on consumption or sales taxes. The share of sales tax in total tax revenue increased from 13% in 1990-91 to 38% in 2003-2004, and the share of international trade taxes decreased from 39% to 15% during the same period. For India, the introduction of Goods and Services TAX (GST) in 2017 and improvements and computerization in tax collection has resulted in a steady increase in indirect tax collection.

When alternative sources of revenue are available to the government, it can choose between these alternative sources of revenue to meet a given revenue constraint. In this paper, we attempt to calculate and characterize the optimum level of taxes, tariffs and rebates to meet a given level of tax revenue. Lahiri and Nasim (2005), estimate optimum

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<sup>4</sup>This automobile industry is an exception in both India and Pakistan. Tariffs on automobiles in these two countries can be over 75%, possibly inducing tariff-jumping foreign direct investments.

<sup>5</sup>For India, see Duty-Free Import Authorisation Scheme  
<https://www.indiantradeportal.in/vs.jsp?lang=0&id=0,25,857,3901>

<sup>6</sup>In Pakistan, Rebates and refunds constituted 2%-5% of gross customs collection in the 1970s, 8%-10% in the 1980s, 10%-15% in the 1990s and 20% and above since 1998-99.

tariffs and sales tax in a somewhat similar framework where the level of government tax revenue is taken as given, and government tax revenue is used to provide a public good. Lahiri *et al.* (2000) estimated optimal tariffs on intermediate inputs for a given level of other tariffs.

The structure of this paper is as follows. Section 2 develops the theoretical framework. Section 3 then characterizes the optimal values of the policy instruments. Finally, some concluding remarks are made in section 4.

## 2 The theoretical framework

We consider a small open economy with three goods in each period: two final consumption goods (labeled 1 and 2) and one intermediate input (labeled good  $I$ ), and there are two periods  $t = 1, 2$ . The country imports good 1 and exports good 2. It is also a net importer of the intermediate input. The international price in period  $t$  of the three goods are respectively  $p_1^t$ ,  $p_2^t$  and  $p_I^t$  ( $t = 1, 2$ ). Imports of good 1 and  $I$  are subject to *ad valorem* tariffs at the rate of  $t_m$  and  $t_I$  respectively in period 1. Exports of good 2 are subject to a transportation cost of the iceberg type at the rate  $\tau^t$  ( $t = 1, 2$ ). Furthermore, there is a consumption tax at the rate  $t_c$  on good 1 in period 1.

Thus the domestic consumer and producer prices of good 1 in period 1 are  $p_1^1(1 + t_m)(1 + t_c)$  and  $p_1^1(1 + t_m)$  respectively. Both the consumer and producer price of good 2 and period 1 are  $p_2^1(1 - \tau^1)$ . We assume that the policy instruments are temporary and therefore the current domestic prices (producer and consumer) of goods 1 and 2 in period 2 are respectively  $p_1^2$  and  $p_2^2(1 - \tau^2)$ . As for the intermediate good, the domestic prices in the two periods are  $p_I^1(1 + t_I)$  and  $p_I^2$  respectively. However, the exporting sector only pays  $p_I^1(1 + t_I - s)$  in period 1 where  $s$  is the unit rebate it receives from the government.

The inter-temporal expenditure is given by  $E(p_1^1(1 + t_m)(1 + t_c), p_2^1(1 - \tau^1), p_1^2/(1 + r), p_2^2(1 - \tau^2)/(1 + r), g, u)$  where  $r$  is the rate of interest,  $g$  is the level of public good provision,

and  $u$  is the utility level.

