Divergent Integration

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DIVERGENT INTEGRATION

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Abstract

Trade liberalisation is often characterised as either preferential or non-discriminatory but not all preferential trade agreements are the same. We focus on non-tariff measures that can constitute barriers to trade and that differ between free-trade agreements (FTAs) and customs unions (CUs). In particular, we investigate the role of rules of origin (RoO) in restricting market access for nations excluded from a CU. We develop a simple general equilibrium model characterised by trade in intermediate and final products and use this to examine the implications of binding RoO in an FTA on market outcomes and the welfare of agents in the economy. We highlight the phenomenon of "induced trade diversion" where RoO can result in countries losing from preferential market access.

Keywords: preferential trading; non-tariff measures; rules of origin

JEL classifications: F12, F13, F15

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1. Introduction

The central difference between the two principal forms of preferential trading agreements (PTAs) is generally accepted as their treatment of imports from non-member countries. In forming a customs union (CU), the member countries agree to impose a set of common external tariffs (CETs) on imports from third countries regardless of the products' final destination. In contrast, members of a free-trade area (FTA) need not agree on the tariffs on imports destined for their own markets and are free to adopt their own most-favoured nation (MFN) tariffs or engage in additional PTAs.

Much of the discussion of the relative merits of FTAs and CUs has focused on issues of sovereignty. Having to cede authority to a supranational agency that sets the common external tariffs (CETs) for a CU is perceived to be a reason why the United States is unwilling to pursue a deeper trade relationship with Canada and Mexico than NAFTA (and its successor, the USMCA). Similarly, a central position of the UK government's negotiations of its relationship with the EU after Brexit was a shift from joint membership of a CU to establishing an FTA between the UK and EU. The resulting agreement permits the UK to pursue FTAs with other countries (such as that with Japan) without the involvement of the EU, at the sacrifice of the UK's membership of the FTAs that the EU currently has with third countries (Canada, South Korea, etc.).

While the issue of sovereignty over tax rates is undoubtedly important to some countries, there are other implications of the choice between the two institutional arrangements that can have important consequences for national production and international trade in modern economies. These effects can arise even if the external tariffs chosen by countries in a CU were identical to those adopted by the same countries in an FTA.

If countries were to maintain the same external tariffs, yet transitioned from a CU to an FTA, there are aspects of the two institutional frameworks that could result in different economic outcomes. We focus on the potential non-tariff measures (NTMs) that constitute barriers to trade and impediments to investment and that differ for FTAs and CUs. In particular, we investigate the role of rules of origin (RoO) in restricting market access for nations excluded from a CU. These form an important element of preferential trade policy that has been largely ignored in both the academic literature and in the public discussion of trade alliances, including the implications of Brexit.

An FTA's RoO constitute measures that determine whether member countries' manufactures have sufficient content produced within the FTA for them to be considered as domestically produced and therefore can be freely traded within the PTA. If the products do not meet the RoO thresholds, then they are subject to the tariff of the importing country. RoO are established through negotiation and take many forms (cumulation, substantial transformation, etc.) and are designed, not only to exclude imports from third countries entering the FTA via the lowest tariff member, but also to protect the importing country's domestic manufacturers.[1]

In a world of global value chains with significant trade flows in intermediate products, RoO can have a much more significant role than in a less integrated world. All PTAs are discriminatory, giving a member country tariff-free access to its partners' markets, while products from third countries face the importer's MFN tariffs. In order to ensure that the goods crossing the borders tax-free are the products of partner countries, and not imports from outside of the PTA, customs officials have to be

[1] Abreu (2016) provides a survey of the RoO for all PTAs reported to the WTO.

able to establish where the goods were manufactured. This is no straightforward task in the modern, globalised economy with few goods being produced with inputs from a single country. When products involve inputs of raw materials and intermediate goods source from multiple countries, arbitrary thresholds have to be established to determine whether the good is given tariff-free entry.

We focus on cumulation such that the RoO establish a minimum "regional value content" (RVC) for a product, RVC being the value added in the territory of FTA countries expressed as a percentage of the value of the final product. Deciding upon the RVC threshold is fraught with difficulty. On the one hand, setting the threshold too low undermines the effectiveness of the FTA, as imports from third countries can enter one country and have only nominal local value added before being shipped tax-free to the trading partner—the phenomenon of trade deflection. If, however, the RVC threshold is set too high, then partner countries may be forced to source intermediates from within the FTA, rather than buying them from the cheapest manufacturers. Thus, this RoO can reflect another facet of Viner's trade diversion, taking place at the level of trade in intermediates, rather than trade in final goods.[2,3]

We investigate the impact of a transition from a CU to an FTA on producers and consumers, where the critical mechanism is the introduction of RoO, not a divergence in tariff rates. This is an interesting analytical issue but also one of significant economic importance to a country such as the UK, that has changed its trading relationship with the EU to an FTA and has the potential to establish additional, new FTAs in the post-Brexit environment. The implications may also involve large, discrete changes in economic activity with strong regional implications. This can be seen in two examples of how FTA production and trade may change for UK firms compared to their experiences prior to Brexit.

Firstly, think of two identical companies, one producing in the UK and one in France. They both import intermediates from a non-EU country and export their final products to other markets in the EU. With France and the UK both members of the CU, the companies paid the CET on their imported intermediates then exported their final products tariff-free to other members of the CU. When the UK left the CU and entered an FTA with the EU it initially kept its external tariffs at the same level, the companies continued to pay the same tariffs on the imported intermediates. But unless the share of imported intermediates is below the RoO threshold, the market access for their final product to the EU would be fundamentally different. The UK firm would either have to change the sourcing of its intermediates, or be subject to full EU tariffs on the final exports. Hence, there are important differences between the two trade regimes, beyond the possible differences in tariff rates.

A second example would be the potential impact of the post-Brexit trading relationship on a company such as Airbus, that has production facilities across Europe. If commercial aircraft face RoO on their exports to Japan or Canada through their respective FTAs, then Airbus presumably has an incentive to ensure that sufficient production takes place within the EU to meet these thresholds. The UK's departure from the EU CU after Brexit means wing production in the UK no longer contributes to satisfying these RoO. In response, Airbus may choose to relocate production of wings to facility within

[2] Perhaps surprisingly, the issue of RoO received little attention in the British press during the negotiations between the UK and EU on their trading relationship post-Brexit. One exception to this was the reported refusal on the part of the EU to accept the British proposal for electric cars assembled in the UK that components manufactured in third countries (such as Japan or Turkey) would be treated as British [see BBC https://www.bbc.co.uk/news/business-54345882].

[3] A reflection of their complexity, the term "rules of origin" appears 87 times in the trade agreement between the UK and the EU (UK Government, 2020).

the EU. Thus, a new bilateral FTA between, say, Japan and the UK that replicates the tariff structure of the EU-Japan FTA, need not give the same market access because of the difficulty facing a single country of meeting the RoO criteria for tariff-free access to other markets.

The UK Prime Minister, Boris Johnson has argued that the move from CU to FTA will involve "no non-tariff barriers" to trade in the new trade bill with the EU.[4]. This is patently wrong, as meeting the conditions for tariff-free exports to the EU will, at a minimum, involve more paperwork than was previously required. But, we shall demonstrate that, beyond this new administrative burden, there can be additional costs to firms, either from adjusting to meet the RoO or from facing a tariff on non-compliant exports.

