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# FIRM BEHAVIOR AND MARKET ACCESS IN A FREE TRADE AREA WITH RULES OF ORIGIN

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## ABSTRACT

We develop a model to study the behavior of firms in a Free Trade Area with Rules of Origin and the consequences of this behavior on the market equilibrium and outcome. We show that firms will choose to specialize, and that an FTA with strict ROOs on the intermediate good raises imports and hence improves market access in the final good market, but reduces imports and hence harms market access in the intermediate good market. More restrictive ROOs on the final good *first raise and then lower imports* of the final good, but *first lower than raise imports* of the intermediate good. Their turning point is common so that imports of the final good are maximized and imports of the intermediate good are minimized at a common level of restrictiveness of the rules of origin. We show that our model can be reinterpreted to show that more restrictive ROOs on the final good first improves and then harms the fortunes of labor, and to cast light on a particular policy to improve market access. Other problems with a similar structure could also be analyzed using our techniques; we expect similar results.

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## 1. Introduction

There has recently been a surge in interest in Preferential Trading Arrangements or *PTAs*. In the *U.S.* much of this is linked to the creation of the North American Free Trade Area or *NAFTA*. A Free Trade Area or *FTA* is a *PTA* in which tariff rates among members are zero, although tariff rates set by members on non members are not necessarily equalized. In an *FTA*, members maintain their own external tariffs. As such, tariffs are likely to differ among member countries.

Given this difference in tariffs, and in the absence of transport costs, what prevents trade in a product from going through the country with the lowest tariff on it and then being shipped within the *FTA*? The answer is Rules of Origin or *ROO*. A good is eligible for zero tariffs in the *FTA* only if it originates there. These *ROO* specify conditions which have to be met for such origin to be granted. There is a large literature on *ROO* in law, see for example [18]. In economics, a few of the notable papers are [5], and [9].[1]

While it is tempting to think of *FTAs* as liberalizing, they are often not. There are three distinct reasons for this. The first has little to do with *FTAs* as such and is well understood: namely the difficulty of defining "liberalizing" in a

[1] This paper also contains a summary of some of the related literature in law and in international trade.

multi good environment[2]. This is addressed in a related paper, see [6]. There we show that even though an $FTA$ without $ROOs$ or transport costs weakly reduces the tariff in effect on all goods, welfare and market access may be hurt. The focus there is on linkages in final and intermediate goods which make the usual trade creating and trade diverting intuition of the Customs Union ($CU$) literature fail. The second reason is that these $ROO$ are in themselves hidden protection: they create what looks like tariffs on imported intermediate inputs and affect the price of domestically made inputs as well. Third, as $ROOs$ are negotiated industry by industry, there is enormous scope for well organized industries to essentially insulate themselves from the effects of the $FTA$ by devising suitable $ROO$. For this reason, there is a lot of lobbying by industries and employment of trade lawyers in the process of defining the $ROO$ for their industry. In [9], Krishna and Krueger provide a number of such examples. A large part of the $NAFTA$ agreement itself has to do with defining these $ROO$!

There are large differences in the effects of $FTAs$ with and without $ROO$. In the absence of $ROO$, an $FTA$ results in large changes in trade flows as trade seeks the lowest tariff entry point into the $FTA$. Goods are then trans-shipped to

[2]Some recent work by Anderson and Neary, see [1] has developed conditions under which this can be clearly defined, but there are drawbacks to their approach as well. See [10] for some perspectives on this issue.

their final destination in the *FTA*. Of course this results in large tariff revenue transfer effects as this "trade deflection" transfers tariff revenue from a good to the country with the lowest tariff entry point. However, in the presence of *ROO*, this trans-shipment is not possible. Nevertheless, there is still some trade deflection possible. By shipping domestic production, which meets the *ROO*, to its *FTA* partners and meeting domestic demand via imports, the low tariff country can still attract trade to its ports. However, the presence of *ROO* will also attract investment in order to circumvent *ROO*. Thus, *FTAs* with *ROO* lead to large investment flows, while those without *ROO* result in large trade flows! In [9], Krishna and Krueger make this point in a model with constant returns to scale. Such a model may represent the long run quite well, but is unlikely to be of much use in the short run. Shorter run effects are likely to be very different and have not been studied. This is the object of this paper.

The model developed in this paper is distinguished by a number of features which are dictated by the nature of the problem. First, that as *ROO* necessarily involve intermediate inputs, it is necessary to build a model with final and intermediate goods. In such models, the usual trade creating-trade diverting classification used in the customs union literature is inadequate[3]. Even without *ROO*,

[3] Lopez and Panagaria in [14] focus on peicemeal policy reform with pure intermediate inputs

the interaction in the final and intermediate goods markets results in two new effects, what we call the input price and the derived demand effects. A fall in the tariff on the final good or intermediate good reduces its price and so reduces the quantity supplied and increases the quantity demanded at home. This *creates trade* as excess demand or imports rise. This is the familiar trade creation effect. However, the fall in the domestic quantity supplied of the final good shifts the domestic derived demand for the intermediate good inward *reducing* its imports. This is the *derived demand* effect. Moreover, a reduction in the tariff on the input reduces its price and shifts outward the domestic supply of the final good. This *reduces* imports of the final good. This is what we term the *input price* effect. In [6] we show that while the trade creation effect raises welfare, the input price and derived demand effects reduce it and their effect can predominate. With $ROO$ further distortions arise which affect trade and are the focus of this paper.

Second, in the short run, firms must decide on production for their own market and for export to the partner in the $FTA$. For this reason, *firm behavior* in the face of $ROO$ needs to be modelled. The constraints under which firms operate limit a country's ability to divert production to its partner in the $FTA$. We focus

and argue that the standard restrictions need not ever hold here. Lopez and Rodrik in [15] develop an intertemporal model, again with pure intermediate inputs to show that the trade balance may deteriorate with import restrictions on inputs as these act like supply shocks.

on the short run where capital is fixed but can be used to produce for the domestic market or for export. In the long run supply is infinitely elastic and some results in this case are to be found in [9].

Third, we focus on the market access effects rather than the welfare effects. This is because a large part of the discussion of $FTAs$ has centered on how they affect the market access of non members, and because clean welfare results are hard to come by here. In general, trade creating effects raise welfare while input price and derived demand effects reduce welfare as shown in [6]. In addition there are tariff shifting effects which can be very large.

There are many aspects of $FTAs$ that we neglect in this paper. Issues of why they might be created, political economy considerations, whether they are stepping stones to global integration or impediments to it[4], which kinds of $FTAs$ are good and which kinds bad, are all outside the scope of this paper. The reader is directed to Krueger's work, see for example [11] for a thoughtful discussion of such issues, to the work of Bhagwati and Panagariya, see for example [3], for a biting criticism of much of the work in the area, and to the work of Bagwell and

[4]Using a median voter model, Philip Levy, see [13], shows that in a Heckscher-Ohlin setting a bilateral agreement cannot supplant multilateral free trade, but bilateralisim can undermine support for future multilateral liberalization when there are variety benifits from trade. Pravin Krishna, see [8], looks at the similar questions using a Cournot model of oligopoly to look at the effect on firm profits.

Staiger, see [2], for some fascinating ideas on developing rules which ensure that $FTAs$, when formed, do not result in negative externalities for non members.

## 2. The Model

We want to consider the effects of an $FTA$. The simplest framework in which this can be done is a three country world. Let the three countries be called $A$, $B$, and $C$. We will assume that countries $A$ and $B$ form an $FTA$, excluding $C$ which can be thought of as the rest of the world. There are two goods, a final good $x$ and an intermediate good $z$ in addition to a numeraire consumption good. Prior to the $FTA$, the pattern of trade is such that $A$ and $B$ both import the final good from $C$. The intermediate good is also imported by both $A$ and $B$. Of course, the numeraire good is exported by them to $C$ so that trade balances.

Both $A$ and $B$ are assumed to be small countries so that they take the world price as given. The world price for x is denoted by $p_x^w$ and the world price for $z$ is denoted by $p_z^w$. Both $A$ and $B$ have tariffs on $x$ and $z$. These are assumed to be specific tariffs. The tariffs on $x$ by $A$ and $B$ are denoted by $t_x^A$ and $t_x^B$ respectively, while those on $z$ are denoted by $t_z^A, t_z^B$ . The price of good $j$ in country $i$, at time $t = 0$ ( $t = 0$ before the $FTA$ and $t = 1$ after it) $p_j^{i0}$, is given by $p_j^{i0} = p_j^w + t_j^i$, for $i = A, B$ and $j = x, z$, as both goods are imported.

When $A$ and $B$ form an $FTA$, their tariffs on each others products are set at zero, while those on imports from the rest of the world are unchanged. We will assume that the tariff on $x$ set by $A$ exceeds that set by $B$, that is, $t_x^A > t_x^B$. Despite this, the rest of the world cannot access $A$ 's market via simple trans-shipment from $B$ due to rules of origin which have to be met to obtain preferential treatment. For this reason, prices in $A$ and $B$ *need not* be the same even after the $FTA$. We will also assume throughout that the tariff on $z$ set by $A$ is less than that set by $B$, that is, $t_z^A < t_z^B$.

We will assume that the $ROO$ in the *intermediate* good industry is so strict that trans-shipment is not possible in this industry. In effect we assume that performing the operations on imports necessary to confer origin are prohibitively expensive. This assumption ensures that prices in $A$ and $B$ for the *imported intermediate good* are not equalized when there is an $FTA$ . Its price after the $FTA$, denoted by $p_z^{A1}$ and $p_z^{B1}$, equals $p_z^{A0}$ and $p_z^{B0}$, the pre $FTA$ prices for the imported input. The domestically made input's price, denoted by $p_z^1$, is equalized in the two countries after the $FTA$, but it *need not equal* the price of the imported intermediate input. Although the imported and internally made inputs are physically identical, they are treated as different by users. This is because the $ROO$ in the final good requires a minimum cost share arising within the $FTA$. Imported intermediate inputs cannot contribute to this cost share while $FTA$ made inputs can. Even if the price of $FTA$ made inputs exceeds that of the imported inputs, they may still be used in order to meet the $ROO$.

What about the price of the final good after the $FTA$? Final goods can come from $C$ directly or from an $FTA$ member if the $ROO$ are met. It is not possible for the price of the final good to rise after the $FTA$ due to the possibility of importing directly from $C$. The price in $A$, which has the higher tariff on the final good, can fall due to the $FTA$. There will be no incentive for firms in country $A$ to export to country $B$.[5] However, firms in country $B$ may wish to export to $A$. As $A$ has higher prices than $B$, it may pay for $B$ to export to $A$ even if there are additional costs in meeting the $ROO$. Since only firms in $C$ export to $B$ the price of $x$ in $B$ stays unchanged and the price in $A$ can fall, at most to that in $B$ after the $FTA$.[6]

In what follows we will examine the problem in the short run where there is no investment, but where firms can use their existing capital as they wish[7]. In Section 3 we consider the problem facing firms for a given level of prices. We

[5] Firms in country $A$ would want to export to $B$ only if the price in $B$ exceeded that in $A$. Thus, if $A$ exported to $B$, it would have to be the case that $A$'s price was below $p_x^{B0}$, the upper limit for the price in $B$. But at such a price, $C$ will not wish to export to $A$ and nor will $B$. But at such a price, $A$ will wish to import $x$. Thus this is not feasible.

[6] In other words, $p_x^{A0} \geq p_x^{A1} \geq p_x^{B1} = p_x^{B0}$.

[7] A simple model of the long run is outlined in [9].

show that while a firm in $B$ could produce for its own market and for export to $A$, *each firm will choose to specialize in one activity or the other.* This is termed the specialization result. Following that, in Section 4, we will consider the determination of the price of the intermediate input made in the $FTA$ and the allocation of firms in $B$ among the two activities. The more the firms in $B$ who choose to export to $A$, the greater the demand for the $FTA$ made intermediate input since these are the only ones who demand it if its price exceeds that of the imported input. The greater the demand for the $FTA$ input, the higher is its price, $p_z^1$, and hence the lower is the profit of the firms using it in order to export to $A$ free of tariffs. We will show that firms will be allocated to each activity so as to ensure that the equilibrium price of the $FTA$ made input is such that profits are equalized in the two activities. This results in some unusual comparative statics results which we explore in later sections. We then show that the price of the final good in $A$, after the $FTA$ which is denoted by $p_x^{A1}$ must lie weakly below its pre $FTA$ price. If Country $B$ is large enough to supply all the demand in country $A$, then this inequality is strict, while if $B$ is *small*, $p_x^A$ is unchanged by the $FTA$.

In Section 5 we consider the implications of our analysis for market access. We show that an $FTA$ with strict $ROO$ on the intermediate good raises imports and hence improves market access in the final good market, but reduces imports and hence harms market access in the intermediate good market. In Section 6 we look at the effect of more restrictive $ROO$ in the final good market assuming that Country $B$ is small so that $p_x^A$ is unchanged by the $FTA$. A consequence of our specialization result is that more restrictive $ROO$ on the final good *first raise and then lower imports* of the final good, but *first lower then raise imports* of the intermediate good. Their turning point is common so that imports of the final good are maximized and imports of the intermediate good are minimized at a common level of restrictiveness of the rules of origin. In Section 7, we offer some concluding remarks and alternative interpretations of our model. We show that our model can be reinterpreted to show that more restrictive $ROO$ on the final good first improves and then harms the fortunes of labor, and to cast light on a particular policy to improve market access.

