More (or Less) on Necessarily Welfare-Enhancing Free Trade Areas

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Abstract

This note considers the extension of the Kemp-Wan theorem on necessarily welfare-improving customs unions to free trade areas. It suggests that the value of this extension is undermined by its very rationale – the greater popularity of free trade areas over customs unions for 'political' reasons.

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1. Introduction

In 1976 Kemp and Wan (KW henceforth) published a very significant contribution to the theory of preferential trading areas (PTAs) in "An elementary proposition concerning the formation of customs unions." They showed that, under certain weak conditions, any number of tariff-ridden countries could form a customs union (CU) with free trade amongst them and choose a common external tariff (CET) in a Pareto-improving fashion. Formally,

> "Consider any competitive world trading equilibrium, with any number of countries and commodities and with no restrictions whatever on the tariffs and other commodity taxes of individual countries and with costs of transport fully recognized. Now let any subset of the countries form a customs union. Then there exists a common tariff vector and a system of lump-sum compensatory payments, involving only members of the union, such that each individual, whether a member of the union or not, is not worse off than before the formation of the union."
> (KW, 1976 p. 95.)

The key to this result is that the CET is set at the so-called Vanek compensating tariff: the tariff that leaves all volumes of trade between the CU members and the rest of the world (ROW) unchanged from its pre-CU aggregate levels. Accordingly, ROW welfare is unaffected by the CU[1] and any gains from the internal trade liberalisation can be redistributed amongst the CU members in a Pareto-improving way through lump-sum redistribution instruments.

The importance of this result lies partly in its clarity – an unusual feature in this field of study in a second-best setting – but also in a number of further conclusions it implies. In particular, by repeated application of the theorem – suppose countries A and B form a KW CU then treat them as a single country and re-apply the theorem to show that they can form a KW CU with C and so on – KW have identified

[1] In the context of the KW set-up, this conclusion requires either that the CU is infinitesimally small vis-à-vis the ROW or that the ROW is not behaving optimally – see Richardson (1995). For a rather different setting in which this condition is not required, see Kemp and Shimomura (2001).

a path to global free trade through a series of PTAs. In the debate that has raged for some decades concerning the impact of PTAs on multilateralism, this has been a cornerstone of the case suggesting that PTAs can be beneficial and need not undermine the goals of multilateral liberalisation.

It is important to note that the KW result, as the authors themselves stress, is an existence result only. No claims are made concerning the optimality of the KW CU, merely that all members can be made better off than in the CU's absence in terms of economists' usual measure of economic welfare. Nevertheless, one could certainly envisage countries taking a KW path to multilateralism through bilateralism, precisely because of its neutrality properties for non-members.

In recent years, a number of authors have noted that free trade areas (FTAs) are a more popular form of PTA than are CUs and have concluded that, therefore, it would be useful to have a result for FTAs that is analogous to KW's result for CUs. So Panagariya and Krishna (2002) write, for example, "…we still lack a parallel result [to KW] on FTAs where members could use member-specific external tariff vectors…. The purpose of the present paper is to fill this gap in the literature – a major gap, in our judgment, given the relative popularity of FTAs over CUs in practice" (Panagariya and Krishna, 2002 p.354.) In endorsement of this paper, Grinols and Silva (2003) suggest that, "Panagariya and Krishna (2002) have performed a great service to the economics profession, indeed to any country considering a FTA… Their contribution does for FTAs what Kemp and Wan (1976) did for CUs twenty-six years earlier." (Grinols and Silva, 2003, p.1). The Panagariya and Krishna paper demonstrates that a result for FTAs that is similar to the KW result for CUs can be established: a number of countries can from a FTA, set their external tariffs so as to freeze trade with the ROW on a member country–by–member country basis and, with lump-sum transfers internal to the FTA and appropriate rules of origin, ensure a Pareto improvement.[2]

The purpose of the present note is to consider this result – which we shall refer to as the Ohyama-Panagariya-Krishna or OPK result – in a little more detail. In particular, we argue that the very rationale for the relative popularity of FTAs versus CUs undermines the usefulness of the OPK result. Furthermore, there are strong reasons to believe that the OPK tariff will be very similar to the corresponding KW tariff.

The remainder of the note is laid out as follows. In the next section we present a brief summary and proof of the OPK result before arguing that the OPK FTA will likely be unattractive to potential member countries. We then observe that in any PTA the OPK and KW external tariffs will be identical for many goods but illustrate, in a partial equilibrium setting, a context in which there might be some difference between them. Nevertheless, our analysis suggests that there are reasons to expect some harmonisation of tariffs between member countries in an OPK FTA. A further section then discusses a numerical simulation performed to illustrate the two forms of trade agreement in practice and a final section concludes.