In the following, we look at these two examples in a formal model of the splitting up of a CU, where a former member of a CU now forms a bilateral FTA with the remaining partners of the CU. Firstly, we consider the impact of RoO on market access in the new trading relationship and determine conditions under which the FTA is inferior to the CU that it replaces. Secondly, we consider the implications for preferential trade with other countries. In this case we look at the effects of replacing a single FTA with another country with two parallel FTAs after the split.

1.1 Related literature

While several contributions have studied various ways in which RoO affect trade and welfare, few if any look at how RoO *per se* may have a negative impact on national welfare. In this section we will review some of the most relevant contributions and also point out how these differ from our approach.

Krueger (1993), using NAFTA as an example, shows how RoO could protect US producers of intermediate goods by inducing Mexican final goods producers to switch from low-cost intermediates sourced from the world market to higher-cost intermediates sourced from the US. Conconi *et al.* (2018) confirm that NAFTA led to a significant reduction of Mexican imports of intermediates from third countries.

Krueger (1997) compares FTAs and CUs and concludes that CUs are always superior in welfare terms. This conclusion follows from the assumption that the common external tariff for the CU will be an average of the pre-CU tariff rates of the member countries, while in the FTA case, external tariffs will remain unchanged. Hence, there will be more trade diversion in the FTA case than with a CU, while trade creation is the same in the two cases. The analysis does not distinguish between intermediate and final goods trade, and the results are entirely driven by differences in external tariff rates.

Francois (2006) compares trade flows for FTAs and CUs in a model with intermediate and final goods trade. He shows that binding RoO lead to relatively more trade in intermediates and less trade in final goods between the member countries in an FTA than would have been the case with a CU. The reason is that the binding RoO have two effects: they imply replacing externally sourced intermediates with intermediates from within the FTA; and they give a cost disadvantage to final goods producers within the FTA, thus yielding less trade in final goods between members.

Falvey and Reed (1998) show how producers, in order to ensure tariff-free trade in final goods, will modify their production processes and choose less efficient input mixes as a consequence of binding

[4] Reported by Islam (2020).

RoO. They illustrate how various types of RoO map into changes in the pattern of production and trade and conclude that RoO are used both to avoid trade deflection and to protect domestic intermediate goods producers.

Ju and Krishna (2005) focus on how increasing restrictiveness of RoO affects internal and external trade in intermediate and final products in an FTA. As the RoO become more restrictive, imports of intermediate goods from outside the FTA will decline, while imports of final goods will increase. However, beyond a certain degree of restrictiveness, firms will choose not to stick to the RoO and the trade pattern will change, resulting in more imports of intermediates and less of final goods. Their results follow from a model with given world market prices, so all of their effects are driven by the interaction of tariff rates and the restrictiveness of the RoO.

In a recent paper, Chung and Perroni (2021) study the effects of RoO in a model with imperfectly competitive intermediate goods markets and show how binding RoO lead to higher mark-ups and more entry of intermediate goods producers within the FTA. The mechanism driving these results is that the RoO tend to segment markets and give more market power to intermediate goods producers inside the FTA. The authors use data from the US-Canada free trade agreement in the early 1990s to confirm these effects.

Jagdish Bhagwati coined the term "spaghetti bowl" to describe the mix of unilateral, bilateral and multilateral trade deals in the world. Richard Baldwin (2006) goes so far as to identify a "spaghetti bowl syndrome" that results, among other things, in differences in RoO across trade agreements such that overlapping bilateral deals result in less freedom of trade than a single multilateral agreement.

Although our approach has elements in common with most of these studies, it deviates from all of them in important ways. While Krueger (1997) and Francois (2006) both compare FTAs and CUs, as we do, their foci are different. In Krueger's analysis, changes in external tariff rates are the driving forces for the welfare results, and she does not distinguish between final and intermediate goods. Francois does make this distinction, but his focus is on the impact on trade rather than welfare effects. With one exception, none of these papers allows the companies to choose to pay the MFN tariff on internal final goods trade rather than to stick to the RoO; a feature that is important in our analysis. The exception is Ju and Krishna (2005), but they do so in a model with given world market prices, while we focus on the price formation effects in imperfectly competitive markets. Falvey and Reed (1998) and Francois (2006) emphasise that RoO imply inefficient production processes and thus higher unit costs, but in their analyses, this does not give rise to alternative choices by the firms. Finally, while Chung and Perroni (2021) focus on imperfectly competitive markets, as we do, they emphasise the impact on competition in the intermediate goods sectors and how this affects production and trade, while we focus on welfare effects and imperfect competition in the markets for final goods.

Contrary to most of these studies, our effects are not driven by diverging external tariff rates. While we could extend our analysis to include such effects as well, we believe that the "pure" effects of binding RoO are more clearly demonstrated in a setting where external tariffs are kept unaltered.

A final, distinguishing feature of our analysis, not studied in these other papers, is that we compare the equilibrium in a CU and that where countries are members of overlapping FTAs with binding RoO. Thus, we provide an analysis of the implications of Bhagwati's "spaghetti bowl" of trade agreements.

2. The model

We assume that there are four countries, *A*, *B*, *C*, and *D*, which are identical in their endowments, technology, and preferences.[5] All of the countries engage in the production and trade of three types of commodity: a homogeneous agricultural good *Y* that is freely traded; differentiated intermediate goods M_i; and a homogeneous manufactured good *X*. We assume that countries only charge tariffs on final manufactures, such that trade in agricultural goods and in intermediates is duty free.[6]

This allows us to focus on the impact of RoO on the choice of production technique in manufacturing. We characterise the RoO as an RVC threshold. If the share of value added by intermediates produced in the FTA is equal to or above the threshold, the final good can be sold tax-free to consumers. If, however, the firm use an input mix that results in the value added of intermediates produced within the FTA falling below this threshold, the firm will face a tariff on its sales unless it adjusts its production technique to be compliant with the RVC rule.

We have assumed that the final good *X* is homogeneous.[7] Our focus is on how the RoO can change the costs of production and therefore the optimal input mix as well as the market access of the firm. The firm either has to change the way in which it makes the final good *X* (using more expensive techniques for the relevant market) or face a tariff as a "foreign" good as it has not met the RoO for tariff-free access. [8]

We shall consider various patterns of (sometimes overlapping) PTAs amongst the countries. Our starting point is where *A* and *B* are the only members of customs union *U* with zero tariffs on intra-union trade and charging a common external tariff on imports from countries *C* and *D*. From there, we shall consider the implications of the end of the CU and its replacement with an FTA with binding RoO. In later sections we shall examine more of a spaghetti bowl of PTAs, where country *C* is in an FTA with CU *U* or there are overlapping FTAs amongst *A*, *B*, and *C*. In all of our scenarios, country *D* is the rest of the world, trading with all the other countries under WTO rules.

Unless covered by a PTA, imports of final products are subject to tariffs. Without loss of generality, we assume that all countries charge the same MFN specific tax, *t*. The crucial aspect of our analysis of an

[5] The assumption that all countries are identical means that any differences in production and welfare are the result of the institutional setting alone. In the absence of PTAs, trade between the countries would be symmetrical. Differences in resource endowments, market size, etc. would move the equilibrium further from symmetry.