## 3. The Firm's Problem

Let $F^i(z, k)$ denote the constant returns to scale ($CRS$) production function for the final good in country $i$, $i = A, B$ , where $k$ denotes the capital used, and $z$ the intermediate input used by the firm. In the short run, being considered here, $k$ is given so we suppress its notation in the production function from here on. As firms in $A$ do not wish to export to $B$, they do not care about the source of the intermediate input. Their production problem consists of using the cheapest source for the intermediate input and equate the marginal value product of the input to its price. The supply of a typical firm in $A$ after the $FTA$ is thus be denoted by $x_A(p_x^{A1}, p_z^{A1})$. It is, as usual, positively related to $p_x^{A1}$ and negatively related to $p_z^{A1}$.

Firms in $B$ have a more complicated problem. They can produce for *export* to $A$ and/or for *domestic consumption.* However, their *exports* must be produced so as to comply with the $ROO$ in order to be free of tariffs. We will assume that the $ROO$ requires that a fraction, $\alpha$, of the cost share, must come from *domestic* inputs. This share is easy to define if the firm produces only for $A$. When it produces for $A$ and for $B$ the share is defined as the share in additional costs incurred as outlined below.

Denote by $z_A^B$ the level of the intermediate input used from $B$ (or the $FTA$ ) in order to produce the goods for export to $A$. More generally, $z_j^i$ denotes the level of the intermediate input used from $i$ to produce output for $j$ and $x_j^i$ denotes the output of a firm in $i$ producing for $j$. If a firm in $B$ produces only for $B$, it would produce output denoted by $x_B^B$ which would equal $F^B(z_B^B + z_B^C)$. If on the other hand it was producing for $A$ alone its production would be denoted by $x_A^B$ which would equal $F^B(z_A^B + z_A^C)$.

A firm in $B$ which produces for both $A$ and $B$ produces $x^B = x^B_B + x^B_A$, where:

$$\begin{aligned} x^B &= F^B(z^B_A + z^C_A + z^B_B + z^C_B), \\ x^B_B &= F^B(z^B_B + z^C_B), \\ x^B_A &= F^B(z^B_A + z^C_A + z^B_B + z^C_B) - F^B(z^B_B + z^C_B). \end{aligned}$$

If the $ROO$ has to be met on exports to $A$, the $ROO$ is defined as :

$$\frac{p^1_z z^B_A \ + \ k}{p^1_z z^B_A \ + \ p^{B1}_z z^C_A \ + \ k} \geq \alpha. \tag{3.1}$$

Note that domestic capital costs, $k$, are counted towards meeting the $ROO$ for a firm from $B$, but the costs of imported intermediate inputs are not.

Thus, the firm's problem is to choose $z^B_A$, $z^B_B$, $z^C_A$, $z^C_B$ to maximize:

$$p^{A1}_x x^B_A + p^{B1}_x x^B_B - \{p^1_z(z^B_A + z^B_B) + p^{B1}_z(z^C_A + z^C_B)\} - k \tag{3.2}$$

subject to:

$$\frac{p^1_z z^B_A \ + \ k}{p^1_z z^B_A + p^{B1}_z z^C_A \ + \ k} \geq \alpha. \tag{3.3}$$

It is worth noting that the constraint is binding if the price of the imported intermediate input ($p_z^{B1} = p_z^{B0}$ given our assumptions) is less than the price of the internally made input, ($p_z^1$), so that the firm is forced to buy the higher cost input to meet the *ROO*. In this case the firm will choose to meet the *ROO* exactly. If $p_z^{B1} > p_z^1$ then firms in $B$ will be happy to only use the domestic input. But if this is the case, then (3.3) is automatically met for all values of $\alpha$.

Since $p_z^1$ cannot be less than the minimum of $p_z^{A1}$ and $p_z^{B1}$ (as we assume that prior to the *FTA* both countries import both $z$ and $x$) it follows that $p_z^{B1} > p_z^1$ can only happen if $p_z^{A1} < p_z^{B1}$ . In addition, it must also be the case that even if all firms in $B$ use only the domestic input, its price is less than that of imports. In other words, when $p_z^{1l}(p_x^{A1})$ is implicitly defined by

$$n_B z_B(p_x^{A1}, p_z^{1l}) = S^{AB}(p_z^{1l}) \tag{3.4}$$

(where $n_B$ is the total number of firms in $B$, $z_B(.)$ is the demand by each of these firms for inputs, and $S^{AB}(.)$ is the supply in the *FTA* of the input) then it must be that $p_z^{1l}(p_x^{A1}) < p_z^{B1}$. Note that this occurs if $n_B$ is small enough. In this event, any level of the *ROO* is automatically met and raising the *ROO* has no effect. Here no further analysis is needed. For this reason we assume from here on that the level of $p_z^1$ that solves (3.4) is weakly more than $p_z^{B1}$.

Hence, the $ROO$ is met exactly, and we can substitute for $z_A^C$ from (3.3) above. (3.3) gives:

$$z_A^C = \frac{p_z^1(1-\alpha)}{\alpha p_z^{B1}} z_A^B + \frac{(1-\alpha)}{\alpha p_z^{B1}} k \tag{3.5}$$

so that the inputs used in making $x_A^B$, the output for country $A$ by a firm from $B$, are:

$$z_A = z_A^C + z_A^B = (\frac{p_z^1(1-\alpha) + \alpha p_z^{B1}}{\alpha p_z^{B1}}) z_A^B + \frac{(1-\alpha)}{\alpha p_z^{B1}} k, \tag{3.6}$$

and the value of these inputs is:

$$V_A = p_z^{B1} z_A^C + p_z^1 z_A^B = p_z^1(\frac{1}{\alpha}) z_A^B + \frac{(1-\alpha)}{\alpha} k. \tag{3.7}$$

Finally, $z_A^B$ in terms of $z_A$ from (3.6) is:

$$z_A^B = \frac{\alpha p_z^{B1}}{\alpha p_z^{B1} + (1-\alpha) p_z^1} z_A - \frac{(1-\alpha)}{\alpha p_z^{B1} + (1-\alpha) p_z^1} k \tag{3.8}$$

so that:

$$V_A = \frac{p_z^1 \, p_z^{B1}}{p_z^1(1-\alpha) + \alpha p_z^{B1}} z_A - \frac{(1-\alpha)(p_z^1 - p_z^{B1})}{p_z^1(1-\alpha) + \alpha p_z^{B1}} k. \tag{3.9}$$

Denote the convex combination $\alpha p_z^{B1} + (1-\alpha)p_z^1$ by $\bar{p}_z$ . Note that the maximization problem facing the firm has been converted to a form where only $z_A$, $z_B^C$, and $z_B^B$ remain to be chosen. However, there is no reason for the firm to want to use higher priced inputs in making goods for the $B$ market so that $z_B^B = 0$. The firm can be thought of as maximizing its profits, $\Pi^B(z_A, z_B^C)$, where:

$$\begin{aligned}\Pi^B(z_A, z_B^C) &= p_x^{A1}\{F^B(z_A + z_B^C) - F^B(z_B^C)\} + p_x^{B1}F^B(z_B^C) \\ &\quad - \left\{\frac{p_z^1\, p_z^{B1}}{\bar{p}_z} z_A - \frac{(1-\alpha)(p_z^1 - p_z^{B1})}{\bar{p}_z} k\right\} - p_z^{B1} z_B^C - k \\ &= p_x^{A1}\{F^B(z_A + z_B^C) - F^B(z_B^C)\} + p_x^{B1}F^B(z_B^C) \\ &\quad - \frac{p_z^1\, p_z^{B1}}{\bar{p}_z} z_A - p_z^{B1} z_B^C - \left[\frac{p_z^{B1}}{\bar{p}_z}\right] k\end{aligned} \tag{3.10}$$

It is useful to think of $\phi = \frac{p_z^1\, p_z^{B1}}{\bar{p}_z}$ as the cost, given the *ROO*, of an additional unit of input used to produce for the $A$ market. Note that as expected, if $\alpha = 0$, then $\phi = p_z^{B1}$, while if $\alpha = 1$, then $\phi = p_z^1$. Lemma 8.3 in the appendix shows that $\phi(.)$ is increasing in $\alpha$ and $p_z^1$. In addition, $\beta(.) = \frac{p_z^{B1}}{\bar{p}_z} \le 1$ can be thought of as the shadow price of $k$[8]. It rises as $p_z^1$ falls and or as $\alpha$ rises as shown in Lemma 8.2.

[8]Raising $k$ makes the constraint looser so that the shadow price is below the nominal price.

We will show that if a firm in $B$ produces for export to $A$ then it will not produce for the home market and vice versa. In other words, *that firms specialize in producing for one or the other market.*

**Proposition 3.1.** *Firms in country $B$ specialize. They either produce for their domestic market or for exports within the $FTA$. Firms in country $A$ only produce for their domestic market.*

The proof consists of showing that an interior maximum for the choice of $z_A$ and $z_B^C$ cannot exist. If an interior maximum exists then the first order conditions with respect to $z_A$ and $z_B^C$ have to be met. These are given by:

$$\frac{\partial \Pi^B}{\partial z_A}(z_A, z_B^C) = p_x^{A1} F^{B'}(z_A + z_B^C) - \phi = 0 \tag{3.11}$$

and

$$\begin{aligned}\frac{\partial \Pi^B}{\partial z_B^C}(z_A, z_B^C) &= p_x^{A1} F^{B'}(z_A + z_B^C) \\ &\quad -p_z^{B1} - (p_x^{A1} - p_x^{B1}) F^{B'}(z_B^C) \\ &= 0.\end{aligned} \tag{3.12}$$

The first condition equates the marginal value product of an additional unit of $z_A$ with its marginal cost. The second equates the marginal value product of a unit of $z_B^C$ with its true marginal cost which equals $p_z^{B1} + (p_x^{A1} - p_x^{B1})F^{B'}(z_B^C) > p_z^{B1}$.

Figure 1 depicts $p_x^{A1}F^{B'}(z)$ by the downward sloping line $AA$. The intersection of $AA$ with the horizontal line depicting $\phi$, labelled $DD$, defines a candidate value for $z_A + z_B^C$ or total input use. This is depicted by the distance $OB$. The curve $CC$ depicts $p_z^{B1} + (p_x^{A1} - p_x^{B1})F^{B'}(z)$. $CC$ is downward sloping. It is flatter than the curve $AA$ (as $p_x^{A1} > p_x^{A1} - p_x^{B1} \geq 0$ ) and is shifted up relative to $(p_x^{A1} - p_x^{B1})F^{B'}(z)$ by the amount $p_z^{B1}$. $CC$ intersects $DD$ at $H$ so that $OE$ gives the candidate level of $z_B^C$ chosen. Note that at $E$, $AA$ must be above $CC$ as drawn assuming that $z_A$ and $z_B^C$ are non zero.[9]

However, these levels for total input use and its allocation do not define a profit maximum, but a profit minimum![10] Raising or lowering $z_B^C$ while keeping

[9] $E$ is to the left of $B$ as $z_B^C < z_B^C + z_A$. As $AA$ is downward sloping and steeper than $CC$ and as its intersection with $DD$ lies to the right of that of $CC$ with $DD$ at $E$, $AA$ must lie above $CC$ at $E$.

[10] Intuitively, one can think of (3.11), (3.12) reflecting the ability of the firm to sell its output at $p_x^{A1}$, and buy its two perfectly substitutable inputs $z_A$ and $z_B^C$ at prices $\phi$ and $p_z^{B1} + (p_x^{A1} - p_x^{B1})F^{B'}(z_B^C)$ respectively. However, note that while the marginal cost of $z_A$ is constant, that of $z_B^C$ is diminishing. For input use equal to zero, the marginal cost of $z_B^C$ lies above $\phi$ while for large enough input use it lies below $\phi$. Thus, (3.11), (3.12) describe a local minimum and not a

total input use constant raises profits as shown in Lemma 8.1. For this reason, firms will choose to specialize in producing for export to $A$ and use input level $OB$, or in producing for the domestic market and choose input level $OX$.

How will firms decide which option to choose? Firms choose the more profitable option. If some firms choose each option, then both options must be equally profitable and the allocation of firms is determined so as to ensure this. Firms who produce for export to $A$ have profits denoted by $\Pi_A^B(z_A)$ where $z_A$ denotes the total input level used. They will choose their total input level used according to:

$$\frac{\partial \Pi_A^B}{\partial z_A}(z_A) = p_x^{A1} F^{B'}(z_A) - \phi = 0 \tag{3.13}$$

that is, at $z_A = OB$ in Figure 1. Note that this choice of $z_A$ depends on $p_x^{A1}$ and $\phi$, but as $\phi(p_z^1, \alpha, p_z^{B1})$ itself rises with $p_z^1$ and $\alpha$, and as $p_z^{B1}$ is given, we will denote this dependence by $z_A(\ p_x^{A1}, \phi(p_z^1, \alpha, p_z^{B1})\ ) \equiv z_A(\ p_x^{A1}, p_z^1, \alpha\ )$ as we suppress $p_z^{B1}$ in our notation. $z_A(\ p_x^{A1}, p_z^1, \alpha\ )$ rises with increases in $p_x^{A1}$, and with decreases in $p_z^1$ and $\alpha$ as shown in Lemma 8.6.