2. The Ohyama-Panagariya-Krishna result

2.1. The OPK Proposition

Following Grinols and Silva (2003), consider two countries *i*=A,B forming a FTA in a world of *n* traded commodities. We can denote the change in welfare for country *i* by the compensating variation, where situation 0 is pre-FTA and situation 1 is post-FTA:

[2] Grinols and Silva (2003) provide a tidier proof of this result. It should also be noted that Ohyama (2002) independently notes the same result. We return to the rules of origin issue below.

$$\Delta W^i = CV = e^i\left(p^1,u^{i1}\right) - e^i\left(p^1,u^{i0}\right) = \underbrace{p^1y^{i1} + p^1\omega^i + p^1z^{i1}}_{e^i\left(p^1,u^{i1}\right)} - e^i\left(p^1,u^{i0}\right) \qquad (1)$$

where p^k is the 1*x*n vector of consumer prices in situation *k*=0,1, y^{ik} is the 1*x*n vector of domestic production in country *i*=A,B in situation *k*=0,1 (treating inputs as negative outputs), ω^i is endowments and z^i denotes the vector of imports into country *i* (where exports are negative elements.) Thus we can write the change in welfare in country *i* as:

$$\Delta W^i = S_C^i + S_P^i + S_T^i \qquad (2)$$

where

$$\begin{aligned} S_C^i &= p^1x^{i0} - e^i\left(p^1,u^{i0}\right) \\ &= p^1y^{i0} + p^1\omega^i + p^1z^{i0} - e^i\left(p^1,u^{i0}\right) \\ S_P^i &= p^1\left(y^{i1} - y^{i0}\right) \\ S_T^i &= p^1\left(z^{i1} - z^{i0}\right) \end{aligned} \qquad (3)$$

and x^{ik} denotes the vector of consumption in country *i*=A,B in situation *k*=0,1. In moving to the OPK FTA, utility maximisation by consumers implies that $S_C^i \geq 0$ so, if $S_P^i \geq 0$, then the change in the joint welfare of the FTA members is given by

$$\Delta W^A + \Delta W^B \geq S_T^A + S_T^B = p^1\left[\left(z^{A1} - z^{A0}\right) + \left(z^{B1} - z^{B0}\right)\right] = 0 \qquad (4)$$

where the last equality follows from each country's trade with the ROW being unchanged and because any changes in A's trade with B are offset by changes in B's trade with A. Thus both countries gain jointly from this FTA if $S_P^i = p^1\left(y^{i1} - y^{i0}\right) \geq 0$.

Grinols and Silva (2003, p.5) write this as $S_P^i = q^1\left(y^{i1} - y^{i0}\right)$ where q^1 denotes the vector of producer prices within the FTA. In this case profit maximisation ensures that the expression is positive. Richardson (1995) shows that, regardless of rules of origin, producer prices must be equated within a FTA but that consumers might face different prices for the same commodity. In particular, the producer price of some commodity initially imported from the ROW might exceed the consumer price if the country's FTA external tariff is less than that of its FTA partner, in which case it will export its entire production to its partner at the partner's internal price (the price received by its producers) and import its entire consumption from the ROW at, for consumers, the world price plus its tariff.[3] However, Grinols and Silva (2003) avoid this issue by differentiating goods by location and so defining consumer and producer prices to be equal for all goods[4]: while the New Zealand (NZ) producer price of "NZ cheese in Australia" might be different to the NZ consumer price of "NZ cheese in NZ", for example, it can arbitrarily set to equal the fictitious NZ consumer price of "NZ cheese in Australia" (fictitious, as none is consumed in NZ, by definition.)

2.2. An objection

The rationale for wishing to extend KW to FTAs is that the latter are far more popular, in practice, than are CUs. But why? The obvious attraction of a FTA over a CU is economic sovereignty: countries are unwilling to cede to others the power to set their external tariffs. A simple application of the KW theorem tells us that a CU weakly welfare-dominates a FTA for member countries (as the latter is a set of tariff-ridden countries and so the KW theorem applies to it directly.) So if countries were willing to coordinate their tariff-setting we know that they should choose a CU *unless* they are motivated by an objective function other than our standard measure of economic welfare. "Free trade areas…are politically attractive compared to CUs

[3] This is illustrated below.
[4] This interpretation also validates Ohyama's (2002) proof of the same proposition.

which require members to agree to a CET" (Grinols and Silva, 2003 p.1.) But then what is the attraction of the OPK FTA? It leaves member countries with no more degrees of freedom in setting their external tariffs than does the KW CU – there is some tariff vector for each member country that yields the OPK FTA just as there is some (common) tariff vector that yields the KW CU – so its attraction cannot be that it leaves member countries less fettered in terms of external tariff policy. Nor does this literature tell us that there exists a path through PTAs to global free trade – we knew that already.

One case that might be made for the OPK FTA is that it yields a tariff vector that, while no less constrained than the Vanek compensating CET, is, nevertheless, different to the latter and perhaps more desirable given a country's trade policy preferences. That, of course, is quite possible but there are reasons to believe that, as a practical matter, the OPK tariff is unlikely to be very different to the KW CET and preserves less difference between members' external tariffs than prevailed before the FTA's formation.

To see this, consider a partial equilibrium analysis of two countries A and B contemplating a PTA excluding the rest of the world, country C. For goods that are not traded at all before the PTA the external tariffs of all countries are irrelevant in that they can be set at the highest of the tariffs in A and B that preserve zero trade (i.e the OPK FTA tariff) with no consequence for the other partner (whose tariff might have water in it, of course.) Similarly, for goods traded only between A and B the external tariffs of the PTA are irrelevant and can be set equal with no effect. For any good traded only between C and a single PTA member the same reasoning applies: preserving the PTA's trade (*à la* KW) is the same as preserving the single trading country's trade and setting the other country's tariff equal has no consequence at all.