[6] The assumption that trade in intermediates is tariff-free simplifies the analysis without losing the core focus on the introduction of an NTM (non-tariff measure) in trade in intermediates, in the form of the imposition of RoO. Having tariffs on imports of intermediate inputs, that deter their use in final production, would complicate the analysis without adding to our understanding of the issue.

[7] An assumption of differentiated goods would add reality, but does not change the choices that have to be made by the firms in terms of their optimal mix of differentiated intermediates.

[8] There are two possibilities with respect to the optimal choice of technique (intermediate-input mix) in producing final foods. The first is that the firm is free to choose the production mix for each individual market, in order to meet any market-specific RoO threshold. Alternatively, we could assume that all final-good production in a country must use a particular technique, regardless of the destination of its product. This would mean that the firm could not adjust its input mix for one market alone, say, because of the prohibitively high fixed cost of retooling. As a consequence, having to adjust its input mix in order to meet the RoO set by one FTA would have spillovers to overall production costs. Given that our modelling choices allow for the equilibrium in a particular market to be determined independently of the outcomes in other markets, we shall assume that the firm can separately choose its production techniques for each market.

FTA is whether the mix of intermediates used in production of manufactures meets the RoO such that trade within the FTA is duty free. The actual tax level is largely irrelevant to the qualitative core of the analysis.[9]

2.1 Households

Each country is endowed with a stock of labour *L*, which is assumed to be equitably shared amongst *N* households with identical, homothetic tastes across the two final goods, *X* and *Y*. This assumption allows us to aggregate household preferences into a single representative utility function, where national demand for *X* and *Y* is dependent on national income and the relative price of manufactures. We adopt *Y* as the numeraire good such that $P_Y = 1$.[10]

Let each of the *N* households in the country have the following utility function:

$$u = \alpha x - \frac{\beta}{2}(x)^2 + y, \tag{1}$$

where *x* and *y* are household demands for the manufactured good and the agricultural good, respectively. Household demand for the manufacture is easily derived:

$$x = \frac{\alpha - p}{\beta}, \tag{2}$$

where *p* is the market price for the homogeneous final good *X* sold by all firms in the market. Consequently, a country's demand curve for the final manufacture is a function of the market price and the size of the economy:

$$X = N\frac{\alpha - p}{\beta}. \tag{3}$$

2.2 Production

Three goods are produced in the economy. The agricultural good *Y* is a homogeneous final good while each country produces a different variety of the intermediate good *M*. These two goods use inputs of the country's sole factor of production, labour. In contrast, good *X* is a manufacture produced by a single firm in each country, using inputs of varieties of the intermediate that are sourced from more than one country.

Production of *Y* and *M* corresponds to a Ricardian framework, with labour as the single input into production, constant returns to scale and perfect competition. Workers are employed in the production of *Y* and *M*, and are paid wages equal to their value marginal product in each sector. Both *Y* and *M* are freely traded across countries with no transport costs nor tariffs. Therefore, prices are equalised across all markets.

Let Y_i be country *i*'s output of the agricultural good *Y* while M_i is the national output of its intermediate. We choose units of output of the *Y* such that employment of a worker results in a unit of output,

[9] We assume that countries impose a specific tariff, rather than an *ad valorem* tariff. This is for simplicity and does not affect the nature of the results.

[10] We assume that the owners of firms only consume *Y* (as they manufacture *X* themselves), and therefore market demand for the final good only arises from the choices of households, given their incomes from production.

yielding the production function $Y_i = L_{Yi}$. Production of each country's variety of the intermediate input, employs labour according to the production function $M_i = m_i L_{Mi}$ where m_i is the marginal productivity of labour in M production. Workers are fully employed such that $L_{Yi} + L_{Mi} = L_i$.

Free movement of labour between the two industries ensures wages are equalised in equilibrium. Let r_i be the price of M_i, the intermediate input produced in country i. Taking into account the fact that good Y is the numeraire and given our assumption that the marginal productivity of labour in agricultural production is constant and equal to one, labour-market equilibrium can be expressed as:

$$w_{Mi} = r_i m_i = 1 = w_{Yi}. \tag{4}$$

We assume that every variety of intermediate input is essential for production of the final manufactured good but that demand for intermediates is not such that any country specialises in production of these goods. Consequently, countries are diversified in production, which yields the equilibrium condition:

$$r_i = \frac{1}{m_i}, \quad \text{for } i \in \{A,B,C,D\}. \tag{5}$$

The demand for intermediates is a derived demand as these goods are not bought directly by consumers but are inputs into the production of the final good. Thus, we need to consider the demand for the final good as well as the inter-relationship between the inputs of the various intermediates. Market clearing for the intermediate product of country i will match domestic output to the international demands by producers of X. Thus:

$$M_j = M_{Aj} + M_{Bj} + M_{Cj} + M_{Dj}, \quad j \in \{A,B,C,D\}, \tag{6}$$

where M_{ij} represents country j's production of its distinct variety for sales in the market of country i.

Each country is host to a single firm that manufactures a homogeneous final good using inputs of differentiated intermediates. We assume that markets for the final good are segmented, so firms set their sales in each market, taking into account their rivals' sales in that market. This yields a Nash equilibrium in quantities.

All of the intermediate inputs are essential and enter the production function symmetrically, but the firm's choice of intermediates input will reflect the prices of the inputs. Should the firm be located in a country that is a member of an FTA, it will further have to take into account whether the intermediate inputs used meet or exceed the RVC threshold in the FTA.

Let X_i be the output of the manufacturing firm based in country i. We assume that its production function is Cobb-Douglas, with constant returns to scale in variable inputs and a unitary constant elasticity of substitution across inputs of intermediate goods:[11]

$$X_i = \prod_j M_{ij}^{\frac{1}{4}}, \quad i,j \in \{A,B,C,D\}. \tag{7}$$

The demand for intermediate input j in the production of firm i is:

[11] We assume that there is a fixed cost to entry that results in a single producer of X located in each country.

$$M_{ij} = \left(\prod_k r_k^{\frac{1}{4}} \right) \frac{X_i}{r_j}, \quad i, j, k \in \{A, B, C, D\}. \tag{8}$$

The corresponding cost function is:

$$C_i = 4 \left(\prod_k r_k^{\frac{1}{4}} \right) X_i, \quad i, k \in \{A, B, C, D\}. \tag{9}$$

Marginal costs therefore are independent of output, such that output decisions with respect to one market are not affected by overall production levels.[12]

If we assume that the same technology is used in the production of each intermediate component, such that $m_i \equiv m$ for $i \in \{A, B, C, D\}$, then the prices of intermediates will also be the same $r_i = r = 1/m$ for $i \in \{A, B, C, D\}$. In these circumstances, the demand for intermediate input j by firm i is $M_{ij} = X_i$. In other words, when the input choice is unconstrained, for every unit of output of the final good that it manufactures, each firm will use one unit of each variety of the intermediate inputs. Substituting this into (9), yields the cost function:

$$C_i = cX_i, \tag{10}$$

where c is the (constant) marginal cost of production, $c = 4r$, and each intermediate input contributes one quarter of the value added to final output.