The revenue functions in the two periods are given by  $R^1(p_1^1(1+t_m), p_2^1(1-\tau^1), p_I^1(1+t_I), I_1, I_2)$  and  $R^2(p_1^2, p_2^2(1-\tau^2), p_I^2)$  respectively. The variables  $I_1$  and  $I_2$  are the total amounts of intermediate inputs used in the importing and the exporting sector respectively so that  $I_1 + I_2 - R_3^1$  is net imports of good  $I$ .<sup>7</sup>  $-E_5 (= -\partial E/\partial g) > 0$  is the marginal willingness to pay (MWP) for the public good,<sup>8</sup> and  $E_6 (= \partial E/\partial u)$  is the reciprocal of the marginal utility of income.

An increase in the provision of public good  $g$ , for a given level of utility  $u$ , must reduce private consumption to keep utility constant. Thus, it is normal to assume that  $E_{i5} \leq 0$  for  $i = 1, 2, 3, 4$ . Taking income effects on demand to be positive, we assume  $E_{i6} \geq 0$  for  $i = 1, 2, 3, 4$ . MWP increases with income and so  $E_{56} < 0$ . Finally, diminishing marginal utility of income implies  $E_{66} > 0$ , and diminishing MWP means  $E_{55} > 0$ .

The budget constraint of the representative consumer is that the total inter-temporal expenditure is the discounted present value of the total value of domestic production minus

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<sup>7</sup> $R_i^j$  ( $i = 1, 2, 3; j = 1, 2$ ) is the partial derivative of the revenue function with respect to its  $i$ th argument.

The way we model intermediate inputs in a revenue function is different from the literature (see, for example, Lahiri et al. (2000)). This is necessitated by the very nature of our framework: because of the presence of tariff rebate for the exporting sector, the use of intermediate inputs are effectively taxed at different rates for the different sectors. If they were not, we did not need to model the intermediate input use in the different sectors explicitly, and the production of intermediate input could be seen as net of their uses in the different sectors, i.e., ‘netted out in vertical integration’ (Dixit and Norman, 1980, p. 31). Here we treat the use of intermediate inputs in the two sectors as endogenous ‘endowments’, and their output  $R_3^1$  is not netted out. This only applies to period 1. Since rebate is given only in period 1, in period 2,  $R_3^2$  is the net output of the intermediate input in period 2, i.e., output minus total intermediate input use.

It is well known that the partial derivative of the revenue function with respect to the  $i$ th price gives the supply function for the  $i$ th good. This is the output version of the well-known Shephard’s Lemma. Similarly, the partial derivative of the expenditure function with respect to the  $i$ th price gives the compensated demand function for the  $i$ th good.  $R_4^1$  and  $R_5^1$  are the prices of the intermediate input paid by the producers of the importing and the exporting sector respectively. Since the level of endowments of primary inputs do not vary in our analysis, for brevity, these are left out of the arguments of the revenue function. See Dixit and Norman (1980) for properties of expenditure and revenue functions.

<sup>8</sup>See, for example, Abe (1992) for details.

the total value of intermediate input used in production, i.e,

$$\begin{aligned}
& E(p_1^1(1+t_m)(1+t_c), p_2^1(1-\tau^1), p_1^2/(1+r), p_2^2(1-\tau^2)/(1+r), g, u) = \\
& R^1(p_1^1(1+t_m), p_2^1(1-\tau^1), p_I^1(1+t_I), I_1, I_2) + R^2(p_1^2, p_2^2(1-\tau^2), p_I^2)/(1+r) \quad (1) \\
& - p_I^1(1+t_I)I_1 - p_I^1(1+t_I-s)I_2.
\end{aligned}$$

Since, as mentioned above, the price of such intermediate inputs faced by the exporting sector is different from the ones faced by other sectors because of the rebate, we have

$$R_4^1 = p_I^1(1+t_I), \quad (2)$$

$$R_5^1 = p_I^1(1+t_I-s). \quad (3)$$

The public good  $g$  is financed by tax revenue,<sup>9</sup> i.e.,

$$g = t_m p_1^1(E_1 - R_1^1) + t_c(1+t_m)p_1^1 E_1 + t_I p_I^1(I_1 + I_2 - R_3^1) - s p_I^1 I_2. \quad (4)$$

The first three terms on the right hand side of (4) are respectively, tariff revenue from good 1, consumption tax revenue from the sale of good 1, and tariff revenue from good  $I$ . The fourth term is the amount of rebate received by the exporting sector.

