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Working Paper 11283
http://www.nber.org/papers/w11283

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
April 2005

I am grateful to Maury Obsfeld, Robert Staiger and Scott Taylor for comments on an earlier version and to Svetlana Demidova for research assistance. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 11282
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JEL No. F13, F15, F16

ABSTRACT

Obtaining lower generalized system of preferences (GSP) tariffs requires meeting costly Rules of Origin (ROOs). Growing coffee in the shade is more costly, but yields a price premium. This paper analyzes the effects of such restrictions in a general equilibrium setting and shows that such policies may have unanticipated effects. It is shown that in a world with capital mobility, the GSP could result in capital outflows rather than inflows and consumer preferences for shade grown coffee end up hurting labor in developing countries. Even small subsidies that are contingent on the use of domestic intermediates can result in specialization in the targeted good. Value added contingent policies can easily lead to multiple equilibria despite the absence of externalities or market imperfections.

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1 Introduction

Trade and domestic policies are often conditional in practice: only if certain conditions are met is a set of benefits obtained. Content protection schemes in developing countries often require firms in an industry to use at least some level of domestic inputs. In a Free Trade Area (FTA) producers become eligible for zero tariffs (when exporting to a partner in the FTA) if the product is deemed to have domestic origin. Otherwise, they must pay the going tariff. Under the Generalized System of Preferences (GSP) poor developing countries obtain preferential tariffs only if the product is deemed to originate in the developing country.[1] In some countries, producers obtain preferential access to inputs only if they export their products. Similarly, products produced in environmentally friendly or socially acceptable ways, (like dolphin safe tuna (caught using nets that allow dolphins to escape), or shade grown coffee (so that tree cover remains), or carpets made by adults (not children) and certified as such,[2] or food certified as organic), command a higher price. Since the price obtained is conditional on the technique used, this also falls under the banner of conditional policies.

The effect of such conditional policies in a general equilibrium setting has been neglected. This paper shows that the use of simple duality arguments allows us to answer such questions in a simple and relatively general manner. A particular policy, namely, the level of ROOs in the FTA, is used for illustrative purposes. It will be evident that the approach applies to all the above examples though details may well differ between applications. For example, some

[1] Most products, other than arms and numerous agricultural goods, are covered by the GSP. The conditions under which origin is granted are defined by the Rules of Origin (ROOs).

[2] Senator Harkin introduced a "Child Labor Deterrence Act" in 1994 to allow imports of such goods to be potentially prohibited. Such an act has not so far made it through the committee process. However, Senator Harkin introduced another bill, "The Child Free Consumer Information Act", which would provide a voluntary labeling system, the accuracy of which would be enforced by a commission.

practices confer a direct benefit to the consumer: organic food is perceived as better tasting and better for you, so that labeling would occur voluntarily. In this case, there is no role for government other than that of checking that labels are accurate. Other practices, like dolphin safe tuna, are costly to implement,[3] and do not impact on the quality of the product per se. In such cases, certification, combined with consumer *dis*approval, could make companies follow such practices.[4] On the other hand, rules of origin in an FTA have to be set and enforced, at substantial cost to producers and to government.

There is a literature on labeling in the trade and environmental economics area. However, it is, by and large, cast in a partial equilibrium setting. Rolo and Winters (2000) argue that taxes, in one form or the other, should be used to deal with environmental externalities while labeling should be used to deal with information asymmetries arising from individuals not knowing the attributes of the product. Beaulieu and Gaisford (2002) look at policies to influence eco dumping and make a case for the use of conditional policies. Matto and Singh (1994), Freeman (1994) along with a host of other work suggests that when asked, consumers say they are willing to pay significantly more for environmentally friendly goods. However, marketing science research suggests that even small price differences result in consumers purchasing the cheaper good when quality is the same. If this is true, labeling so as to avert consumer displeasure

[3]The furor over dolphin safe tuna arose, to begin with, after March 8th 1988, when all the major U.S. networks broadcast a tape of hundreds of dolphins being killed by the Panamanian tuna fishing boat "Maria Luisa". A boycott of tuna led to all the major canned tuna producers committing to only selling dolphin safe tuna! Voluntary restraints on such harvesting in the Eastern Pacific (mostly by the U.S. though also involving Mexico and Latin American countries) were replaced by binding agreements (the international dolphin conservation program act) among the states concerned in 1998. (See Dyck and Zingales (2002).)

[4]An in between case, where there are some reasons to adopt the practice independent of consumer willingness to pay, is shade grown coffee. Shade growing results in bigger beans and greater fruit weight without compromising on flavor at low altitudes as shade protects from temperature extremes. Shade grown coffee reduces deforestation as well as providing enhanced pest control and enhancing bird diversity. Under optimal conditions, however, coffee can be grown efficiently in the open with the use of high levels of agro chemical inputs which have possible adverse runoff effects.

would be a fragile force.

Previous work on Rules of Origin and content protection and preference has also taken a partial equilibrium approach. Early work by McCulloch and Johnson (1973), Grossman (1981) and Mussa (1984) considered competitive settings while Krishna and Itoh (1988) look at a duopoly and strategic interaction effects. Krueger (1999) and Krishna and Krueger (1995) look at ROOs in a partial equilibrium setting. The most closely related papers to this one are Ju and Krishna (1998) and (2002). Using a partial equilibrium setting, they point out an essential non monotonicity occurs when the link between final and intermediate goods markets is accounted for. If the requirement that has to be met is easy to meet, all firms choose to do so. In this regime, one set of comparative statics results are obtained. At some point, however, firms will become indifferent between meeting and not meeting the restriction. Some firms meet the requirement, while others do not. In this regime, the comparative statics results are reversed.[5]

However, a deep understanding of such situations is still lacking. The current paper develops a way of looking at such situations in a general equilibrium setting under perfect competition. The model is based on the dual approach utilizing the factor price frontier. It will become clear that the approach developed here has a host of applications in a variety of areas. Using the techniques developed, questions such as the effects of encouraging stricter labor standards internationally through trade policy or the effects of consumer movements building a market base for environmentally friendly products can easily be dealt with in a general equilibrium setting.

Section 2 lays out the basic tools taking a physical content requirement to be the requirement for origin in the FTA. Section 3 looks at the effects of FTAs

[5] This points to the importance of allowing ex ante identical firms to behave differently ex post. Even the classic papers in this area do not seem to appreciate this.

with ROOs (defined as a physical requirement) in general equilibrium in the presence and absence of capital mobility. It is shown that when ROOs are set at ex ante just binding levels, they need not be binding ex post, nor must they result in an inflow of capital. However, they always result in an expansion of the affected sector, and increased trade deflection though the economy as a whole may shrink.[6] Section 4 considers a value added ROO. With such a ROO, it is shown that the concavity of the cost function need not always obtain, and as a result, duality cannot be exploited fully. In addition, when factors are not good substitutes, there can be many equilibria despite the absence of market imperfections. Section 5 concludes.

2 The Basic Tools

Although the tools are standard, there is a slight twist in their use that needs some explaining. Using a mixed metaphor, conditional polices have a carrot and hoop element to them. The carrot, preferential treatment in the case of ROOs in the FTA, is obtained only by jumping through hoops, namely, meeting origin requirements. We ask, what factor prices can a firm afford to pay if it can choose to avail itself of these conditional policies? The basic insight used in this paper is that if, by taking advantage of the policy, the firm can raise the factor prices it can afford to pay, it will be willing to do so. Otherwise, it will not. In other words, we look at the effects of such restrictions on the factor price frontier.[7] We then use the dual definition of the standard revenue function: namely, as the value function for the problem of minimizing factor payments subject to the factor price frontier. Given the availability of resources and technology, if the

[6] Less central results are relegated to appendices. The first extends the technique to ROOs which require a particular intermediate input to be produced domestically. The second derives the effects of making ROOs more restrictive and argues that the kind of non monotonicity seen in Ju and Krishna (1998) is likely to be prevalent in general equilibrium.

[7] In a way, such restrictions can be viewed as a combination of a tariff and technological regression.

opportunities created by the FTA increase the factor price that firms can pay, then the restriction matters in equilibrium.