Of course, since output rises with increases in input use, the output of each

maximum and the optimizing solution must lie at a corner!

of these firms, denoted by $x_A^B(p_x^{A1}, p_z^1, \alpha)$, also rises with increases in $p_x^{A1}$ and with decreases in $p_z^1$ and $\alpha$. Their profits are denoted by $\Pi_A^B( p_x^{A1}, p_z^1, \alpha)$ and by the envelope theorem, as shown in Lemma 8.5, the profits of such firms are increasing in the output price $(p_x^{A1})$ and decreasing in the price of the $FTA$ made input, $(p_z^1)$ and $\alpha$ .

Firms who produce for $B$ only choose their total input level, all of which is imported from $C$, according to:

$$\frac{\partial \Pi_B^B}{\partial z_B^C}(z_B^C) = p_x^{B1} F^{B'}(z_B^C) - p_z^{B1} = 0. \tag{3.14}$$

Their choice of input use is denoted by $z_B^C( p_x^{B1}, p_z^{B1})$ depicted in Figure 1 by the point $X$. Note that as both $p_x^{B1}$and $p_z^{B1}$ are exogenously given, so is $z_B^C( p_x^{B1}, p_z^{B1}) = \bar{z}_B^C$ and the output of each such firm, denoted by $\bar{x}_B^B$, as well as their profits which are constant at $\bar{\Pi}_B^B$. This will play a central part in what follows. We summarize the above results as:

**Proposition 3.2.** *Firms in $B$ who produce for the domestic market have a fixed level of profits, $\bar{\Pi}_B^B$, while firms who export to $A$ have profits, $\Pi_A^B( p_x^{A1}, p_z^1, \alpha)$, input use $z_A(p_x^{A1}, p_z^1, \alpha)$, and output $x_A^B(p_x^{A1}, p_z^1, \alpha)$, all of which are increasing in the price of output in $A$ $(p_x^{A1})$ and decreasing in the price of the $FTA$ made input*

$(p_z^1)$ *and* $\alpha$.

## 4. Equilibrium Conditions

Let the number of firms in $B$ who specialize in producing for $A$ be denoted by $n_A^B$ and the number who specialize in producing for $B$ be denoted by $n_B^B$. How are these numbers determined? The answer is clear. The number of firms of each type will be such that the profits of both types of firms are equalized. If the profits of one type exceeds that of another, then only the type with the higher profits will be viable. We take as given, for the time being, the level of $p_x^{A1}$.

What is the equilibrium price of the $FTA$ made input? This equilibrium price is denoted by $p_z^{1*}$. We will argue that it is either the price that equates demand and supply assuming that all firms in $B$ export to $A$, denoted by $p_z^{1l}$, or the price that makes firms in $B$ indifferent between exporting to $A$ and producing for the domestic market, denoted by $\tilde{p}_z^1$.

We first define the price of the $FTA$ made input at which the profits of the two options are equalized. For this input price, we determine the number of firms in $B$ who must produce for export to $A$ for supply to equal demand in this input market. Recall that the profits of firms in $B$ exporting to $A$ fall as the price of the $FTA$ made input, $(p_z^1)$, rises. Let $\tilde{p}_z^1$ denote the price at which firms are indifferent between the two options, that is, $\tilde{p}_z^1$ is implicitly defined by:

$$\begin{aligned}\Pi_A^B(p_x^{A1}, \tilde{p}_z^1, \alpha) &= p_x^{A1} F^B(z_A(p_x^{A1}, \tilde{p}_z^1, \alpha)) - \phi(\tilde{p}_z^1, \alpha) z_A(.) + \psi(\tilde{p}_z^1, \alpha)k - k \\ &= \bar{\Pi}_B^B \qquad (4.1)\end{aligned}$$

where $\psi(p_z^1, \alpha) = \frac{(1-\alpha)(p_z^1 - p_z^{B1})}{(p_z^1(1-\alpha) + \alpha p_z^{B1})}$ [11]. This condition and $\tilde{p}_z^1$ are depicted in Figure 2. We suppress the dependence on $p_z^{B1}$ for ease of notation from here on so that $\tilde{p}_z^1(p_x^{A1}, \alpha)$ is this indifference price. $\tilde{p}_z^1(p_x^{A1}, \alpha)$ rises as $p_x^{A1}$ rises or $\alpha$ falls as shown in Lemma (8.7) .

At $\tilde{p}_z^1(.)$, the demand for inputs from the $FTA$ by each of the firms specializing in selling to $A$, in terms of the demand for all inputs used by such firms, is given by (3.8). The equilibrium number of firms choosing to export to $A$, $n_A^B$, is such that the total demand for inputs from the $FTA$ equals the total supply of intermediate inputs from the $FTA$. That is:

$$z_A^B(p_x^{A1}, \tilde{p}_z^1, \alpha) n_A^B = S^{AB}(\tilde{p}_z^1). \qquad (4.2)$$

[11] Note that $\psi(\tilde{p}_z^1, \alpha)$ is increasing in its first argument and decreasing in its second as shown in Lemma 8.4.

This is depicted in Figure 3. Note that this demand function is downward sloping as $\frac{\partial z_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial p_z^1} < 0$ as shown in Lemma 8.8.

A corner solution will exist if $z_A^B(p_x^{A1}, \tilde{p}_z^1, \alpha) n_B < S^{AB}(\tilde{p}_z^1)$, so that $p_z^1$ falls below $\tilde{p}_z^1$ as depicted in Figure 3, and all firms choose to sell to $A$, none produce for the domestic market. The equilibrium level of $p_z^1$ in this case is implicitly given by $p_z^{1l} < \tilde{p}_z^1$, such that[12]:

$$z_A^B(p_x^{A1}, p_z^{1l}, \alpha) n^B = S^{AB}(p_z^{1l}). \tag{4.3}$$

It should be clear from Figure 3 that if $n^B$ is small enough ( so that $z_A^B(p_x^{A1}, p_z^{1l}, \alpha) n^B$ is given by $AA$) then the equilibrium price will be $p_z^{1l}$ and defined by (4.3) while if $n^B$ is large enough (so that $z_A^B(p_x^{A1}, p_z^{1l}, \alpha)$ $n^B$is given by $CC$) then the equilibrium price will be $\tilde{p}_z^1$ as defined by (4.2).

As shown in Lemma (8.8) $z_A^B(p_x^{A1}, p_z^{1l}, \alpha)$ is increasing in $p_x^{A1}$ and $\alpha$ (under our assumptions) as well as being downward sloping. Hence $p_z^{1l}( p_x^{A1}, \alpha)$ is increasing in $p_x^{A1}$ and $\alpha$. For very low values of $\alpha$, below $\alpha_0$, the constraint imposed by the $ROO$ is not binding and costs of production are unaffected by $\alpha$ . Even in the eventuality that all firms in $B$ export to $A$, demand for the domestic intermediate input is low enough that its price does not exceed that of the imported input.

[12] Note that $p_z^{1l}$ cannot exceed $\tilde{p}_z^1$. If at $\tilde{p}_z^1$, $z_A^B(p_x^{A1}, \tilde{p}_z^1, \alpha) n_B > S^{AB}(\tilde{p}_z^1)$, then the equilibrium price exceeds $\tilde{p}_z^1$ and all firms prefer to produce for the domestic market so that $n_B^A = 0$, which contradicts the above and so cannot be.

In this region cost is unaffected by $\alpha$. As long as the production cost in $B$ is weakly below $p_x^{A1}$, all firms in $B$ will produce for export to $A$. As $\alpha$ rises above $\alpha_0$, $p_z^{1l}(p_x^{A1}, \alpha)$ rises above $p_z^{B0}$ but it remains profitable for all firms in $B$ to produce for export to $A$. Let $\alpha_1$ be defined by

$$p_z^{1l}(p_x^{A1}, \alpha_1) = \tilde{p}_z^1(p_x^{A1}, \alpha_1). \tag{4.4}$$

Then, for $\alpha$ between $\alpha_1$ and 1, $p_z^{1*}(.) = \tilde{p}_z^1(p_x^{A1}, \alpha)$ and some firms in $B$ produce for $A$ while others produce for $B$. As the inputs are perfect substitutes, there will always be some firms in $B$ who wish to sell to $A$. If there were not, then the price of the $FTA$ input would equal that of the imported one and profits would be higher from exporting to $A$ than selling in the domestic market.[13].

**Proposition 4.1.** *Let the equilibrium price for the $FTA$ made input be denoted by $p_z^{1*}(.)$. If $\alpha$ is below $\alpha_0$ it equals $p_z^{B0}$. If $\alpha$ is between $\alpha_0$ and $\alpha_1$, where $\alpha_1$ is defined by (4.4), $p_z^{1*}(.)$ equals $p_z^{1l}(\ p_x^{A1}, \alpha)$ which is increasing in $\alpha$, as shown in Lemma 8.8 and for $\alpha$ above $\alpha_1$ it equals $\tilde{p}_z^1(\ p_x^{A1}, \alpha)$ which is decreasing in $\alpha$ as shown in Lemma 8.11.*

[13]Note that the price of the domestic input must exceed that of the imported on in this case as they are perfect substitutes and the $ROO$ includes capital costs.

This leaves the price $p_x^{A1}$ to be determined. Here there are two possibilities. If $B$ is large and $A$ is small then exporters from $B$ will be able to produce enough while complying with the $ROO$ to ensure that $A$ does not import from $C$ directly, but only from $B$. In this case $p_x^{A1} < p_x^{A0}$. We will call this the large $B$ case. In this case the supply function from firms in $B$ exporting in $A$ and from firms in $A$ themselves intersects the demand function $D^A(p_x^A)$ of country $A$ at a price $OE$ which lies below $p_x^{A0}$ as shown in Figure 4.

However, if $A$ is large and $B$ is small then exporters from $B$ will not be able to produce enough while complying with the $ROO$ to meet all of $A$'s demand at $p_x^{A0}$ so that $A$ also imports from $C$ directly. This is called the small $B$ case and is depicted by the supply function from firms in $A$ and those in $B$ exporting to $A$ being given by $bb$. In Figure 4, $A$ imports $CD$ from $C$ directly. In this case $p_x^{A1} = p_x^{A0}$.

**Proposition 4.2.** *If $B$ is large relative to $A$, then $p_x^{A1} < p_x^{A0}$. If $B$ is small relative to $A$ then $p_x^{A1} = p_x^{A0}$.*

## 5. Market Access Effects of an FTA

Much of the concern in the popular press regarding preferential trading arrangements has had to do with the implications of such arrangements on market access. Will arrangements like $NAFTA$ lead to a reduction in trade of the area with the rest of the world or will it enhance it? Here we have three comments to offer.

First, in the absence of $ROO$, there are large changes in trade flows due to the $FTA$ as trade seeks the lowest tariff country. A consequence of this is that the lower tariff country, which attracts the trade flow, also gets the tariff revenue. This gain in tariff revenue is an important distributional consideration. It can also create incentives causing a race to the bottom in tariffs as each country tries to appropriate the tariff revenues. See Richardson in [17] on this "race to the bottom". We do not consider how tariffs are set in this paper but take them as given.

With $ROO$ in place this kind of trans-shipment is prevented. However, domestic production, if it meets the $ROO$ can be exported to the partner country in the $FTA$. This permits some trans-shipment in effective terms and creates some of the tariff revenue distribution effects of an $FTA$ with $ROO$. In the short run, this is limited by the extent of domestic production, but in the long run, investment flows relax this constraint. A consequence of this is that an $FTA$ with $ROO$ induces capital flows, while one without $ROO$ induces changes in trade flows rather than in investment flows. Krishna and Krueger in [9] deal with a long run model of an $FTA$ with $ROO$.

The form and level of $ROO$ is likely to matter in these considerations. We assume for the most part in this paper that $ROO$ are impossible to meet in the intermediate good market and focus on changes in the restrictiveness of $ROO$ in the final good market. In [6] we look at the other extremes of $FTAs$ without $ROO$. Other combinations like $FTAs$ with $ROO$ but where the $ROO$ in the intermediate good market are easy to meet are easy to analyze in our framework[14].

Second, effects in both final and intermediate good market need to be considered as they can work in opposite directions. We show below, for example, that market access of the rest of the world is improved in the final good market, but reduced in the intermediate good market

Finally, it is important to look at the effect on the $FTA$ as a whole, as done here, as well as on each member. This is because in response to changes in flows in one member country, compensating flows occur in other member countries.[15]

[14]In this case, the price of the imported input is the same in the two countries and imports of the intermediate good enter through the lower tariff country. The $FTA$ can reduce the imported input's price in this case so that there is an "input price effect" as discussed below.

[15]For example, if $A$ imports from $B$ due to the FTA as above, then $B$ must import more from

### 5.1. The Effect on Imports of an FTA

Let us first consider the final good market. Imports of the final good before the $FTA$ is the excess demand for $x$ by $A$ and $B$ at pre $FTA$ prices:

$$I^{F0} = D^A(p_x^{A0}) + D^B(p_x^{B0}) - x^A(p_x^{A0}, p_z^{A0})n^A - x^B(p_x^{B0}, p_z^{B0})n^B$$

where $n^A$ denotes the number of final good producers in $A$ and $x^A(.)$ denotes each ones supply of the final good.