This leaves the only goods of interest (i.e. where the KW and OPK tariffs might differ to some effect) as those which C trades with both A and B. Consider, without loss of generality, some good exported by C to both A and B before the PTA is formed. And suppose, also without loss of generality, that the pre-PTA tariff in A, t^A, is less than that in B, t^B. We then have three generic cases to consider as illustrated in Fig. 1:

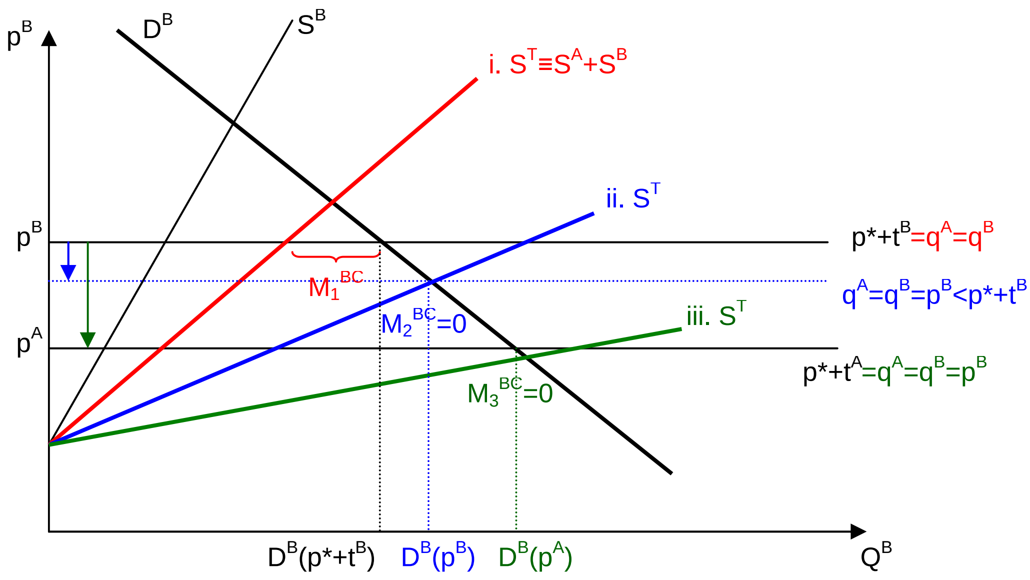


Figure One

i. It could be that total supply in A and B at p^*+t^B (i.e. $S^T(p^*+t^B) \equiv S^A(p^*+t^B)+S^B(p^*+t^B)$ where S^i denotes supply of the good in country i=A,B and p^* denotes the world price) is less than consumer demand in B at $p^B=p^*+t^B$, $D^B(p^*+t^B)$ where D^i denotes demand for the good in country i=A,B.

ii. Total PTA supply might exceed demand in B at the pre-PTA price – i.e. $S^T(p^*+t^B) > D^B(p^*+t^B)$ – but is less than consumer demand in B at A's initial price, or $S^T(p^*+t^A) < D^B(p^*+t^A)$.

iii. It could be that total PTA supply at A's initial price exceeds demand in B at that price: $S^T(p^*+t^A) > D^B(p^*+t^A)$.

In the first case, following Richardson (1995), the formation of a FTA will lead country A's producers to sell their entire output in B at price $p^B = p^* + t^B >$ $p^A = p^* + t^A$ (which is fine, even if rules of origin require 100% local content, as it is all domestically produced) and all consumption in A will be imported from C and sold to consumers at price p^A. In country B, consumers still pay p^B as they did before the PTA, but some of the imports previously sourced from C are now displaced by (duty-free) imports from A' leaving imports from C of M_1^{BC}, as shown. All up, producers in A receive p^B for all their production of this good while consumers in A pay the lower price p^A. Producers and consumers in B both face the same price p^B.

In the second case this trade displacement from A to B suffices to squeeze out all imports from C (so $M_2^{BC}=0$, as shown) and so reduces the price in B below the world price *cum* tariff.[5] Now producers in both A and B sell all their output in B at B's consumer price, p^B, which is something between $p^* + t^A$ and $p^* + t^B$. Consumers in A still import their entire consumption from C and pay the lower price $p^A = p^* + t^A < p^B$. Finally, in the third case, the volume of production from A is sufficient to equate both countries' prices at the lower $p^A = p^* + t^A$ in which case producers in A and B are indifferent about where they sell and all consumers and producers prices are equated within the FTA.

We now wish to consider each of these cases in turn and ask what will the tariffs in A and B have to be to preserve pre-PTA trade on a country-by-country basis in an OPK FTA and on aggregate in a KW CU.

In the first case, where induced trade from A does not displace all of B's imports from C, if a FTA were formed note that, at pre-PTA tariffs, B's trade with C is reduced by more (by $S^A(p^* + t^B)$) than A's trade is increased (by $S^A(p^* + t^B)$) so A and

[5] Note this qualification to the suggestion in Grinols and Silva (2003 p.4) that the producer price of a good in a FTA will equal p^*+Max[t^A,t^B]. In fact, producer prices are equated but the highest tariff may have water in it, as in this second case.

B's overall imports from C have risen. Fig. 2, adapted from Panagariya and Krishna (2002), illustrates this case.