2.1 The Revenue Function

It is easiest to illustrate the approach with one good and two factors, capital (K) and labor (L) with prices r and w respectively. Let factors be supplied inelastically and let $\frac{w}{r} = \omega$, the wage rental ratio. Consider a unit isoquant with K on the vertical axis. Combinations of K and L that lie above the unit isoquant are feasible ways of producing a unit of the good. Unit costs are minimized where the slope of the unit isoquant equals $-\frac{w}{r}$. Minimizing unit cost involves using $[a_L(\omega), a_K(\omega)]$ to make the good, that is, using a capital labor ratio of $\frac{a_K(\omega)}{a_L(\omega)} = k(\omega)$. Denote the minimized unit cost by $c(w, r)$.

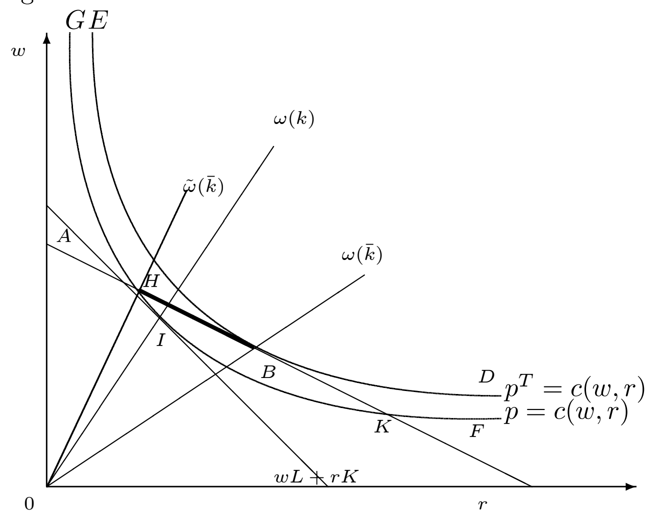
The curve $p = c(w, r)$ defines the factor price frontier in this one good economy and is depicted in Figure 1. As is well understood, the equilibrium factor prices can be obtained as the solutions to minimizing factor payments subject to $p \leq c(w, r)$, while the revenue function is the value function for this problem.[8] Equilibrium factor prices for a one good economy at price p, and endowments $V = (L, K)$, would be given by the tangency of the line $wL + rK$ to the curve $p = c(w, r)$ which occurs at I.

As long as constant returns to scale are preserved and the restrictions do not make the cost function non concave, we can proceed in the same manner when considering conditional policy schemes. We will first derive the factor price frontier under the scheme and then minimize factor payments subject to the factor price frontier to get equilibrium factor prices.

Suppose we consider a physical content requirement as the origin rule: in particular, that the capital labor ratio used in production be weakly below an upper limit or $\frac{a_K}{a_L} \leq \bar{k}$. When we consider the unit isoquant as done earlier we

[8] See Dixit and Norman (1979).

Figure 1: The Factor Price Frontier with ROOs



see that in order to meet the origin rule, inputs must lie below the ray from the origin with slope $\bar{k}$ as well as above the unit isoquant. Let the wage rental ratio that induces a capital labor ratio of k be $\omega(k)$. Hence, only if the wage rental ratio exceeds $\omega(\bar{k})$ is the requirement binding. In this event, it is easy to see that cost minimization involves just meeting the origin rule. Let these distorted input choices be denoted by $\left[a_L(\bar{k}), a_K(\bar{k})\right]$. Consequently, the unit cost of production when meeting the requirement is

$$\begin{aligned} c(w,r,\bar{k}) &= wa_L(\bar{k}) + ra_K(\bar{k}) > c(w,r), \; if \; \omega > \omega(\bar{k}) \\ &= c(w,r), \qquad\qquad\qquad\qquad\quad if \; \omega \leq \omega(\bar{k}). \end{aligned}$$

The factor price frontier in the FTA with ROOs is, thus, given by combining this with the option of ignoring the FTA. This is depicted in Figure 1. The physical content requirement has to be met for the firm to obtain the higher price, p^T, from selling in the FTA. Since obtaining a higher price allows factors to be paid more, the higher price alone results in the price equal to cost curve in the absence of any policies being proportionally blown up to the level given by

$p^T = c(w, r)$. However, in order to obtain the higher price $p^T = p(1+t)$, where t is the ad-valorem default tariff, a sub-optimal technique, namely, $(a_K(\bar{k}), a_L(\bar{k}))$ is used if $\omega > w(\bar{k})$, where $w(\bar{k})$ is the slope of ray from the origin to B in Figure 1. Since it would be optimal to use this technique if the restriction were binding, unit costs given the restriction is binding would be given by the line tangent to the curve $p^T = c(w, r)$ at B with slope $\bar{k}$. Note that if the wage rental ratio is not too high, this line lies above the factor prices a firm can afford to pay and meet costs, if it ignores the conditional policy, so that it is in its interest to take advantage of the policy. Once the wage rental ratio exceeds $\tilde{\omega}(\bar{k})$, as depicted in Figure 1, it is best to ignore the conditional policy.[9]

The highest factor prices that a firm can pay, if it has the option of availing itself of a conditional policy of this form, is, therefore, given by $GHBD$ in Figure 1. This is the augmented price equal to cost curve and the relevant factor price frontier with a single good. The tangency of the line $wL + rK$ to this frontier gives the equilibrium factor prices. If there is only one good and the ROO is set at exactly the pre-FTA level of k, then any wage rental ratio along the straight line part of the factor price frontier would be equilibrium wage rental ratio. It is easy to see that even a slightly binding ROO could cause large factor price changes. For example, if the ROO is set at $\bar{k}$, then the wage rental ratio would rise to $\tilde{\omega}(\bar{k})$. Making the restriction weaker, that is raising $\bar{k}$, will also raise the corresponding $\tilde{\omega}(\bar{k})$ but that as long as $p^T > p$, $\tilde{\omega}(\bar{k}) > w(k)$.

With many goods, the factor prices that each sector can afford to pay in the presence of such policies, can be derived in the same way. The factor price frontier is then the set of factor prices that lie above all these (possibly augmented) price equal cost curves. Factor prices which minimize factor payments subject to this set are the factor prices in equilibrium. Goods (techniques) which have

[9] Note that making the restriction stricter, that is lowering $\bar{k}$, will also lower the corresponding $\tilde{\omega}(\bar{k})$.

cost exceeding price are not made (used), and output levels are determined so that factor markets clear. The value function for this problem yields the revenue or national income function.

2.2 Equilibrium Conditions in FTAs with ROOs

Suppose that there are two goods, 1 and 2, and two countries, A and B, which form the FTA. Assume that there is no specialization prior to the FTA and that both countries import good 1. Denote the world price by p^* and label the countries so that country A has a lower tariff and, hence, a lower domestic price of good 1 prior to the FTA. If one of the countries exports the good to the other after the FTA, it must be A as its domestic price is lower than that in B. There are no export subsidies and good 2 is assumed to be freely traded and is taken as the numeraire.[10]

Superscripts A and B refer to the countries while the superscripts 0 and 1 refer to pre and post FTA levels respectively. Let $e(P, u)$ and $r(P, V)$ denote the standard expenditure and revenue functions, where P denotes the vector of prices. Subscripts on $e(P, u)$ and $r(P, V)$ denote the partial derivative with respect to the subscripted variable. As usual, by the envelope theorem, $e_P(.) = c^h(.)$, the vector of Hicksian compensated demands. Similarly, $r_P(.) = x(.)$, the supply of goods, while $r_V(.) = w(.)$, the vector of factor prices.