This parameterisation and the additional simplifications that have been made yields a straightforward means of characterising RoO in the model. We let τ be the "RVC threshold", defined as the share of value-added in the production of the manufacture that is sourced from within the FTA. In the absence of RoO, a manufacturer of the final good would choose to use equal shares of the intermediate varieties sourced from all four countries. Consequently, if the firm is located in a country that is part of a 2-country FTA, then its cost-minimising technique would be such that the value-added of inputs from within the FTA collectively amounted to 50%. Thus, if the RVC threshold is 50% or less, the firm would meet the RoO without having to take any additional steps to comply. If, however, the threshold exceeds 50%, then the firm is faced with a dilemma: it can either continue to use the cost-minimising input mix, but face a tariff on its sales into the partner country's market; or it can use a more-costly production process through adjusting the share of inputs sourced from within the FTA in order to comply with the RoO.[13]

2.3 Government choices

Our benchmark equilibrium is one of multilateral trading with no PTAs, that is, where there are no CUs or FTAs. Thus, good *X* faces an import tariff on all international trade regardless of the countries involved. In this WTO benchmark, there will be one "home" producer of the final good and three

[12] This property, together with the assumption that final-goods markets are segmented, allows us to analyse the production and sales decisions in one market independently of the other final goods markets.

[13] As noted before, we assume that any adjustment in production techniques by a firm will apply only to its sales in the partner's market. Production for its local market, as well as for exports to the other countries, will continue to use cost-minimising techniques. This assumption is grounded in reality in that the partner's market is effectively segmented by administrative barriers where products are examined to verify compliance with RoO. Without the appropriate certification, the goods are denied entry.

"foreign" firms. Given the additional, initial assumptions that the four countries are identical, this will yield a symmetric outcome for all countries.

We then let *A* and *B* form a CU named *U,* such that sales of the final good *X* by the two "local" producers within the CU will be tariff-free. *U* is effectively a single market, twice the size of that of each member country. This will reveal the familiar, pro-competitive gains from liberalising trade in an imperfectly competitive industry. Following this we look at various scenarios, relevant to any discussion of the nature and choice of PTA. The common thread to all of the scenarios is that *U*, the CU between *A* and *B*, is dissolved. The options facing *A* (assumed to be the country choosing to break away) are several.[14]

If *A* and *B* are members of an FTA, rather than a CU, we shall focus on the impact of RoO, as these distinguish an FTA from a CU. This will require us to consider the actions of the "partner" firm, in the FTA as well as those of the home firm and two foreign firms. In the absence of RoO, firms source intermediate inputs taking into account only their relative productivity and cost. RoO put an additional constraint on the choices of the partner firm in exporting to consumers in the other market within the FTA.

3. WTO benchmark

Suppose global trade is entirely non-discriminatory, such that there are no preferential trading agreements and all nations impose a common MFN tariff on imports of the manufactured good. This means that local firms have a cost advantage over their foreign rivals. Given the complete symmetry of this scenario, we can drop the subscripts for individual firms and countries but we introduce a *W* subscript to denote WTO outcomes and *H* and *F* to represent the home and foreign firms, respectively. As the manufactured good is homogeneous, there is a single price *p* for the good, regardless of where it is produced and sold.

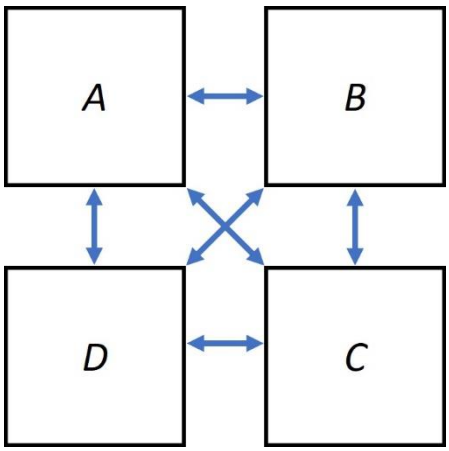

Figure 1. Multilateral trading

The trading relationship is illustrated in Figure 1. Each firm faces three foreign markets, where its sales are subject to the tariff, and one home market, where it can access consumers without a tariff being paid. The operating profits for a firm in its local market are:

[14] Each scenario parallels an option that faced the UK after Brexit.

$$\pi_{HW} = (p_W - c) X_{HW}, \tag{11}$$

where the subscript *H* represents activity in a firm's home market. Profits in one of the firm's foreign markets are:

$$\pi_{FW} = (p_W - c - t) X_{FW}, \tag{12}$$

where the subscript *F* represents activity in one of the firm's foreign markets. In each case, the firm faces fixed marginal costs of selling in a market. In its home market, each unit sold costs *c* to produce. Sales in foreign markets face the additional barrier of the specific tariff *t* that the firm must absorb in order to sell the product at the same price as its domestic rival.

Each firm chooses its sales in each market in order to maximise its profits, given demand for the manufacture (3) and taking the output decisions of its rivals as given. Solving for outputs, we find:

$$\begin{aligned} X_{HW} &= \frac{N}{5\theta}\left[(\alpha - c) + 3t\right]; \\ X_{FW} &= \frac{N}{5\theta}\left[(\alpha - c) - 2t\right]. \end{aligned} \tag{13}$$

As should be expected, the home firm exploits its cost advantage to sell more than any of its foreign rivals. In each country's market, the equilibrium output and corresponding price, respectively, are:

$$\begin{aligned} X_W &\equiv X_{HW} + 3X_{FW} = \frac{N}{5\theta}\left[4(\alpha - c) - 3t\right]; \\ p_W &= \frac{1}{5}(\alpha + 4c + 3t). \end{aligned} \tag{14}$$

We can calculate the welfare components for each country in this WTO benchmark. National welfare has three components: consumer surplus *CS*, tariff revenue *T*, and the profits of the national firm *Π*. Consumer surplus is:

$$CS_W \equiv \frac{\theta X_W^{\,2}}{2N} = \frac{N}{50\theta}\left[4(\alpha - c) - 3t\right]^2. \tag{15}$$

Tariff revenue is collected by the government of a country on its imports from the three foreign firms:

$$T_W \equiv 3tX_{FW} = \frac{3N}{5\theta}\left[(\alpha - c) - 2t\right]t. \tag{16}$$

The profits of a firm arise from its sales in its home market and from exports to its three foreign markets:

$$\Pi_W \equiv \pi_{HW} + 3\pi_{FW} = \frac{N}{25\theta}\left[4(\alpha - c)^2 - 6(\alpha - c)t + 21t^2\right]. \tag{17}$$

National welfare is assumed to be the sum of these terms, such that:

$$W_W \equiv CS_W + T_W + \Pi_W = \frac{3N}{50\theta}\left[2(\alpha - c) + t\right]\left[4(\alpha - c) - 3t\right]. \tag{18}$$

This completes the characterisation of the WTO benchmark in which trade policy does not discriminate amongst trading partners. We can now consider the impact on national economies (consumers and firms) of preferential trading regimes.

4. Bilateral CU

Let countries *A* and *B* form *U*, a customs union with a single market in *X*, as illustrated in Figure 2. That means that firms selling *X* into *U* face an integrated market with twice the number of consumers than in the individual national markets, such that firms are no longer able to price discriminate between consumers in *A* and *B*. The two local firms located within the CU have preferential access compared to external, foreign firms. Given our assumption of market segmentation, exports and sales in *C* and *D* are not affected by the formation of the CU. As there are twice as many consumers in *U* than in the previously segmented national markets, the demand curve becomes:

$$X_U = \frac{2N}{\beta}(\alpha - p_U), \tag{19}$$

where subscript *U* is used to distinguish variables in the CU scenario.