Finally, we assume that there is an inter-temporal externality in exports in the sense that exporters in period 2 face a lower transportation cost if the exporters in period 1 exports more, i.e., the rate of transportation cost in period 2 is a decreasing function of the level of exports in period 1:

$$\tau^2 = \tau^2(X^1), \quad (5)$$

where  $X^1 = R_2^1 - E_2$  and  $\tau^{2'} < 0$ .

We shall, for simplicity, assume that  $R_{45}^1 = 0$ . That is, a change in the intermediate input use in one sector does not affect the demand for the intermediate input use in the other sector. Since  $I_1$  ( $I_2$ ) is the use of intermediate input use in sector 1 (2), we shall assume that

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<sup>9</sup>It is assumed that one unit of the numeraire good is used up to produce one unit of the public good.

$R_{14}^1 > 0$  and  $R_{25}^1 > 0$ . Since in our model structure, the intermediate input is used in the production of both the importables and the exportable, an increase in the rate of tariff on intermediate inputs which makes intermediate inputs more expensive in both importables and exportables, reduces outputs of both sectors, i.e.,  $R_{13}^1 < 0$  and  $R_{23}^1 < 0$ .

This completes the description of the model structure and we shall now derive the basic welfare equations.

### 3 Welfare Analysis

In this section, we shall derive the optimal values of the policy parameters  $s$ ,  $t_c$ ,  $t_I$  and  $t_m$ .

Differentiating (2), (3) and (5), we get

$$R_{44}^1 dI_1 = p_I^1(1 - R_{43}^1)dt_I - R_{41}^1 p_1^1 dt_m, \quad (6)$$

$$R_{55}^1 dI_2 = p_I^1(1 - R_{53}^1)dt_I - R_{51}^1 p_1^1 dt_m - p_I^1 ds, \quad (7)$$

$$\Lambda dX^1 = p_1^1 A_m dt_m + p_I^1 A_I dt_I - E_{21} p_1^1 (1 + t_m) dt_c - \frac{p_I^1 R_{25}^1}{R_{55}^1} ds - E_{25} dg - E_{26} du, \quad (8)$$

where

$$\begin{aligned} \Lambda &= 1 - p_2^2 E_{24} \tau^{2'}, \\ A_m &= R_{21}^1 - (1 + t_c) E_{21}^1 - \frac{R_{41}^1 R_{24}^1}{R_{44}^1} - \frac{R_{51}^1 R_{25}^1}{R_{55}^1}, \\ A_I &= R_{23}^1 + \frac{R_{24}^1 (1 - R_{43}^1)}{R_{44}^1} + \frac{R_{25}^1 (1 - R_{53}^1)}{R_{55}^1}. \end{aligned}$$

Since  $R_{44}^1 < 0$  and  $R_{55}^1 < 0$ , an increase in the tariff on intermediate input would reduce its use in the production of both the importable and the exportable in period 1. An increase in the tariff on the importable would increase (decrease) the production of the importable (exportable) and hence increase (decrease) the use of intermediate inputs in the production of the importable (exportable). Finally, an increase in the rebate  $s$  would increase the use of intermediate input in the production of the exportable.

As for the effects of the policy parameters on the level of exports in period 1 (equation (8)),  $X^1$ , are easily explained. An increase in utility  $u$  increases period-1 consumption of the exportable and therefore reduces exports in that period. An increase in  $g$ , as mentioned before, reduces consumption and therefore increases exports. An increase in the tariff on the importables in period 1, reduces output of the exportable and increases its domestic consumption, and therefore lowers exports, for given levels of  $I_1$  and  $I_2$ . These are given by the first two terms in the expression for  $A_m$ . The last two terms in  $A_m$  arise via induced changes in  $I_1$  and  $I_2$ . An increase in consumption tax on the importable increases domestic consumption of the exportable and therefore reduces exports. Finally, an increase in the tariff on the intermediate input reduces output of the exportable, and therefore lowers exports, for given levels of  $I_1$  and  $I_2$ . This is given by the first term in the expression for  $A_I$ . The last two terms in  $A_I$  arise via induced changes in  $I_1$  and  $I_2$ .