In the equilibrium before the FTA the endogenous variables are $\left(u^{A0}, u^{B0}\right)$ while p_1^{A0} and p_1^{B0} are given by the tariffs set by each country and the fixed world price. Setting expenditure equal to income gives the equilibrium levels of

[10] Alternatively, A can be thought of as the developing country who obtains lower tariffs when exporting to B if it meets origin requirements. For the most part the example will be the FTA one but the analogy to the GSP example is obvious.

utility in A and B to be defined by

$$e(p_1^{A0},1,u^{A0}) = r(p_1^{A0},1,V^A)+t^A\left[e_1(p_1^{A0},1,u^{A0})-r_1(p_1^{A0},1,V^A)\right] \quad (1)$$

$$e(p_1^{B0},1,u^{B0}) = r(p_1^{B0},1,V^B)+t^B\left[e_1(p_1^{B0},1,u^{B0})-r_1(p_1^{B0},1,V^B)\right]. \quad (2)$$

After the FTA the endogenous variables are u^{A1}, u^{B1}, and p_1^{B1}. p_1^{A0} and p_1^{B0} are given by the tariffs prior to the FTA and the fixed world price. Instead of the standard revenue function we now need to use the constrained revenue function, where factor payments are minimized over the factor price frontier in the presence of the FTA and the given ROO. Call this function $R(p,1,V)$. It has the usual properties of a revenue function. For any given p_1^{B1}, we can get u^{A1} and u^{B1} from

$$e(p_1^{A0},1,u^{A1}) = R(p_1^{B1},1,V^A)+t^A\left[e_{p_1}(p_1^{A0},1,u^{A1})+\min\left[s_1(p_1^{B1}),0\right]\right] \quad (3)$$

$$e(p_1^{B1},1,u^{B1}) = R(p_1^{B1},1,V^B)+t^B\max\left[s_1(p_1^{B1}),0\right] \quad (4)$$

where

$$s_1(p_1^{B1})=e_{p_1}(p_1^{B1},1,u^{B1})-R_{p_1}(p_1^{B1},1,V^B)-r_{p_1}(p_1^{B1},1,V^A).$$

s_1 is the excess of B's demand over FTA supply at p_1^{B1}. If s_1 is positive, then B must import from outside the FTA and as the world price is fixed, $p_1^{B1} = p_1^{B0}$. As A imports all its consumption at its pre FTA price, its tariff revenue is $t^A e_{p_1}(p_1^{A0},1,u^{A1})$ while B's equal $t^B s_1(p_1^{B1})$ as given above. On the other hand, if s_1 is negative, i.e., the FTA can supply all of B's needs, then p_1^{B1} equals p_1^{A0}. A imports only some of its consumption, so that its tariff revenue is $t^A\left[e_1(p_1^{A01},1,u^{A1})+s_1(p_1^{B1})\right]$ while B obtains no tariff revenue. If s_1 is zero, then A imports all its consumption from the rest of the world, B imports nothing from the rest of the world, and p_1^{B1} comes from

$$e_1(p_1^{B1},1,u^{B1})=r_1(p_1^{B1},1,V^B)+R_1(p_1^{B1},1,V^A) \quad (5)$$

and (3), (4), and (5) can be used to solve for the endogenous variables.

3 Physical ROOs

We proceed by examining the effects of ROOs defined in physical terms requiring a minimum use of labor relative to capital. We look at the effects of the FTA both with and without capital mobility assuming that the ROO is set at the pre FTA level. Two cases are considered: when good 1 is relatively capital intensive and when it is relatively labor intensive.

3.1 Restricting the Capital Intensive Good

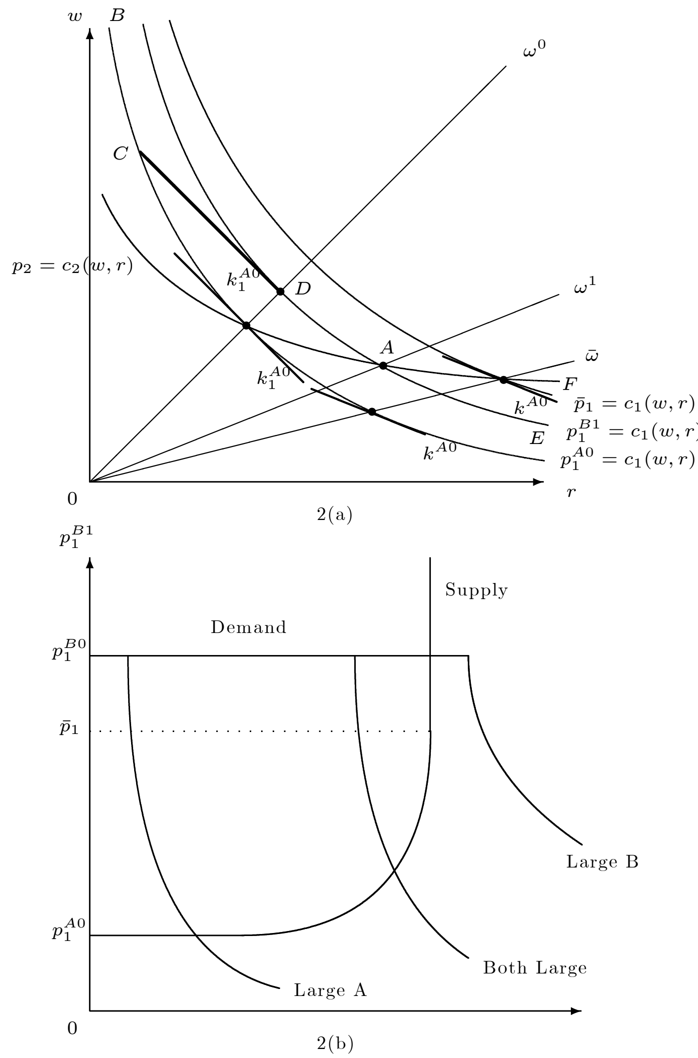
Assume good 1 is relatively capital intensive. Then the FTA allows A to obtain a higher price for good 1 by exporting to B on preferential terms if it meets the ROO.

3.1.1 Price Effects of Status Quo ROOs

The factor price frontier on the assumption that the ROO is set at the status quo, namely, the pre FTA capital labor ratio in sector 1, is depicted in Figure $2(a)$ by $BCDAF$. Before the FTA the prices faced by producers in A are (p_1^{A0}, p_2), and the factor price ratio is ω^0, which occurs at the intersection of the price equal to cost curves for the two goods. The capital labor ratios in the two sectors are k_1^{A0} and k_2^{A0} and the economy wide capital labor ratio, k^{A0}, lies in between them. Being forced to use the pre FTA capital labor ratio to meet origin makes the factor price frontier depart from that associated with a higher price of good 1 alone only at wage rental ratios above ω^0. If the ROO is set at the pre FTA capital labor ratio in Sector 1 and p_1^{B1} exceeds p_1^{A0}, the factor prices that firms can just afford to pay are given by $BCDAE$ while the factor price frontier for the economy is given by $BCDAF$ in Figure $2(a)$. As is evident, such a ROO is not binding in equilibrium.[11] Access to higher prices for good 1 raises r and

[11] The factor price changes in A cause a ROO set to be just binding prior to the FTA to be not binding after the FTA. It is easy to see that even an initially slightly restrictive ROO

Figure 2: Physical Content Requirement on the Capital Intensive Good



lowers w for country A thereby reducing the capital labor ratio in both sectors.[12] These are direct consequences of the Stolper Samuelson Theorem.

Consider the supply of good 1 from A when the ROO is set at k_1^{A0}. Recall that k^{A0} is the aggregate capital labor ratio. At $p_1 = \bar{p}_1$, the slope of the curve $\bar{p}_1 = c^1(w,r)$ where it intersects the curve $p_2 = c^2(w,r)$ is given by k^{A0} as depicted in Figure 2(a). A ROO set at k_1^{A0} results in complete specialization in good 1 for prices at or above $\bar{p}_1$. When the price is $\bar{p}_1$, the ROO does not bind in equilibrium so that capital labor ratio in making good 1 in equilibrium equals the aggregate capital labor ratio, specialization occurs and supply becomes vertical. A ROO at k_1^{A0} is not binding at any price above p_1^{A0}. Thus, A's supply to B is as depicted in Figure 2(b). It is zero at prices below p_1^{A0} as firms in A can do better by selling domestically in this event. At p_1^{A0} firms are willing to supply to B, and as price rises, the normal supply response occurs. When the price reaches $\bar{p}_1$, A specializes in good 1 and supply becomes inelastic.

Similarly, B's excess demand for good 1 from A is zero at all prices above p_1^{B0} as it can obtain good 1 from the rest of the world at p_1^{B0}. It equals its total excess demand for good 1 at prices below p_1^{B0} and is horizontal at p_1^{B0} as shown. Whether the price in B after the FTA is p_1^{A0}, or p_1^{B0}, or in between depends on the size of A's supply relative to B's excess demand. If A is large and B is not, then the price faced by consumers and producers in A and B will be p_1^{A0}. All of B's imports of good 1 will be produced in A while A will import enough to meet its own demand.