The imports of the final good after the $FTA$ is the excess demand for $x$ by $A$ and $B$ at post $FTA$ prices. It is defined by:

$$I^{F1} = D^A(p_x^{A1}) + D^B(p_x^{B1}) - x^A(p_x^{A1}, p_z^{A1})n^A - x_A^B(p_x^{A1}, \phi(.))n_A^B - x_B^B(p_x^{B1}, p_z^{B1})n_B^B.$$

Thus:

$$\begin{aligned} I^{F1} - I^{F0} &= \left\{D^A(p_x^{A1}) - D^A(p_x^{A0})\right\} + \left\{D^B(p_x^{B1}) - D^B(p_x^{B0})\right\} \\ &\quad - \left\{x^A(p_x^{A1}, p_z^{A1}) - x^A(p_x^{A0}, p_z^{A0})\right\} n^A \\ &\quad - \left\{x_A^B(p_x^{A1}, \phi(.)) - x^B(p_x^{B0}, p_z^{B0})\right\} n_A^B \end{aligned}$$

the rest of the world to meet its own demand which was formerly met by domestic production.

$$- \left\{ x_B^B(p_x^{B1}, p_z^{B1}) - x^B(p_x^{B0}, p_z^{B0}) \right\} n_B^B. \tag{5.1}$$

However, recall that $p_x^{B1} = p_x^{B0}$, $p_z^{A1} = p_z^{A0}$ and $p_z^{B1} = p_z^{B0}$ as $ROO$ on intermediate inputs are very strict[16]. Taking this into account and rearranging the terms in the above gives:

$$\begin{aligned} I^{F1} - I^{F0} &= \left\{ D^A(p_x^{A1}) - D^A(p_x^{A0}) \right\} - \left\{ x^A(p_x^{A1}, p_z^{A0}) - x^A(p_x^{A0}, p_z^{A0}) \right\} n^A \\ &\quad - \left\{ x^B(p_x^{A1}, \phi(.)) - x^B(p_x^{B0}, p_z^{B0}) \right\} n_A^B \end{aligned} \tag{5.2}$$

Recall that $p_x^{A1} \leq p_x^{A0}$ so that demand is higher and supply lower for the final good so that the first line is positive.

Also, recall that $p_z^1 \geq p_z^{B1} = p_z^{B0}$ since if it were not, there would be excess demand for the $FTA$ made input. Hence, $\phi(.) \geq p_z^{B0}$. However, $p_x^{A1} > p_x^{B0}$. Thus, output of the firms in $B$ producing for $A$ could rise or fall. If the second line is positive, then imports of the final good must rise with an $FTA$. The second line is positive if $x^B(p_x^{A1}, \phi(.))$, the output supplied by one of the $n_A^B$ firms who are exporting to $A$, is less than $x^B(p_x^{B0}, p_z^{B0})$, the output supplied by one of the

[16] If they were easy to satisfy the price of imported intermediate inputs would be the minimum of the prices in the two countries and there would be an input price effect.

$n_B^B$ firms who are producing for the domestic market. This is shown to be so in Lemma 8.10 if $\alpha \geq \alpha_1$[17]. However, if $\alpha < \alpha_1$ this need not be so. If $\alpha \leq \alpha_0$ then all firms in $B$ sell to $A$ and Lemma 8.9 shows that they use more of the intermediate input and make more of the final good than before the $FTA$. Hence, more of the intermediate input is imported and less of the final good compared to before the $FTA$.

One way to interpret this result is to note that the $FTA$ seems to result in *trade diversion* as firms in $B$ export to $A$ so that $A's$ imports from the rest of the world fall by $x^B(p_x^{A1}, \phi)n_A^B$. However, as these firms in $B$ no longer produce for $B$, $B's$ imports rise by what these firms would have produced had they not produced for export to $A$, that is, by $x^B(p_x^{B0}, p_z^{B1})n_A^B$. This *trade substitution* overwhelms the apparent *trade diversion* for $\alpha > \alpha_1$ as these firms produce less than they would have had they produced for $B$ so that imports of the countries together rise due to the $FTA$.

It is worth thinking of the component effects of an $FTA$ on the final goods

[17] Lemma 8.10 is not obvious for two reasons. First, while such firms are faced with a higher product price, $(p_x^{A1} \geq p_x^{B0})$, which raises their output, thay also face a higher input price $(\phi \geq p_z^{B0})$ which lowers their output. Second, $\phi$ is itself endogenous and depends on $p_x^{A1}$. As $p_x^{A1}$ rises, profits of firms exporting to $A$ rise for a given $\phi$ so that to equalize profits, $\phi$ must rise. As $\phi(p_z^1, \alpha)$ rises with increases in both its arguments, $p_z^1$ must rise as $p_x^{A1}$ does. This relationship needs to be respected. For this reason we cannot compare the point $B$ and the point $X$ which give the input use of the firms which sell in $A$ and those which do not respectively and argue that $B$ is less than $X$.

market. There are three effects at work. First there is the well understood trade creation/diversion effect. The $FTA$ changes prices for the final good. A reduction in the price of the final good raises imports as less is produced and more is demanded. In the absence of *ROO* final good prices fall so that the trade creation effect raises imports. This is not so with *ROO*. For the $n_A^B$ firms in $B$ who export to $A$ after the $FTA$, the final good price *rises* from $p_x^{B0}$ to $p_x^{A1}$due to the $FTA$. For them the trade creation effect *reduces* imports from the rest of the world. For all other firms in $B$ and in $A$ the trade creation effect raises imports.

Second, as some firms in $B$ begin to produce for $A$ due to the $FTA$, these firms in effect face a higher price for the input, that of $\phi$ rather than $p_z^{B1}$. Thus, there is an input distortion effect. This effect raises input costs for these firms and reduces their supply as $\phi$ lies between $p_z^{B1}$ and $p_z^1$. In other words, the content protection rule raises costs! This effect *raises* imports from the rest of the world.

We could also have a third input price effect if the price of imported inputs changed. If, for example, the *ROO* on intermediate inputs were lax and if $B$ had a higher tariff on $z$ than $A$, its imported intermediate input price would fall to that of $A$ as all imports of the intermediate good were routed through $A$ so that $p_z^{B1} = p_z^{A0} < p_z^{B0}$. This input price effect would raise supply of the final good in the $FTA$ and *reduce* imports from the rest of the world. It would be negative but small, if the difference in tariff in the intermediate good is small. We rule this out by assuming that the $ROO$ in the intermediate good market are very strict.

Now we turn to the intermediate good. Note that imports of the intermediate good after the $FTA$ are:

$$\begin{aligned} I^{I1} &= \left\{n_A^B z^B(p_x^{A1}, \phi) - S^A(p_z^{1*}) - S^B(p_z^{1*})\right\} + n_B^B z^B(p_x^{B1}, p_z^{B1}) \\ &\quad + n^A z^A(p_x^{A1}, p_z^{A1}) \end{aligned}$$

and before the $FTA$ are:

$$\begin{aligned} I^{I0} &= n^B z^B(p_x^{B0}, p_z^{B0}) - S^B(p_z^{B0}) \\ &\quad + n^A z^A(p_x^{A0}, p_z^{A0}) - S^A(p_z^{A0}). \end{aligned}$$

From this it follows that:

$$\begin{aligned} I^{I1} - I^{I0} &= n_A^B\{z^B(p_x^{A1}, \phi) - z^B(p_x^{B0}, p_z^{B0})\} \\ &\quad + n_B^B\{z^B(p_x^{B1}, p_z^{B1}) - z^B(p_x^{B0}, p_z^{B0})\} \\ &\quad + n^A\{z^A(p_x^{A1}, p_z^{A1}) - z^A(p_x^{A0}, p_z^{A0})\} \\ &\quad - \{S^A(p_z^{1*}) - S^A(p_z^{A0})\} - \{S^B(p_z^{1*}) - S^B(p_z^{B0})\} \end{aligned}$$

Note that $\phi(.) \geq p_z^{B0}$ but $p_x^{A1} \geq p_x^{B0}$ so that while higher input cost reduces the derived demand, the higher product price raises it. The former effect is shown to dominate if $\alpha \geq \alpha_1$ in Lemma 8.10 so that the first line is negative. The second line is zero as $p_x^{B1} = p_x^{B0}$ and $p_z^{B1} = p_z^{B0}$ as firms in $B$ who continue to produce for the domestic market face unchanged product and factor prices. The third line is negative as the product price is lower and the factor price is unchanged for firms in $A$. The last line is also negative as the domestic factor price weakly rises so that the change in $FTA$ supply is positive. It is worth thinking about the total change in the intermediate good market in terms of its component parts. In the intermediate input market, there are three effects: the derived demand effect, the trade creation effect and the input distortion effect. The derived demand effect in an $FTA$ without $ROO$ serves to reduce trade as the reduction in the price of the final good caused by such an $FTA$ reduces the derived demand for the input and reduces imports. In the case of an $FTA$ with $ROO$ however, firms in $B$ who export to $A$ get a higher price than before so that the derived demand effect works to *raise* the demand for the intermediate good, raising imports. On the other hand, firms in $A$ face a possible reduction in the price of the final good and so the derived demand effect for them reduces imports. Firms in $B$ who continue to produce for their own market face no price change for the final good and no derived demand effect.

Then there is the usual trade creation effect. A reduction in the price of the intermediate good caused by an $FTA$ without $ROO$ raises its demand and reduces supply, creating trade. However, with $ROO$ which are strict in the input market as $p_z^{B1} = p_z^{B0}$ and $p_z^{A1} = p_z^{A0}$, so that there are no trade creation effects. However, the price of the intermediate input produced domestically rises so that supply rises, rather than falls and imports fall for this reason. The $n_A^B$ firms in $B$ selling to $A$ face a higher effective input price due to the $ROO$ and this reduces their input demand. This is the input distortion effect which reduces imports.

Our results so far are summarized below.

**Proposition 5.1.** *If the $ROO$ on the intermediate good are strict, and $\alpha \in [\alpha_1, 1]$, then imports of the final good from the rest of the world must rise and imports of the intermediate good must fall with an $FTA$. If $\alpha \leq \alpha_0$ then imports of the final good from the rest of the world fall with an $FTA$ but imports of the intermediate good rise. For $\alpha \in (\alpha_0, \alpha_1)$ imports of the final good and of the intermediate good from the rest of the world could rise or fall with an $FTA$.*

## 6. The Effect of More Restrictive ROOs

We now turn to the effect of more restrictive *ROO* on market access. Here we restrict attention to the case where $B$ is small relative to $A$ so that $p_x^{A0} = p_x^{A1}$. We need to distinguish between a number of cases which occur as the *ROO* becomes progressively more binding.

Case 1: For very low values of $\alpha, \alpha \leq \alpha_0$, all firms in $B$ produce for export to $A$ but the supply of intermediate inputs within the $FTA$ is sufficient to meet demand at $p_z^{B0}$. Hence, then $p_z^{1*} = p_z^{B0} = p_z^{B1} = \phi$ and more restrictive *ROO* do not affect $\phi$. The price in $A$ is unaffected by the $FTA$ as $B$ is not large enough to supply its entire demand at $p_x^{A0}$ so that $A$ still imports from the rest of the world. In this case, it is easy to see that more restrictive *ROO* have no effect on $FTA$ imports of the final or the intermediate good as they do not affect prices or costs of production[18].

Case 2: As the *ROO* become more restrictive, for $\alpha_0 \leq \alpha \leq \alpha_1$, the $FTA$ supply of the input becomes inadequate to meet demand and the price of the input in the $FTA$ starts to rise. However, all firms in $B$ export to $A$ and prefer this to producing for the domestic market and $p_z^{1*} = p_z^{1l}$ which is defined by (4.3). In this

[18] This is the case considered in Bhagwati and Panagaria (1996) as they assume the supply curve of firms is unaffected by *ROO*. They point out the possibility of trade revenue transfers due to trade deflection.

case the effect of more restrictive $ROO$ is indeterminate in general. Assuming that the derived demand for the $FTA$ input by each firm in $B$ producing for $A$ shifts outwards as $\alpha$ rises ensures that $p_z^{1*}$ rises with increases in $\alpha$. A sufficient condition for derived demand to shift outward is that the derived demand curve be not too elastic as shown in Lemma 8.8. In fact, a sufficient condition is that the derived demand elasticity be less than unity.

Case 3: As the $ROO$ become even more restrictive, for $\alpha_1 \leq \alpha \leq \alpha_2$, $p_z^{1*}$ has risen enough for profits from exporting to $A$ to no longer exceed those from producing for the domestic market. Not all firms in $B$ prefer to produce for $A$. Some firms do produce for the domestic market. Recall that in this case, $p_z^{1*} = \tilde{p}_z^1$ is defined by(4.2). In this case $p_z^{1*}$ *falls* as $\alpha$ rises.

Thus, we need to look at cases 2 and 3 in more detail.