We now consider the government's problem of choosing the tax instruments and the rebate rate optimally, subject to the budget constraint (1) and the revenue constraint (4). This problem can be formally stated as the following Lagrangean problem:

$$\begin{aligned}
\max_{t_c, t_I, t_m, s, u} \quad & \mathcal{L} = \\
& u + \lambda [R^1(p_1^1(1+t_m), p_2^1(1-\tau^1), p_I^1(1+t_I), I_1, I_2) + R^2(p_1^2, p_2^2(1-\tau^2), p_I^2)/(1+r) \\
& - p_I^1(1+t_I)I_1 - p_I^2(1+t_I-s)I_2 \\
& - E(p_1^1(1+t_m)(1+t_c), p_2^1(1-\tau^1), p_1^2/(1+r), p_2^2(1-\tau^2)/(1+r), g, u)] \\
& + \beta [t_m p_1^1(E_1 - R_1^1) + t_c(1+t_m)p_1^1 E_1 + t_I p_I^1(I_1 + I_2 - R_3^1) - s p_I^1 I_2 - g],
\end{aligned} \tag{9}$$

where  $\lambda$  and  $\beta$  twp Lagrange multipliers.

Using (6)-(8) and substituting (2) and (3), the first-order conditions of the above

problem are simplified as:

$$\frac{1}{\lambda} \frac{\partial \mathcal{L}}{\partial s} = I_2(1 - \delta) + \frac{p_2^2 R_{25}^1 \tau^{2'} \Delta}{(1 + r) R_{55}^1 \Lambda} + \frac{\delta}{R_{55}^1} [t_m p_1^1 R_{15}^1 + s p_I^1 - t_I p_I^1 (1 - R_{35}^1)] = 0, \quad (10)$$

$$\begin{aligned} \frac{1}{\lambda} \frac{\partial \mathcal{L}}{\partial t_I} = & (I_1 + I_2 - R_3^1)(\delta - 1) - \frac{p_2^2 \tau^{2'} A_I \Delta}{(1 + r) \Lambda} + \delta \left[ -t_m p_1^1 \left\{ R_{13}^1 + \frac{R_{14}^1 (1 - R_{43}^1)}{R_{44}^1} \right. \right. \\ & + \left. \frac{R_{15}^1 (1 - R_{53}^1)}{R_{54}^1} \right\} + t_I p_I^1 \left\{ -R_{33}^1 + \frac{(1 - R_{43}^1)(1 - R_{34}^1)}{R_{44}^1} + \frac{(1 - R_{53}^1)(1 - R_{35}^1)}{R_{55}^1} \right\} \\ & \left. - \frac{s p_I^1 (1 - R_{53}^1)}{R_{55}^1} \right] = 0, \end{aligned} \quad (11)$$

$$\begin{aligned} \frac{1}{\lambda} \frac{\partial \mathcal{L}}{\partial t_m} = & (\delta - 1)[E_1(1 + t_c) - R_1^1] - \frac{p_2^2 \tau^{2'} A_m \Delta}{(1 + r) \Lambda} + \delta [p_1^1(1 + t_c) E_{11}(t_m + t_c(1 + t_m)) \\ & + t_m p_1^1 \left\{ -R_{11}^1 + \frac{R_{14}^1 R_{41}^1}{R_{44}^1} + \frac{R_{15}^1 R_{51}^1}{R_{55}^1} \right\} - t_I p_I^1 \left\{ R_{31}^1 + \frac{R_{41}^1 (1 - R_{34}^1)}{R_{44}^1} + \frac{R_{51}^1 (1 - R_{35}^1)}{R_{55}^1} \right\} \\ & + \left. \frac{s p_I^1 R_{51}^1}{R_{55}^1} \right] = 0 \end{aligned} \quad (12)$$