If B is large and A is not, then the price faced by consumers and producers in B will be p_1^{B0}. Consumers in A will face p_1^{A0} while producers will face p_1^{B0}. Some

will not be binding in equilibrium. A ROO has to be stricter than $\hat{k}$, the slope of the price cost curve in 1 at A in Figure 2, in order to be restrictive in equilibrium. Of course, as the price differential in the two countries falls, the corresponding $\hat{k}$ rises so that this minimally restrictive ROO is less strict.

[12] If the price in B falls, the opposite happens in B.

of B's imports of good 1 will be produced in A while all of A's consumption will be imported.

If both A and B are large, the price faced by consumers and producers in B post FTA lies in between these two extremes.[13] Consumers in A will face p_1^{A0} while producers will face p_1^{B1}.

If A is large, it will supply all B's imports and A must gain from the FTA due to its appropriation of tariff revenue from B. B's prices fall but it is worse off than if it merely reduced its tariffs to get its post FTA price level as it loses tariffs to A. If B is large but A is not, B must lose as its prices are unaffected and it loses tariff revenue. In contrast, A must gain as it not only gains tariff revenue but it exports good 1 to B and this price rises while its consumer prices are unchanged.

Thus, to summarize, a ROO on the capital intensive good set to be initially just binding is not binding after the FTA. The FTA raises the welfare of the lower tariff country in the FTA and can reduce the welfare of the higher tariff country: it must do so if this country is large.

3.1.2 Allowing Capital Mobility

Allowing capital mobility into country A has very standard effects along the lines of Mundell (1957). We assume that there is a function $G(r^A)$, which defines the rental rate in A such that there are no capital flows to A.[14] Also, we assume that $G(r^{A0}) = 0$. We assume that $G(r)$ is increasing in r. Since r is weakly higher in A after the FTA (as p weakly rises in A), capital will flow into A. The inflow shifts the production possibility frontier of country A out further in good 1 than good 2 as good 1 is capital intensive and (via the Rybczynski Theorem)

[13] Note that A can completely specialize in serving B after the FTA only if $p_1^{B0} > \bar{p}_1$, which is how Figure 2(b) is drawn.

[14] Changes in the price faced by producers and consumers in B will also affect rental rates there and as rental rates will fall in B, we would expect capital outflows from B. If capital in B is mobile, then analogous output changes would occur there.

shifts out the supply curve for good 1 from country A. The process comes to an end when one of two things occurs. Either enough capital flows in to make p^{B1} fall to p^{A0} so that pre FTA equilibrium factor prices are reinstated in A, or A specializes in good 1. The former occurs if A has enough labor to meet all of B's demand at p^{A0}. If A has a small enough labor force, then a price differential between A and B can be maintained but A will specialize in making good 1.

To illustrate, consider ex ante just binding ROO so that the ROO is set at the pre FTA capital labor ratio in good 1, namely, k_1^{A0}. Now suppose enough capital has flowed in to make the aggregate capital labor ratio in A equal to k_1^{A0} and that A's labor force is small so that the producer and consumer price in B, which equals the producer price in A, denoted by p_1^{B1}, still exceeds p_1^{A0} as depicted in Figure 3(a). At this aggregate capital labor ratio, A is specializing in Good 1. This follows from the fact that the capital labor ratios in both sectors at D, the incomplete specialization point, where price equals cost for both sectors, lie below k_1^{A0}. As depicted in Figure 3(a), the equilibrium factor prices are given by the point C, which lies just above A, the pre FTA rental rate in A. Rental rates are equalized, preventing further capital inflows, but wages in A are higher than before the FTA.

3.2 Restricting the Labor Intensive Good

What if good 1 is relatively labor intensive? Figure 4 is the analogue of Figure 2 for this case. If the ROO is set at the pre FTA capital labor ratio in Sector 1 and p_1^{B1} exceeds p_1^{A0}, the factor prices that firms can just afford to pay are given by the line $BCADF$ while the factor price frontier for the economy is given by $GADF$ in Figure 4(a). As is evident, such a ROO is strictly binding in equilibrium.[15]

[15] The factor price changes in A cause a ROO set to be just binding prior to the FTA to be strictly binding after the FTA.

Figure 3: Effects with Capital Mobility

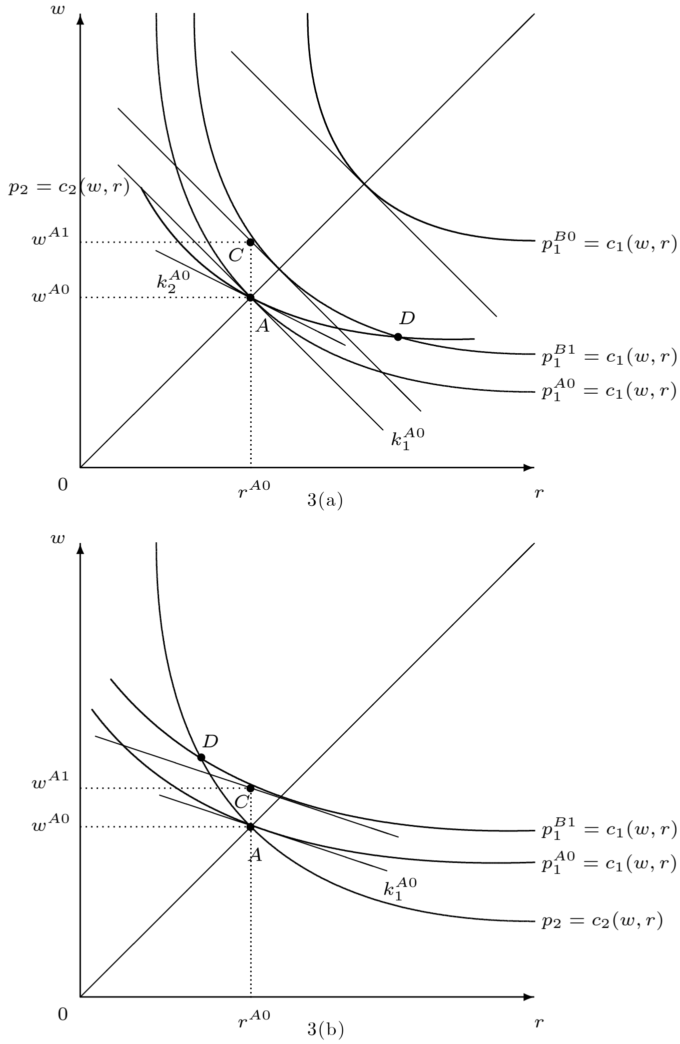
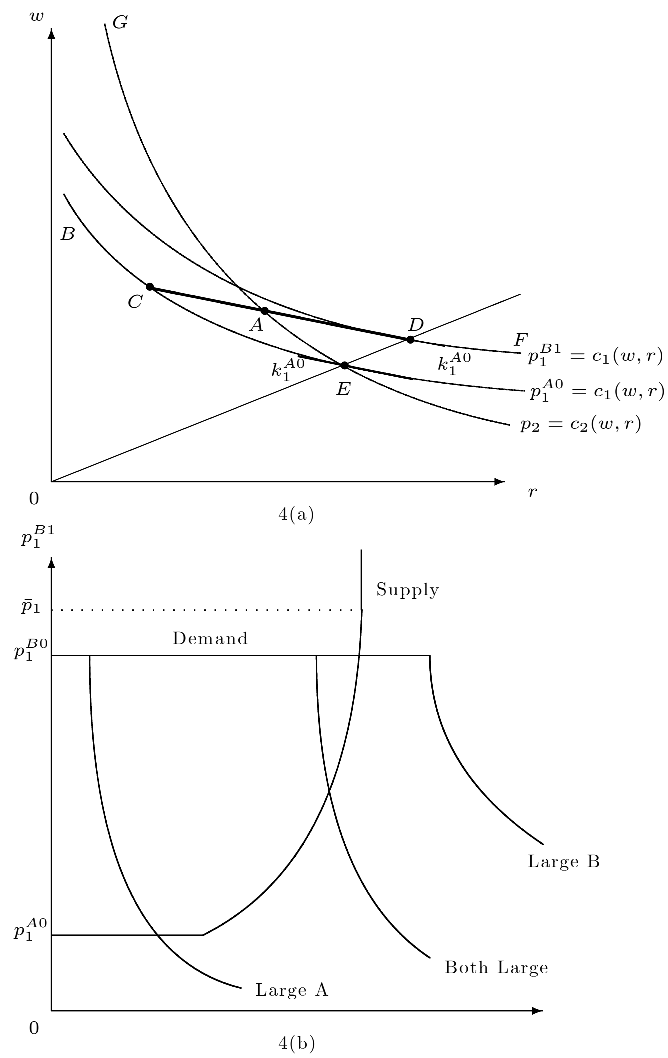


Figure 4: Physical Content Requirement on the Labor Intensive Good



Access to higher prices for good 1 raises w and lowers r for country A thereby raising the unconstrained capital labor ratio in both sectors and making a previously just binding ROO strictly binding. If the price in B falls, the opposite happens in B.