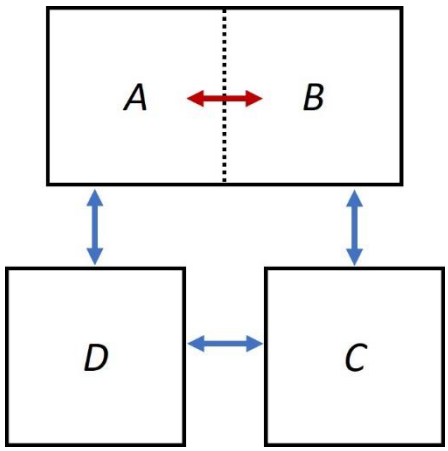

Figure 2. Bilateral PTA

We focus on the impact on firms' profits of the establishment of the CU, as well as the implications for consumer surplus and tariff revenues in *U*, as these are the only elements that change relative to the WTO benchmark. In the CU market, there are two types of producers of final manufactures: the two local firms, each based in one of the partner countries *A* and *B*, selling the good tariff-free; and two foreign firms based outside the CU, in *C* and *D*, that face the tariff on their exports. The corresponding expressions for profits for a local firm are:

$$\pi_{LU} = (p_U - c)X_{LU}, \tag{20}$$

where the subscript *LU* represents activity in the CU by a local firm, and for a foreign firm in the CU are:

$$\pi_{FU} = (p_U - c - t)X_{FU}, \tag{21}$$

where the subscript *FU* represents activity in the CU of a foreign firm.

As before, each firm chooses its sales in each market in order to maximises its profits, given demand for the manufacture (19) and taking the output decisions of its rivals as given. For ease of comparison, we consider the impact of the formation of the CU on outcomes in the market of a representative partner country.[15] Solving for outputs for a representative partner, we find:

$$X_{LU} = \frac{N}{5\theta}\left[(\alpha - c) + 2t\right];$$
$$X_{FU} = \frac{N}{5\theta}\left[(\alpha - c) - 3t\right]. \tag{22}$$

Comparing the output levels for the CU in (22) with those for the WTO benchmark (13), there is a striking dissimilarity, in that the nature of competition in the market has been changed from one home and three foreign firms to two partner and two foreign firms. The former single home firm's advantage of being behind a tariff wall has been diminished by another firm being given the same market access, resulting in a more-competitive marketplace. The equilibrium output and corresponding price, respectively, in the CU are:

$$X_U = \frac{N}{5\theta}\left[4(\alpha - c) - 2t\right];$$
$$p_U = \frac{1}{5}(\alpha + 4c + 2t). \tag{23}$$

Comparing these outcomes for the CU with those in the WTO benchmark (14), we find that the equilibrium price in the CU is less due to the increased competition amongst final goods producers with tariff-free access to the market, while the total sales of *X* have risen, such that consumers in *A* and *B* are consuming more than they did in the WTO benchmark.

For completeness, we can report that the change in the aggregate welfare of *A* and *B* as a result of their forming *U* is the following:[16]

$$\Delta W_U = \frac{Nt}{5\theta}\left[2(\alpha - c) - 3t\right]. \tag{24}$$

5. Bilateral FTA with binding RoO

Suppose that, instead of CU *U*, countries *A* and *B* form *V*, an FTA. We assume that this also involves free trade in *X* between the partners, as long as the manufactured goods meet the eligibility requirements set in the RoO of the FTA. The structure is again as illustrated in Figure 2. The asymmetries between firms competing for market share in the FTA are greater than in the case of a CU. In the CU, local firms do not face the tariff while imports from foreign firms are subject to the tariff. Beyond this, the firms are identical. With an FTA, the benefits of tariff-free access are tempered by meeting the binding RoO, that raise marginal costs of production.[17]

[15] In a CU composed of two partner countries, the sales in each national market are half the total for the CU.

[16] Details of these calculations and of the corresponding results for countries *C* and *D* are available from the authors.

[17] When the RoO do not bind, the FTA solution is identical to that for the CU except that the partner firm will face the bureaucratic burden of having to provide evidence of compliance with the RoO.

If the RoO bind, the firm has an added constraint in choosing its production technique in manufacturing *X*. Given the symmetry of factors in the production function (7) and the fact that the intermediates all sell for a common price *r*, we can simplify expressions such that there are local inputs from within sources within the FTA such that $M_{LV} \equiv M_{AV} = M_{BV}$ and foreign inputs from firms outside the FTA such that $M_{FV} \equiv M_{CV} = M_{DV}$. The firm will conform to the RoO if the share of RVC meets or exceeds the threshold τ, such that:

$$\frac{2M_{LV}}{2M_{LV}+2M_{FV}} \geq \tau,$$

which can be rewritten as:

$$M_{LV} \geq \frac{\tau}{1-\tau} M_{FV}. \tag{25}$$

When the RoO bind, the input mix is skewed towards intermediates produced in the FTA. Minimising cost subject to the RoO, yields demands for intermediates:

$$M_{LV} = \sqrt{\frac{\tau}{1-\tau}} X_V, \quad M_{FV} = \sqrt{\frac{1-\tau}{\tau}} X_V.$$

The corresponding cost function for firms complying with the RoO is:

$$C_V = \omega c X_V, \quad \text{where} \quad \omega \equiv \frac{1}{2\sqrt{\tau(1-\tau)}}. \tag{26}$$

When $\tau = 0.5$, then $\omega = 1$ and firms are free to use equal inputs of all intermediates. Values of ω in excess of one reflect the fact that the RoO are binding ($\tau > 0.5$). Thus, costs are increasing in the RoO threshold τ and are strictly greater than the less constrained costs in (10).[18]

We can calculate the equilibrium outputs and price under the FTA and determine when local firms will choose to suffer the costs of the RoO in order to get preferential market access. The analysis will clearly demonstrate that, while a CU and FTA share tariff-free access to partners' markets, the additional constraints associated with an FTA undercut the benefits of preferential trading, such that firms may prefer to accept the cost of the tariff in selling to partners' markets. It may simply be the case that compliance with RoO is not worth the enhanced market access.[19, 20]

[18] The 50% share of intermediates sourced from outside of the FTA in the unrestricted equilibrium follows from our simplifying assumptions of four symmetric countries and no tariffs on intermediates. A higher number of (symmetric) countries in the rest of the world (i.e. outside the FTA), would imply a higher share of imported intermediates, while tariffs on intermediates would imply a lower share. However, this does not alter the analysis; it only affects the level at which a threshold RoO will be binding.

[19] We are assuming that firms are able to retool their manufacturing processes to adapt the input mix for sales in each market. If the retooling process itself is costly, attempts to conform to a partner country's RoO will have an additional cost that we ignore in our modelling. Consequently, our analysis would understate the impact of conforming to RoO.

[20] An additional avenue for response to RoO is not modelled, in that it is not possible for production of the different varieties of intermediate inputs to relocate and thereby meet the local content requirements. This would allow for discrete jumps in economic activity as entire production facilities could be shifted from one country to another. If such options were to be included in the model, it would require a richer cost structure in intermediate production, with fixed costs of production as well as cost asymmetries between countries.