$$\frac{1}{\lambda} \frac{\partial \mathcal{L}}{\partial t_c} = (\delta - 1) E_1 + \frac{p_2^2 E_{21} \tau^{2'} \Delta}{(1 + r) \Lambda} + \delta p_1^1 [t_m + t_c(1 + t_m)] E_{11} = 0, \quad (13)$$

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial u} = & 1 - \lambda \left[ E_6 - \frac{p_2^2 \tau^{2'} (R_2^2 - E_4) E_{26}}{(1 + r) \Lambda} \right] + \beta p_1^1 (t_m + t_c(1 + t_m)) \\ & \left[ E_{16} + \frac{p_2^2 \tau^{2'} E_{14} E_{26}}{(1 + r) \Lambda} \right] = 0, \end{aligned} \quad (14)$$

where

$$\begin{aligned} \Delta &= R_2^2 - E_4 + \delta p_1^1 E_{14} (t_m + t_c(1 + t_m)) \\ \delta &= \frac{\beta}{\lambda}. \end{aligned}$$

The variable  $\delta = \beta/\lambda$  is the marginal rate of substitution between private income and government revenue, *i.e.*, the amount of private income that consumers would have to receive to compensate for the government's need to raise an extra dollar of revenue. In other words,  $\delta$  is the marginal cost for public funds (MCPF) (see, for example, Wilson, 1991; Lahiri and Nasim, 2005). In the presence of a binding revenue constraint, we shall have  $\delta > 1$ .

We further assume  $E_{14} = E_{24} = R_{15}^1 = R_{24}^1 = R_{34}^1 = R_{35}^1 \simeq 0$  so that  $\Delta = X^2$  and  $\Lambda = 1$ . The rise in the price of the exportable in period 2 does not affect consumption levels in period 1. A rise in the intermediate input use of the importable (exportable) in period 1 has no effect on the output of the exportable (importable). These are all simplifying assumptions.

Substituting (10) and (13) in (12), and (10) in (11), we get respectively:

$$-(\delta - 1)R_1^1 + \delta t_m p_1^1 \left( R_{11}^1 + \frac{R_{14}^1 R_{41}^1}{R_{44}^1} \right) - \delta t_I P_I^1 \left( R_{31}^1 + \frac{R_{41}^1}{R_{44}^1} \right) - \frac{p_2^2 \tau^{2'} X^2 R_{21}^1}{1+r} = 0, \quad (15)$$

$$-\delta t_m p_1^1 \left( R_{13}^1 + \frac{R_{14}^1}{R_{44}^1} \right) + \delta t_I P_I^1 \left( R_{33}^1 + \frac{1}{R_{44}^1} \right) + (\delta - 1)(I_1 - R_3^1) - \frac{p_2^2 \tau^{2'} X^2 R_{23}^1}{1+r} = 0. \quad (16)$$

This way  $t_c$  and  $s$  are eliminated from (12) and  $s$  from (11).

Dividing through (15) by  $R_1^1$ , (16) by  $R_3^1$ , and (13) by  $E_1$ , and using (6) to write  $\partial I_1 / \partial (p_1^1(1 + t_m))$ , equations (10), (13), (15) and (16) are rewritten respectively as:

$$(\delta - 1) - \delta \eta_{11} \cdot \frac{t_m + t_c(1 + t_m)}{(1 + t_m)(1 + t_c)} + \eta_{12} \frac{p_2^2 \tau^{2'} X^2}{(1 + r)p_2^1(1 - \tau^1)} = 0, \quad (17)$$