Consider the supply of good 1 from A. If $p_1^{B1} = p_1^{A0}$, then the ROO is just binding. Firms in A are indifferent between selling in A and selling to B. This is responsible for the horizontal segment at $p_1^{B1} = p_1^{A0}$ in Figure 4(b). As p_1^{B1} rises, it is easy to verify that factor prices move from E along GE. Supply of good 1 in A rises with p_1^{B1} since $R(.)$ is convex in prices and $R_1(.)$ equals supply. The equilibrium price in B after the FTA depends on the size of A relative to B as before.

Note, however, that there is one minor difference in the behavior of supply. A will not specialize in good 1 at any price. As p_1 rises from p_1^{A0}, factor prices move from E towards G in Figure 4(a). All firms in Sector 1 choose to meet the ROO so that the capital labor ratio in Sector 1 is fixed at k_1^{A0} while that in Sector 2 rises with p_1^{B1}. The economy wide capital labor ratio lies between them,[16] so that both goods are always made. Hence, w rises and r falls in A due to the FTA, in line with Stolper Samuelson effects, unless A is large and can supply all that B demands at p_1^{A0}. Note that whether the targeted good is labor intensive or capital intensive, an FTA results in trade deflection: the lower tariff country's production of the good is exported to the partner whose price weakly falls due to the FTA, while it imports its own needs.

Now consider capital mobility. Since r falls due to the FTA unless A is large relative to B, capital will flow out of A rather than into it. This outflow shifts the production possibility frontier of country A in and does so more for good 2 than good 1 as good 2 is capital intensive. Via the Rybczynski theorem, capital

[16] This is ensured because there in no specialization in the initial equilibrium.

outflows shift the supply curve for good 1 from country A outward. Of course, the supply for good 2 is shifting in with the shift in of the PPF. The shift out in the supply curve of A, in turn, reduces the price of good 1 in B. The process comes to an end when one of two things occurs. Either enough capital flows out to make p_1^{B1} fall to p_1^{A0} so that the pre FTA equilibrium factor prices are reinstated in A. This occurs when A is very large: even after enough capital has left for the aggregate capital labor ratio in A to equal the pre FTA capital labor ratio in Sector 1 in A, A is still able to supply all that B demands at p_1^{A0}. If it is not able to do so, then a price differential between A and B can be maintained but A will specialize in making good 1.

This is illustrated in Figure $4(a)$. Suppose enough capital has flowed out of A to make the aggregate capital labor ratio equal to k_1^{A0} and that $A's$ labor force is small so that the price in B, denoted by p_1^{B1}, still exceeds that in A, p_1^{A0}. At this aggregate capital labor ratio A is specializing in good 1. This follows from the fact that the capital labor ratios in both sectors at D, the incomplete specialization point, lie weakly above k_1^{A0}, so that there must be specialization. As depicted in Figure $4(a)$, the equilibrium factor prices are given by a point along AD, which lies vertically above E. Thus, rental rates are equalized, preventing further capital inflows, but the wages in A are higher than before the FTA. Thus, general equilibrium analysis suggests that the FTA need not always result in capital flowing into the low tariff country in order to export to the high tariff one! As shown, if Sector 1 is labor intensive, capital may well flow into Sector 1, but flow out of the economy as a whole.

An obvious implication of this result concerns the effects of the GSP on developing countries. Developing countries, being relatively labor abundant, tend to have a comparative advantage in labor intensive goods. Thus, offering them lower tariffs on their exports (if origin is met) will tend to raise w and reduce r

thereby leading to capital flowing out of the developing country! Even though the labor intensive sector expands, the capital intensive one would contract even more!

It is fairly straightforward to extend the above analysis to other applications. Consider the example of shade grown coffee given earlier. Suppose there are two ways to make coffee, one is shade grown and, as machinery is harder to use in this setting, relatively labor intensive. The other is on plantations using more mechanization and fertilizer. Then the price equal to cost curve of coffee will be a composite of the two techniques in the usual manner: namely, use the shade grown technique when the wage rental rate is low and the plantation one when the wage rental ratio is high. A preference for shade grown coffee manifested in a price premium offered for shade grown coffee will shift the shade grown part of the composite curve up. Now, if the shade grown technique is not being used, this shift could, if it is large enough, ensure the use of the shade grown technique. However, its effect on factor prices in general equilibrium depends on whether coffee is more or less intensive than the other good, call it food. If coffee is more labor intensive than food under both techniques, then this premium, at a given price for regular coffee, would raise the wage rental ratio, while if it was always more capital intensive than food, it would lower it a la the Stolper Samuelson theorem.[17] Thus, whether workers in the developing country making coffee gain or lose from such a price premium, and whether one should expect capital inflows or outflows from the economy depends on the capital intensity of what else is being made. Similarly, we can reinterpret the example calling the two techniques the dolphin safe technique and the other. The main results for conditional policies, where the requirement is a physical one, are summarized in Proposition 1.

[17] Also, factor intensity reversals could occur even if they are none for the two techniques separately.

Proposition 1 *Policies which provide an incentive to produce the capital intensive good conditional on meeting a physical requirement on inputs, need not involve distortions on the input side in the final equilibrium even if they are binding at the initial equilibrium levels. However, if the good is relatively labor intensive, distortions on the input side occur even if the physical requirement is not strictly binding to begin with. In the presence of capital mobility, such policies always attract capital to the targeted sector and raise supply so that trade deflection is greater when capital is mobile. However, they do so at the cost of capital outflows from the economy as a whole when the targeted sector is labor intensive.*

3.3 Extensions

Two extensions are considered. Their details are in the Appendix. First the effects of more restrictive ROOs are analyzed. It is shown that the same kind of non monotonicity that occured in Ju and Krishna (1998) also occurs here and for similar reasons.

Proposition 2 *There are two regimes: in one all firms in Sector 1 make the same choices (homogeneous regime) and in the other, firms makes different choices (heterogeneous regime). Making ROOs stricter moves the economy from the homogeneous to the heterogeneous regime and can first raise exports to B and then reduce them.*

Second, the technique is extended to ROOs which require a particular intermediate input to be produced domestically. This extension is useful as such ROOs are common. It also provides an example where even a very slight ROO of this form in an FTA can result in drastic changes in production patterns.

Proposition 3 *When policies provide a benefit conditional on the use of domestic intermediates, their effects can be extremely discontinuous. Even if the* *domestic intermediate is currently in use, the smallest benefit, conditional on its use, can result in specialization in the targeted sector.*

4 Value Added ROOs

The analysis is also relevant for value based restrictions. However, with value based restrictions, the ROOs cause a form of an externality that can create multiple equilibria and limit the use of the dual approach used so far. With the value added restriction in effect, how can restricted cost functions not be concave? The set of inputs that both make a unit of output and meet the ROO in this case depends on factor prices. As a result, one cannot make the usual argument that choices available to a firm are unaffected by prices, and as a result, the value function for a minimization problem has to be concave. In fact, as we will see below, with fixed coefficients costs *cannot* be concave in factor prices in the presence of a value based ROO. Consequently, the factor price frontier need not have the usual shape. Hence, the full use of duality, in particular the interpretation of the revenue function as the value function of the dual minimization problem, is not possible. However, the price equal to cost conditions remain necessary for equilibrium and we can associate equilibrium with the intersection of the curves as before. Multiple equilibria occur because the non standard shapes of the price equal to cost curves allow for more than one intersection of the price equal to cost curves in a way that permits multiple equilibria to arise.