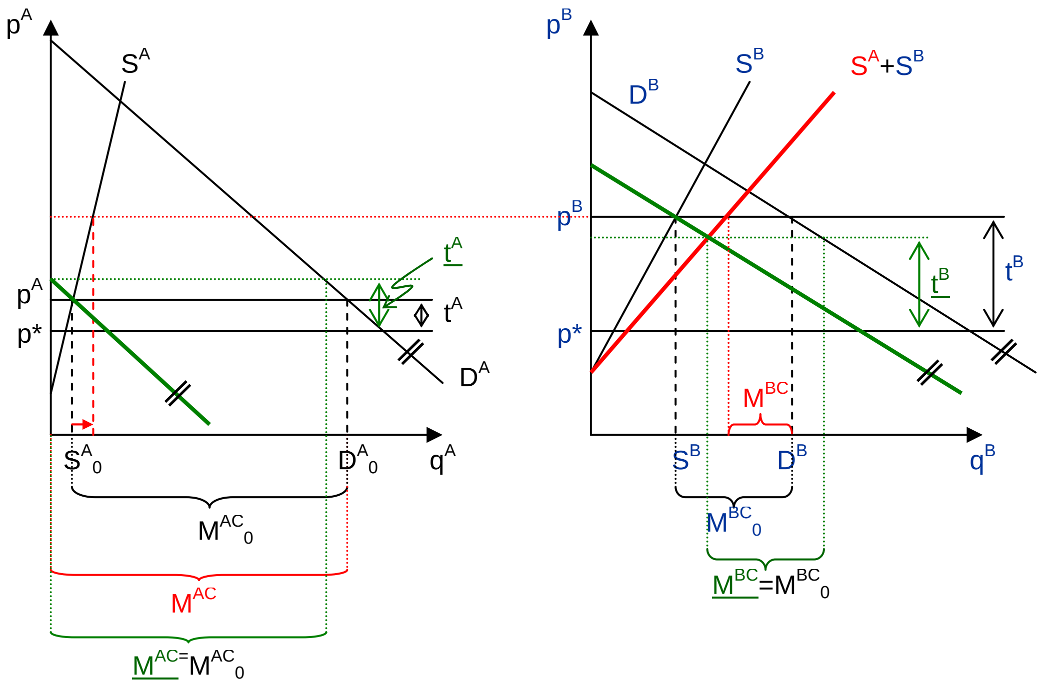
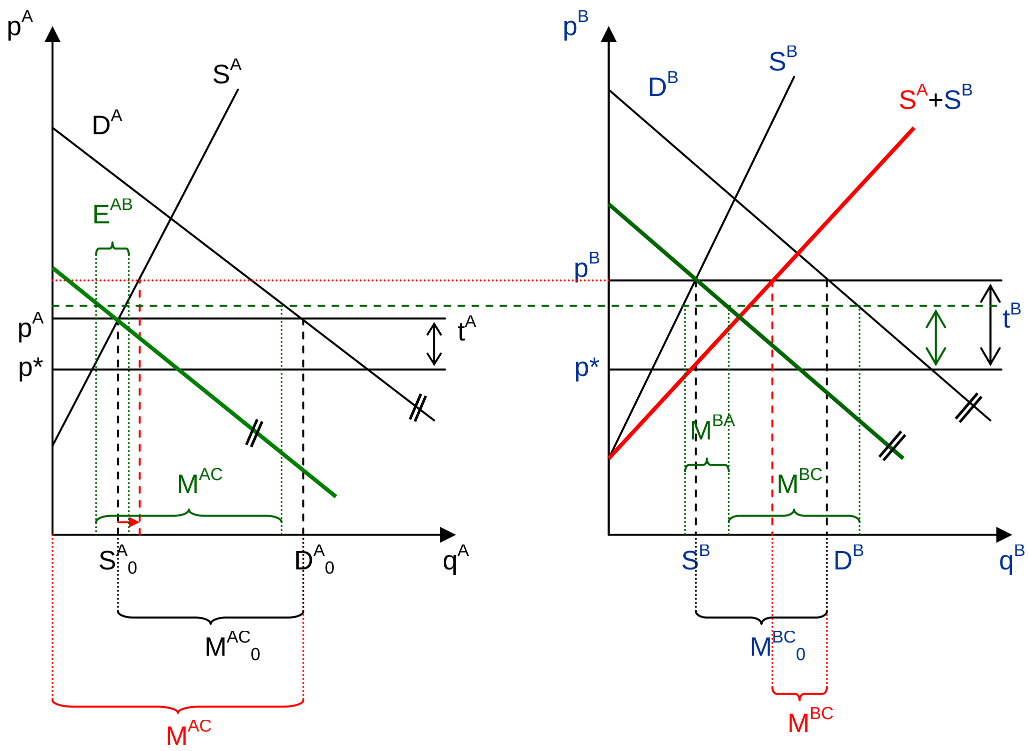


Figure Two

Here we start with t^A and t^B as the tariffs in A and B respectively and the formation of a FTA displaces A's production to be sold in B. Accordingly, imports from C rise in A (from $M^{AC}{}_0$ to M^{AC}) and fall in B (from $M^{BC}{}_0$ to M^{BC}) as shown. As all demand in A is met by imports in C, to find the tariff that restores imports from C to their previous level, we simply find the tariff $\underline{t}^A$ at which $D^A(p^*+\underline{t}^A) = D^A(p^*+t^A)\text{-}S^A(p^*+t^A) = M^{AC}{}_0$, as shown in the Figure. Note that it must be true that $\underline{t}^A > t^A$. In country B, to find the tariff that restores imports from C to their pre-FTA levels we need to find the tariff $\underline{t}^B$ such that $D^B(p^*+\underline{t}^B)\text{-}S^A(p^*+\underline{t}^B)\text{-}S^B(p^*+\underline{t}^B) = D^B(p^*+t^B)\text{-}S^A(p^*+t^B) = M^{BC}{}_0$. Note that it must be true that $\underline{t}^B < t^B$.