### 6.1. Case 2

Consider the effects of more restrictive $ROO$ in this case assuming that $B$ is a small country so that the pattern of trade is not affected by the $FTA$. We need to be careful to incorporate the effects of changing $\alpha$ (which indexes the restrictiveness of the $ROO$) on all the endogenous variables. In particular, on $p_z^{1*} = p_z^{1l}$ in this region and through it on other variables. We need certain comparative statics results in order to proceed further. These are developed in Lemma 8.11 in the Appendix.

Note that

$$I^F(\alpha) = D^A(p_x^{A0}) + D^B(p_x^{B0}) - x_A^A n^A - x_A^B n^B$$

Since the prices of the final goods in $A$ and $B$ and the output of final good producer in $A$, $x_A^A$, are not affected by $\alpha$, $I^F(\alpha)$ increases with an increase in $\alpha$ if and only if $x_A^B$ falls with an increase in $\alpha$. Since $\frac{dx_A^B}{d\alpha} < 0$, as shown in Lemma 8.11:

$$\frac{dI^F}{d\alpha} = -n^B \frac{dx_A^B}{d\alpha} > 0.$$

.

The imports of the intermediate good by the $FTA$ are given by:

$$I^I(\alpha) = n^A z_A^A + n^B z_A - S^{AB}(p_z^{1l})$$

where $z_A^A$ is the input used by a final good producer in $A$, which is not affected by $\alpha$ and $z_A$ is the total intermediate input use of firms in $B$ which are producing for $A$. Since $\frac{\partial z_A}{\partial \alpha} < 0$ and $\frac{\partial p_z^{1l}}{\partial \alpha} > 0$, assuming that the conditions in Lemma 8.8 are met, as shown in Lemma 8.11, then

$$\frac{\partial I^{I}(\alpha)}{\partial \alpha} = n^{B}\frac{\partial z_{A}}{\partial \alpha} - S^{AB\prime}(.)\frac{\partial p_{z}^{1l}}{\partial \alpha} < 0.$$

### 6.2. Case 3

Consider the effects of more restrictive $ROO$ in Case 3 assuming that the pattern of trade is not affected by the $FTA$. Of course, given the sizes of the two countries, this depends on how restrictive the $ROO$ is. Again we need to be careful to incorporate the effects of changing $\alpha$ (which indexes the restrictiveness of the $ROO$) on all the endogenous variables. In particular, on $p_{z}^{1}$ and through it on other variables. We need certain comparative statics results in order to proceed further. These are proved in Lemma 8.12 in the Appendix.

We are now in a position to consider the effects of increasingly restrictive $ROO$ on market access. First consider imports of the final good.

$$I^{F}(\alpha) = D^{A}(p_{x}^{A0}) + D^{A}(p_{x}^{B0}) - x^{A}n^{A} - x_{A}^{B}(\alpha)n_{A}^{B} - x_{B}^{B}n_{B}^{B}.$$

Differentiating gives:

$$\begin{aligned}
\frac{dI^F(\alpha)}{d\alpha} &= -\left[n_A^B \frac{dx_A^B(\alpha)}{d\alpha} + x_A^B(\alpha)\frac{dn_A^B}{d\alpha} + x_B^B \frac{dn_B^B}{d\alpha}\right] \\
&= -\left[n_A^B \frac{dx_A^B(\alpha)}{d\alpha} + \left(x_A^B(\alpha) - x_B^B\right)\frac{dn_A^B}{d\alpha}\right] \\
&< 0.
\end{aligned}$$

given that $\frac{dx_A^B(\alpha)}{d\alpha} > 0$ and $\frac{dn_A^B}{d\alpha} < 0$ as shown in Lemma 8.12.

Recall that as the pattern of trade does not change, prices in $A$ and $B$ of the final good do not change as $\alpha$ rises. Thus, output of the firms in $A$ is unchanged as is demand in both countries. The output of firms in $B$ producing for $B$ also doesn't change with $\alpha$. There are two effects of an increase in $\alpha$ on firms in $B$ producing for $A$. First, the output of the $n_A^B$ firms who produce for $A$ rises, but there are fewer of them as some switch to producing for $B$. The switchers; however, produce more upon switching so that both effects raises output and decreases imports.

Next, consider the import of the intermediate input. Let $I^I(\alpha)$ denote the excess demand for $z$.

$$I^I(\alpha) = \left\{n_A^B(\alpha) z_A^B(\alpha) - S^{AB}(p_z^1(\alpha))\right\} + n_B^B(\alpha) z_B^B + n^A z^A$$

$$= \left\{n^B - n_B^A(\alpha)\right\} z_B^B + n^A z^A$$

The equality follows from the fact that demand equals supply for the $FTA$ made input so that:

$$\left\{n_A^B(\alpha) z_A^B(\alpha) - S^{AB}(p_z^1(\alpha))\right\} = 0.$$

As $n_B^A(\alpha)$ falls as $\alpha$ rises as shown in Lemma 8.12, and as $z_B^B$ doesn't change, it follows from inspection that $\frac{dI^I(\alpha)}{d\alpha} > 0$. Our results so far are summarized below.

**Proposition 6.1.** *Assume country B is small so that the pattern of trade is not changed. If $\alpha \leq \alpha_0$ then an increase in the restrictiveness of the ROO as captured by an increase in $\alpha$ has no effect on the imports of the final good or the intermediate good. If $\alpha \in (\alpha_0, \alpha_1)$ and $z_A^B(p_x^{A1}, p_z^1, \alpha)$ shifts out as $\alpha$ rises, that is, derived demand is not very elastic, then an increase in the restrictiveness of the ROO as captured by an increase in $\alpha$ raises imports of the final good and reduces imports of the intermediate good. If $\alpha \in (\alpha_1, 1]$, then an increase in the restrictiveness of the ROO as captured by an increase in $\alpha$ reduces imports of the final good and raises imports of the intermediate good.*

The implications of our results so far are easiest to see in Figure 5. They suggest that the intermediate good market is the most protected (in the sense that both imports reach a minimum and the price of $FTA$ made input reaches its maximum) when $\alpha = \alpha_1$. In sharp contrast, the final good market is most open (in the sense that the imports reach their maximum) at the same point, that where $\alpha = \alpha_1$.

### 6.3. Long Term Effects

There are many ways to model the long term effects of such $FTAs$. Their results are bound to differ with different assumptions on the ability of supply to respond in the long run. If supply of both final and intermediate inputs is perfectly elastic in the long run, then the price of the intermediate input made in and imported by the $FTA$ is constant. The supply of the final good is infinitely elastic at the unit cost of production of a final good when the $ROO$ are met. Thus, all demand in the higher tariff country can be met by supply in the $FTA$. But in order for this supply to be possible, capital must flow in to create the necessary capacity. This is what we mean by there are likely to be large capital flows caused by an $FTA$ with $ROO$.

This unit cost of production of the final good rises with the restrictiveness of the $ROO$. The price in country $A$ rises with it. Finally, when the $ROO$ is so restrictive that this unit cost reaches the price of imported final goods in $A$, $A$

returns to importing from the rest of the world. Note that the welfare effects of more restrictive $ROO$ are not monotonic as once the $ROO$ get too restrictive they are in effect ignored and it is as if there were no $FTA$ at all. It is when the $ROO$ is restrictive but not prohibitive that welfare losses are likely. In this event, consumers in $A$ do not enjoy the gains from lower prices and country A does not collect any tariff revenue either! We reserve more detailed study of investment flows and welfare effects to future work.

## 7. Conclusion

Much of the concern felt about regional trading areas has been that they will exclude non member countries from their markets. Much of this discussion, see for example [12] and counter arguments by [4], has been couched in terms of the greater market power, and hence higher optimal tariffs of larger trade blocs. This is not the direction we follow for two reasons. First, tariffs on most manufactured goods are bound by concessions made in successive rounds of negotiations under the auspices of $GATT$. While the use of Non Tariff Barriers ($NTBs$) provide a way to circumvent these limits, they often cause unanticipated side effects and stand to be disallowed if too blatantly abused. Moreover, there is little evidence that this avenue has been important in practice. Second, we believe that the avenue we focus on, $ROO$, are less well understood, do end up providing reason for concern, and are extremely important in practice.

In this paper, and a companion one, [6], we have shown that $FTAs$ can be far from free, especially with $ROO$. In this paper we show that more restrictive $ROO$ in the final good market can initially serve to restrict access to the intermediate good market and improve access in the final good market. However, beyond a certain point, they must begin to improve access to the intermediate good market and reduce access to the final good market! We do not study the welfare consequences of such $FTAs$ here but it is easy to construct welfare decreasing $FTAs$ both with and without $ROO$.

We believe that the model developed here has an internal structure that makes it suitable for a number of other purposes. An interesting and provocative result of the model is the non monotonic effect of an increase in restrictiveness of the $ROO$ on the price of the intermediate input made in the $FTA$. If, for example, this input was made by labor alone using a unit of labor to make it, the wage would be equal to the price of the domestically made input and this result would imply that there may be reason for labor to not always gain from more restrictive $ROO$. Thus, labor would favor restrictive, but not too restrictive $ROO$.

Another application might be to studying market access requirements. Consider, for example a market access requirement in auto parts on Japanese firms linked to preferential tariffs on autos in the following manner. If a Japanese firm buys sufficient *U.S.* auto parts for a minimum cost share of *U.S.* parts to be met then it qualifies for a low tariff to the *U.S.*. If it does not, then it faces a penalty tariff. Such a situation is analogous to the one studied above. For a low enough cost share, all Japanese firms will meet the requirement and sell to the *U.S.* meeting their own demand through imports. As the cost share rises, the price of *U.S.* parts will rise but all Japanese firms will still export to the *U.S.*. At some point Japanese firms will be indifferent between exporting and serving their own market. From this point onward the price of the *U.S.* inputs will fall as the cost share increases, with changes in the number of Japanese firms who serve the U.S. market acting to equalize the profits from these two options. Our results above suggest that there is a level of this cost share which simultaneously maximizes exports of the intermediate good and minimizes imports of the final good.

Other examples of such restrictions could be taxes (or rewards if the target is met) if certain kinds of workers, be they welfare recipients or domestic workers, do not make up a given fraction of the work force or certain kinds of fuels do not make up a given proportion of energy consumption.

## 8. Appendix

In this Appendix we put together a series of Lemmas, which are critical for the results we derive.

**Lemma 8.1.** *Raising or lowering $z_B^C$ while keeping total input use constant raises profits.*

Consider, starting from the candidate levels, a reallocation of input use which reduces $z_B^C$ , and raises $z_A$ so as to keep their sum constant. The fall in $z_B^C$ to $z_B^C - \epsilon$ and the rise in $z_A$ to $z_A + \epsilon$ causes profits to change from $\Pi^B(z_A, z_B^C)$ to $\Pi^B(z_A + \in, z_B^C - \epsilon)$. Using the definition of profits gives:

$$\begin{aligned}
\Pi^B(z_A + \epsilon, z_B^C - \epsilon) - \Pi^B(z_A, z_B^C) &= (p_x^{B1} - p_x^{A1})[F^B(z_B^C - \epsilon) \\
&\quad - F^B(z_B^C)] - \phi\epsilon + \ p_z^{B1}\epsilon \\
&= (p_x^{A1} - p_x^{B1})[F^B(z_B^C) \\
&\quad - F^B(z_B^C - \epsilon)] + p_z^{B1}\epsilon - \ \phi\epsilon \\
&= \int_{z_B^C - \in}^{z_B^C} \{(p_x^{A1} - p_x^{B1})F^{B'}(z) \\
&\quad + p_z^{B1}\} dz - \phi\epsilon
\end{aligned}$$

However, this is just the area under the $CC$ curve between $z_B^C - \epsilon$ and $z_B^C$ less $\phi\epsilon$ which is the height of the $DD$ curve times $\epsilon$. This is positive and equals the shaded area in Figure 1. Similarly, a reduction in $z_A$ and an equal increase in $z_B^C$ of $\epsilon$ also raises profits.

$$\begin{aligned}
\Pi^B(z_A - \epsilon,\ z_B^C + \epsilon) - \Pi^B(z_A, z_B^C) &= (p_x^{B1} - p_x^{A1})[F^B(z_B^C + \epsilon) \\
&\quad -F^B(z_B^C)] + \phi\epsilon - p_z^{B1}\epsilon \\
&= (p_x^{A1} - p_x^{B1})[F^B(z_B^C) - F^B(z_B^C + \in)] \\
&\quad - p_z^{B1}\epsilon + \phi\epsilon \\
&= \phi\epsilon - \int_{z_B^C}^{z_B^C + \in} \left\{(p_x^{A1} - p_x^{B1})F^{B'}(z) + p_z^{B1}\right\} dz.
\end{aligned}$$

However, this is just $\phi\epsilon$, the height of the $DD$ curve times $\epsilon$, less the area under the $CC$ curve between $z_B^C$ and $z_B^C + \epsilon$ . This is positive and equals the dotted area in Figure 1. Thus, raising or lowering $z_B^C$ while keeping total input use constant raises profits. For this reason, firms will choose to specialize in producing for export to $A$ and use input level $OB$, or in producing for the domestic market and choose input level $OX$.

**Lemma 8.2.** $\beta(p_z^1, \alpha) = \frac{p_z^{B1}}{((1-\alpha)p_z^1 + \alpha p_z^{B1})}$ *is increasing in* $\alpha$ *and decreasing in* $p_z^1$.