Unlike the CU scenario, there are now three types of producers of final manufactures in each national market of an FTA: one "home" firm selling freely to domestic consumers without constraint on its techniques; the "partner" firm based in the partner countries (with subscript *P*), selling the good tariff-free but conforming with the RoO; and two "foreign" firms based outside the CU, that face the tariff on their exports but are free to use cost-minimising production techniques. The corresponding expressions for profits for the three types of firm are:

$$\begin{aligned}\pi_{HV} &= (p_V - c)X_{HV};\\ \pi_{PV} &= (p_V - \omega c)X_{PV};\\ \pi_{FV} &= (p_V - c - t)X_{FV}.\end{aligned} \tag{27}$$

As before, each firm chooses its sales in each market in order to maximises its profits, given demand for the manufacture in each national market (3) and taking the output decisions of its rivals as given. Solving for outputs, we find:

$$\begin{aligned}X_{HV} &= \frac{N}{5\beta}\left[\alpha - (2-\omega)c + 2t\right];\\ X_{PV} &= \frac{N}{5\beta}\left[\alpha + (3-4\omega)c + 2t\right];\\ X_{FV} &= \frac{N}{5\beta}\left[\alpha - (2-\omega)c - 3t\right].\end{aligned} \tag{28}$$

Comparing the output levels for the FTA in (28) with those for the CU in (22), the dissimilarity arises with respect to the RoO term ω. As $\omega > 1$, the partner country's firm has a smaller share of the FTA market than it would have had in a CU, while both the home firm and the foreign firms increase their shares.

The equilibrium output and corresponding price, respectively, in the FTA are:

$$\begin{aligned}X_V &= \frac{N}{5\beta}\left[4\alpha - (3+\omega)c - 2t\right];\\ p_V &= \frac{1}{5}\left[\alpha + (3+\omega)c + 2t\right].\end{aligned} \tag{29}$$

The equilibrium price in the FTA is greater than that in the single market of the CU and the corresponding quantity of *X* sold is less.

5.1 Is market access worth the cost?

In order to determine whether local firms will conform to the RoO, we need to compare the profits under compliance to the profits that they earn under the WTO benchmark, which is their fall-back position. Substituting the equilibrium outcomes (29) into the profit expressions (27) yields the profits accruing to a firm for sales in its partner's market:

$$\pi_{PV} = \frac{N}{25\beta}\left[\alpha + (3-4\omega)c + 2t\right]^2. \tag{30}$$

However, it would not alter the fact that RoO constitute an additional cost and hence a non-tariff barrier to trade.

Selling in the FTA in breach of the RoO, would imply that exports in the partner's market would attract the tariff. The profits from selling into the partner's market can be found by substituting the equilibrium price (14) and output (13) into (12) the profit term to yield:[21]

$$\pi_{FW} = \frac{N}{25\beta}\left[(\alpha - c) - 2t\right]^2. \tag{31}$$

Figure 3 plots profits for a firm from sales in the partner's market under the various trade regimes across a range of tariffs. The profits from free access under a CU (π_{LU}), equivalent to those for an FTA when the RoO are not binding, can be determined by substituting (23) into (21) to find:

$$\pi_{LU} = \frac{N}{25\beta}\left[(\alpha - c) + 2t\right]^2. \tag{32}$$

These can be compared with the firm's profits from adhering to the RoO (π_{PV}) and those from exporting its least-cost product subject to the tariff (π_{FW}).[22]

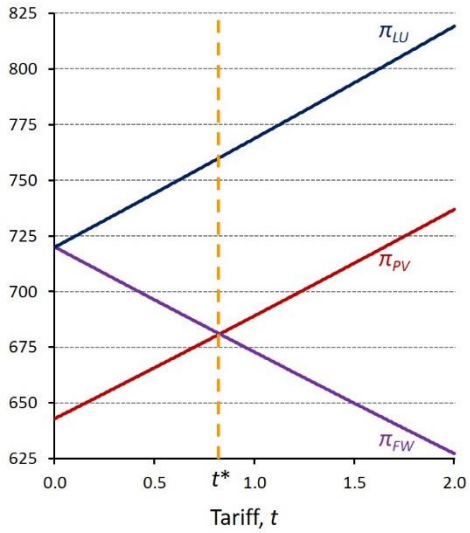

Figure 3. Profits in the partner's market from different modes

When trade in final goods is untaxed, it is most profitable for firms to adopt their least-cost manufacturing techniques. This remains the best option even when exports are subject to small trade taxes. As the tariff increases, the advantage of tax-free access increases, such that it offsets the cost of complying with the RoO, and the firms become willing to pay the penalty of conforming to the RoO in order to get tax-free access to the partner's market. Comparing (31) with (30), we can determine the corresponding "threshold tariff" $t^* = (\omega - 1)c$ where the marginal costs to the firm of the two modes of selling into the partner's market coincide[23].

Above the threshold tariff, when the firm chooses to meet the threshold of the RoO for sales into its partner's market in an FTA, the resulting higher marginal cost of production leads in it losing market share to both the firm in the partner country and foreign producers of the manufacture compared to

[21] Note that this will be as in benchmark WTO-case, with one home firm and three foreign firms. Hence, π_{FW} is the profit of the partner firm in this case.

[22] The parameter choices are as follows: $N = 10$; $\alpha = 100$; $\beta = 2$; $c = 40$; and $\tau = 0.6$.

[23] Note that a more restrictive RoO would increase ω and move the π_{PV} curve to the right, thereby increasing the threshold tariff rate.

the CU outcome. At higher levels of tariff, the benefits of preferential market access increasingly outweigh the higher marginal cost such that the partner firm's sales in the market rise, while the foreign firm is increasingly shut out.

5.2 Induced trade diversion

We now consider the welfare implications of forming an FTA when, prior to this, countries were trading under WTO rules. In his seminal work, Jacob Viner (1950) introduced the terms "trade creation" and "trade diversion," the latter reflecting the potential distortion in the choice of import source resulting from the preferential access given to goods produced in the partner country. In our WTO benchmark case, all countries share the same production costs, such that the trade concession resulting from the formation of a CU is pure trade creation, as imports are encouraged from the (joint) least-cost country.

Our analysis allows us to identify a new dimension to, what is generally known as, "customs-union theory."[24] Our finding arises with respect to the formation of an FTA, where tariff-free access comes at the cost of having to adopt more expensive production techniques associated with the RoO. Thus, RoO may result in "induced trade diversion", such that consumption switches to goods sourced from a partner supplier that *ex post* is more expensive, due to it having to adopt different techniques in order to obtain tariff-free access to the market. What is more is that, while trade diversion in Viner's analysis did not necessarily result in a welfare loss to the partners, there is a range of tariff values for which induced trade diversion *guarantees* that the partners will be worse off.[25]

To see this, consider what happens to tariff revenues in each of the countries in an FTA at the point where the partner firm changes its input mix to meet the RoO. This is illustrated in Figure 4, where tariff revenues drop at the threshold tariff t^*, shown by the vertical dashed line, as the partner firm gains duty-free access within the FTA. All other components of welfare are unchanged at t^*, given that firms' marginal costs are the same, hence outputs and prices are unaffected by the firms' choices of techniques. Consequently, forming an FTA when the tariff is immediately above t^* will result in a discrete loss in welfare for both partner countries, arising both from the shock of lost tariff revenue and from the more expensive production technique that has to be adopted in order to conform with the RoO.