Suppose the restriction is that the value of $\frac{wL}{wL+rK} \geq \theta$. This is equivalent to $k \leq \omega\frac{(1-\theta)}{\theta}$. The feasible set is now defined by combinations of K and L that lie above the unit isoquant and below the line $k = \frac{\omega(1-\theta)}{\theta}$. Thus, the constraint is that k should lie below the line $\frac{\omega(1-\theta)}{\theta} = k(\omega, \theta)$. Hence, the shaded region in Figure 5 is the feasible set. There are two further complications in defining the input choice set. The first is that the feasible set of inputs depends on ω. However, it is obvious from Figure 5 that if the constraint is binding, the cost minimizing input coefficients lie on the unit isoquant and just meet the constraint. Let these input coefficients be denoted by $[a_L(\theta,\omega), a_K(\theta,\omega)]$, which in the above example would be the point B in Figure 5. Note that if the constraint is binding at a given ω, it must require a lower capital labor ratio than the unconstrained cost minimizing capital labor ratio, i.e., $k(\omega,\theta) < k(\omega)$ as depicted in Figure 5.

Let the cost, assuming that these inputs are used, be denoted by

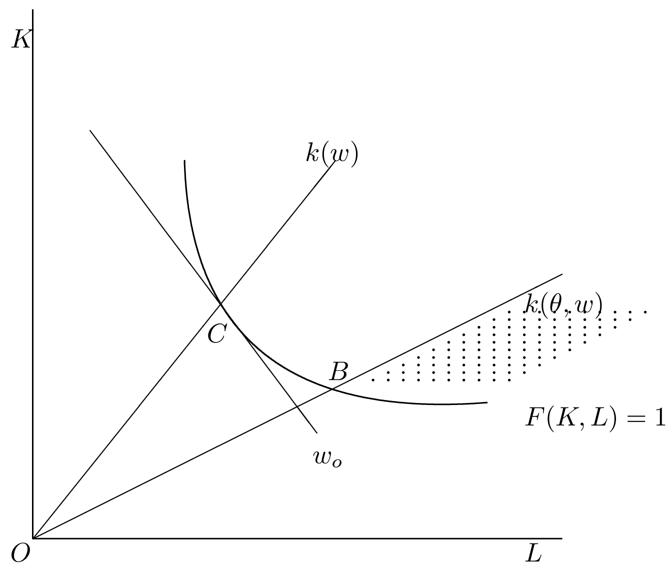
$$c(w,r,\theta) = wa_L(\theta,\omega) + ra_K(\theta,\omega).$$

By definition, $c(w,r,\theta)$ must strictly exceed $c(w,r)$ whenever the constraint is strictly binding. Hence, in w, r space, the curve $p = c(w,r,\theta)$ must lie below the curve $p = c(w,r)$ when the constraint is binding and touch it when the constraint is just binding.

4.1 The Role of Input Substitutability

Where does the constraint bind? This depends on the substitutability between inputs. Recall that the constraint can be written as $\frac{\omega}{k} \geq \frac{\theta}{1-\theta}$. Start from the constraint being just binding. Assume the elasticity of substitution between capital and labor falls short of unity. In this event, a fall in ω results in a smaller percentage fall in k so that $\frac{\omega}{k}$ falls, while a rise in ω results in a smaller percentage increase in k so that $\frac{\omega}{k}$ rises. Hence, the constraint does not bind for increases in ω but does bind for decreases in ω. If, on the other hand, the elasticity of substitution between capital and labor exceeds unity, a fall in ω results in a larger percentage fall in k so that $\frac{\omega}{k}$ rises, while a rise in ω results in a larger percentage increase in k so that $\frac{\omega}{k}$ falls. Hence, the constraint binds for increases in ω but does not bind for decreases in ω, exactly as in the physical

Figure 5: Value Added ROOs



ROOs case. *If the elasticity of substitution is less than unity, the constraint binds for low* ω, *not high!*

The above facts are enough to depict the price equal to cost curves. Instead of drawing these we will use Figure 1 to illustrate the similarities and differences. The curve $p^T = c(w, r, \theta)$ must lie below the curve $p^T = c(w, r)$ when the constraint is binding, touching it at the point when it is just binding. If the elasticity of substitution exceeds unity, the constraint binds for high ω, as was the case with the physical content definition of ROOs studied earlier. The composite price equal to cost curve looks like $GHBD$ in Figure 1, except that the segment HB is not linear. It is easy to verify that the analysis of the effects of value based ROOs in this case is similar to that associated with a physical definition of ROOs and we leave this to the reader.

If the elasticity of substitution is less than unity, the constraint binds for low ω. The composite price equal to cost curve looks like $EBKF$ except for BK

not being linear.[18] As a result, a ROO at the status quo level is binding in the FTA, if good 1 is capital intensive, but not, if good 1 is labor intensive, rather than the other way around. Once this is noted, the effects on factor prices and the direction of factor flows can be analyzed as usual. Thus the relevant change in the results is given below.

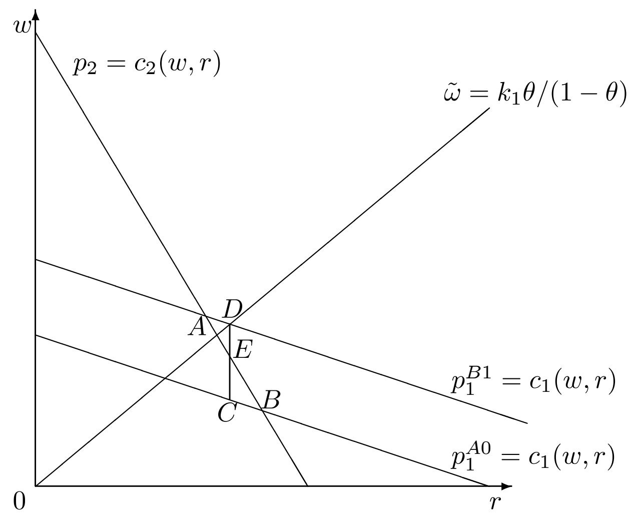
Proposition 4 *Policies which provide an incentive to produce the labor intensive good conditional on meeting a value based requirement on inputs, need not involve distortions on the input side in the final equilibrium even if they are binding at the initial equilibrium levels. However, if the good is relatively capital intensive, distortions on the input side occur even if the requirement is not strictly binding to begin with.*

4.2 Multiple Equilibria

With value based ROOs, multiple equilibria may exist. Consider the case where there are fixed coefficients in both sectors, the targeted sector is relatively labor intensive, and the ROO is set to be slightly binding in the initial equilibrium as depicted in Figure 6. For $\omega > \tilde{\omega}$, the ROO is not binding and the firm can obtain the higher price at no extra cost. The ROO is just binding, if ω equals $\tilde{\omega}$. Lower values of ω force $\frac{\omega}{k}$ below $\frac{\theta}{1-\theta}$ making the constraint binding. The absence of substitutability makes producers use more L per unit of output to meet ROO even though it has a zero marginal product. Recall that the constraint is $\frac{wL}{wL+rK} \geq \theta$. When w falls, meeting the ROO exactly, which is the least cost way of meeting it, involves raising L by the same percentage as the fall in w so that wL is constant. Consequently, so is the ratio, $\frac{wL}{wL+rK}$. This explains the vertical segment CD in Figure 6. Once the wage falls below the

[18] If the elasticity of substitution between capital and labor equals unity, then $\frac{\omega}{k}$ is a constant and equals the (constant) share of labor in costs relative to that of capital. If this share ratio is identical to $\frac{\theta}{1-\theta}$, the constraint is never binding and if it is not, it is always binding.

Figure 6: A Valued Based ROO Example



point given by C, it is best to ignore the ROO.

Note that when the *ROO* is binding, i.e., for low w, a fall in w results in an equi-proportional increase in L used per unit of output so that unit cost is constant. When it is not binding, i.e., for high w, it is linear and increasing in w. This gives a convex composite curve, not a concave one providing an example of the non concavity of the cost function mentioned earlier.

Note that the two price equal to cost curves in the presence of the ROO intersect three times: once at A, then at E, and lastly at B. At A, the wage rental ratio is high. Thus, the constraint is not binding and there is no cost to meeting the ROO, only the benefit. All firms in Sector 1 meet the ROO. Output is given by the factor market clearing conditions

$$\begin{aligned} a_{L1}X_1 + a_{L2}X_2 &= L \\ a_{K1}X_1 + a_{K2}X_2 &= K. \end{aligned}$$

At B, the wage rental ratio is low. Thus, the constraint is binding and an inefficient level of labor needs to be used to meet the *ROO*. The cost to meeting the ROO exceeds its benefit as the low wage rental ratio requires a considerable waste of labor to meet the ROO and no firms in Sector 1 meet it. Though, output at B is the same as that at A as there are fixed input coefficients, trade patterns differ as there is no deflection: A does not send its production to B and import its own needs.