So the OPK FTA ends with some tariff harmonisation here. If A and B formed a CU in this case then the KW CET will lie somewhere between t^A and t^B, clearly, at a level where the increase in B's imports from C exactly equal the decrease in A's imports from C, compared to the pre-PTA situation. Indeed, a little inspection reveals that it must lie between $\underline{t}^A$ and $\underline{t}^B$.[6]

Note that the adjustment of tariffs to the OPK levels offsets, at least in part, the incentive for trade displacement. It is quite possible, in fact, that even in this case we can get complete tariff harmonisation in the FTA (in which case the tariff is identical to the KW CET.) Consider the variant of Fig. 2 shown in Fig. 3.



<u>Figure Three</u>

Here the tariff in A that would restore imports to their pre-FTA levels is so high that it leads to an internal price in excess of that in B: A's producers would not then wish to divert their sales to B. The equilibrium now involves a common tariff, no trade

[6] Consider going from the OPK FTA to the KW CU. If the CET in the latter were set at $\underline{t}^B$ exactly then total imports would be too low – A's production would be sold in A displacing a quantum of imports from C, compared to the FTA case, but would be exactly offset by increased imports from C into B. Thus the net impact on total imports is just the decline in demand in A and, as we started with total imports into A and B being at the desired pre-PTA level, so this means the CET is too high. A symmetric argument, *mutatis mutandis*, applies to $\underline{t}^A$.

displacement and a common internal FTA price shown by the dotted line. This, of course, is fully equivalent to the Vanek compensating tariff in the KW CU although it is accompanied by some internal trade between A and B where none occurred before.

Similar analysis reveals that in the second of the cases discussed earlier we also get tariff convergence in the OPK FTA, in the sense just discussed and, again, it can be partial or complete. In the third case, however, it is always complete: the OPK tariff is the same as the KW CET. In the first two of these cases the existence of incomplete convergence is more likely the greater is the initial divergence between tariffs and the less significant is domestic production in the lower-tariff country relative to imports in its partner.

The conclusion we can draw from this discussion is that while the tariff vectors that support the OPK FTA will generally differ across member countries, they will not differ as much as the initial pre-FTA tariffs – there will be some convergence and they may, in many cases, converge to the KW CET. What does this do to the case for the OPK FTA in comparison to a KW CU? While it is quite possible that the OPK tariff is preferred to the KW CET by a particular country on political economy grounds, it seems to us that there is no presumption in favour of this over the alternative that a country is worse off under the OPK tariff. Furthermore, the leeway that the FTA allows for tariffs to differ across countries – the purported advantage of an FTA over a CU – is unlikely to be great.

However, this analysis is all partial equilibrium and general equilibrium considerations, affecting demands through income effects and supplies through factor prices, may upset these presumptions. A full analytical general equilibrium approach is unlikely to be very revealing so we turn to a numerical simulation of one popular global CGE model for illustrative purposes.

3. A numerical simulation

3.1. Background

Our simulation exercises employ version 6 the Global Trade Analysis Project (GTAP) database (Dimaranan and McDougall 2005), which is operationalised using the GTAP6inGAMS model (Rutherford 2005). The model is a static, perfectly competitive general equilibrium representation of global trade and production in 2001.

Although our chosen model is discussed in detail elsewhere and is well known, we outline two features important for our analysis. First, unlike the standard GEMPACK version of the GTAP model, each region's trade balance is fixed in GTAP6inGAMS. Second, the treatment of imports in our general equilibrium model differs from that in the previous section. Specifically, imports are differentiated from domestic commodities and by region of origin according to the Armington assumption (Armington 1969) in GTAP6inGAMS. That is, for each good, imports from different regions are gathered in a constant elasticity of substitution (CES) nest to create an import composite. The import composite is combined in a further CES nest with the domestically produced variety to generate a composite that is consumed in the domestic economy. We assign values of eight and four, respectively, as elasticity parameters governing substitution possibilities between imports from different regions, and the domestically produced variety and composite imports for all commodities. It should be noted that the structure of this model is highly unfavourable to our earlier arguments, in that each good here is differentiated by location so the possibility of a partner country's exports completely substituting for domestic production is removed.

We aggregate the GTAP database to fit our purpose. Our regional aggregation of the GTAP database identifies North America (the US, Canada and Mexico), the EU (the EU 25) and Rest of World (ROW – all other regions). Our aggregation also identifies either three sectors (agriculture, manufacturing and services) or 22 (see Tables) and two factors of production (capital and labour).