[24] Richard Lipsey, in his review of developments in the area since Viner's seminal work, defined customs-union theory as "that branch of tariff theory which deals with the effects of geographically discriminatory changes in trade barriers." [see Lipsey, 1960].

[25] This phenomenon can arise even when countries choose to form the FTA with the partners who have, *ex ante*, lower costs than other countries. The crucial aspect is that, in adjusting their production techniques to meet the RoO, the partner firm can end up adopting more expensive methods, resulting in it being the more expensive producer *ex post*.

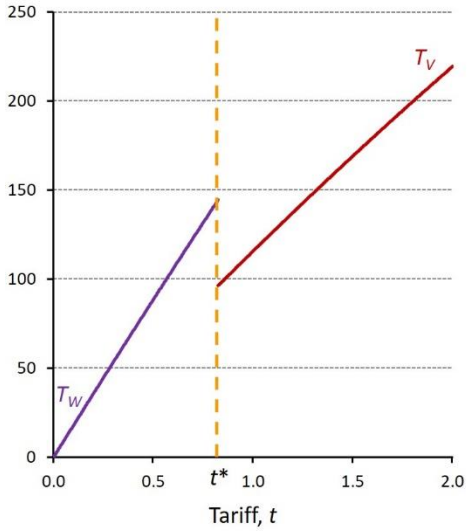

Figure 4. Tariff revenues

This is illustrated in Figure 5, where the welfare of each member of the PTA is shown for each scenario. Both countries in the PTA set the same external tariff, for both FTA and CU, which impacts on final goods producers' profits in their domestic and partner markets. The left-hand vertical line represents t^*, the tariff at which the firm changes its technique.[26]

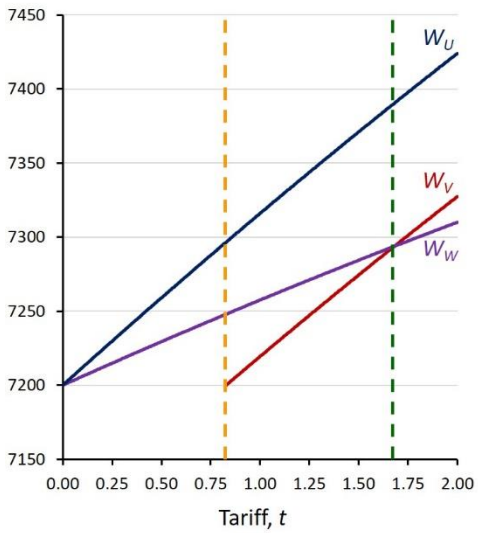

Figure 5. Welfare of a PTA member under different scenarios

The gap between W_V and W_W at t^* equals the lost tariff revenue resulting from the firm switching to conform with the RoO. Above t^*, the partner firm enjoys having preferential market access and consumer prices fall, resulting in W_V rising in the tariff. Clearly the welfare from an FTA can never equal that of a CU, given the more expensive production techniques being used in the former. But it is the

[26] In illustrating our point, we further depart from symmetry by assuming that only the two partner countries adjust their MFN tariffs, such that firms' profits in the other two markets do not change. Thus, all of the welfare effects (as well the decision as to whether partner firms conform to the RoO) arise from the choice of external tariffs made by the partner countries. We view this as a relatively innocuous assumption, given that national markets are segmented, such that any changes in the other countries' tariffs would impact on our three welfare measures by the identical discrete amounts.

comparison between FTA and WTO that is important in this story of trade diversion, in that there is a range of tariffs (between the two vertical dashed lines) over which formation of the FTA reduces welfare of the partners.

6. Linked FTAs in an economic area

We argue that the negative impact of RoO is greatest when the FTA in question is between fewer countries, constituting a small share of the world market. This can be illustrated by considering the differences in trade when countries are collectively members of a large multilateral FTA as opposed to being members of overlapping bilateral FTAs.

6.1 Multilateral PTA

Let *A*, *B*, and *C* be the members of an economic area *E* as illustrated in Figure 6. Suppose, initially that *E* is a CU of which all three countries are members. In this setting, three *X* producers are "local" in the enlarged market, while only imports from *D* are treated as "foreign" and subject to the tariff.[27]

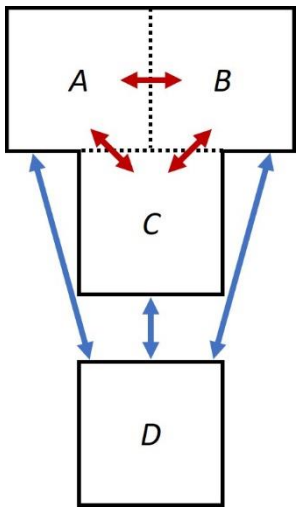

Figure 6. Multilateral or overlapping PTAs

The outcomes in equilibrium can be straightforwardly derived where the price and total output of the final good in equilibrium in each partner country are:

$$X_E = \frac{N}{5\beta}\left[4(\alpha - c) - t\right]; \qquad p_E = \frac{1}{5}(\alpha + 4c + t). \tag{33}$$

These results are fairly intuitive. Three local firms are now competing in a market composed of three countries. The expansion of the preferential trading zone has been a further move towards free trade. Essentially, we are witnessing pure trade creation.

[27] We maintain our assumption that there are no tariffs on trade in intermediates and that the four countries are identical with respect to their technology and endowments. Then the only departure from symmetry, in the absence of RoO, is the fact that all exports of *X* from country *D* (and all imports of *X* into that country) are subject to the tariff.

Now suppose that *E* is composed of an FTA with the three countries as its members.[28] In this case, there will continue to be free trade across the three constituent countries, provided that the partners meet the RoO of the FTA. It is immediately obvious that any RVC threshold is less likely to be binding in *E* compared to the case for *V*. With three of the four countries being members of the FTA, the local value-added contributed by all manufacturing firms is 75%, compared to the 50% share when the membership was two countries. In the bilateral FTA, a value of τ strictly greater than 0.5 forced firms to either adjust their input mix or accept the tariff on their sales into the partners' markets.

What this example highlights is the general rule that, when the membership of an FTA expands, local content rules become less restrictive. This easing of the impact of RoO simply reflects the fact that inputs from more countries are included in the calculation. The policy implication of this result is that whether countries form a CU or an FTA becomes less crucial the more member countries that the PTA incorporates, as concerns fall with respect to meeting RoO.

6.2 Overlapping FTAs

Suppose that the trading relationships in *E* change such that, rather than all three nations being members of a single PTA, each country negotiates a bilateral deal with each of its partners, such that there end up being three FTAs amongst *A*, *B*, and *C*. Thus, the three countries constitute a spaghetti bowl of overlapping FTAs, with each country being a member of two of these FTAs. If the final goods meet the RoO of the relevant FTA, then trade can take place as it did before the change in the institutional arrangements. The difficulty arises in that, while each country continues to count intermediate inputs from partner countries towards the RoO, the number of countries involved in the RVC calculation has decreased. Thus, for example, the RoO for the FTA between *A* and *C* will not count the value-added of intermediates sourced from *B*. Consequently, final goods produced by firm *A* that are destined for sale in countries *B* and *C* must now meet two different RVC requirements, raising the costs of compliance.[29]

We continue to assume that firms can adjust their production techniques to be consistent the RoO for a specific market while maintaining the least-cost technique for sales in all other markets, both home and foreign. The decision as to which production technique to adopt will, as with our analysis in the previous section, depend upon the relative costs of choosing the production technique that just meets the RoO requirements and the alternative of selling into partner markets facing the MFN tariff.[30]

Rather than engaging in further modelling, we can use the intuition already developed to understand the issue arising from overlapping FTAs. The economic area *E* constitutes three-quarters of the countries in the model and, given a free choice, firms would source 75% of their intermediate inputs

[28] Equivalently, *E* could be thought of as an FTA between customs union *U* and *C*. Thinking of it in these terms helps to motivate the understanding of a Brexit process, where *U* splits and the trading relationships between *A* and both *B* and *C* have to be resolved.