$$(1 - \delta)(1 + t_I - s) - \frac{p_2^2 \tau^{2'} X^2}{(1 + r)p_I^1} \cdot \epsilon_{25}^1 \epsilon_{55}^1 \cdot \frac{R_2^1}{I_2} - \delta \epsilon_{55}^1 (t_I - s) = 0, \quad (18)$$

$$\begin{aligned} -(\delta - 1) + \delta \cdot \frac{t_m}{1 + t_m} (-\epsilon_{11}^1 - \epsilon_{14}^1 \epsilon_{41}^1) + \delta \frac{t_I}{1 + t_I} (\epsilon_{13}^1 + \epsilon_{14}^1 \epsilon_{44}^1) \\ + \frac{p_2^2 \tau^{2'} X^2 \epsilon_{12}^1}{(1 + r)p_2^1(1 - \tau^1)} = 0, \end{aligned} \quad (19)$$

$$\begin{aligned} \frac{\delta t_m}{1 + t_m} \left( \epsilon_{31}^1 + \epsilon_{41}^1 \cdot \frac{I_1}{R_3^1} \right) + \frac{\delta t_I}{1 + t_I} \left( -\epsilon_{33}^1 - \epsilon_{44}^1 \cdot \frac{I_1}{R_3^1} \right) + (\delta - 1) \left( \frac{I_1}{R_3^1} - 1 \right) \\ + \frac{p_2^2 \tau^{2'} X^2 \epsilon_{32}^1}{(1 + r)p_2^1(1 - \tau^1)} = 0, \end{aligned} \quad (20)$$

where

$$\begin{aligned}
\eta_{11} &= -\frac{\partial E_1}{\partial(p_1^1(1+t_m)(1+t_c))} \cdot \frac{p_1^1(1+t_m)(1+t_c)}{E_1} = -\frac{E_{11}(p_1^1(1+t_m)(1+t_c))}{E_1}, \\
\eta_{12} &= \frac{\partial E_1}{\partial(p_2^1(1-\tau^1))} \cdot \frac{p_2^1(1-\tau^1)}{E_1} = \frac{E_{12}(p_2^1(1-\tau^1))}{E_1}, \\
\epsilon_{25}^1 &= \frac{\partial R_2^1}{\partial I_2} \cdot \frac{I_2}{R_2^1} = \frac{R_{25}^1 I_2}{R_2^1}, \quad \epsilon_{55}^1 = -\frac{\partial I_2}{\partial R_5^1} \cdot \frac{R_5^1}{I_2} = -\frac{R_5^1}{R_{55}^1 I_2}, \\
\epsilon_{11}^1 &= -\frac{\partial R_1^1}{\partial(p_1^1(1+t_m))} \cdot \frac{p_1^1(1+t_m)}{R_1^1} = -\frac{R_{11}^1(p_1^1(1+t_m))}{R_1^1}, \quad \epsilon_{14}^1 = \frac{\partial R_1^1}{\partial I_1} \cdot \frac{I_1}{R_1^1} = \frac{R_{14}^1 I_1}{R_1^1}, \\
\epsilon_{41}^1 &= -\frac{\partial I_1}{\partial(p_1^1(1+t_m))} \cdot \frac{p_1^1(1+t_m)}{I_1} = -\frac{R_{41}^1(p_1^1(1+t_m))}{R_{44}^1 I_1}, \\
\epsilon_{13}^1 &= -\frac{\partial R_1^1}{\partial(p_I^1(1+t_I))} \cdot \frac{p_I^1(1+t_I)}{R_1^1} = -\frac{R_{13}^1(p_I^1(1+t_I))}{R_1^1}, \\
\epsilon_{14}^1 &= \frac{\partial R_1^1}{\partial I_1} \cdot \frac{I_1}{R_1^1} = \frac{R_{14}^1 I_1}{R_1^1}, \quad \epsilon_{44}^1 = -\frac{\partial I_1}{\partial R_4^1} \cdot \frac{R_4^1}{I_1} = -\frac{R_4^1}{R_{44}^1 I_1}, \\
\epsilon_{12}^1 &= -\frac{\partial R_1^1}{\partial(p_2^1(1-\tau^1))} \cdot \frac{p_2^1(1-\tau^1)}{R_1^1} = -\frac{R_{12}^1(p_2^1(1-\tau^1))}{R_1^1}, \\
\epsilon_{31}^1 &= \frac{\partial R_3^1}{\partial(p_1^1(1+t_m))} \cdot \frac{p_1^1(1+t_m)}{R_3^1} = -\frac{R_{31}^1(p_1^1(1+t_m))}{R_3^1}, \\
\epsilon_{33}^1 &= \frac{\partial R_3^1}{\partial(p_I^1(1+t_I))} \cdot \frac{p_I^1(1+t_I)}{R_3^1} = \frac{R_{13}^1(p_I^1(1+t_I))}{R_3^1}, \\
\epsilon_{32}^1 &= -\frac{\partial R_3^1}{\partial(p_2^1(1-\tau^1))} \cdot \frac{p_2^1(1-\tau^1)}{R_3^1} = -\frac{R_{32}^1(p_2^1(1-\tau^1))}{R_3^1}.
\end{aligned}$$