Before undertaking our FTA-CU simulations, we modify the base model to suit our needs. Specifically, we remove transport costs from the model, and eliminate tariffs and export taxes on intra-regional trade in North America and EU separately. We also calculate (regional) volume-weighted tariffs levied by North America on imports from the EU and ROW for each commodity, which we use to replace tariffs imposed by North America on imports from all regions. Similarly, we replace North American export taxes on goods shipped to other regions with volume-weighted average tax rates. Analogous changes are made to EU tariffs and export tariffs.[7] We create a database consistent with our modified model by introducing the above changes as shocks, solving the model and saving the updated data.

Turning to our simulations, both our FTA and CU simulations eliminate tariffs and export taxes on trade between North America and the EU but differ in their treatment of members' trade taxes on transactions with the ROW. In our FTA scenario, tariffs and exports taxes on North American and EU trade with the ROW are assigned so that, for each commodity, each member's exports to and imports from the ROW are unchanged. Our CU simulation stipulates common North American and EU import tariffs and export taxes on trade between member nations and the ROW,

[7] It is necessary to modify tariffs and export taxes is such a way as tariffs in the GTAP database are commodity-weighted averages, so recorded tariffs on, say, North American imports from nations facing the same MFN tariff can differ.

which are chosen so that, for each commodity, combined North America-EU exports to and imports from the ROW are constant.[8]

3.2. Simulation results

Table One shows our results in a highly aggregated case.

(Table One here)

Note, first, that the welfare numbers indicate that North America loses from both an OPK FTA and a KW CU but that the EU gains in both and that, as expected, the CU leads to higher (aggregate) welfare than the FTA.

Looking at tariffs, we see that general equilibrium considerations can, indeed, offset the effects noted in the partial equilibrium analysis of the previous section. Note that the biggest change in tariff from the FTA to the CU – both absolutely and in relative terms – is the North American tariff on agriculture which goes from around 0.6% to 1.5%: an increase of over 145%. This is a massive percentage increase, of course, but represents an actual tariff increase of less than one percentage point. Perhaps a better measure can be gained by looking at a more disaggregated case in which we can consider trade-weighted tariffs. Tables Two and Three present results for import and export taxes respectively, for a 22-sector disaggregation.

(Tables Two and Three here)

Again, there are some large relative changes here, most notably for the North American tariff on Forestry and Fishing which rises by some 180% from the OPK FTA to the KW CU but, once more, this masks a very small absolute change (from less than 0.5% in the FTA to around 1.3% in the CU.) Overall, if we weight all trade

[8] We have conducted 'sensitivity analysis' for these exercises, too, looking at how they respond to changes in assumed elasticities. However, as the point of this whole exercise is simply to illustrate our arguments numerically, the 'realism' of these numbers is not of great concern so we do not report these numbers here. These and more details from our simulations are available from the authors on request.

taxes by base-level trade with the rest of the world, the North American tariff in the base case is 2.8% (the EU tariff being 2.5%) and the North American tariff in the FTA is 2.3% (the EU tariff being 2.7%), which rises (falls, for the EU) to 2.6% in the CU: a 13% rise from the FTA for North America and a 3% fall for the EU.

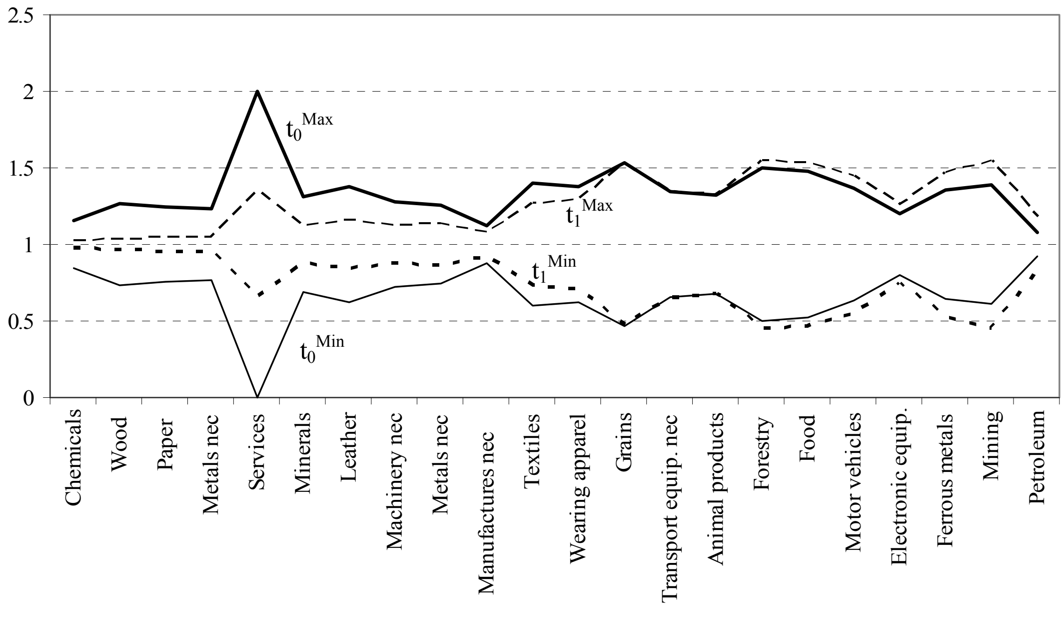
To make some formal attempt at measuring these differences on a sectoral basis, we define the convergence ratio, ρ, as in (5):

$$\rho = \frac{\left|t_0^{US} - t_0^{EU}\right| \Big/ \bar{t}_0 - \left|t_1^{US} - t_1^{EU}\right| \Big/ \bar{t}_1}{\left|t_0^{US} - t_0^{EU}\right| \Big/ \bar{t}_0} \tag{5}$$

where $\bar{t}$ is the US-EU average tariff, and "0" and "1" identify, respectively, the initial and FTA states of affairs. So ρ varies from zero to one as tariffs converge, equalling unity if there is complete convergence, and is negative if there is divergence. Table Four reports this metric for each of 22 sectors: in 13 of these we find ρ>0.