Note that an increase in $\alpha$ reduces the denominator as $p_z^1 > p_z^{B1}$ and so raises $\beta(p_z^1, \alpha)$. An increase in $p_z^1$ raises the denominator and so reduces $\beta(p_z^1, \alpha)$.

**Lemma 8.3.** $\phi(p_z^1, \alpha) = \frac{p_z^1 p_z^{B1}}{((1-\alpha)p_z^1 + \alpha p_z^{B1})}$ *is increasing in both its arguments.*

Note that an increase in $\alpha$ reduces the denominator of the expression, raising $\phi$. An increase in $p_z^1$ can be seen to raise $\phi$ by dividing the numerator and denominator in $\phi$ by $p_z^1$ and noting that an increase in $p_z^1$ reduces the denominator, raising the ratio.

**Lemma 8.4.** $\psi(p_z^1, \alpha) = \frac{(1-\alpha)(p_z^1 - p_z^{B1})}{((1-\alpha)p_z^1 + \alpha p_z^{B1})}$ *is increasing in* $p_z^1$ *and decreasing in* $\alpha$.

To see that $\psi(.)$ is decreasing in $\alpha$, divide numerator and denominator by $(1-\alpha)$. It is then apparent that increasing $\alpha$ raises the denominator, thereby reducing $\psi(.)$. To see that $\psi(.)$ is increasing in $p_z^1$, divide numerator and denominator by $p_z^1$. It is then apparent that increasing $p_z^1$ raises the numerator, and reduces the denominator, thereby raising $\psi(.)$.

**Lemma 8.5.** $\Pi_A^B(p_x^{A1}, p_z^1, \alpha)$ *is increasing in* $p_x^{A1}$ *and decreasing in* $p_z^1$ *and* $\alpha$. *That is:*

$(i)\ \frac{\partial \Pi_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial p_x^{A1}} > 0,\ (ii)\ \frac{\partial \Pi_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial p_z^1} < 0,\ (ii)\ \frac{\partial \Pi_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial \alpha} < 0.$

Proof:

($i$) From (3.10) it is clear that

$$\Pi_A^B(p_x^{A1}, p_z^1, \alpha) = p_x^{A1} F^B(z_A) - \phi(p_z^1, \alpha) z_A + \psi(p_z^1, \alpha) k - k.$$

By the envelope theorem, $\Pi_A^B(p_x^{A1}, p_z^1, \alpha)$ is increasing in $p_x^{A1}$.

($ii$) Also, by the envelope theorem $\Pi_A^B(p_x^{A1}, p_z^1, \alpha)$ is decreasing in $p_z^1$ since:

$$\begin{aligned}
\frac{\partial \Pi_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial p_z^1} &= \frac{\bar{p}_z\{(1-\alpha)k - p_z^{B1} z_A\} - \{(1-\alpha)\left(p_z^1 - p_z^{B1}\right) k - p_z^1 p_z^{B1} z_A\}(1-\alpha)}{\{\bar{p}_z\}^2} \\
&= \frac{\{\bar{p}_z - (1-\alpha)\left(p_z^1 - p_z^{B1}\right)\}(1-\alpha)k + \{p_z^1 p_z^{B1}(1-\alpha) - p_z^{B1}\bar{p}_z\} z_A}{\{\bar{p}_z\}^2} \\
&= \left[(1-\alpha)k - \alpha p_z^{B1} z_A\right] \frac{p_z^{B1}}{\{\bar{p}_z\}^2} \qquad (8.1) \\
&< 0.
\end{aligned}$$

This follows from the fact that:

$$\begin{aligned}
\frac{k}{p_z^{B1} z_A + k} &< \frac{k}{p_z^{B1} z_A^C + k} < \frac{p_z^1 z_A^B + k}{p_z^1 z_A^B + p_z^{B1} z_A^C + k} = \alpha \qquad (8.2) \\
&\Rightarrow -\alpha p_z^{B1} z_A + (1-\alpha) k < 0
\end{aligned}$$

where the above equality follows from the fact that (3.1) is binding.

($iii$) Similarly, again using the envelope theorem, we show that:

$$\frac{\partial \Pi_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial \alpha} < 0.$$

This follows from taking the partial derivative of $\Pi_A^B(p_x^{A1}, p_z^1, \alpha)$ :

$$\begin{aligned} \frac{\partial \Pi_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial \alpha} &= -\frac{\partial \phi(p_z^1, \alpha)}{\partial \alpha} z_A + \frac{\partial \psi(p_z^1, \alpha)}{\partial \alpha} k \\ &< 0 \end{aligned}$$

from using Lemma (8.3) and Lemma (8.4).

**Lemma 8.6.** *(i)* $\frac{\partial z_A(p_x^{A1}, p_z^1, \alpha)}{\partial p_x^{A1}} > 0$, *(ii)* $\frac{\partial z_A(p_x^{A1}, p_z^1, \alpha)}{\partial \alpha} < 0$, *(iii)* $\frac{\partial z_A(p_x^{A1}, p_z^1, \alpha)}{\partial p_z^1} < 0$.

Proof: $(i)$ follows directly from (3.13), while $(ii)$ and $(iii)$ follow from Lemma 8.3 which shows that $\phi(p_z^1, \alpha)$ is increasing in both its arguments, and from (3.13).

**Lemma 8.7.** $\frac{\partial \tilde{p}_z^1(p_x^{A1}, \alpha)}{\partial p_x^{A1}} > 0$ *and* $\frac{\partial \tilde{p}_z^1(p_x^{A1}, \alpha)}{\partial \alpha} < 0$.

Proof: Note that since $\Pi_A^B(p_x^{A1}, p_z^1, \alpha)$ rises with increases in $p_x^{A1}$ and decreases in $p_z^1$ and $\alpha$ as shown in Lemma (8.5), $\tilde{p}_z^1(p_x^{A1}, \alpha)$ rises as $p_x^{A1}$ rises or $\alpha$ falls.

**Lemma 8.8.** *(i)* $\frac{\partial z_A^B(p_x^{A1},p_z^1,\alpha)}{\partial p_z^1} < 0$, *(ii)* $\frac{\partial z_A^B(p_x^{A1},p_z^1,\alpha)}{\partial p_x^{A1}} > 0$, *and when the elasticity of derived demand,* $\varepsilon$*, is not "too high", that is,*

$$\varepsilon = -\frac{\partial z_A}{\partial \phi}\frac{\phi}{z_A} < \frac{\alpha\left(p_z^1 z_A + p_z^{B1} z_C^A + k\right)}{\alpha(p_z^1 - p_z^B) z_A},$$

*then (iii)* $\frac{\partial z_A^B(p_x^{A1},p_z^1,\alpha)}{\partial \alpha} > 0$ .

Proof:

*(i)* Note that the demand function in Figure 3 is downward sloping. From equation (3.8) we have the form of $z_A^B(p_x^{A1}, p_z^1, \alpha)$ to be

$$z_A^B = \frac{\alpha p_z^{B1}}{\alpha p_z^{B1} + (1-\alpha)p_z^1} z_A - \frac{(1-\alpha)}{\alpha p_z^{B1} + (1-\alpha)p_z^1} k.$$

Differentiating it gives

$$\frac{\partial z_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial p_z^1} = -\left(\frac{(1-\alpha)}{\alpha p_z^{B1} + (1-\alpha)p_z^1}\right) z_A^B + \left(\frac{\alpha p_z^{B1}}{\alpha p_z^{B1} + (1-\alpha)p_z^1}\right)\frac{\partial z_A}{\partial p_z^1} < 0$$

since $\frac{\partial z_A}{\partial p_z^1} < 0$ as shown in Lemma (8.6).

*(ii)*

$$\frac{\partial z_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial p_x^{A1}} = \frac{\alpha p_z^{B1}}{\alpha p_z^{B1} + (1-\alpha)p_z^1}\frac{\partial z_A(p_x^{A1}, p_z^1, \alpha)}{\partial p_x^{A1}} > 0$$

as $\frac{\partial z_A(p_z^{A1}, p_z^1, \alpha)}{\partial p_z^{A1}} > 0$ from Lemma 8.6.

$(iii)$ we have from (3.8)

$$
\begin{aligned}
z_A^B &= \frac{\alpha p_z^{B1}}{\overline{p_z}} z_A - \frac{(1-\alpha)}{\overline{p_z}} k \\
&= \frac{\alpha \phi z_A}{p_z^1} - \frac{(1-\alpha)}{\overline{p_z}} k
\end{aligned}
$$

So we have

$$
\begin{aligned}
\frac{\partial z_A^B}{\partial \alpha} &= \frac{\phi z_A}{p_z^1} + \frac{\alpha z_A}{p_z^1} \frac{\partial \phi}{\partial \alpha} + \frac{\alpha \phi}{p_z^1} \frac{\partial z_A}{\partial \phi} \frac{\partial \phi}{\partial \alpha} \\
&\quad + \frac{k p_z^{B1}}{\overline{p_z}^2}
\end{aligned}
$$

where the last term is $\frac{\partial}{\partial \alpha}\left(-\frac{(1-\alpha)}{\overline{p_z}} k\right)$. Let $\varepsilon = -\frac{\partial z_A}{\partial \phi} \frac{\phi}{z_A}$ denote the elasticity of derived demand, so that

$$
\begin{aligned}
& z_A \left[ \frac{\phi}{p_z^1} + \frac{\alpha}{p_z^1} \frac{\partial \phi}{\partial \alpha} - \frac{\alpha \varepsilon}{p_z^1} \frac{\partial \phi}{\partial \alpha} \right] + \frac{k p_z^{B1}}{\overline{p_z}^2} \\
=\ & \frac{z_A}{p_z^1} \left[ \phi + \alpha \frac{\partial \phi}{\partial \alpha} (1 - \varepsilon) \right] + \frac{k p_z^{B1}}{\overline{p_z}^2}
\end{aligned}
$$

for $\frac{\partial z_A^B}{\partial \alpha} > 0$, we have

$$\begin{aligned}
\frac{z_A}{p_z^1}\left[\phi + \alpha\frac{\partial\phi}{\partial\alpha}(1-\varepsilon)\right] &> -\frac{kp_z^{B1}}{\overline{p_z}^2} \Leftrightarrow \\
\phi + \alpha\frac{\partial\phi}{\partial\alpha}(1-\varepsilon) &> -\frac{kp_z^{B1}p_z^1}{z_A\overline{p_z}^2} \Leftrightarrow \\
1-\varepsilon &> -\frac{\phi}{\alpha}\left(\frac{\partial\phi}{\partial\alpha}\right)^{-1} - \left(\frac{\partial\phi}{\partial\alpha}\right)^{-1}\frac{kp_z^{B1}p_z^1}{\alpha z_A\overline{p_z}^2} \Leftrightarrow \\
1-\varepsilon &> -\frac{\phi}{\alpha}\left(\frac{\partial\phi}{\partial\alpha}\right)^{-1} - \frac{\phi}{\alpha}\left(\frac{\partial\phi}{\partial\alpha}\right)^{-1}\frac{k}{z_A\overline{p_z}}
\end{aligned}$$

Now

$$\begin{aligned}
-\frac{\phi}{\alpha}\left(\frac{\partial\phi}{\partial\alpha}\right)^{-1} &= -\frac{\phi}{\alpha}\left(\frac{(p_z^1-p_z^B)\phi}{\overline{p_z}}\right)^{-1} \\
&= -\frac{\overline{p_z}}{\alpha(p_z^1-p_z^B)} \\
&= -\frac{p_z^1}{\alpha(p_z^1-p_z^B)} + 1
\end{aligned}$$

So we have

$$\begin{aligned}
\frac{\partial z_A^B}{\partial\alpha} &> 0 \Leftrightarrow \\
-\varepsilon &> -\frac{p_z^1}{\alpha(p_z^1-p_z^B)} - \frac{k}{\alpha(p_z^1-p_z^B)z_A}
\end{aligned}$$

and the necessary and sufficient condition is

$$
\begin{aligned}
-\varepsilon &> -\frac{(p_z^1 z_A + k)}{\alpha(p_z^1 - p_z^B) z_A} \\
&= -\frac{\alpha\left(p_z^1 z_A + p_z^{B1} z_C^A + k\right)}{\alpha(p_z^1 - p_z^B) z_A}
\end{aligned}
$$

or

$$
\varepsilon < \frac{\left(p_z^1 z_A + p_z^{B1} z_C^A + k\right)}{(p_z^1 - p_z^B) z_A}.
$$

Since $\frac{\left(p_z^1 z_A + p_z^{B1} z_C^A + k\right)}{(p_z^1 - p_z^B) z_A} > 1$, a sufficient condition is that the elasticity, defined as a positive number, be less than unity, that is, $\varepsilon < 1$.