At E, the wage rental ratio is at an in between level so that not much extra labor needs to be used to meet the ROO. Hence, the cost of meeting the ROO is less than the benefit and all firms meet the ROOs. However, as more labor needs to be used in the production of good 1 to meet the ROO the factor market clearing conditions are given by

$$\begin{aligned} a_{L1}(\omega^C)X_1 + a_{L2}X_2 &= L \\ a_{K1}X_1 + a_{K2}X_2 &= K \end{aligned}$$

where $a_{L1}(\omega^C) > a_{L1}$. Hence the output of good 1 must fall and that of good 2 rise. However, trade deflection occurs and the output of 1 is sent to B.

In the standard setting with concave costs, even if there were multiple intersections of the price cost curves (as would occur with factor intensity reversals) the factor price set over which factor payments are minimized would remain a convex set. As a result, endowments using the dual definition of the revenue function would pin down factor prices. Here this technique cannot be used as this factor price set is not convex. All three intersections, A, B and E are possible equilibria. Factor prices are not pinned down in this setting, and hence, multiple equilibria occur.[19]

Proposition 5 *With value based ROOs, there can be multiple equilbria as factor endowments do not pin down factor prices and supplies even in the standard two good model.*

[19] Factor availability does not completely pin down the equilibrium here.

Finally, note that in the above fixed coefficient example, the ROO on the labor intensive good can be interpreted as trying to raise the cost share of labor. Note that in all three equilibria, wages weakly rise as does the share of labor in costs.[20] However, this is not the case when the ROO is on the capital intensive good. Consider a ROO on the capital intensive good set so that it is *just* binding at the pre FTA wage rental rate. It is straight-forward to verify that it is strictly binding in the unique post FTA equilibrium. In this equilibrium, the wage rental rate falls relative to that under free trade while the share of labor in costs is unchanged: lower wages are compensated for by the wasteful use of labor in producing the capital intensive good. However, in the labor intensive good, labor share falls! Output of the capital intensive good falls and of the labor intensive one rises. Thus, attempts to make the capital intensive good use more labor would backfire and reduce wages, overall labor share in income, as well as its output.

5 Conclusion

This paper provides a simple way of using well understood tools in trade to better understand "conditional policies" of various kinds. The results suggest that the form of the *ROO*, the intensity of the sector it is applied to, and the extent of input substitutability have important roles to play in determining the effects of such restrictions. Moreover, that regime switches and non monotonic behavior are endemic in such settings. For these reasons, such policies may have unanticipated effects and need to be carefully analyzed before being implemented.

[20] At B wages and cost share is unaffected.

6 Appendices

6.1 Making ROOs More Restrictive

The object of this section is to convince the reader that comparative statics in such models is likely to involve regime switching and non monotonicity as found in Ju and Krishna (1998) and (2002). To illustrate, we consider the case where good 1 is capital intensive and country B is large while A is small. Also, we assume that A is not specializing in either good prior to the FTA. We ask, what is the effect of more restrictive ROOs on the equilibrium?

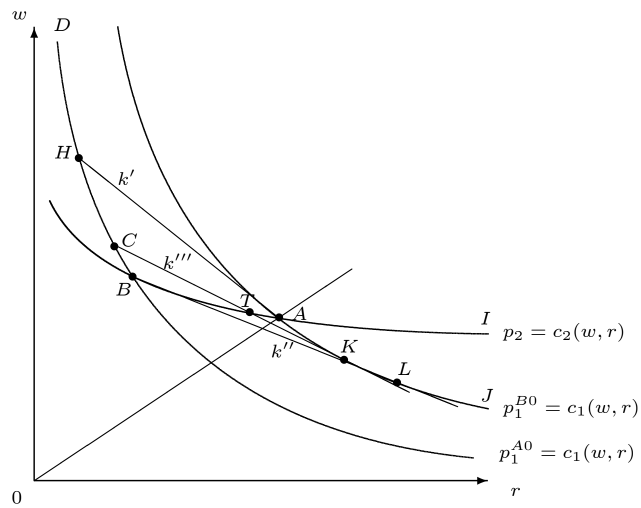
Proposition 6 *Making ROOs stricter can first raise exports to B and then reduce them.*

Our apparatus makes this analysis quite simple. Since B is large and A is small, the equilibrium price after the FTA is p_1^{B0}. k' in Figure 7 denotes the slope of the curve $p_1^{B0} = c_1(w, r)$ at its intersection with $p_2 = c_2(w, r)$ at A. ROOs less restrictive than k' are not binding in equilibrium. Let k'' be the slope of the line anchored at B and tangent to the curve $p_1^{B0} = c_1(w, r)$ at L as depicted in Figure 7. Note that with ROOs more restrictive than k'', it is optimal to ignore the possibility of meeting the ROOs and getting lower tariffs since the factor price frontier will not include this possibility. Let the aggregate capital labor ratio be k^{A0} and assume that $k_1^{A0} > k' > k^{A0} > k'' > k_2^{A0}$ as drawn in Figure 7.

Start from a ROO at k'. At this level, or for levels less restrictive than this, the ROO is clearly not binding in equilibrium.[21] When the ROO is set at k', the price equal to cost curve in Sector 1 with the FTA would be $DHAJ$. The intersection of the price equal cost curves in the two sectors would occur at A and the factor price frontier would be $DHAI$. Given our assumptions,

[21] In fact, it would not be binding at any possible equilibrium values of p_1^B.

Figure 7: Making the ROO more Restricitve



equilibrium factor prices would lie at A, where factor payments are minimized subject to the factor price frontier. Country A would not specialize in either good.[22]

With a ROO at k', the FTA raises A's output due to a normal supply response to increasing prices. Neither consumer, nor producer surplus in B is affected by the FTA and as B loses tariff revenues while A gains it, B is made worse off. A is better off as producer prices as well as tariff revenues are higher while consumer prices are unchanged.

When the ROO is between k' and k'', the two price equal to cost curves will intersect somewhere along AB in Figure 7. If the *ROO* were set at $k''' > k^{A0}$, the two curves would intersect at T. The factor price frontier would be $DCTI$. Factor payments would be minimized along AB at T, both goods would be made and all the firms in sector 1 would exactly comply with the ROO, i.e., all firms

[22] If $k^{A0} > k'$, then equilibrium factor prices would lie at H. Country A would specialize in good 1 but some firms would meet the *ROO* and some would not because the slope of the price equals cost line at H when the ROO is not met is steeper than k^{A0}. The mix of firms would be such as to ensure that factor markets cleared.

would be the same ex post as well as ex ante, so we are in the "homogeneous regime".

If $k''' < k^{A0}$, then only good 1 would be made and factor payments would be minimized at C. When all firms in sector 1 do the same thing, we say the regime is homogeneous. If $k''' < k^{A0}$, then though country A would specialize in making good 1, some firms would meet the ROO while others would not. This is termed the heterogeneous regime. When the ROO is stricter than $k^{''}$, equilibrium factor prices are at B and firms prefer not to invoke the FTA and the FTA is undone.

How can non monotonicity in exports to B come about in this setting? Consider what happens when the ROOs are between k^{A0} and k'. In this case both goods are made and all firms making good 1 meet the ROO. More restrictive ROOs will raise w and reduce r as equilibrium factor prices move along BA. However, the capital labor ratios in the two sectors will move in opposite directions. The capital labor ratio used in Sector 2 will rise due to labor becoming relatively more expensive, while that in Sector 1 will fall due to the ROO becoming more restrictive. Thus, the unit labor requirement in Sector 1 will rise and the unit capital requirement will fall while the unit labor requirement in Sector 2 will fall and the unit capital requirement will rise.