(Table Four here)

We also illustrate this convergence ratio on a sectoral basis in Figure Four.



Note: Sectors are arrayed in ascending order of convergence ratios.

Figure Four

Are these large differences between the OPK FTA and KW CU cases? This depends on the metric one uses to assess divergence, but it does not seem to us that these numbers provide much to support the notion that a OPK FTA will be attractive compared to a KW CU because of the resulting tariff levels: a 2.6% tariff (trade-weighted) does not seem like much versus 2.3% or 2.7%.

Finally, Table Five lists the welfare effects of the two schemes in this 22-sector disaggregation. Once more, the CU welfare-dominates the FTA, as it must, from an aggregate welfare perspective. It is noteworthy again that one region actually loses from both the FTA and the CU which simply underscores the importance of transfers to make these trading areas mutually attractive.[9]

(Table Five here)

4. Conclusion

This note has looked at recent arguments extending Kemp and Wan's seminal theorem on necessarily welfare-improving customs unions to free trade areas. We note that the very rationale for the relative popularity of FTAs versus CUs – the degrees of freedom left to a policymaker in terms of setting external tariffs – undermines the usefulness of this extension. Furthermore, we suggest that the OPK tariff might be very similar to the corresponding KW tariff and provide a numerical CGE simulation to illustrate this.

We finish with an unproven conjecture. We have considered two pairs of tariff vectors that freeze the trade of FTA member countries with the rest of the world: the OPK tariffs that freeze such trade country by country and the KW tariffs

[9] Dixit and Norman (1980) have noted that the KW result can be implemented using only commodity taxes (although this scheme can only realize production gains from trade); it is not obvious that the logic would apply directly to the OPK result as well, however.

that are identical for members and freeze the trade in aggregate (all on a good-by-good basis.) We also know that aggregate welfare is higher in the KW case than in the OPK case, due simply to the fact that all prices are equalised within the member countries. Our conjecture is that there exists a continuum of tariff vectors between the OPK and KW levels that hold aggregate FTA trade with the rest of the world fixed (good by good) and that aggregate FTA welfare is increasing monotonically as the tariff is varied from the OPK value to that of KW.[10]

[10] The Appendix provides a confirmation of this conjecture in the context of our CGE simulation.

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Table 1: Trade taxes imposed by North America and EU, 3 sectors			
Import tariffs, percent			
	North America	EU	
	Base values		
Agriculture	0.541	1.850	
Manufacturing	3.280	2.965	
Services	0.000	0.012	
	North America-EU FTA		
Agriculture	0.611	2.169	
Manufacturing	2.806	3.159	
Services	0.236	0.460	
	North America-EU CU		
Agriculture	1.499	1.499	
Manufacturing	2.902	2.902	
Services	0.279	0.279	
Export taxes, percent			
	North America	EU	
	Base values		
Agriculture	0.000	-2.330	
Manufacturing	-0.012	-0.425	
Services	0.000	0.000	
	North America-EU FTA		
Agriculture	0.019	-2.849	
Manufacturing	-0.035	-0.880	
Services	-0.109	-0.514	
	North America-EU CU		
Agriculture	-0.814	-0.814	
Manufacturing	-0.463	-0.463	
Services	-0.266	-0.266	
Changes in Welfare, (equivalent variation, 2001 US dollars, million)			
	North America	EU	Total
FTA	-716.84	2,439.81	1,722.97
CU	-1,328.50	3,801.63	2,473.13

Table 2: Import tariffs imposed by North America and EU, percent, 22 sectors					
	Base values		**FTA**		**CU**
	North America	**EU**	**North America**	**EU**	**N. America & EU**
Grains and plant based fibres	2.474	8.164	2.437	7.861	6.188
Animal products	0.968	1.884	1.023	2.014	1.627
Forestry and fishing	0.431	1.308	0.493	1.659	1.385
Mining	0.062	0.027	0.121	0.411	0.376
Food	6.483	18.244	5.329	17.713	14.144
Textiles	10.590	4.485	8.617	4.954	6.784
Wearing apparel	12.393	5.561	10.686	5.874	8.504
Leather products	12.725	5.750	8.532	6.250	7.346
Wood products	1.192	0.697	1.111	1.042	1.185
Paper products & publishing	0.665	0.404	0.686	0.747	0.784
Petroleum & coal products	1.904	2.220	1.779	2.561	2.347
Chemical, rubber & plastic products	2.704	1.987	2.090	2.164	2.189
Mineral products nec	5.130	2.681	3.669	2.843	3.286
Ferrous metals	2.060	4.320	1.675	4.630	3.433
Metals nec	1.347	0.845	1.233	1.122	1.230
Metal products	3.475	2.055	3.066	2.329	2.803
Motor vehicles and parts	2.920	6.339	2.425	6.388	3.829
Transport equipment nec	0.779	1.591	0.666	1.360	1.146
Electronic equipment	0.576	0.864	0.617	1.048	0.920
Machinery and equipment nec	2.049	1.154	1.707	1.323	1.617
Manufactures nec	1.856	1.451	1.418	1.659	1.598
Services	0.000	0.012	0.169	0.351	0.328