**Lemma 8.9.** *Assume that $\alpha \in [0, \alpha_1]$ so that all firms in $B$ export to $A$. For $\alpha$ below $\alpha_0$, $\phi = p_z^{B1} = p_z^1$ and as the input cost is unchanged for all firms in $B$ and the output price is raised, they raise their use of inputs and produce more of the final good. Firms in $A$ are unaffected. Thus, in this region imports of the intermediate good are higher than they were before the $FTA$ and imports of the final good are lower. If $\alpha$ is above $\alpha_0$, then $p_z^{1*} = p_z^{1l} > \phi > p_z^{B1}$ so that the effective input price is higher for firms in $B$, all of who export to $A$. However the product price is higher as well. While the former reduces the use of inputs, the latter raises it so that firms in $B$ may use more or less of the intermediate input and* *produce more or less of the final good than before the $FTA$ in this region. Thus, imports of the intermediate and final goods could rise or fall due to the $FTA$ in this region. However, at $\alpha = \alpha_1$, firms in $B$ are indifferent between producing for $A$ and for $B$ and must use less of the intermediate input, and produce less of the final good than before the $FTA$ as shown below. Hence, at $\alpha = \alpha_1$ imports of the intermediate good by the $FTA$ members are lower and imports of the final good by the $FTA$ members are higher than before the $FTA$.*

**Lemma 8.10.** *Assume that $\alpha \in [\alpha_1, 1]$ so that some firms in $B$ continue to produce for the domestic market. Then the input use and hence output of the firms in $B$ who produce for $A$ is less than the output of the firms in $B$ who produce for $B$. That is:*

$$x^B(p_x^{A1}, \phi) \leq x^B(p_x^{B0}, p_z^{B1}) \text{ } for \text{ } p_x^{A1} \geq p_x^{B0} \text{ } and \text{ } \phi \geq p_z^{B1}.$$

Proof:

$$\begin{aligned} \Pi_A^B &= p_x^{A1} F^B(z_A) - \phi z_A + \psi k - k \\ &= p_x^{A1} \left[ F^B(z_A) - \frac{\phi}{p_x^{A1}} z_A + \frac{\psi k}{p_x^{A1}} \right] - k \end{aligned}$$

$$= \overline{\Pi_B^B} = p_x^{B1}\left[F^B(z_B^C) - \frac{p_z^{B1}}{p_x^{B1}} z_B^C\right] - k$$

Because $p_x^{A1} > p_x^{B1}$ and $\frac{\psi k}{p_x^{A1}} > 0$, we must have

$$F^B(z_A) - \frac{\phi}{p_x^{A1}} z_A < F^B(z_B^C) - \frac{p_z^{B1}}{p_x^{B1}} z_B^C$$

to maintain the equality. Note that $z_A$ is what maximizes

$$F^B(z) - \frac{\phi}{p_x^{A1}} z$$

while $z_B^C$ maximizes

$$F^B(z) - \frac{p_z^{B1}}{p_x^{B1}} z.$$

Let $z*$ maximize $F^B(z) - Rz$ and let $F^B(z*) - Rz* \equiv G(R)$ be the value function for this problem. Of course, by the envelope theorem, $G'(R) < 0$. Since $G(\frac{\phi}{p_x^{A1}}) < G(\frac{p_z^{B1}}{p_x^{B1}})$, this implies that $\frac{\phi}{p_x^{A1}} > \frac{p_z^{B1}}{p_x^{B1}}$. Using the first order conditions, (3.13) and (3.14), and the fact that $F^B(.)$ is concave, we immediately have that $z_A < z_B^C$ which implies that $x_A^B < x_B^B$.

**Lemma 8.11.** *Assume that $\alpha \epsilon (\alpha_0, \alpha_1)$, and country $B$ is small and that $\frac{\partial z_A^B(p_x^{A1}, p_z^1, \alpha)}{\partial \alpha} > 0$. An increase in the restrictiveness of the ROO as captured by an increase in $\alpha$*

*results in the following:* $(i)\frac{dz_A^B}{d\alpha} > 0, (ii)\frac{dp_z^{1*}}{d\alpha} > 0$, $(iii)\frac{dz_A}{d\alpha} < 0$,*and* $(iv)\frac{dx_A^B}{d\alpha} < 0$.

$(i)\frac{dz_A^B}{d\alpha} > 0$ follows from the fact that if $z_A^B(p_x^{A1}, p_z^1, \alpha)$ shifts out as $\alpha$ rises, the equilibrium level of $z_A^B$ also rises.

$(ii)\frac{dp_z^{1l}}{d\alpha} > 0$ follows from the assumption that $z_A^B(p_x^{A1}, p_z^1, \alpha)$ shifts out as $\alpha$ rises.

$(iii)$ To prove $\frac{dz_A}{d\alpha} < 0$, note that $\phi(p_z^{1l}, \alpha) = \frac{p_z^{1l}p_z^B}{\alpha p_z^B + (1-\alpha)p_z^{1l}}$ increases in both its arguments as shown in Lemma 8.3. Then from equation (3.13), we immediately have the result.

$(iv)$ $\frac{\partial x_A^B}{\partial \alpha} = F^{B'}\frac{\partial z_A}{\partial \alpha} < 0$.

**Lemma 8.12.** *For* $\alpha \in (\alpha_1, 1]$ *so that* $p_z^{1*} = \tilde{p}_z^1$, *and country* $B$ *small, an increase in the restrictiveness of the ROO as captured by an increase in* $\alpha$ *results in a decrease in* $p_z^{1*}$ *and* $n_A^B$, *and an increase in* $z^A$, $x_A^B$ *and* $z_A^B$. *In other words:*

$(i)$ $\frac{d\tilde{p}_z^1(\alpha)}{d\alpha} < 0$, $(ii)$ $\frac{d\phi(p_z^1(\alpha),\alpha)}{d\alpha} < 0$, $(iii)$ $\frac{dz_A(p_z^1(\alpha),\alpha)}{d\alpha} > 0$, $(iv)$ $\frac{dz_A^B(p_z^1(\alpha),\alpha)}{d\alpha} > 0$, $(v)$ $\frac{dn_A^B(\alpha)}{d\alpha} < 0$, $(vi)$ $\frac{dx_A^B(p_z^1(\alpha),\alpha)}{d\alpha} > 0$, $(vii)$ $\frac{d\psi(p_z^1(\alpha),\alpha)}{d\alpha} < 0$ and $(viii)$ $\frac{dV_A(p_z^1(\alpha),\alpha)}{d\alpha} > 0$.

Proof: A sketch of the proof is provided next. In order to consider the effects of an increase in $\alpha$ we need to first outline the system which determines these endogenous variables. These are given by (3.13), (4.1), (4.2), and (3.8). Together these determine $p_z^{1*}(\alpha)$ (from (4.1)), $z^A(\alpha)$ from (3.13), $z_A^B$ from (3.8), $n_A^B(\alpha)$ from

(4.2), and $x_A^B$ from the definition of the production function, that is $x_A^B(\alpha) = F^B($ $z^A(\alpha))$.

First consider $(i)$. Lemma 8.5 shows that $\Pi_A^B(p_x^{A1},\ p_z^1,\ \alpha)$ is decreasing in $p_z^1$ and $\alpha$ and increasing in $p_x^{A1}$. Since $\Pi_A^B(p_x^{A1},\ p_z^1,\ \alpha)$ must equal $\bar{\Pi}_B^B$, and as $p_x^{A1}$ is fixed since $B$ is small, we get $(i)$.

$(ii)$ and $(iii)$. Recall that $\Pi_A^B = p_x^{A1} F^B(z_A) - \phi(p_z^1, \alpha) z_A + \psi(p_z^1, \alpha)k - k$. [19]In response to the increase in $\alpha$, $p_z^1$ must fall to keep $\Pi_A^B$ fixed at $\bar{\Pi}_B^B$. Consider the effect of an increase in $\alpha$ and a decrease in $p_z^1$ such that $\phi(p_z^1, \alpha)$ is unchanged. Also, note that:

$$\psi = \frac{(1-\alpha)\{\phi - p_z^{B1}\}}{\alpha p_z^{B1}},$$

so that if $\phi$ is kept constant by the induced reduction in $p_z^1$, $\psi$ must fall! Hence $\Pi_A^B$ falls. In order to keep $\Pi_A^B$ fixed, $p_z^1$ must fall even further than it needs to in order to keep $\phi(p_z^1, \alpha)$ fixed and this results in a lower $\phi(p_z^1, \alpha)$ than at the original $\alpha$. A consequence of this, from (3.11) is that $z_A$ rises in response to the increase in $\alpha$.

[19]Remember that $\psi(p_z^1, \alpha)$ is positively related to $p_z^1$ and negatively to $\alpha$ and that $\Pi_A^B$ falls with increases in $p_z^1$ or $\alpha$.

$(iv)$ Recall that

$$z_A^B = \frac{\alpha p_z^{B1} z_A - (1-\alpha)k}{\alpha p_z^{B1} + (1-\alpha)p_z^1} \equiv \frac{\alpha p_z^{B1} z_A - (1-\alpha)k}{\tilde{p}_z}$$

from (3.8). An increase in $\alpha$ raises the numerator as $(iii)$ shows that $z_A$ rises in response to the increase in $\alpha$. It also reduces the denominator as from $(i)$, $\tilde{p}_z^1$ falls as $\alpha$ rises and as $p_z^1 > p_z^{B1}$ and the weight on $p_z^1$ falls. Thus, the ratio rises.

$(v)$ As $p_z^{1*}$ falls due to an increase in $\alpha$, supply of $z$ from the $FTA$ falls. As $z_A^B$ rises due to an increase in $\alpha$, for demand to equal supply at the lower $p_z^{1*}$, $n_B^A$ must fall from (4.2).

$(vi)$ Follows from the fact that $x_A^B(\alpha) = F^B(\, z^A(\alpha))$.

$(vii)$ Note that due to the envelope theorem and since profits are fixed:

$$\frac{d\Pi_A^B(p_z^1(\alpha),\alpha)}{d\alpha} = z_A \frac{d\phi(p_z^1(\alpha),\alpha)}{d\alpha} - k\frac{d\psi(p_z^1(\alpha),\alpha)}{d\alpha} = 0. \tag{8.3}$$

Since by $(ii)$, $\frac{d\phi(\tilde{p}_z^1(\alpha),\alpha)}{d\alpha} < 0$, the above implies that $\frac{d\psi(p_z^1(\alpha),\alpha)}{d\alpha} < 0$.

$(viii)$ Note from (3.8) that:

$$V_A(p_z^1(\alpha),\alpha) = \phi(p_z^1(\alpha),\alpha)z_A - \psi(p_z^1(\alpha),\alpha)k.$$

Hence:

$$\begin{aligned}\frac{dV_A(p_z^1(\alpha),\alpha)}{d\alpha} &= z_A\frac{d\phi(.)}{d\alpha} - k\frac{d\psi(.)}{d\alpha} + \phi\frac{dz_A(.)}{d\alpha} \\ &= \phi\frac{dz_A(.)}{d\alpha} > 0\end{aligned}$$

where the last equality follows from (8.3).