[29] In terms of Baldwin's discussion (Baldwin, 2006), the problem that we identify here is not one of lack of harmonisation of RoO. The concern will arise even if every FTA set the same RVC threshold. Baldwin suggests that the problem, of RoO becoming more restrictive as FTA groupings diminish in size, could be addressed by the introduction of some form of "diagonal cumulation" where the value-added across intersecting FTAs was aggregated.

[30] We continue to ignore any costs associated with the retooling necessary to change production techniques. If the firm has to adjust its input mix for sales in the partner market of each FTA, then these fixed costs of compliance would rise for each separate trade deal.

from member countries. Consequently, an RVC threshold of less than 0.75 would have no impact on the choice of production technique. Compare this with the situation for overlapping FTAs amongst the same countries. Each of the three FTAs amongst *A*, *B* and *C* has 50% local intermediate input. The crucial element, as mentioned above, is that, for example, intermediates sourced from *A* no longer count towards fulfilment of the RoO for the FTA between *B* and *C*. Clearly a firm located in the 3-country FTA that covers *E* is better positioned to meet RoO without having to adjust its input mix compared to the situation in which it is selling across overlapping bilateral FTAs.

Without going into the details, it follows from the above analysis that each partner firm in each of the FTAs will have to choose between two modes of supplying the partner in the FTA—incurring the higher marginal cost to secure tariff-free sales or paying the tariff. The threshold is still determined by the relative marginal costs of the two modes; hence we still have $t^* = (\omega - 1)c$. However, since this is the same for all three FTAs, each country will suffer a larger tariff revenue loss at this threshold, as two partners switch from paying tariffs to incurring the higher marginal cost. Hence, the induced trade diversion will have a larger negative impact on welfare.

7. Summary and conclusions

We have considered the analytical differences between CUs and FTAs, demonstrating that, even in the case where countries adopt the same external tariffs, the two preferential frameworks differ from each other in a significant respect, the role of RoO.

Our results, if anything, understate the impact of RoO, in that we model them as impacting only upon the firms' production decisions with respect to sales in the partner markets. If the fixed cost of retooling production lines were prohibitive, the firm would have to decide which production technique to adopt: one that minimised production costs; or one that ensured tariff-free access into the partner's market. Either way, the impact on profitability would be more negative for any tariff or RoO threshold.

Our modelling approach is very simple, assuming that all intermediates are necessary but imperfectly substitutable in production. Thus, discrete changes in the sourcing of particular intermediate inputs (from a supplier in a foreign country to a producer in the local or partner market) in response to RoO do not occur. We argue, however, that despite the lack of discrete switches in input sourcing, our model effectively captures these adjustments, albeit in a continuous modelling environment.[31]

Our analysis has revealed a new dimension to customs union theory. Viner's categorisation of the effects of PTA formation focused on the choice of trading partner. Preferential tariff concessions can result in imports being switched to higher cost sources, resulting in potentially harmful trade diversion. In our model, all potential partners are *ex ante* identical such that the reciprocal tariff cuts from CU formation raises no concerns with respect to trade diversion. However, when the improved market access is tied to RoO, formation of an FTA can induce trade diversion, in that firms may have to adopt more expensive production techniques in order to avail themselves of the tariff-free access.

[31] Thus, our model predicts switching to greater local sourcing of intermediates due to the RoO associated with Brexit. For example, the UK Government unsuccessfully lobbied on behalf of its car manufacturers to have electric car batteries exempted from the EU's RoO. In response, Nissan UK announced its decision to begin local production of electric batteries, rather than continuing to source these from foreign countries and facing the EU's 10% tariff on vehicles not meeting its RoO. The fact that they did not do this prior to Brexit, reveals that it implies a cost disadvantage, i.e. it is an example of having to incur higher unit costs due to the RoO.

In numerical examples, we demonstrate that this induced trade diversion can result in welfare losses for the partner countries. We also show theoretically that, close to the threshold level of tariffs for which the partner country firm will switch from paying the MFN tariff to obeying to the RoO, welfare will always decline due to the induced trade diversion, as the real costs of more expensive production techniques replace tariff revenues.

Contrary to much of the literature, our results are not driven by differences in tariffs rates for intermediate and/or final goods from various sources. We show that binding RoO *per se* imply a welfare loss when going from a CU to an FTA, even if all tariff levels remain unchanged. Furthermore, we show that going from a multi-country CU to a set of overlapping FTAs yields more severe welfare losses, since the RoO cannot be cumulated across different PTAs.

Several of the previous contributions have focussed on trade effects. While we have not reported trade effects, some follow directly from our analysis. For trade in intermediates, our results are obvious. Since there are no tariffs for intermediates, the only trade obstacles are the RoO, so with binding RoO there will be less imports of intermediates from outside the FTA and more internal trade. For final goods, imports from outside the PTA depend on the tariff rate as well as whether the RoO are binding or not. Hence, final goods imports from non-partner countries will be lowest in the CU case and highest in the WTO case. For FTAs, imports from outside will always be (weakly) higher than in the CU case, since internal final-goods producers either choose to pay the MFN tariff on their exports to partner countries or use more inefficient input mixes to obey to the RoO. Both result in a cost disadvantage for final goods producers from within the FTA in comparison to a CU, as long as the RoO are binding. We should, however, add that this is one area where our simplifying assumption of free trade in intermediates may have an effect; with differential tariffs on intermediates, the trade picture would be more complex.

While our analysis has a theoretical focus, the motivation has been to shed light on real-world, important trade-policy issues. With Brexit as the background, it is of vital importance to understand how various preferential trade arrangements work and what the benefits and costs of the different choices may be. While leaving a CU may give benefits in terms of increased national sovereignty, there are clear economic costs related to such a move; and forming new and overlapping FTAs is not an easy remedy for such cost disadvantages.

As we have pointed out, our results may well understate the costs of moving from a CU to an FTA. One reason is that the smooth adjustments in production processes that we have modelled are likely to be unrealistic. Another is the added paperwork and bureaucracy that inevitably come with an FTA. Even if firms in the end adhere to the rules of origin requirements, they will still have to document that this is actually the case. In a world with complex global value chains, providing such evidence is not an easy task. With overlapping FTAs, this task will have to be done separately for each FTA, even if they happen to have similar rules, as different intermediates will count as internally sourced in the various FTAs.[32] Finally, adding the fact that MFN tariffs on intermediate and final goods vary significantly between products and countries, makes the picture even more complex. Judging from the first few months of experience with Brexit, the consequences of such additional costs are significant.

[32] In reality, RoO differ significantly between different FTAs and within an FTA for various industries, and tend to be very detailed and complicated, thus adding to the firms' costs of adhering to the rules.

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