Table 3: Export taxes imposed by North America and EU, percent, 22 sectors					
	Base values		**FTA**		**CU**
	North America	**EU**	**North America**	**EU**	**N. America & EU**
Grains and plant based fibres	-	-4.866	0.111	-6.034	-1.693
Animal products	-	-0.600	0.024	-0.881	-0.497
Forestry and fishing	-	-	-0.053	-0.381	-0.307
Mining	-	-	-0.060	-0.381	-0.322
Food	-0.161	-7.625	-0.171	-7.942	-4.246
Textiles	-	0.080	0.306	-0.307	-0.261
Wearing apparel	-	0.186	0.530	-0.215	-0.140
Leather products	-	-	0.838	-0.326	-0.227
Wood products	-	-	0.021	-0.368	-0.288
Paper products & publishing	-	-	-0.031	-0.384	-0.307
Petroleum & coal products	-	0.083	-0.047	-0.307	-0.275
Chemical, rubber & plastic products	-	-	0.041	-0.330	-0.252
Mineral products nec	-	-	0.041	-0.368	-0.280
Ferrous metals	-	-	0.026	-0.350	-0.245
Metals nec	-	-	0.004	-0.347	-0.271
Metal products	-	-	0.023	-0.367	-0.283
Motor vehicles and parts	-0.177	-	-0.078	-0.288	-0.227
Transport equipment nec	0.048	-	0.045	-0.285	-0.207
Electronic equipment	-	-	-0.028	-0.344	-0.281
Machinery and equipment nec	-	-	0.010	-0.342	-0.272
Manufactures nec	-	-	0.141	-0.348	-0.251
Services	-	-	-0.066	-0.403	-0.324

Table 4: Convergence metrics					
	t_0^{Min}	t_0^{Max}	t_1^{Min}	t_1^{Max}	ρ
Grains and plant based fibres	0.465	1.535	0.473	1.527	0.015
Animal products	0.679	1.321	0.674	1.326	-0.015
Forestry and fishing	0.496	1.504	0.458	1.542	-0.076
Mining	0.611	1.389	0.455	1.545	-0.402
Food	0.524	1.476	0.463	1.537	-0.130
Textiles	0.595	1.405	0.730	1.270	0.334
Wearing apparel	0.619	1.381	0.709	1.291	0.236
Leather products	0.622	1.378	0.846	1.154	0.591
Wood products	0.738	1.262	0.968	1.032	0.876
Paper products & publishing	0.756	1.244	0.957	1.043	0.824
Petroleum & coal products	0.923	1.077	0.820	1.180	-1.348
Chemical, rubber & plastic products	0.847	1.153	0.982	1.018	0.885
Mineral products nec	0.687	1.313	0.873	1.127	0.595
Ferrous metals	0.646	1.354	0.531	1.469	-0.323
Metals nec	0.771	1.229	0.953	1.047	0.793
Metal products	0.743	1.257	0.864	1.136	0.469
Motor vehicles and parts	0.631	1.369	0.550	1.450	-0.218
Transport equipment nec	0.657	1.343	0.657	1.343	0.000
Electronic equipment	0.800	1.200	0.741	1.259	-0.295
Machinery and equipment nec	0.720	1.280	0.873	1.127	0.547
Manufactures nec	0.878	1.122	0.922	1.078	0.361
Services	0.000	2.000	0.651	1.349	0.651

Note: t_0^{Min} is defined as $\min(t_0^{US}, t_0^{EU}) / \overline{t}$, and t_0^{Max} as $\max(t_0^{US}, t_0^{EU}) / \overline{t}$

Table 5: Changes in Welfare, (equivalent variation, 2001 US dollars, million), 22-sectors			
	North America	**EU**	**Total**
FTA	-955.21	3,125.70	2,170.49
CU	-2,592.33	6,958.31	4,365.98

Appendix

This appendix illustrates the paper's closing conjecture in the context of our CGE simulations. We examine this by stipulating that European trade taxes are equal to weighted averages of KW and OPK trade taxes and adjusting North American trade taxes so that aggregate FTA trade with ROW is held constant. So the European trade tax for a particular commodity, t^{EU}, is given by:

$$t^{EU} = \alpha t_{KW}^{EU} + (1-\alpha) t_{OPK}^{EU}$$

where t_{KW}^{EU} and t_{OPK}^{EU} denote the appropriate European KW and OPK trade taxes respectively (given the North American tariff) and α is a parameter bound between zero and one.

When α is equal to one this framework produces the KW tariffs in both regions, converging towards OPK tariffs as α approaches zero. We illustrate aggregate FTA welfare for alternative values of α in Figure A1; these results are consistent with our conjecture.

Figure A1: Change in FTA welfare (equivalent variation, 2001 US dollars) for alternative tariff regimes