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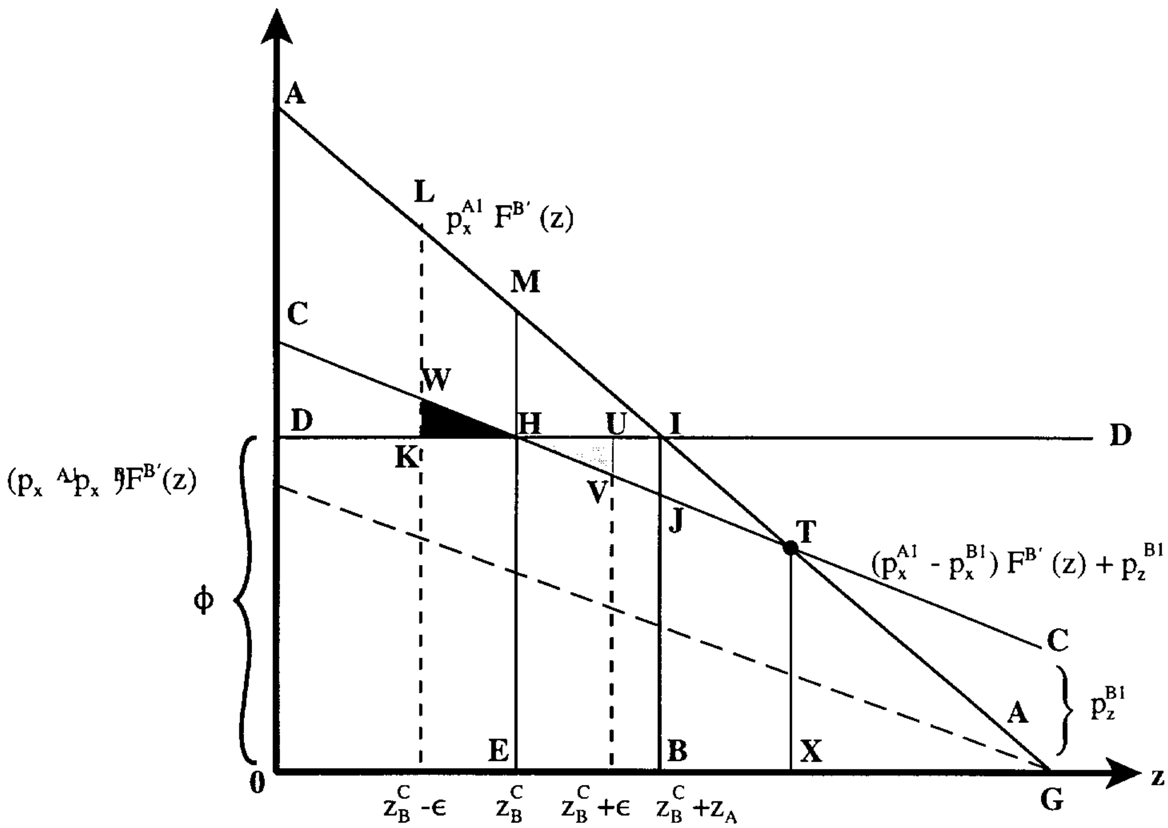
A
L
$p_x^{A1} F^{B'}(z)$
M
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$(p_x^{A1} - p_x^{B1}) F^{B'}(z) + p_z^{B1}$
C
A
$p_z^{B1}$
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B
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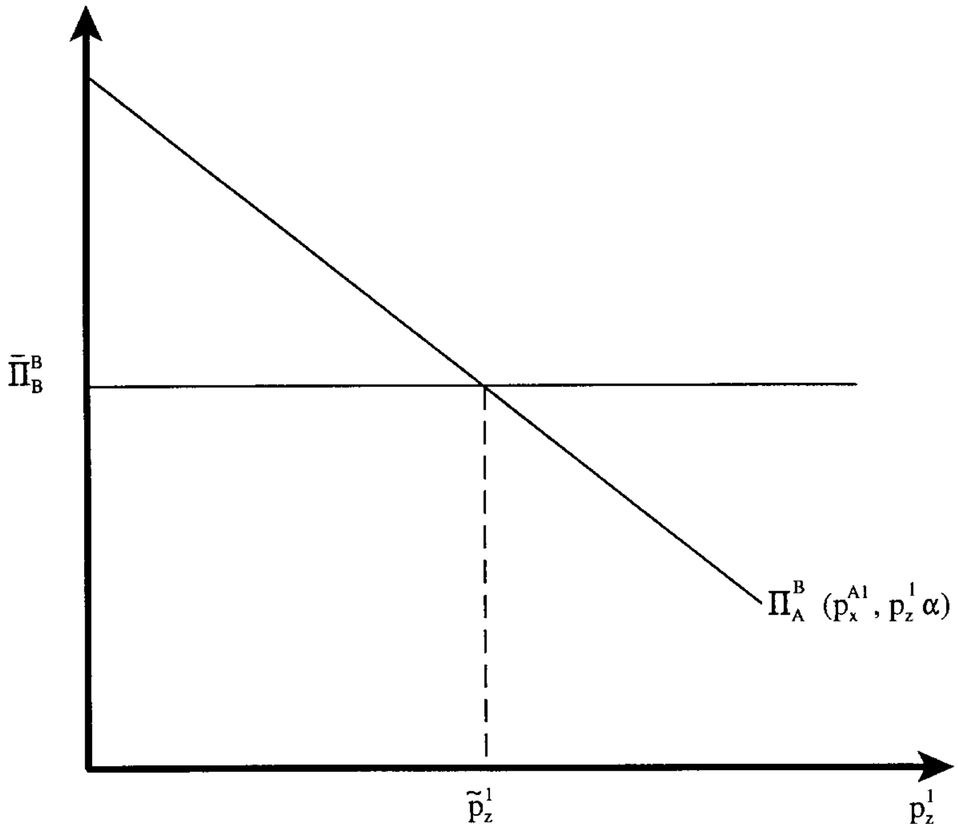
$z_B^C + z_A$

**Figure 1**

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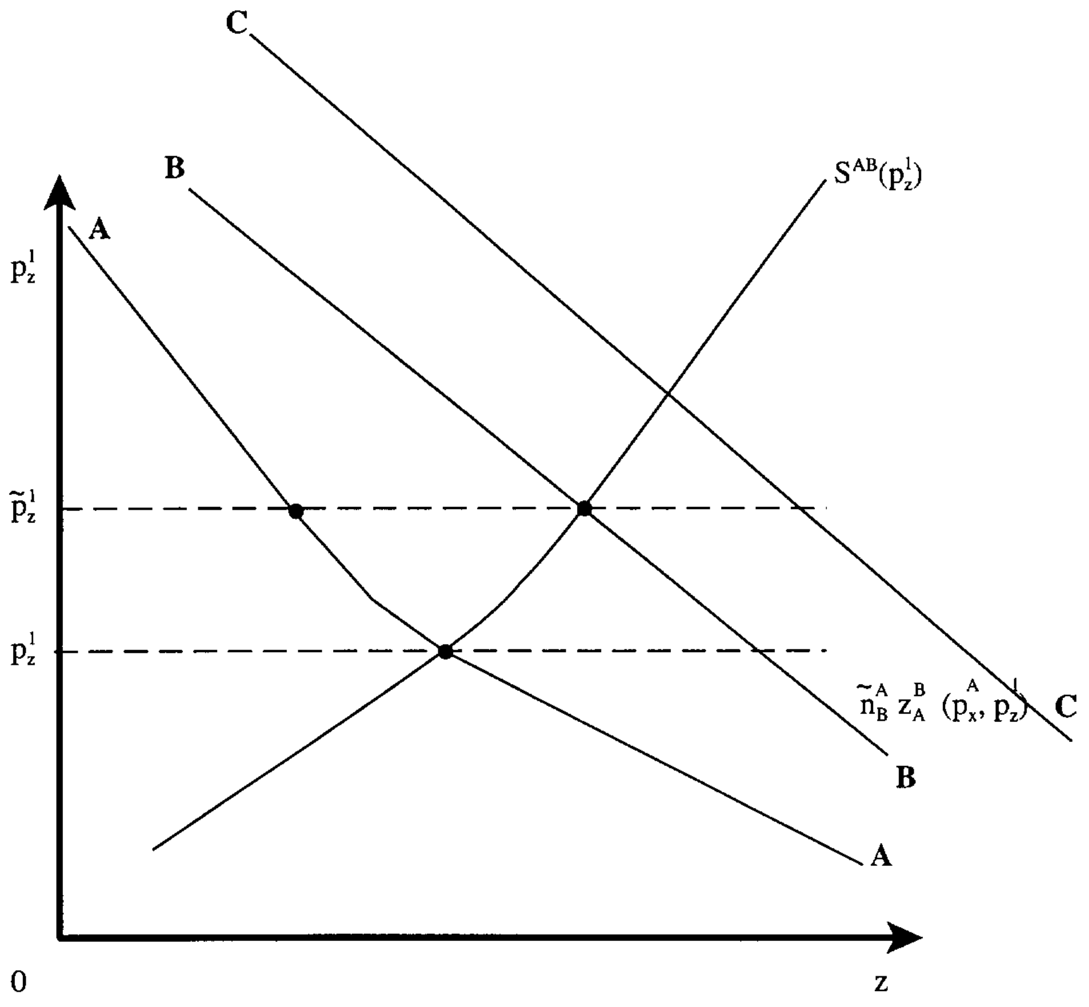


**Figure 3**

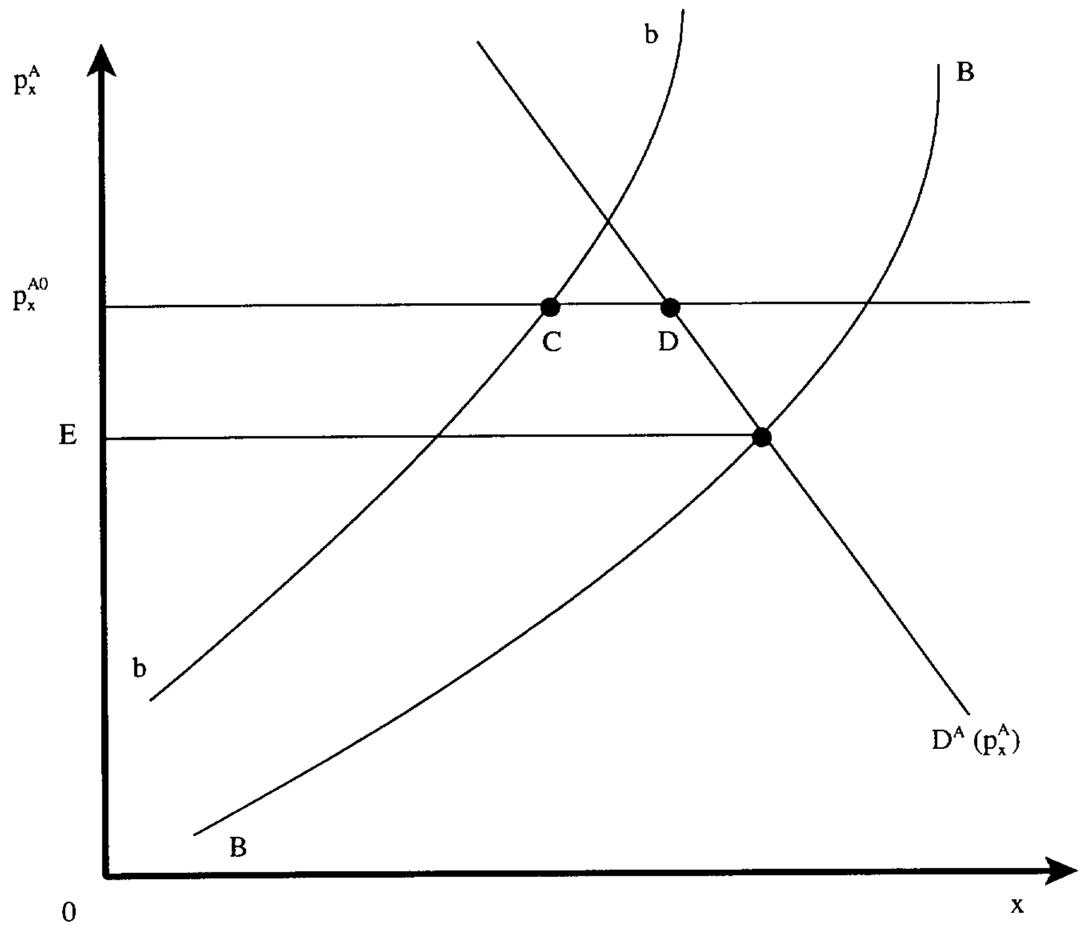


**Figure 4**

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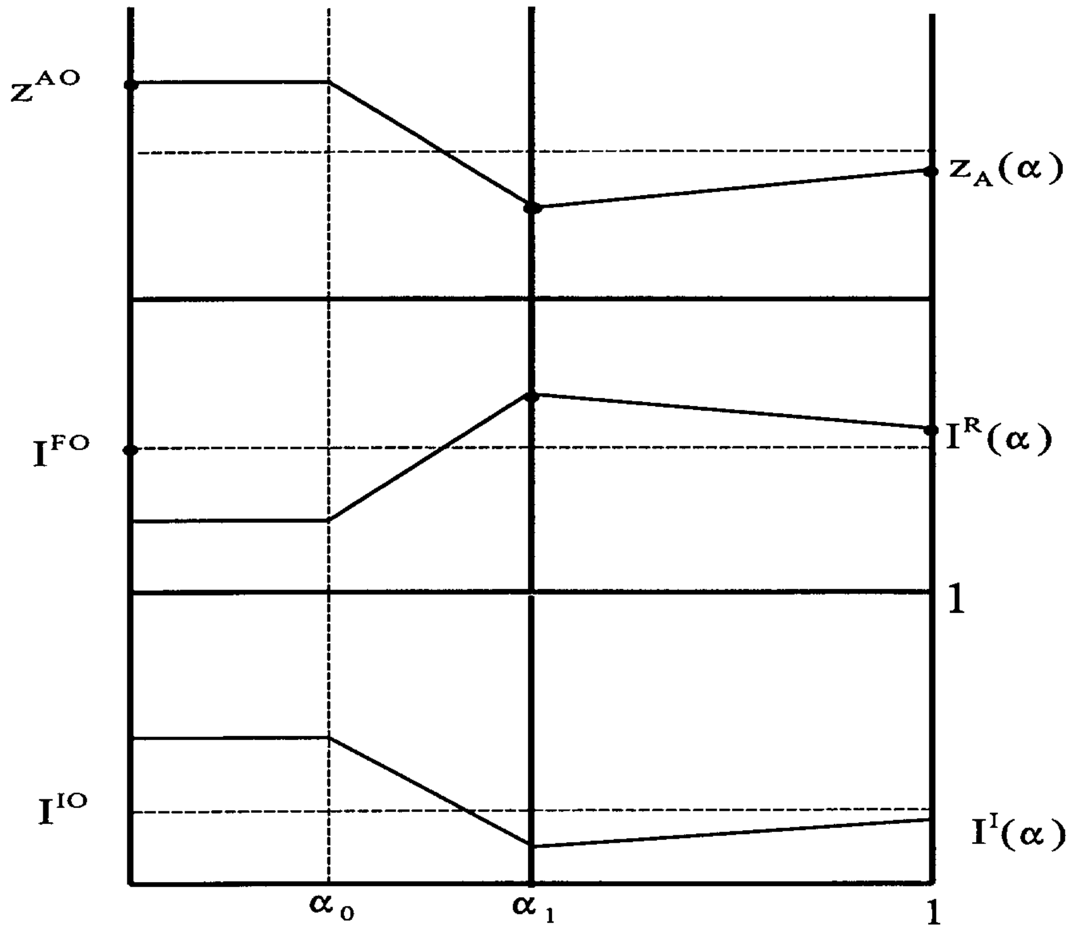


**Figure 5**