As Sector 2 is labor intensive, the labor market clearing constraint is flatter than the capital market clearing one in output space.[23] If, in addition, there is relatively little substitutability in inputs in Sector 2, then the unit labor and capital requirements in Sector 2 will not change much so that the lines representing factor markets clearing will not shift much where they hit the vertical axis. However, the labor market clearing line will shift in and the capital market clearing line will shift out where they hit the horizontal axis. As

[23] We put X_2 on the vertical axis and X_1 on the horizontal axis.

a result, output of good 1 will rise (and with it exports to B as all firms meeting the ROOs export) and of good 2 will fall when the ROO is made more strict!

However, when the constraint becomes so strict that only good 1 is made, i.e., the ROO is between k^{A0} and k'', we move to another regime. There are two kinds of firms making good 1, the ones who meet the ROO and use labor intensive techniques, and the ones who do not and use capital intensive techniques. No one makes good 2. Equilibrium is along HB. As the ROO gets stricter, we move down HB, so w/r falls. Firms who meet the ROO use a lower capital labor ratio because they have to, while firms who choose not to meet the ROO use a higher capital labor ratio than the firms who meet the ROO. A stricter ROO will reduce the capital labor ratio of those meeting the ROO as well as reduce w/r and, hence, reduce the capital labor ratio of those not meeting the ROO. Since both capital labor ratios are falling, the output of firms meeting the ROO, the labor intensive ones, must fall and exports to B must fall. In other words, since both use a lower capital labor ratio, the capital constraint is loosened (the K constraint shifts out) and the labor constraint is tightened (the L constraint shifts in) so that there is more output made by firms not meeting the ROO and less by firms meeting it. Hence, there are fewer exports of good 1 to B from A!

Once the ROO becomes stricter than k'', it is ignored and there are no exports from A to B of good 1. Thus, we can easily get non monotonic behavior in the supply of good 1 from A to B at a given price as the ROO changes.

Summarizing the above, when the ROO is weak, it does not bind in equilibrium, both goods are made and all firms making good 1 choose to meet the ROO and export to B. Initially, stricter ROOs have no effect. Once the ROOs become binding at k', stricter ROOs raise w/r and in this regime, exports to B from A rise. This regime prevails until the ROO hits k^{A0}. At this point, only good 1 is made and all firms meet the ROO. Further restrictiveness of the ROO results in a lower ω, more firms not meeting the ROO, and exports to B falling, though only good 1 is made. Once the ROO passes k'', there is another change in regime: both goods are made and the FTA itself is undone as firms choose to ignore its existence!

6.2 Domestic Intermediate Use

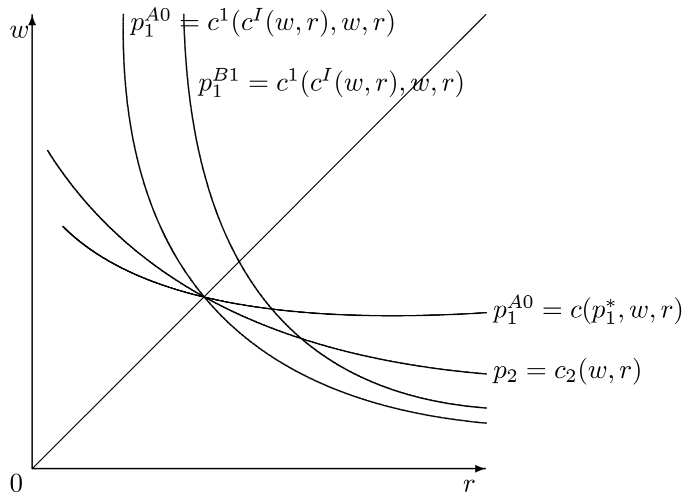
Consider policies that are conditional on the use of a domestic intermediate. This application is useful both because the model is slightly different technically from the phyical requirement studied above and because it provides an additional message: unlike price based policies (like tariffs and subsidies), where the effects of polices are continuous, conditional policies that are very "small" can have large effects. Hence, special care should be taken when such polices are used. An example is provided below.

Consider a common form of ROO that requires the use of domestic intermediates to obtain origin. For example, under $NAFTA$, transformation from any other chapter (2 digit classification level) of the harmonized system to tomato catsup, chapter 21, confers origin *except* transformation from tomato paste, though paste falls in chapter 20. In other words, to get origin, domestic tomato paste has to be used to obtain origin and be eligible for zero tariffs for exports to the U.S.

Suppose that production requires the use of an intermediate input, which is available from the rest of the world at a price of P^{*I}. It can also be made domestically at cost $c^I(w, r)$. Note that even if $c^I(w, r)$ exceeds P^{*I}, firms making good 1 in A may choose to use the domestic intermediate since it confers origin and allows them to export duty free to B whose domestic price, p_1^{B1}, may be higher than that in A, denoted by p_1^{A0}.

Proposition 7 *When policies provide a benefit conditional on the use of do-*

Figure 8: Intermediate Input Usage



mestic intermediates, their effects can be extremely discontinuous. Even if the domestic intermediate is currently in use, the smallest benefit, conditional on its use, can result in specialization in the targeted sector.

Firms in A choose between meeting the ROO and not. If the firm does not meet the ROO, it can afford to pay factors along $c^1(p^{*I}, w, r) = p_1^{A0}$. If they choose to meet the ROO, they can afford to pay factors along $c^1(c^I(w,r), w, r) = p_1^{B1} > p_1^{A0}$. We assume that the ROO is set at an initially just binding level so that in the initial equilibrium firms are indifferent between the domestic and imported intermediate input, i.e., $c^I(w,r) = p^{*I}$. Since all goods are made in A to prior to the FTA, it must be that all three price equal to cost curves, namely, $c^1(p^{*I}, w, r) = p_1^{A0}$, $c^2(w,r) = p_2$, and $c^I(w,r) = p^{*I}$ go through the same point. For simplicity, $c^I(w,r) = p^{*I}$ is not drawn in Figure 8. Hence, the curve $c^1(c^I(w,r), w, r) = p_1^{A0}$ also goes through the same point. Standard arguments show that $c^1(c^I(w,r), w, r)$ has all the usual properties of a cost function including concavity.

At any given (w, r), it is easy to verify that the slope of $c^1(c^I(w,r), w, r)$, called $\hat{k}_1$, is a convex combination of slopes of $c^1(p^{*I}, w, r)$, called k_1, and $c^I(w,r)$, called k^I.[24] As a result, the curve $c^1(c^I(w,r), w, r) = p_1^{A0}$ lies between the curves $c^1(p^{*I}, w, r) = p_1^{A0}$ and $c^I(w,r) = p^{*I}$. Figure 8 is drawn so $k^I > \hat{k}_1 > k_2 > k_1$.

Since firms in A can obtain the higher price prevailing in B, if they meet the *ROO*, the curve $c^1(c^I(w,r), w, r) = p_1^{A0}$ shifts out to $c^1(c^I(w,r), w, r) = p_1^{B1}$. As a result, the composite price equal to cost curve for firms making good 1 is given by $c^1(p^{*I}, w, r) = p_1^{A0}$ for low w/r and by $c^1(c^I(w,r), w, r) = p_1^{B1}$ for high w/r, the dark curve in Figure 8.

Next, add the price equal to cost curve for good 2. As drawn, good 2 is more capital intensive than good 1 but less than $\hat{k}_1$ at the initial factor prices. In this case, the composite price equal to cost curve for good 1 would lie above that for good 2 everywhere no matter how small the difference between p_1^{A0} and p_1^{B1}! Hence, only good 1 would be made by all firms in A. Note that even a ROO that is just binding prior to the FTA, and where the conditional subsidy is small, can result in drastic changes in production patterns. Even if the ROO is set to be non binding prior to the FTA, and no matter how small the tariff differences in A and B, the economy will end up specializing in good 1. Other cases are left to the interested reader.

[24] Recall that from Shephard's Lemma, $\frac{c_r(.)}{c_w(.)} = k$, the capital labor ratio. Thus,

$$\begin{aligned}\hat{k}_1 &= \frac{c_r^1(.) + c_I^1(.)c_r^I(.)}{c_w^1(.) + c_I^1(.)c_w^I(.)} \\ &= \frac{k_1 c_w^1(.) + k_I c_I^1(.)c_w^I(.)}{c_w^1(.) + c_I^1(.)c_w^I(.)} \\ &= k_1\theta + k^I(1-\theta),\end{aligned}$$

where $\theta = \frac{c_w^1(.)}{c_w^1(.) + c_I^1(.)c_w^I(.)}$ and lies between zero and one.

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