The optimal  $t_m$  and  $t_I$  are jointly determined from (19) and (20). Then the optimal value of  $s$  is computed from (18), and  $t_c$  from (17).

We first of all consider the case where all the policy instruments, except the tariff rebate  $s$ , are exogenously given and only  $s$  is optimally chosen. In this situation the optimal value of  $s$  is derived from equation (18) and this can be rewritten as

$$s = t_I - \frac{\delta - 1}{\delta - 1 + \delta \epsilon_{55}^1} + \frac{p_2^2 \tau^{2'} X^2}{(1+r)p_I^1} \cdot \epsilon_{25}^1 \epsilon_{55}^1 \cdot \frac{R_2^1}{I_2(\delta - 1 + \delta \epsilon_{55}^1)}. \quad (21)$$

From equation (21), we note that in the absence of any revenue constraint ( $\delta = 1$ ) and any inter-temporal exports externality ( $\tau^{2'}=0$ ), the optimal value of  $s$  satisfies  $s = t_I$ . That is, the exporting sector gets 100% rebate on tariffs on intermediate inputs. A binding revenue constraint adds a negative, and an inter-temporal exports externality contributes a positive, term to the expression for optimal  $s$ .

When a consumption tax is absent, but  $t_m$ ,  $t_I$  and  $s$  are optimally chosen, we note that a binding revenue constraint adds a positive, and inter-temporal export externality adds a negative, term to the optimal values of  $t_I$  and  $t_m$ . The first is due to revenue-raising motive and the second due to the negative effects of these two instruments on the exporting sector. The final point is that a higher value of  $t_I$  implies a lower value of  $t_m$  and vice versa.

## 4 Conclusion

In this paper we have developed and analyzed a two-period theoretical model of a perfectly competitive small open economy with a number of characteristics which include a government revenue constraint, tariff on intermediate inputs, and a tariff on the imports of a final good. We also include an inter-temporal externality in exports in the sense that more exports in period 1 reduces the transaction costs of exports in period 2. In this framework, we characterize the optimal value of a rebate on imports on intermediate inputs received only by the exporting sector. We find that in the absence of any revenue constraint and any inter-temporal exports externality, the exporting sector gets 100% rebate on tariffs on intermediate inputs. A binding revenue constraint adds a negative, and inter-temporal exports externality contributes a positive, term to the expression for optimal level of the rebate.

We also find that when all instruments are optimally chosen, a binding revenue adds a positive, and inter-temporal export externality adds a negative, term to the optimal values of the two tariff rates. The first is due to revenue-raising motive and the second due to the negative effects of these two instruments on the exporting sector.

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